Total Mods for Structural in Pending Review: 319

Total Mods for report: 319

Proposed Code Modifications

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TAC: Structural

Total Mods for **Structural** in **Pending Review: 319**

Total Mods for report: 319

Sub Code: Building

S7233

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Date Submitted	11/12/2018	**Section**	202	**Proponent**	T Stafford
Chapter	2	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

7226

Summary of Modification

Revises the definition of Wind-borne Debris Region for correlation with ASCE 7-16.

Rationale

This code change correlates the definition of Wind-borne Debris Region with the newly referenced ASCE 7-16. During Phase I of the 2020 update of the FBC, the Commission voted to update ASCE 7 from the 2010 edition to the 2016 edition (ASCE 7-16). ASCE 7-16 provides separate wind speed maps for Risk Category III and Risk Category IV buildings and other structures, recognizing the higher reliabilities required for essential facilities and facilities whose failure could pose a substantial hazard to the community. This code change simply makes the necessary updates to the body of the code for correlation with ASCE 7-16.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This code change correlates the code with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This code change improves the code by providing correlation with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This code change dos not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This code change does not degrade the effectiveness of the code.

WIND-BORNE DEBRIS REGION. Areas within hurricane- prone regions located:

1. Within 1 mile (1.61 km) of the coastal mean high water line where the ultimate design wind speed, V_{ult}, is 130 mph (58 m/s) or greater; or
2. In areas where the ultimate design wind speed, V_{ult}, is 140 mph (63.6 m/s) or greater.

For Risk Category II buildings and other structures and Risk Category III buildings and other structures, except health care facilities, the wind-borne debris region shall be based on Figure 1609.3.(1). For Risk Category IV buildings and structures and Risk Category III health care facilities, the windborne debris region shall be based on Figure 1609.3(2). For Risk Category IV buildings and other structures, the wind-borne debris region shall be based on Figure 1609.3(3).

S7375

Date Submitted	11/20/2018	**Section**	202	**Proponent**	Joseph Crum
Chapter	2	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

G7-16

Summary of Modification

Clarification of Drilled Pile Defination

Rationale

The purpose of the proposed code change is to distinguish it from auger-cast piles (reference to removing drilling equipment). Alternate names are included which are in common use in the industry. Drilling fluids (e.g. slurry) are often used in lieu of casing to stabilize the hole.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will assist in interpretation of the code as it is a clarification of definition for drilled and socketed shafts.

Impact to building and property owners relative to cost of compliance with code

There will be no cost impact as it is a clarification of a definition only.

Impact to industry relative to the cost of compliance with code

There will be no cost impact as it is a clarification of a definition only.

Impact to small business relative to the cost of compliance with code

There will be no cost impact as it is a clarification of a definition only.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Provides clarification of code definition.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Provides clarification of code definition.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against any of these items as it only provides clarification of code definition.

Does not degrade the effectiveness of the code

Provides clarification of code definition only so will assist in the effectiveness of the code.

2018 FLORIDA BUILDING CODE

SECTION 202 DEFINITIONS

Revise as follows:

[BS]DRILLEDSHAFT. Acast-in-placedeepfoundationelement,alsoreferredtoascaisson,drilledpier, and bored pile, constructed by drilling a hole (with or without permanent casing or drilling fluid) into soil or rock and filling it with fluid concrete after the drilling equipment isremoved.

Socketed drilled shaft. A drilled shaft with a permanent pipe or tube casing that extends down to bedrock and an uncased socket drilled into the bedrock.

S7381

Date Submitted 11/21/2018	**Section** 202	**Proponent** Joseph Crum
Chapter 2	**Affects HVHZ** No	**Attachments** No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **Yes** **Alternate Language** **Yes**

Related Modifications

G9-16 Part I

Summary of Modification

This proposal revises the definitions of fenestration and vertical fenestration in the FBCB and FBCR, for consistency with the IECC, and each other.

Rationale

This proposal revises the definitions of fenestration and vertical fenestration in the FBCB and FBCR, for consistency with the FBCEC, and each other. It places the most distinguishing characteristics of fenestration in the main definition of that product type, and further distinguishes between vertical fenestration, and skylights and sloped glazing.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

The code change proposal is simply a clarification for consistency between the FBCB, FBCR and FBCEC.

Impact to building and property owners relative to cost of compliance with code

The code change proposal will not change the cost of construction and is simply a clarification for consistency between the FBCB, FBCR and FBCEC.

Impact to industry relative to the cost of compliance with code

The code change proposal will not change the cost of construction and is simply a clarification for consistency between the FBCB, FBCR and FBCEC.

Impact to small business relative to the cost of compliance with code

The code change proposal will not change the cost of construction and is simply a clarification for consistency between the FBCB, FBCR and FBCEC.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The code change proposal is simply a clarification for consistency between the FBCB, FBCR and FBCEC.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The code change proposal is simply a clarification for consistency between the FBCB, FBCR and FBCEC.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The code change proposal is simply a clarification for consistency between the FBCB, FBCR and FBCEC.

Does not degrade the effectiveness of the code

The code change proposal is simply a clarification for consistency between the FBCB, FBCR and FBCEC.

Alternate Language

1st Comment Period History

7381-A1

Proponent Dick Wilhelm **Submitted** 2/9/2019 **Attachments** Yes

Rationale

AAMA prefers the definition of vertical fenestration in the 2018 IBC in lieu of proponent's definition. The 2020 IBC definition clarifies that fenestration installed in a wall measured at 15 degrees from the vertical rather than the horizontal.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to Small Business relative to the cost of compliance with code

The code change proposal will not change the cost of construction and is simply a clarification for consistency between the FBCB, FBCR and FBCEC.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Provides an internationally accepted definition.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Maintains ICC code language in Florida Building Code for clarity.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade effectiveness od code.

1st Comment Period History

S7381-G1

Proponent Roger LeBrun **Submitted** 2/1/2019 **Attachments** No

Comment:

This mod (and the companion S7382) proposes language that directly contradicts other definitions for skylights in the same chapter. I strongly urge the TAC to disapprove, since the proponent did not address the conflict or provide any reason for the contradiction to exist.

1st Comment Period History

S7381-G2

Proponent Joseph Crum **Submitted** 2/4/2019 **Attachments** No

Comment:

I think the changes in other areas of the chapter would be a correlation issue and editorial to be done by staff. Please let me know if that is incorrect.

FBCB SECTION 202

~~FENESTRATION. Skylights, roof windows, vertical windows (fixed or moveable), opaque doors, glazed doors, glazed block and combination opaque/glazed doors. Fenestration includes products with glass and nonglass glazing materials.~~

FENESTRATION. Products classified as either vertical fenestration or skylights.

Skylight. Glass or other transparent or translucent glazing material installed at a slope of less than 60 degrees (1.05 rad) from horizontal~~. Glazing materials in skylights~~, including unit skylights, tubular daylighting devices, and glazing materials in solariums, sunrooms, roofs and sloped walls. ~~are included in this definition~~.

Vertical fenestration. Windows (fixed or moveable), opaque doors, glazed doors, glazed block and combination opaque/glazed doors composed of glass or other transparent or translucent glazing materials and installed at a slope of at least 60 degrees (1.05 rad) from horizontal.

FBCB SECTION 202

FENESTRATION, VERTICAL. Windows that are fixed or movable, opaque doors, glazed doors, glazed block and combination opaque and glazed doors installed in a wall at less than 15 degrees from the vertical.

S7417

Date Submitted	11/24/2018	**Section**	202	**Proponent**	Joseph Crum
Chapter	2	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

S243-16 Part I

Summary of Modification

To eliminate an incorrect unnecessary definition.

Rationale

The definition is not needed and is incorrect. ASTM C1386 was withdrawn n by ASTM in 2013, and AAC is now manufactured to different ASTM standards (ASTM C1691 for AAC masonry and ASTM C1693 for AAC in general). In addition, FBC Section 202 already contains a definition for AAC Masonry, which is both more appropriate and correct. While this definition could apply AAC as used in conjunction with Chapter 19, that Chapter does not address AAC. Deleting the definition of Autoclaved Aerated Concrete thus removes the reference to an ASTM standard no longer used, and it cleans up the FBC as a whole.
Part II updates references to it in the FBCR.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact, code cleanup only.

Impact to building and property owners relative to cost of compliance with code

No cost impact, code cleanup only.

Impact to industry relative to the cost of compliance with code

No cost impact, code cleanup only.

Impact to small business relative to the cost of compliance with code

No cost impact, code cleanup only.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

No impact, code cleanup only.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

No impact, code cleanup only.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No impact, code cleanup only.

Does not degrade the effectiveness of the code

No impact, code cleanup only.

Delete without substitution:

NOW DEFINED IN FBC BUILDING UNDER AAC MASONRY AND THIS DEFINITION IS NOT NEEDED AND THE STANDARD C1386 HAS BEEN WITHDRAWN BY ASTM

~~**AUTOCLAVED AERATED CONCRETE (AAC).** AUTOCLAVED AERATED CONCRETE (AAC). Low~~ ~~**density cementitious product of calcium silicate hydrates, whose material specifications are defined in ASTM C1386.**~~

Date Submitted	12/8/2018	Section	202	Proponent	Rebecca Quinn obo FL Dept Emerg Mg
Chapter	2	Affects HVHZ	No	Attachments	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

7461 (existing building volume)

Summary of Modification

In FBC Building, in "Existing Structure" remove sentence about flood hazard areas and add "Existing Building" consistent with FBC Existing Building.

Rationale

This code proposal was submitted for the I-Codes (ADM13-16). The purpose of this code change is to have consistent definitions of "existing building" and "existing structure" in the building and existing building volumes of the Florida Building Code. The terms are used interchangeably in the codes. The proposal not only adds “existing building” to the building volume, it modifies all definitions to remove the flood-specific sentence.

For the I-Codes, FEMA concurred with removal of the sentence pertaining to application of provisions for flood hazard areas. The determination as to whether improvements or repairs for existing buildings and structures in flood hazard areas constitute substantial improvement or repair of substantial damage is made for all existing buildings. As flood hazard data are changing over time, sometimes with higher base flood elevations or changed flood zone designations, compliance that is triggered by substantial improvement or substantial damage includes bringing building into compliance with the revised flood hazard data. In addition, there’s a presumption that buildings built after the community’s first flood ordinance are fully compliant, which may not be the case if unpermitted improvements or additions were made that alter whether the building remains compliant.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Definition clarification makes easier to enforce because only one definition is used for all existing buildings in flood hazard areas.

Impact to building and property owners relative to cost of compliance with code

Definition clarification does not change in costs when compliance with flood provisions is triggered.

Impact to industry relative to the cost of compliance with code

Definition clarification does not change in costs when compliance with flood provisions is triggered.

Impact to small business relative to the cost of compliance with code

Definition clarification does not change in costs when compliance with flood provisions is triggered.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Definition clarification does not change the purpose of the flood provisions to protect health, safety and general welfare.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Definition clarification does not change the compliance requirements with respect to products, methods or systems used for flood resistant constructions.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Definition clarification does not change the compliance requirements with respect to products, methods or systems used for flood resistant constructions.

Does not degrade the effectiveness of the code

Definition clarification does not alter the effectiveness of the code.

EXISTING BUILDING. A building erected prior to the date of adoption of the appropriate code, or one for which a legal building *permit* has been issued.

EXISTING STRUCTURE. A structure erected prior to the date of adoption of the appropriate code, or one for which a legal building *permit* has been issued. ~~For application of provisions in flood hazard areas, an existing structure is any building or structure for which the start of construction commenced before the effective date of the community's first flood plain management code, ordinance or standard.~~

S7480

Date Submitted	12/14/2018	**Section**	202	**Proponent**	Joseph Crum
Chapter	2	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

G2-16 PART I

Summary of Modification

This proposal simply revises the definition of Light- Frame Construction and should not be confused with the different "Types of Construction" specified in Chapter 6.

Rationale

The proposal removes references to 'type of construction" that is a source of confusion in the definitions for "light frame construction". The modification further simplifies and clarifies the definitions by removing unnecessary wording.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification will simplify the definition and make enforcement easier.

Impact to building and property owners relative to cost of compliance with code

There is no increase in the cost of construction due to this change as it is only intended to clarify the existing code provisions.

Impact to industry relative to the cost of compliance with code

There is no increase in the cost of construction due to this change as it is only intended to clarify the existing code provisions.

Impact to small business relative to the cost of compliance with code

There is no increase in the cost of construction due to this change as it is only intended to clarify the existing code provisions.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the code by clarification of the definition and makes enforcement easier.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by clarification of the definition.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This change as it is only intended to clarify the existing code provisions so does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This change as it is only intended to clarify the existing code provisions so does not degrade the effectiveness of the code.

Section: 202

Modify as follows:

LIGHT-FRAME CONSTRUCTION. ~~A type of c~~ Construction whose vertical and horizontal structural elements are primarily ~~formed by~~ a system of repetitive wood or cold-formed steel framing members.

S7498

Date Submitted	11/28/2018	**Section** 202		**Proponent**	Ann Russo5
Chapter	2	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

This proposal revises the definitions of fenestration and vertical fenestration for consistency. It places the most distinguishing characteristics of fenestration in the main definition of that product type, and further distinguishes between vertical fenestration, and skylights and sloped glazing.

Rationale

The definition of fenestration, skylights, sloped glazing, unit skylights and tubular daylighting devices was revised and reformatted from the earlier Code editions. This proposal revises the definitions of fenestration and vertical fenestration with each other. It places the most distinguishing characteristics of fenestration in the main definition of that product type, and further distinguishes between vertical fenestration, and skylights and sloped glazing.

Although fenestration is an opening in the building envelope, it is to be designed and installed in such a manner as to preserve the integrity of the building envelope component in which it is installed. Fenestration products typically consist of assemblies that are glazed with glass or other transparent or translucent materials. This proposal places both of these characteristics into the main definition of fenestration.

Although similar, the performance characteristics for skylights and sloped glazing are different than for vertical fenestration. This proposal maintains the measurement of 15 degrees from vertical as the point at which fenestration products go from being vertical fenestration installed in a wall, to skylights or sloped glazing. Although earlier definitions set this threshold at 30 degrees from vertical, AAMA strongly feels that this is an erroneous point at which to draw this distinction. The design of products to be weather resistant, particularly with regards to water penetration and related loads, is quite different for products installed at any slope at all in comparison to products installed in a completely vertical position. 15 degrees from vertical has been the accepted threshold for this distinction for many years. It should not be increased.

The change will increase reliability and safety while not materially impacting costs.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No material impact as product approval and related information would be consulted in the normal process of plan review and inspection

Impact to building and property owners relative to cost of compliance with code

Cost impact would be minimal and would increase value and reliability to the property owners with regards to life safety and service life

Impact to industry relative to the cost of compliance with code

None foreseen as this is an adopted industry standard as well as practice

Impact to small business relative to the cost of compliance with code

None foreseen as this is an adopted industry standard as well as practice

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Increases safety and welfare of the owner and occupants due to reduced probability of infiltration which reduces risk of mold and other contaminants

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the quality of construction and end product, the building, for benefit of owner and occupants of the structure

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The change will not impact products, just increase their effectiveness as part of the building envelope

Does not degrade the effectiveness of the code

It increases the base effectiveness and benefit to the building's owner and occupants

Revise as follows:

FENESTRATION. ~~**Skylights,**~~ Products classified as either vertical fenestration or skylights and sloped glazing, installed in such a manner as to preserve the weather resistant barrier of the wall or **roof** ~~**windows, vertical windows (fixed or moveable), opaque doors, glazed doors, glazed block and combination opaque/glazed doors**~~ **in which they are installed. Fenestration includes products with glass** ~~**and nonglass glazing**~~ **or other transparent or translucent materials.**

Add new definition as follows:

FENESTRATION, VERTICAL. Windows that are fixed or movable, opaque doors, glazed doors, glazed block and combination opaque and glazed doors installed in a wall at less than 15 degrees from vertical.

S7502

Date Submitted	11/28/2018	**Section**	202	**Proponent**	Ann Russo5
Chapter	2	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No   **Alternate Language** No

Related Modifications

Summary of Modification

This revision clarifies the types of products that are included in the category of "skylights" and brings the Energy Code more closely in alignment with the Building and Residential Codes. It clarifies which products fall under the category of "skylight", and which do not.

Rationale

This revision clarifies the types of products that are included in the category of "skylights" and brings the Energy Code more closely in alignment with the Building and Residential Codes.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code
No new impact expected

Impact to building and property owners relative to cost of compliance with code
Will clarify choices and expect greater efficiency in selecting proper products

Impact to industry relative to the cost of compliance with code
Highlight more energy and cost effective product options

Impact to small business relative to the cost of compliance with code
Positive as more efficient products will be highlighted

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public
Increases welfare benefits with expected improvement on energy efficiency benefits

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction
Improves Code with better coordination and efficiency of Energy Conservation

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities
Better defines applications

Does not degrade the effectiveness of the code
Improves efficiency and coordination

Delete:

~~**[BS]SKYLIGHTS AND SLOPED GLAZING.** Glass or other transparent or translucent glazing material installed at a slope of 15 degrees (0.26 rad) or more from vertical. Glazing material in skylights, including *unit skylights*, *tubular daylighting devices*, solariums, *sunrooms*, roofs and sloped walls, are included in this definition.~~

Add:

FENESTRATION. Products classified as either vertical fenestration or skylights.

- **Skylight.**Glass or other transparent or translucent glazing material installed at a slope of less than 60 degrees (1.05 rad) from horizontal, including unit skylights, tubular daylighting devices, and glazing materials in solariums, sunrooms, roofs and sloped walls.

- **Vertical fenestration.** Windows (fixed or moveable), opaque doors, glazed doors, glazed block and combination opaque/glazed doors composed of glass or other transparent or translucent glazing materials and installed at a slope of at least 60 degrees (1.05 rad) from horizontal.

S7513

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Date Submitted	12/14/2018	**Section**	202	**Proponent**	Joseph Crum
Chapter	2	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

G22-16

Summary of Modification

This change is intended to clarify the definition of Substantial Structural Damage to avoid misinterpretation.

Rationale

There has been some debate among engineers regarding the meaning of the word "supports". Some argue that since the term "tributary area" is not used, the word "supports" can be interpreted as requiring postulation of a collapse mechanism (e.g., in a square structure with four columns, one at each corner, if you hypothetically removed a single column and half the structure would collapse, then that column "supports" half of the structure. Or if in the same structure, if you removed a single column and the entire structure would collapse, then that column "supports" 100 percent of the structure). Similarly, another interpretation is that if a load is placed somewhere on a structure, and any portion of the load is resisted by the element in question in any amount, then that element "supports" the area where the load was applied. Both these interpretations can result in the columns and walls at any given level of a structure supporting far more than 100 percent of the building.
Neither interpretation is the intent of the trigger, which was only ever intended to incorporate the concept of tributary area.
Addition of the term "tributary area" will clarify the intent using a commonly understood technical term.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Code definition to clarify the code will assist in interpretation and enforcement of the code with no added cost.

Impact to building and property owners relative to cost of compliance with code

Code definition to clarify the code will assist in interpretation and enforcement of the code with no added cost.

Impact to industry relative to the cost of compliance with code

Code definition to clarify the code will assist in interpretation and enforcement of the code with no added cost.

Impact to small business relative to the cost of compliance with code

Code definition to clarify the code will assist in interpretation and enforcement of the code with no added cost.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Code definition to clarify the code will assist in interpretation and enforcement of the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Code definition to clarify the code will assist in interpretation and enforcement of the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Code definition to clarify the code only so does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not degrade the effectiveness of the code

Code definition to clarify the code only so does degrade the effectiveness of the code

Revise as follows:

[BS] SUBSTANTIAL STRUCTURAL DAMAGE. A condition where one or both of the following apply:

1. The vertical elements of the lateral force resisting system have suffered damage such that the lateral load-carrying capacity of any story in any horizontal direction has been reduced by more than 33 percent from its pre-damage condition.
2. The capacity of any vertical component carrying gravity load, or any group of such components, that ~~supports~~ has a tributary area more than 30 percent of the total area of the structure's floors and roofs has been reduced more than 20 percent from its pre-damage condition and the remaining capacity of such affected elements,with respect to all dead and live loads,is less than 75 percent of that required by this code for new buildings of similar structure, purpose and location.

S7520

Date Submitted	12/5/2018	**Section**	202	**Proponent**	Ann Russo5
Chapter	2	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

This proposal revises the definitions of fenestration and vertical fenestration for consistency. It places the most distinguishing characteristics of fenestration in the main definition of that product type, and further distinguishes between vertical fenestration, and skylights and sloped glazing.

Rationale

The definition of fenestration, skylights, sloped glazing, unit skylights and tubular daylighting devices was revised and reformatted from the earlier Code editions. This proposal revises the definitions of fenestration and vertical fenestration with each other. It places the most distinguishing characteristics of fenestration in the main definition of that product type, and further distinguishes between vertical fenestration, and skylights and sloped glazing.

Although fenestration is an opening in the building envelope, it is to be designed and installed in such a manner as to preserve the integrity of the building envelope component in which it is installed. Fenestration products typically consist of assemblies that are glazed with glass or other transparent or translucent materials. This proposal places both of these characteristics into the main definition of fenestration.

Although similar, the performance characteristics for skylights and sloped glazing are different than for vertical fenestration. This proposal maintains the measurement of 15 degrees from vertical as the point at which fenestration products go from being vertical fenestration installed in a wall, to skylights or sloped glazing. Although earlier definitions set this threshold at 30 degrees from vertical, AAMA strongly feels that this is an erroneous point at which to draw this distinction. The design of products to be weather resistant, particularly with regards to water penetration and related loads, is quite different for products installed at any slope at all in comparison to products installed in a completely vertical position. 15 degrees from vertical has been the accepted threshold for this distinction for many years. It should not be increased.

The change will increase reliability and safety while not materially impacting costs.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No material impact as product approval and related information would be consulted in the normal process of plan review and inspection

Impact to building and property owners relative to cost of compliance with code

Cost impact would be minimal and would increase value and reliability to the property owners with regards to life safety and service life

Impact to industry relative to the cost of compliance with code

None foreseen as this is an adopted industry standard as well as practice

Impact to small business relative to the cost of compliance with code

None foreseen

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Increases safety and welfare of the owner and occupants due to reduced probability of infiltration which reduces risk of mold and other contaminants

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the quality of construction and end product, the building, for benefit of owner and occupants of the structure

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The change will not impact products, just increase their effectiveness as part of the building envelope

Does not degrade the effectiveness of the code

It increases the base effectiveness and benefit to the building's owner and occupants

Revise as follows:

FENESTRATION. ~~Skylights~~ Products classified as either vertical fenestration or skylights and sloped glazing, installed in such a manner as to preserve the weather resistant barrier of the wall or roof ~~windows, vertical windows (fixed or moveable), opaque doors, glazed doors, glazed block and combination opaque/glazed doors~~ in which they are installed. Fenestration includes products with glass ~~and nonglass glazing~~ or other transparent or translucent materials.

Add new definition as follows:

FENESTRATION, VERTICAL. Windows that are fixed or movable, opaque doors, glazed doors, glazed block and combination opaque and glazed doors installed in a wall at less than 15 degrees from vertical.

S7528

Date Submitted	11/28/2018	**Section**	202	**Proponent**	Joseph Crum
Chapter	2	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

G22-16

Summary of Modification

This change is intended to clarify the definition of Substantial Structural Damage to avoid misinterpretation.

Rationale

There has been some debate among engineers regarding the meaning of the word "supports". Some argue that since the term "tributary area" is not used, the word "supports" can be interpreted as requiring postulation of a collapse mechanism (e.g., in a square structure with four columns, one at each corner, if you hypothetically removed a single column and half the structure would collapse, then that column "supports" half of the structure. Or if in the same structure, if you removed a single column and the entire structure would collapse, then that column "supports" 100 percent of the structure). Similarly, another interpretation is that if a load is placed somewhere on a structure, and any portion of the load is resisted by the element in question in any amount, then that element "supports" the area where the load was applied. Both these interpretations can result in the columns and walls at any given level of a structure supporting far more than 100 percent of the building.
Neither interpretation is the intent of the trigger, which was only ever intended to incorporate the concept of tributary area.
Addition of the term "tributary area" will clarify the intent using a commonly understood technical term.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This is a code definition clarification and will assist in the interpretation and enforcement of the code with no additional cost.

Impact to building and property owners relative to cost of compliance with code

This is a code definition clarification and will assist in the interpretation and enforcement of the code with no additional cost.

Impact to industry relative to the cost of compliance with code

This is a code definition clarification and will assist in the interpretation and enforcement of the code with no additional cost.

Impact to small business relative to the cost of compliance with code

This is a code definition clarification and will assist in the interpretation and enforcement of the code with no additional cost.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This is a code definition clarification and will assist in the interpretation and enforcement of the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This is a code definition clarification and will assist in the interpretation and enforcement of the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This is a code definition clarification only and does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This is a code definition clarification only and does not degrade the effectiveness of the code.

Revise as follows:

[BS] SUBSTANTIAL STRUCTURAL DAMAGE. A condition where one or both of the following apply:

1. The vertical elements of the lateral force resisting system have suffered damage such that the lateral load-carrying capacity of any story in any horizontal direction has been reduced bymore than 33 percent from its pre-damage condition.

2. The capacity of any vertical component carrying gravity load, or any group of such components, that ~~supports~~ has a tributary area more than 30 percent of the total area of the structure's floors and roofs has been reduced more than 20 percent from its pre-damage condition and the remainingcapacityofsuchaffectedelements,withrespecttoalldeadandliveloads,islessthan 75 percent of that required by this code for new buildings of similar structure, purpose and location.

S7535

Date Submitted	11/28/2018	**Section**	202	**Proponent**	Ann Russo5
Chapter	2	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

Summary of Modification

To make definitions in both the Building and Residential of vapor retarder class more consistent by adding reference to Procedure A of ASTM E96.

Rationale

To make definitions of vapor retarder class more consistent by adding reference to Procedure A of ASTM E96 which gives the correct testing for this product. It also will allow both the Building and Residential Code requirements to align with same requirements.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Clearer definition on testing allows for better adherence and minimizes any misconceptions

Impact to building and property owners relative to cost of compliance with code

No impact on costs expected

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Clearer definition as to appropriate testing will allow for better control of moisture and provide better moisture control and lowering probability of mold development within the structure

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves Code by better defining moisture testing of barriers

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not as it provides a recognized test standard protocol

Does not degrade the effectiveness of the code

No, does not

Revise as follows:

________________**VAPOR RETARDER CLASS.** A measure of a material or assembly's ability to limit the amount of moisture that passes through that material or assembly. Vapor retarder class shall be defined using the desiccant method with Procedure A of ASTM E 96 as follows:

Class I: 0.1 perm or less.

Class II: 0.1 < perm = 1.0 perm.

Class III: 1.0 < perm = 10 perm.

S7602

Date Submitted	11/30/2018	**Section**	202	**Proponent**	Ann Russo5
Chapter	2	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

To distinguish drilled shaft from augercast piles (reference to removing drilling equipment).

Rationale

The purpose of the proposed code change is to distinguish it from augercast piles (reference to removing drilling equipment). Alternate names are included which are in common use in the industry. Drilling fluids (e.g. slurry) are often used in lieu of casing to stabilize the hole.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Better defines process and clarifies options available and improves possible safety aspects

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves understanding and options for piles and methofs

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not

Does not degrade the effectiveness of the code

Does not

Revise as follows:

DRILLED SHAFT. A cast-in-place deep foundation element, also referred to as caisson, drilled pier and bored pile, constructed by drilling a hole (with or without permanent casing or drilling fluid) into soil or rock and filling it with fluid concrete after the drilling equipment is removed.

Socketed drilled shaft. A drilled shaft with a permanent pipe or tube casing that extends down to bedrock and an uncased socket drilled into the bedrock.

S7606

Date Submitted	11/30/2018	**Section**	202	**Proponent**	Ann Russo5
Chapter	2	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

The word "membrane" is superfluous. The definition applies to the vapor permeance property of any material. It has no need to be limited to "membranes".

Rationale

The word "membrane" is superfluous. The definition applies to the vapor permeance property of any material. It has no need to be limited to "membranes". The definition and the property are relevant to other materials such as sheathings, insulation, paint, drywall, etc. The term "vapor permeable membrane" is currently used only once in Section 702.1 and this proposal will have no effect on this usage since the term "vapor permeable" remains defined and the term "membrane" is well understood by its plain meaning. This will match Residential Code.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None, but clarifies usage and application

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Clarity of definition then allows focus on product and/or system being used thus improving quality benefiting safety and health of occupants

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves by focusing on attributes of product

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not

Does not degrade the effectiveness of the code

Does not

Revise as follows:

VAPOR PERMEABLE ~~MEMBRANE~~. The property of having a moisture vapor permeance rating of 5 perms (2.9 × 10-10 kg/Pa × s × m2) or greater, when tested in accordance with the desiccant method using Procedure A of ASTM E 96. A vapor permeable material permits the passage of moisture vapor..

S7841

Date Submitted	12/10/2018	**Section**	202	**Proponent**	Paul Coats
Chapter	2	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

yes

Summary of Modification

Slightly modifies definitions of Conventional Light-Frame Construction and Light-Frame Construction.

Rationale

These modifications were approved by the ICC membership and appear in the 2018 edition of the International Building Code, and make no technical changes. The wording of these definitions has sometimes caused confusion among code users. Chapter 6 of the IBC describes and provides the requirements for the different types of construction ranging from Type IA to VB. Light wood frame is not considered a type of construction. Changing from "type of construction" to simply "construction" precludes confusion with "Types of Construction" specified in Chapter 6.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact, improves clarity only.

Impact to building and property owners relative to cost of compliance with code

No cost-related impact.

Impact to industry relative to the cost of compliance with code

No cost-related impact.

Impact to small business relative to the cost of compliance with code

No cost-related impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves clarity of the code, makes no technical change.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code by improving clarity.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

It may improved the effectiveness of the code.

CONVENTIONAL LIGHT-FRAME CONSTRUCTION.

~~A type of construction~~ Construction whose primary structural elements are formed by a system of repetitive wood-framing members. See Section 2308 for conventional light-frame construction provisions.

LIGHT-FRAME CONSTRUCTION. ~~A type of construction~~ Construction whose vertical and horizontal structural elements are primarily formed by a system of repetitive wood or cold-formed steel framing members.

G2-16

Part I:
IBC: 202.
Part II:
IRC: R202.

THIS IS A 2 PART CODE CHANGE. PART I WILL BE HEARD BY THE IBC-STRUCTURAL CODE COMMITTEE. PART II WILL BE HEARD BY THE IRC-BUILDING CODE COMMITTEE. SEE THE TENTATIVE HEARING ORDERS FOR THESE COMMITTEES.

Proponent : David Tyree, American Wood Council, representing American Wood Council (dtyree@awc.org)

Part I

2015 International Building Code

Revise as follows:

SECTION 202 DEFINITIONS

CONVENTIONAL LIGHT-FRAME CONSTRUCTION. A ~~type~~ method of construction whose primary structural elements are formed by a system of repetitive wood-framing members. See Section 2308 for conventional light-frame construction provisions.

LIGHT-FRAME CONSTRUCTION. A ~~type~~ method of construction whose vertical and horizontal structural elements are primarily formed by a system of repetitive wood or cold-formed steel framing members.

Part II

2015 International Residential Code

Revise as follows:

SECTION 202 DEFINITIONS

[RB] LIGHT-FRAME CONSTRUCTION. A ~~type~~ method of construction ~~with~~ whose vertical and horizontal structural elements ~~that~~ are primarily formed by a system of repetitive wood or cold-formed steel framing members.

Reason: The wording of this definition has often caused confusion among code users when determinng the type of construction of a building. Chapter 6 of the IBC describes and provides the requirements for the different types of construction ranging from Type IA to VB. Light wood frame is not considered a type of construction. This proposal simply revises the definition to state that Light-Frame is a "method" of construction and should not be confused with the different "Types of Construction" specified in Chapter 6.
For a complete list of AWC code change proposals and additional information please go to http://www.awc.org/Code-Officials/2015-IBC-Code-Changes.

Cost Impact: Will not increase the cost of construction
There is no increase in the cost of construction due to this change as it is only intended to clarify the existing code provisions.

G2-16 : 202-CONVENIONAL LIGHT-FRAME CONSTRUCTION-TYREE4370

Final action: both parts Approved as Modified (modifications by the Committee below)

G2-16

THIS IS A 2 PART CODE CHANGE. PART I WILL BE HEARD BY THE IBC-STRUCTURAL CODE COMMITTEE. PART II WILL BE HEARD BY THE IRC-BUILDING CODE COMMITTEE. SEE THE TENTATIVE HEARING ORDERS FOR THESE COMMITTEES.

Part I

Committee Action: **Approved as Modified**

Modification:

2015 International Building Code
SECTION 202 DEFINITIONS

CONVENTIONAL LIGHT-FRAME CONSTRUCTION. ~~A method of construction~~Construction whose primary structural elements are formed by a system of repetitive wood-framing members. See Section 2308 for conventional light-frame construction provisions.
LIGHT-FRAME CONSTRUCTION. ~~A method of construction~~Construction whose vertical and horizontal structural elements are primarily formed by a system of repetitive wood or cold-formed steel framing members.

Committee Reason: The proposal removes references to 'type of construction" that is a source of confusion in the definitions for "light frame construction". The modification further simplifies and clarifies the definitions by removing unnecessary wording.

Assembly Action: **None**

Part II

Committee Action: **Approved as Modified**

Modification:

SECTION 202

DEFINITIONS

LIGHT-FRAME CONSTRUCTION. ~~A method of construction~~Construction whose vertical and horizontal structural elements are primarily a system of repetitive wood or cold-formed steel framing members.

Committee Reason: The modification deleted "A method of" which was ambiguous and unnecessary language.

Assembly Action: **None**

S8238

Date Submitted 12/14/2018
Chapter 2
Section 202
Affects HVHZ No
Proponent John Woestman
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**
Alternate Language **No**

Related Modifications

Summary of Modification

Revise the definition of plastic composite.

Rationale

Slight revisions to the definition of plastic composite to include similar materials. While vague, "similar materials" includes such material as recycled carpet fiber or material such as mineral-filled PVC.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No discernible impact. Updates the definition to include a broader scope of materials.

Impact to building and property owners relative to cost of compliance with code

No cost implications identified.

Impact to industry relative to the cost of compliance with code

No cost implications identified.

Impact to small business relative to the cost of compliance with code

No cost implications identified.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Reasonable but not substantial connection with welfare of the general public. Helps connect requirements in the code for plastic composites with scope of applicable products.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Slightly improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate - allows a broader range of materials in plastic composites.

Does not degrade the effectiveness of the code

Does not degrade effectiveness of the code.

Revise as follows:

PLASTIC COMPOSITE. A generic designation that refers to ~~wood/~~-plastic composites, ~~and~~ plastic lumber, and similar materials.

S8249

Date Submitted	12/14/2018	**Section**	202	**Proponent**	John Woestman
Chapter	2	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation	Pending Review
Commission Action	Pending Review

Comments

General Comments No **Alternate Language** No

Related Modifications

Summary of Modification

Revise definition of Vapor Retarder Class to specify Procedure A of ASTM e96.

Rationale

Reason: To make building code and residential code definitions of vapor retarder class more consistent by adding reference to Procedure A of ASTM E96. The residential code definition also should be adjusted to be more grammatically correct and consistent with the building code (e.g., the residential code definition reads "A measure of a material or assembly to limit..." which misses the word "ability" included in the building code definition).

Cost Impact: Will not increase the cost of construction This is a definition editorial change to coordinate codes with no cost impact.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Adds a bit more specificity to the building code; should not be more difficult to enforce.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction or code enforcement. This is a definition editorial change to coordinate codes with no cost impact.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction or code enforcement. This is a definition editorial change to coordinate codes with no cost impact.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction or code enforcement. This is a definition editorial change to coordinate codes with no cost impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Connection to the welfare of the general public via improvement of the definition of Vapor Retarder Class.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code with more accurate definition.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

Revise as follows:

SECTION 202 DEFINITIONS

VAPOR RETARDER CLASS. A measure of a material or assembly's ability to limit the amount of moisture that passes through that material or assembly. Vapor retarder class shall be defined using the desiccant method with Procedure A of ASTM E96 as follows:

Class I: 0.1 perm or less.

Class II: 0.1 < perm = 1.0 perm.

Class III: 1.0 < perm = 10 perm.

Date Submitted 12/14/2018
Chapter 2
Section 202
Affects HVHZ No
Proponent John Woestman
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**
Alternate Language **No**

Related Modifications

Summary of Modification

Revise "Vapor Permeable Membrane" to "Vapor Permeable"

Rationale

The word "membrane" is superfluous. The definition applies to the vapor permeance property of any material. It has no need to be limited to "membranes". The definition and the property are relevant to other materials such as sheathings, insulation, paint, drywall, etc. The term "vapor permeable membrane" is currently used only once in Section 702.1 and this proposal will have no effect on this usage since the term "vapor permeable" remains defined and the term "membrane" is well understood by its plain meaning.

Cost Impact: Will not increase the cost of construction This proposal makes no material change to the code or the definition that has cost implications.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Clarifies this definition - should not impact code enforcement.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction or code compliance. This proposal makes no material change to the code or the definition that has cost implications.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction or code compliance. This proposal makes no material change to the code or the definition that has cost implications.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction or code compliance. This proposal makes no material change to the code or the definition that has cost implications.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Helps improve the code readability and usability, which helps with enforcement of energy conservation provisions of the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the accuracy of the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Expands the scope of the types of materials which meet vapor permeable provisions.

Does not degrade the effectiveness of the code

Improves the effectiveness of the code.

Revise as follows:

VAPOR PERMEABLE ~~MEMBRANE~~. <remainder of definition unchanged>

S8264

Date Submitted	12/14/2018	**Section**	202	**Proponent**	Joseph Crum
Chapter	2	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

G24-16

Summary of Modification

This change will make the FBCB definition consistent with the ICC Green Building Code and ASTM D1079.

Rationale

This change will make the FBCB definition consistent with the ICC Green Building Code and ASTM D1079.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Code update only and has no effect on code enforcement.

Impact to building and property owners relative to cost of compliance with code

Code update only and will not increase the cost of construction.

Impact to industry relative to the cost of compliance with code

Code update only and will not increase the cost of construction.

Impact to small business relative to the cost of compliance with code

Code update only and will not increase the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Code update only and will update the code to current standards.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Code update only and will update the code to current standards.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Code update only and will update the code to current standards. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not degrade the effectiveness of the code

Code update only and will update the code to current standards. Does not degrade the effectiveness of the code

VEGETATIVE ROOF. An assembly of interacting components designed to waterproof ~~and normally~~ ~~insulate~~ a building's top surface that includes, by design, vegetation and related landscape elements.

S8361

Date Submitted	12/15/2018	**Section**	202	**Proponent**	Joseph Belcher for MAF
Chapter	2	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Chapter 35 ASTM C1386

Summary of Modification

Deletes incorrect definition and defunct standard

Rationale

(Note: Reason is from original ICC proponent.)

The definition is not needed and is incorrect. ASTM C1386 was withdrawn by ASTM in 2013, and AAC is now manufactured to different ASTM standards (ASTM C1691 for AAC masonry and ASTM C1693 for AAC in general). In addition, IBC Section 202 already contains a definition for AAC Masonry, which is both more appropriate and correct. While this definition could apply AAC as used in conjunction with Chapter 19, that Chapter does not address AAC. Deleting the definition of Autoclaved Aerated Concrete thus removes the reference to an ASTM standard no longer used, and it cleans up the IBC as a whole.

Part II updates references to it in the IRC.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact on the cost of enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact on the cost to property owners.

Impact to industry relative to the cost of compliance with code

No impact on the cost to industry.

Impact to small business relative to the cost of compliance with code

No impact on cost to small business.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The proposal deletes an incorrect definition and a defunct standard promoting the health, safety, and welfare of the public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The proposal improves the code by deleting an incorrect definition and a defunct standard.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The change does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The proposed change does not degrade the effectiveness of the code.

Delete without substitution:

~~AUTOCLAVED AERATED CONCRETE (AAC). AUTOCLAVED AERATED CONCRETE (AAC). Low density cementitious product of calcium silicate hydrates, whose material specifications are defined in ASTM C1386.~~

Chapter 35 Delete referenced standard.

~~ASTM C1386~~

S7612

Date Submitted 11/30/2018
Chapter 4
Section 423.1
Affects HVHZ No
Proponent Ann Russo5
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

423.1.1, 423.2, 423.3

Summary of Modification

The purpose of this code change is to clarify which types of shelters are required to be assigned to Risk Category IV per Table 1604.5.

Rationale

The intent of the change proposal is to simply clarify that shelters built for protection during wind storms in accordance with ICC500-14 are not emergency shelters that are required to be designed as Risk Category IV structures in accordance with Section 1604.5.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Clarifies designation of storm shelters and improves enforcement clarity

Impact to building and property owners relative to cost of compliance with code

Minimal cost but clarifies requirements thus lowers corrective action

Impact to industry relative to the cost of compliance with code

Minimal

Impact to small business relative to the cost of compliance with code

Minimal

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves protection for those needing use of emergency shelters during extreme weather thus increasing protection for health, safety and welfare of the public during those times

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves clarify and enforcement of requirements under Code

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not

Does not degrade the effectiveness of the code

Improves Code effectiveness

Modify as follows:

423.1General.

In addition to other applicable requirements in this code, storm shelters shall be constructed in accordance with ICC 500. Buildings or structures that are also designated as emergency shelters shall also comply with Table 1604.5 as Risk Category IV structures.

S7613

Date Submitted	11/30/2018	**Section**	423.1.1	**Proponent**	Ann Russo5
Chapter	4	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

423.1, 423.2, 423.3

Summary of Modification

The purpose of this code change is to clarify which types of shelters are required to be assigned to Risk Category IV per Table 1604.5.

Rationale

The intent of the change proposal is to simply clarify that shelters built for protection during wind storms in accordance with ICC500-14 are not emergency shelters that are required to be designed as Risk Category IV structures in accordance with Section 1604.5.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Clarifies designation of storm shelters and improves enforcement clarity

Impact to building and property owners relative to cost of compliance with code

Minimal cost but clarifies requirements thus lowers corrective action

Impact to industry relative to the cost of compliance with code

Minimal

Impact to small business relative to the cost of compliance with code

Minimal

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves protection for those needing use of emergency shelters during extreme weather thus increasing protection for health, safety and welfare of the public during those times

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves clarify and enforcement of requirements under Code

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not

Does not degrade the effectiveness of the code

Improves Code effectiveness

Modify as follows:

423.1.1 Scope. This section applies to the construction of storm shelters constructed as separate detached buildings or constructed as safe rooms within buildings for the purpose of providing safe refuge from storms that produce high winds, such as tornados and hurricanes during the storm. Such structures shall be designated to be hurricane shelters, tornado shelters, or combined hurricane and tornado shelters. Design of facilities for use as emergency shelters after the storm are outside the scope of ICC 500 and shall comply with Table 1604.5 as a Risk Category IV Structure.

S7614

Date Submitted	11/30/2018	**Section**	423.2	**Proponent**	Ann Russo5
Chapter	4	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

523.1, 423.1.1, 423.3

Summary of Modification

The purpose of this code change is to clarify which types of shelters are required to be assigned to Risk Category IV per Table 1604.5.

Rationale

The intent of the change proposal is to simply clarify that shelters built for protection during wind storms in accordance with ICC500-14 are not emergency shelters that are required to be designed as Risk Category IV structures in accordance with Section 1604.5.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Clarifies designation of storm shelters and improves enforcement clarity

Impact to building and property owners relative to cost of compliance with code

Minimal cost but clarifies requirements thus lowers corrective action

Impact to industry relative to the cost of compliance with code

Minimal

Impact to small business relative to the cost of compliance with code

Minimal

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves protection for those needing use of emergency shelters during extreme weather thus increasing protection for health, safety and welfare of the public during those times

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves clarify and enforcement of requirements under Code

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not

Does not degrade the effectiveness of the code

Improves Code effectiveness

Modify as follows:

423.2 Definitions. The following terms are defined in Chapter 2:

STORM SHELTER.

Community storm shelter
Residential storm shelter.

Shelters built for protection during wind storms in accordance with ICC500-14 are not emergency shelters that are required to be designed as Risk Category IV structures in accordance with Section 1604.5.

S7615

Date Submitted	11/30/2018	**Section**	423.3	**Proponent**	Ann Russo5
Chapter	4	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

523.1, 423.1.1, 423.2

Summary of Modification

The purpose of this code change is to clarify which types of shelters are required to be assigned to Risk Category IV per Table 1604.5.

Rationale

The intent of the change proposal is to simply clarify that shelters built for protection during wind storms in accordance with ICC500-14 are not emergency shelters that are required to be designed as Risk Category IV structures in accordance with Section 1604.5.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Clarifies designation of storm shelters and improves enforcement clarity

Impact to building and property owners relative to cost of compliance with code

Minimal cost but clarifies requirements thus lowers corrective action

Impact to industry relative to the cost of compliance with code

Minimal

Impact to small business relative to the cost of compliance with code

Minimal

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves protection for those needing use of emergency shelters during extreme weather thus increasing protection for health, safety and welfare of the public during those times

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves clarify and enforcement of requirements under Code

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not

Does not degrade the effectiveness of the code

Improves Code effectiveness

Modify as follows:

423.3Critical emergency operations.

In areas where the shelter design wind speed for tornados in accordance with Figure 304.2(1) of ICC 500 is 250 MPH, 911 call stations, emergency operation centers and fire, rescue, ambulance and police stations shall comply with Table 1604.5 as a Risk Category IV structure and shall be provided with ~~have~~ a storm shelter constructed in accordance with ICC 500.

~~**Exception:** Buildings meeting the requirements for shelter design in ICC 500.~~

S7522

Date Submitted	11/29/2018	**Section**	602.4	**Proponent**	Paul Coats
Chapter	6	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

#7553 for Section 2304.11 is a duplicate of this proposal which takes provisions from Chapter 6 and moves them to Chapter 23, necessitating review by both the Fire Safety and Structural TACs.

Summary of Modification

This proposed modification takes the details for heavy timber construction out of Chapter 6 and consolidates them in Chapter 23.

Rationale

The proposed modifications were approved by the ICC membership and appear in the 2018 IBC. They do not change the technical requirements for heavy timber but improve their usability. The changes shown reflect ICC code changes G179-15 (primarily), G178-15, and G175-18, which were all Approved as Submitted by the General Code Development Committee and subsequently the ICC membership (files are attached). The IBC General Code Development Committee made the following statement in the 2015 ICC Report of Committee Action Hearing, for G179-15: "The proposal provides necessary consolidation and eliminates duplicative text between Chapters 6 and 23. The revised table is sorely needed to make help the users of the code. Moving the table to Chapter 23 is totally appropriate. The was comfort that with a detailed comparision this is a good clean up with no technical changes. As with any major revision, there remained concerns that all pieces have been maintained and there might be some unintended consequences. The new organization provides better logic for the requirements." See the uploaded file for the complete rationale for G179-15, the primary code change, and a table comparing the locations of sections in the current code and what is proposed. Reason statements for G175 and G178 can also be seen in the uploaded support files for the proposed text.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Enforcement of provisions may be easier.

Impact to building and property owners relative to cost of compliance with code

There is no cost impact.

Impact to industry relative to the cost of compliance with code

There is not cost impact.

Impact to small business relative to the cost of compliance with code

There is no cost impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This reorganization and consolidation of heavy timber provisions in one location will promote better compliance and better enforcement and therefore affects the safety and welfare of the general public positively.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This reorganization and consolidation of heavy timber provisions in one location will improve the usability and application of the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate in any way.

Does not degrade the effectiveness of the code

Retains the current effectiveness of the code and improves it.

602.4 Type IV. Type IV construction ~~(Heavy Timber, HT)~~ is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of solid <u>wood,</u> ~~or~~ laminated wood<u>, heavy timber (HT) or structural composite lumber (SCL)</u> without concealed spaces. <u>The minimum dimensions for permitted materials including solid timber, glued-laminated timber, structural composite lumber (SCL), and cross-laminated timber and</u> ~~The~~ details of Type IV construction shall comply with the provisions of this section and Section 2304.11. Exterior walls complying with Section 602.4.1 or 602.4.2 shall be permitted. <u>Interior walls and partitions not less than 1-hour fire-resistance rating or heavy timber complying with Section 2304.11.2.2 shall be permitted.</u> ~~Minimum solid sawn nominal dimensions are required for structures built using Type IV construction (HT). For glued-laminated members and structural composite lumber (SCL) members, the equivalent net finished width and depths corresponding to the minimum nominal width and depths of solid sawn lumber are required as specified in Table 602.4. *Cross-laminated timber* (CLT) dimensions used in this section are actual dimensions.~~

602.4.1 Fire-retardant-treated wood in exterior walls. *Fire-retardant-treated wood* framing <u>and sheathing</u> complying with Section 2303.2 shall be permitted within exterior wall assemblies <u>not less than 6 inches (152 mm) in thickness</u> with a 2-hour rating or less.

602.4.2 Cross-laminated timber in exterior walls. *Cross-laminated timber* complying with Section 2303.1.4 shall be permitted within exterior wall assemblies <u>not less than 6 inches (152 mm) in thickness</u> with a 2-hour rating or less, provided the exterior surface of the cross-laminated timber is protected by one the following:

1. *Fire-retardant-treated wood* sheathing complying with Section 2303.2 and not less than 15/32 inch (12 mm) thick;
2. *Gypsum board* not less than 1/2 inch (12.7 mm) thick; or
3. A noncombustible material.

~~**602.4.3 Columns.** Wood columns shall be sawn or glued laminated and shall be not less than 8 inches (203 mm), nominal, in any dimension where supporting floor loads and not less than 6 inches (152 mm) nominal in width and not less than 8 inches (203 mm) nominal in depth where supporting roof and ceiling loads only. Columns shall be continuous or superimposed and connected in an *approved* manner. Protection in accordance with Section 704.2 is not required.~~

~~**602.4.4 Floor framing.** Wood beams and girders shall be of sawn or glued-laminated timber and shall be not less than 6 inches (152 mm) nominal in width and not less than 10 inches (254 mm) nominal in depth. Framed sawn or glued-laminated timber arches, which spring from the floor line and support floor loads, shall be not less than 8 inches (203 mm) nominal in any dimension. Framed timber trusses supporting floor loads shall have members of not less than 8 inches (203 mm) nominal in any dimension.~~

~~**602.4.5 Roof framing.** Wood-frame or glued-laminated arches for roof construction, which spring from the floor line or from grade and do not support floor loads, shall have members not less than 6 inches (152 mm) nominal in width and have not less than 8 inches (203 mm) nominal in depth for the lower half of the height and not less than 6 inches (152 mm) nominal in depth for the upper half. Framed or glued-laminated arches for roof construction that spring from the top of walls or wall abutments, framed timber trusses and other roof framing, which do not support floor loads, shall have members not less than 4 inches (102 mm) nominal in width and not less than 6 inches (152 mm) nominal in depth. Spaced members shall be permitted to be composed of two or more pieces not less than 3 inches (76 mm) nominal in thickness where blocked solidly throughout their intervening spaces or where spaces are tightly closed by a continuous wood cover plate of not less than 2 inches (51 mm) nominal in thickness secured to the underside of the members. Splice plates shall be not less than 3 inches (76 mm) nominal in thickness. Where protected by *approved* automatic sprinklers under the roof deck, framing members shall be not less than 3 inches (76 mm) nominal in width.~~

~~**602.4.9**~~ **<u>602.4.3</u> Exterior structural members.** Where a horizontal separation of 20 feet(6096 mm) or more is provided, wood columns and arches conforming to heavy timber sizes <u>complying with 2304.11</u> shall be permitted to be used externally.

2304.11 Heavy timber construction. Where a structure ~~or~~ , portion thereof ~~is~~,or individual structural elements are required to be of ~~Type IV construction~~ heavy timber by ~~other~~ provisions of this code, the building elements therein shall comply with the applicable provisions of Sections 2304.11.1 through ~~2304.11.5~~ 2304.11.4.Minimum dimensions ofheavytimber shall comply as applicable in Table2304.11 based on roofs or floors supported and the configuration of each structural element, or as applicable in Sections2304.11.2 through 2304.11.4.

2304.11.1 ~~Columns~~Details of heavy timber structural members. ~~Columns~~ Heavy timber structural members shall be ~~continuous or superimposed throughout all stories by means of reinforced concrete or metal caps~~ detailed and constructed inaccordance with ~~brackets, or shall be connected by properly designed steel or iron caps,with pintles and base plates,or by timber splice plates affixed to the columns by metal connectors housed within the contact faces, or by other *approved* methods.~~Sections 2304.11.1.1 through 2304.11.1.3.

2304.11.1.1~~Column connections~~Columns. Minimum dimensions of columns shall be in accordance with Table 2304.11.Columns shall be continuous or superimposed throughout all stories and connected in an *approved* manner. Girders and beams at column connections shall be closely fitted around columns and adjoining ends shall be cross tied to each other,or intertied by caps or ties,to transfer horizontal loads across joints. Wood bolsters shall not be placed on tops of columns unless the columns support roof loads only.Where traditional heavy timber detailing is used, connections shall be permitted to be by means of reinforced concrete ormetal caps with brackets, or shall be connected by properly designed steel or iron caps, with pintles and base plates, or by timber splice plates affixed to the columns by metal connectors housed within the contact faces, or by other approved methods.

~~2304.11.2~~ 2304.11.1.2 Floor framing. Minimum dimensions of floor framing shall be in accordance with Table 2304.11. *Approved* wall plate boxes or hangers shall be provided where wood beams, girders or trusses rest on masonry or concrete walls. Where intermediate beams are used to support a floor, they shall rest on top of girders, or shall be supported by ~~ledgers or blocks securely fastened to the sides of the girders, or they shall be supported by~~ an *approved* metal hanger into which the ends of the beams shall be closely fitted.Where traditional heavy timber detailing is used, these connections shall be permitted to be supported by ledgers or blocks securely fastened to the sides of the girders.

~~2304.11.3~~ 2304.11.1.3 Roof framing. Minimum dimensions of roof framing shall be in accordance with Table 2304.11. Every roof girder and at least every alternate roof beam shall be anchored to its supporting member; ~~and every monitor and every sawtooth construction shall be anchored to the main roof construction. Such anchors shall consist o fsteel or iron bolts of sufficient strength~~ to resist ~~vertical uplift of the roof.~~forces as required in Chapter 16.

~~602.4.8~~ 2304.11.2 Partitions and walls. Partitions and walls shall comply with Section ~~602.4.8.1~~2304.11.2.1 or ~~602.4.8.2~~ 2304.11.2.2.

~~602.4.8.2~~ 2304.11.2.1Exterior walls. Exterior walls shall permitted to be ~~of one of the following:~~

~~1. Noncombustible materials.~~

1. ~~Not less than 6 inches (152 mm) in thickness and constructed of one of the following:~~
    - ~~1.1. *Fire-retardant-treated wood* in accordance with Section 2303.2 and complying with Section 602.4.1.~~
    - 1.1.*Cross-laminated timber*~~complying with~~ meeting the requirements of Section ~~602.4.2~~ 2303.1.4.

~~602.4.8.1~~ 2304.11.2.2 Interior walls and partitions. *No change to text.*

~~602.4.6~~ 2304.11.3 Floors. Floors shall be without concealed spaces. Wood floors shall be constructed in accordance with Section ~~602.4.6.1~~2304.11.3.1 or ~~602.4.6.2~~2304.11.3.2.

~~602.4.6.2~~ 2304.11.3.1 Cross-laminated timber floors. *Cross-laminated timber* shall be not less than 4 inches (102 mm) in actual thickness. *Cross-laminated timber* shall be continuous from support to support and mechanically fastened to one another. *Cross-laminated timber* shall be permitted to be connected to walls without a shrinkage gap providing swelling or shrinking is considered in the design.Corbelling of masonry walls under the floor shall be permitted to be used.

~~602.4.6.1~~ 2304.11.3.2 Sawn or glued-laminated plank floors. *No change to text.*

Delete without substitution:

~~**2304.11.4 Floor decks.** Floor decks and covering shall not extend closer than 1/2 inch (12.7 mm) to walls. Such 1/2-inch(12.7 mm) spaces shall be covered by a molding fastened to the wall either above or below the floor and arranged such that the molding will not obstruct the expansion or contraction movements of the floor. Corbeling of masonry walls under floors is permitted in place of such molding.~~

Revise as follows:

~~2304.11.5~~ 2304.11.4 Roof decks. Roofs shall be without concealed spaces and roof decks shall be constructed in accordance with Section 2304.11.4.1 or2304.11.4.2.Other types of decking shall be permitted to be used where equivalent fire resistance and structural properties are being provided. Where supported by a wall, roof decksshall be anchored to walls to resist ~~uplift~~ forces determined in accordance with Chapter 16.Such anchors shall consist of steel bolts, lags, screws or ~~iron bolts~~ *approved* hardware of sufficient strength to resist ~~vertical uplift of the roof.~~prescribed forces.

~~602.4.7~~ 2304.11.4.1 ~~Roofs~~ Cross-laminated timber roofs. ~~Roofs shall be without concealed spaces and wood roof decks shall be sawn or glued laminated, splined or tongue-and-groove plank,not less than 2 inches (51 mm) nominal in thickness; 11 /8-inch-thick(32 mm)wood structural panel (exterior glue); planks not less than 3inches (76 mm) nominal in width, set on edge close together and laid as required for floors; or of cross-laminated timber. Other types of decking shall be permitted to be used if providing equivalent fire resistance and structural properties.~~

Cross-laminated timber roofs shall be not less than 3 inches (76 mm) ~~nominal in~~ in actual thickness and shall be continuous from support to support and mechanically fastened to one another.

Add new text as follows:

2304.11.4.2Sawn, wood structuralpanel, or glued-laminated plank roofs.

Sawn,wood structural panel, or glued-laminated plank roofs shall be one of the following:

1. Sawn or glued laminated, splined or tongue-and-groove plank, not less than 2 inches (51 mm) nominal in thickness;
2. 11 /8-inch-thick (32mm) wood structural panel (exterior glue);
3. Planks not less than 3inches (76mm) nominal in width, set on edge close together and laid as required for floors.

TABLE ~~602.4~~ 2304.11
~~WOODMEMBER SIZE EQUIVALENCIES~~ MINIMUM DIMENSIONS OF HEAVY TIMBER STRUCTURAL MEMBERS

		MINIMUM NOMINAL SOLID SAWN SIZE		MINIMUM GLUED-LAMINATED NETSIZE		MINIMUM STRUCTURAL COMPOSITELUMBER NETSIZE	
Supporting	**Heavy Timber Structural Element**	**Width, inch**	**Depth, inch**	**Width, inch**	**Depth, inch**	**Width,inch**	**Depth, inch**
Floor loads only or combined floor and roof loads	Columns; Framed sawn or glued- laminated timber arches which spring from the floor line; Framed timber trusses	8	8	6 3/4	8 1/4	7	7 1/2
	Wood beams and girders	6	10	5	10 1/2	5 1/4	9 1/2
	Columns (roof and ceiling loads); Lower half of: Wood-frame or glued- laminated arches which spring from the floor line or from grade	6	8	5	8 1/4	5 1/4	7 1/2

	Upper half of: Wood-frame or glued- laminated arches which spring from the floor line or from grade	6	6	5	6	5 1/4	5 1/2
Roof loads only	Framed timber trusses and other roof framing;[a] Framed or glued-laminated arches that spring from the top of walls or wall abutments	4 [b]	6	3 [b]	6 7/8	3 1/2 [b]	5 1/2

For SI:1inch =25.4 mm.

[a]Spaced members shall be permitted to be composed of two or more pieces not less than 3 inches (76mm) nominal in thickness where blocked solidly throughout their intervening spaces or where spaces are tightly closed by a continuous wood coverplate of not less than 2 inches (51 mm) nominal in thickness secured to the underside of the members. Splice lates shall be not less than 3 inches (76mm) nominal in thickness.

[b]Where protected by approved automatic sprinklers under the roof deck, framing members shall be not less than 3 inches(76 mm) nominal in width.

Reason: The cross laminated timber product standard was approved in the 2015 IBC in addition to a code change allowing this material to be utilized for the construction of 2 hour exterior walls in type IV-HT construction.

Cross Laminated Timber has been manufactured for over 30 years in Europe and has just recently caught hold on the American Continent where some major structures are under way in Canada and smaller buildings are being built in the US. In Europe buildings of 8 to 10 stories and above are regularly constructed. The following link gives examples of CLT buildings throughout the world. http://www.rethinkwood.com/tall-wood-survey

Because of the high level of carbon sequestration and low embodied energy, it is anticipated there will be a renewed interest in the use of type IV heavy timber as a type of construction. One bit of feedback American Wood Council received after CLT was approved in the 2015 IBC was the observation from one building department that the heavy timber and type IV provisions are confusing, sometimes redundant and spread across different sections of the building code.

This code change is an attempt to address that concern without making any change in the substance of the requirements. Currently type IV construction and heavy timber requirements are found in Sections 602.4 and 2304.11 of the IBC. The clean up and reorganization of those sections is part one of this effort. Part two is the identification and update of many references to type IV construction and heavy timber found throughout the code.

In order to pare down Section 602.4, only the provisions specific to type IV construction remain along with a list of the types of materials found in heavy timber and the reference to the requirements for those materials in Section 2304.11. Requirements specific to type IV remain in 602.4.

Section 2304.11 can best be described as "all things heavy timber". Heavy timber structural elements have long been referenced throughout other parts of the code where a specific heavy timber structural element is detailed for use incorporated in another type of construction. The most general example of this is table 601 footnote c allowing the use of heavy timber roof construction in place of one hour fire resistance rated roof construction in types IB, II, IIIA, and VA construction. The design professional may detail heavy timber as the roof structure and assembly for these different types of construction and they are treated as building elements but the type of construction for the overall structure does not change from the type IB, II, IIIA, or VA.

Heavy timber requirements removed from Section 602.4 are combined and organized with the existing content of Section 2304. Table 602.4 is moved and renamed Table 2304.11. It is updated with information placing a description of the elements that are applicable for a given size timber element based on whether the element supports roof loads and floor loads or only roof loads. Specific footnotes about the size and protection of spaced truss elements and the reduction of roof beam width for sprinklers are noted where applicable.

The non-size related detailing provisions for framing members and connections (columns, floor framing and roof framing) are coalesced into Sections 2304.11.1.1, 2304.11.1.2 and 2304.11.1.3. All of the information in table 2304.11 and the following sections are organized so that the most pertinent information for most designs is found first.

Finally, some of the detailing provisions for traditional heavy timber are identified as such and relocated later in each section while some other information that is archaic and better replaced by reference is removed. A good example of this is the removal of the requirement for the anchorage of "every monitor and every sawtooth construction" to the main roof construction in Section 2304.11.3. New Section 2304.11.1.3 requires roof girders and alternate roof beams to be anchored to their supports as required by Chapter 16.

Finally, Sections 2304.11.2 through 2304.11.4 contain pertinent thickness and detailing requirements for walls, roof and floor deck construction.

The following table gives a more detailed description of where specific requirements are moved.

Since this change is intended not to create any new requirements or delete pertinent content, there are other code changes which contain specific code changes to this information. It is intended this code change will serve as a template for the relocation of those other specific changes through the correlation process should other specific changes be approved.

Part 2 of this effort follows with the change to specific code references to: Section 602.4, type IV construction, heavy timber and Section 2304.11.

Section in 2015 IBC	Location in proposed change	Comments
602.4 Type IV	602.4 (same location)	modified to direct users to news section on heavy timber details; retains essentials for Type IV construction
Table 602.4	Table 2304.11	additional content is added describing the thickness of structural elements based on loading and configuration from 602.4.3 through 602.4.5
602.4.1 Fire-retardant treated wood in exterior walls, and 602.4.2 Cross-laminated timber in exterior walls	602.4.1 and 602.4.2 (same location)	thickness of wall assembly added from 602.4.8.2 item 2.
602.4.3 Columns	2304.11, Table 2304.11, and Section 2304.11.1.1	requirements combined with existing 2304.11.1 Columns; dimensions in new Table 2304.11.1
602.4.4 Floor framing	2304.11, Table 2304.11	
602.4.5 Roof framing	2304.11, Table 2304.11	
602.4.6 Floors	2304.11.3	
602.4.6.1 Sawn or glued-laminated plank floors	2304.11.3.2	the end of proposed Section 2304.11.3.2 comes from current 2304.11.2
602.4.6.2 Cross-laminated timber floors	2304.11.3.1	
602.4.7 Roofs	2304.11.4 and subsections 2304.11.4.1 and 2304.11.4.2	the current provisions of current section 2304.11.5 are folded into these sections
602.4.8 Partitions and walls and subsections 602.4.8.1 Interior walls and partitions and 602.4.8.2 Exterior walls	602.for exterior wall thickness in type IV; heavy timber in 2304.11.2 2304.11.2.1 and 2304.11.2.2	kept essentials for a Type IV building in 602.4; essentials for heavy timber in proposed section 2304.11.2
602.4.9 Exterior structural members	602.4.3	Unchanged but references proposed heavy timber section
2304.11 Heavy timber construction	2304.11 (same location)	Modified to become charging language for all heavy timber, not just Type IV construction; adds

		charging language for proposed Table 2304.11
2304.11.1 Columns	2304.11.1.1	new section 2304.11.1.1 combines current sections 2304.11.1 and 2304.11.1.1; updates text to be more design focused; retains traditional details
2304.11.1.1 Column connections	2304.11.1.1	incorporated in 2304.11.1
2304.11.2 Floor framing	2304.11.1.2	modifies text to make lesser-used methods a permitted option
2304.11.3 Roof framing	2304.11.1.3	modifies text to refer to design for all forces, not just uplift, archaic language deleted
2304.11.4 Floor decks	2304.11.3.2	current text appears at the end of the proposed section with hardware choices updated; this section incorporates requirements for floors moved from Chapter 6
2304.11.5 Roof decks	2304.11.4	current text appears at end of proposed section, and updates language to reflect current methods and to include consideration of all forces

S7553

Date Submitted	11/29/2018	**Section**	2304.11	**Proponent**	Paul Coats
Chapter	6	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

#7522 for Section 602.4 is a duplicate of this proposal which takes provisions from Chapter 6 and moves them to Chapter 23, necessitating review by both the Fire Safety and Structural TACs.

Summary of Modification

This proposed modification takes the details for heavy timber construction out of Chapter 6 and consolidates them in Chapter 23.

Rationale

The proposed modifications were approved by the ICC membership and appear in the 2018 IBC. They do not change the technical requirements for heavy timber but improve their usability. The changes shown reflect ICC code changes G179-15 (primarily), G178-15, and G175-18, which were all Approved as Submitted by the General Code Development Committee and subsequently the ICC membership (files are attached). The IBC General Code Development Committee made the following statement in the 2015 ICC Report of Committee Action Hearing, for G179-15: "The proposal provides necessary consolidation and eliminates duplicative text between Chapters 6 and 23. The revised table is sorely needed to make help the users of the code. Moving the table to Chapter 23 is totally appropriate. The was comfort that with a detailed comparision this is a good clean up with no technical changes. As with any major revision, there remained concerns that all pieces have been maintained and there might be some unintended consequences. The new organization provides better logic for the requirements." See the uploaded file for the complete rationale for the primary code change, G179-15, and a table comparing the locations of sections in the current code and what is proposed. Reason statements for G175-15 and G178-15 can also be seen in the support files for the text.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Enforcement of provisions may be easier.

Impact to building and property owners relative to cost of compliance with code

There are no changed cost implications.

Impact to industry relative to the cost of compliance with code

There are no changed cost implications.

Impact to small business relative to the cost of compliance with code

No impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This reorganization and consolidation of heavy timber provisions in one location will promote better compliance and better enforcement and therefore affects the safety and welfare of the general public positively.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This reorganization and consolidation of heavy timber provisions in one location will improve the usability and application of the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate in any way.

Does not degrade the effectiveness of the code

Retains the current effectiveness of the code and improves it.

602.4 Type IV. Type IV construction ~~(Heavy Timber, HT)~~ is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of solid wood, ~~or~~ laminated wood, heavy timber (HT) or structural composite lumber (SCL) without concealed spaces. The minimum dimensions for permitted materials including solid timber, glued-laminated timber, structural composite lumber (SCL), and cross-laminated timber and ~~The~~ details of Type IV construction shall comply with the provisions of this section and Section 2304.11. Exterior walls complying with Section 602.4.1 or 602.4.2 shall be permitted. Interior walls and partitions not less than 1-hour fire-resistance rating or heavy timber complying with Section 2304.11.2.2 shall be permitted. ~~Minimum solid sawn nominal dimensions are required for structures built using Type IV construction (HT). For glued-laminated members and structural composite lumber (SCL) members, the equivalent net finished width and depths corresponding to the minimum nominal width and depths of solid sawn lumber are required as specified in Table 602.4. *Cross-laminated timber* (CLT) dimensions used in this section are actual dimensions.~~

602.4.1 Fire-retardant-treated wood in exterior walls. *Fire-retardant-treated wood* framing and sheathing complying with Section 2303.2 shall be permitted within exterior wall assemblies not less than 6 inches (152 mm) in thickness with a 2-hour rating or less.

602.4.2 Cross-laminated timber in exterior walls. *Cross-laminated timber* complying with Section 2303.1.4 shall be permitted within exterior wall assemblies not less than 6 inches (152 mm) in thickness with a 2-hour rating or less, provided the exterior surface of the cross-laminated timber is protected by one the following:

1. *Fire-retardant-treated wood* sheathing complying with Section 2303.2 and not less than 15/32 inch (12 mm) thick;
2. *Gypsum board* not less than 1/2 inch (12.7 mm) thick; or
3. A noncombustible material.

~~**602.4.3 Columns.** Wood columns shall be sawn or glued laminated and shall be not less than 8 inches (203 mm), nominal, in any dimension where supporting floor loads and not less than 6 inches (152 mm) nominal in width and not less than 8 inches (203 mm) nominal in depth where supporting roof and ceiling loads only. Columns shall be continuous or superimposed and connected in an *approved* manner. Protection in accordance with Section 704.2 is not required.~~

~~**602.4.4 Floor framing.** Wood beams and girders shall be of sawn or glued-laminated timber and shall be not less than 6 inches (152 mm) nominal in width and not less than 10 inches (254 mm) nominal in depth. Framed sawn or glued-laminated timber arches, which spring from the floor line and support floor loads, shall be not less than 8 inches (203 mm) nominal in any dimension. Framed timber trusses supporting floor loads shall have members of not less than 8 inches (203 mm) nominal in any dimension.~~

~~**602.4.5 Roof framing.** Wood-frame or glued-laminated arches for roof construction, which spring from the floor line or from grade and do not support floor loads, shall have members not less than 6 inches (152 mm) nominal in width and have not less than 8 inches (203 mm) nominal in depth for the lower half of the height and not less than 6 inches (152 mm) nominal in depth for the upper half. Framed or glued-laminated arches for roof construction that spring from the top of walls or wall abutments, framed timber trusses and other roof framing, which do not support floor loads, shall have members not less than 4 inches (102 mm) nominal in width and not less than 6 inches (152 mm) nominal in depth. Spaced members shall be permitted to be composed of two or more pieces not less than 3 inches (76 mm) nominal in thickness where blocked solidly throughout their intervening spaces or where spaces are tightly closed by a continuous wood cover plate of not less than 2 inches (51 mm) nominal in thickness secured to the underside of the members. Splice plates shall be not less than 3 inches (76 mm) nominal in thickness. Where protected by *approved* automatic sprinklers under the roof deck, framing members shall be not less than 3 inches (76 mm) nominal in width.~~

~~602.4.9~~ 602.4.3 Exterior structural members. Where a horizontal separation of 20 feet(6096 mm) or more is provided, wood columns and arches conforming to heavy timber sizes complying with 2304.11 shall be permitted to be used externally.

2304.11 Heavy timber construction. Where a structure ~~or~~ , portion thereof ~~is~~, or individual structural elements are required to be of ~~Type IV construction~~ heavy timber ~~by other~~ provisions of this code, the building elements therein shall comply with the applicable provisions of Sections 2304.11.1 through ~~2304.11.5~~ 2304.11.4.Minimum dimensions ofheavytimber shall comply as applicable in Table2304.11 based on roofs or floors supported and the configuration of each structural element, or as applicable in Sections2304.11.2 through 2304.11.4.

2304.11.1 ~~Columns~~Details of heavy timber structural members. ~~Columns~~

Heavy timber structural members shall be ~~continuous or superimposed throughout all stories by means of reinforced concrete or metal caps~~ detailed and constructed inaccordance with ~~brackets, or shall be connected by properly designed steel or iron caps,with pintles and base plates,or by timber splice plates affixed to the columns by metal connectors housed within the contact faces, or by other *approved* methods.~~Sections 2304.11.1.1 through 2304.11.1.3.

2304.11.1.1~~Column connections~~Columns. Minimum dimensions of columns shall be in accordance with Table 2304.11.Columns shall be continuous or superimposed throughout all stories and connected in an *approved* manner. Girders and beams at column connections shall be closely fitted around columns and adjoining ends shall be cross tied to each other,or intertied by caps or ties,to transfer horizontal loads across joints. Wood bolsters shall not be placed on tops of columns unless the columns support roof loads only.Where traditional heavy timber detailing is used, connections shall be permitted to be by means of reinforced concrete ormetal caps with brackets, or shall be connected by properly designed steel or iron caps, with pintles and base plates, or by timber splice plates affixed to the columns by metal connectors housed within the contact faces, or by other approved methods.

~~2304.11.2~~ 2304.11.1.2 Floor framing. Minimum dimensions of floor framing shall be in accordance with Table 2304.11. *Approved* wall plate boxes or hangers shall be provided where wood beams, girders or trusses rest on masonry or concrete walls. Where intermediate beams are used to support a floor, they shall rest on top of girders, or shall be supported by ~~ledgers or blocks securely fastened to the sides of the girders, or they shall be supported by~~ an *approved* metal hanger into which the ends of the beams shall be closely fitted.Where traditional heavy timber detailing is used, these connections shall be permitted to be supported by ledgers or blocks securely fastened to the sides of the girders.

~~2304.11.3~~ 2304.11.1.3 Roof framing. Minimum dimensions of roof framing shall be in accordance with Table 2304.11. Every roof girder and at least every alternate roof beam shall be anchored to its supporting member; ~~and every monitor and every sawtooth construction shall be anchored to the main roof construction. Such anchors shall consist o fsteel or iron bolts of sufficient strength~~ to resist ~~vertical uplift of the roof.~~forces as required in Chapter 16.

~~602.4.8~~ 2304.11.2 Partitions and walls. Partitions and walls shall comply with Section ~~602.4.8.1~~2304.11.2.1 or ~~602.4.8.2~~ 2304.11.2.2.

~~602.4.8.2~~ 2304.11.2.1Exterior walls. Exterior walls shall permitted to be ~~of one of the following:~~

~~1. Noncombustible materials.~~
1. ~~Not less than 6 inches (152 mm) in thickness and constructed of one of the following:~~
   ~~1.1. *Fire-retardant-treated wood* in accordance with Section 2303.2 and complying with Section 602.4.1.~~
   1.1.*Cross-laminated timber*~~complying with~~ meeting the requirements of Section ~~602.4.2~~ 2303.1.4.

~~602.4.8.1~~ 2304.11.2.2 Interior walls and partitions.*No change to text.*

~~602.4.6~~ 2304.11.3 Floors. Floors shall be without concealed spaces. Wood floors shall be constructed in accordance with Section ~~602.4.6.1~~2304.11.3.1 or ~~602.4.6.2~~2304.11.3.2.

~~602.4.6.2~~ 2304.11.3.1 Cross-laminated timber floors. *Cross-laminated timber* shall be not less than 4 inches (102 mm) in actual thickness. *Cross-laminated timber* shall be continuous from support to support and mechanically fastened to one another. *Cross-laminated timber* shall be permitted to be connected to walls without a shrinkage gap providing swelling or shrinking is considered in the design.Corbelling of masonry walls under the floor shall be permitted to be used.

~~602.4.6.1~~ 2304.11.3.2 Sawn or glued-laminated plank floors. *No change to text.*

Delete without substitution:

2304.11.4 Floor decks. Floor decks and covering shall not extend closer than 1/2-inch (12.7 mm) to walls. Such 1/2-inch(12.7 mm) spaces shall be covered by a molding fastened to the wall either above or below the floor and arranged such that the molding will not obstruct the expansion or contraction movements of the floor. Corbeling of masonry walls under floors is permitted in place of such molding.

Revise as follows:

2304.11.5 2304.11.4 Roof decks. Roofs shall be without concealed spaces and roof decks shall be constructed in accordance with Section 2304.11.4.1 or2304.11.4.2.Other types of decking shall be permitted to be used where equivalent fire resistance and structural properties are being provided. Where supported by a wall, roof decksshall be anchored to walls to resist uplift forces determined in accordance with Chapter 16.Such anchors shall consist of steel bolts, lags, screws or iron bolts *approved* hardware of sufficient strength to resist vertical uplift of the roof.prescribed forces.

602.4.7 2304.11.4.1 Roofs Cross-laminated timber roofs. Roofs shall be without concealed spaces and wood roof decks shall be sawn or glued laminated, splined or tongue-and-groove plank,not less than 2 inches (51 mm) nominal in thickness; 11-/8-inch-thick(32 mm)wood structural panel (exterior glue); planks not less than 3inches (76 mm) nominal in width, set on edge close together and laid as required for floors; or of cross-laminated timber. Other types of decking shall be permitted to be used if providing equivalent fire resistance and structural properties.

Cross-laminated timber roofs shall be not less than 3 inches (76 mm) nominal in in actual thickness and shall be continuous from support to support and mechanically fastened to one another.

Add new text as follows:

2304.11.4.2Sawn, wood structuralpanel, or glued-laminated plank roofs.

Sawn,wood structural panel, or glued-laminated plank roofs shall be one of the following:

1. Sawn or glued laminated, splined or tongue-and-groove plank, not less than 2 inches (51 mm) nominal in thickness;
2. 11 /8-inch-thick (32mm) wood structural panel (exterior glue);
3. Planks not less than 3inches (76mm) nominal in width, set on edge close together and laid as required for floors.

Revise as follows:

TABLE 602.4 2304.11
WOODMEMBER SIZE EQUIVALENCIES MINIMUM DIMENSIONS OF HEAVY TIMBER STRUCTURAL MEMBERS

		MINIMUM NOMINAL SOLID SAWN SIZE		MINIMUM GLUED-LAMINATED NETSIZE		MINIMUM STRUCTURAL COMPOSITELUMBER NETSIZE
Supporting	Heavy Timber Structural Element	Width,inch	Depth, inch	Width, inch	Depth,inch	Widtl

Floor loads only or combined floor and roof loads	Columns; Framed sawn or glued- laminated timber arches which springfrom the floor line; Framed timber trusses	8	8	6 3/4	8 1/4	
	Wood beams and girders	6	10	5	10 1/2	5
	Columns (roof and ceiling loads); Lower half of: Wood-frameor glued-laminated arches which spring from the floor line or from grade	6	8	5	8 1/4	5
	Upper half of: Wood-frameor glued-laminated arches which spring from the floor line or from grade	6	6	5	6	5

Roof loadsonly	Framed timber trusses and other roof framing;a Framed or glued-laminated arches that spring from the top of walls or wall abutments	4 b	6	3 b	6 7/8	3 1.

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For SI:1inch =25.4 mm.

aSpaced members shall be permitted to be composed of two or more pieces not less than 3 inches (76mm) nominal in thickness where blocked solidly throughout their intervening spaces or where spaces are tightly closed by a continuous wood coverplate of not less than 2 inches (51 mm) nominal in thickness secured to the underside of the members. Splice lates shall be not less than 3 inches (76mm) nominal in thickness.

bWhere protected by approved automatic sprinklers under the roof deck, framing members shall be not less than 3 inches(76 mm) nominal in width.

G 175-15

602.3, 602.4.1

Proponent: Homer Maiel, PE, CBO, representing ICC Tri-Chapter (Peninsula, East Bay, Monterey Bay) (hmaiel@gmail.com)

2015 International Building Code

Revise as follows:

602.3 Type III. Type III construction is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of any material permitted by this code. *Fire-retardant-treated wood* framing <u>and sheathing</u> complying with Section 2303.2 shall be permitted within *exterior wall* assemblies of a 2-hour rating or less.

602.4.1 Fire-retardant-treated wood in exterior walls. *Fire-retardant-treated wood* framing <u>and sheathing</u> complying with Section 2303.2 shall be permitted within exterior wall assemblies with a 2-hour rating or less.

Reason: The word framing creates some confusion. some have interpreted that framing does not include the sheathing utilized for lateral resistance to be framing. This has resulted in at least one interpretation that the walls cannot have FRT structural wood panel framing and yet another interpretation that the structural wood panel is permitted to be installed but unlike the studs does not need to be FRT.
ASCE considers sheathing to be part of the framing system. The ICC ES has AQ for a product equivalent to FRT plywood for use on Type III construction.

The addition of sheathing clarifies wood framing and sheathing is permitted to be within the assembly if FRT.

Cost Impact: Will not increase the cost of construction
This code change does not create a new requirement. It clarifies existing code language to prevent misinterpretation of the code.

G 175-15 : 602.3-MAIEL4965

G 178-15

602.4

Proponent: Sam Francis, American Wood Council, representing American Wood Council (sfrancis@awc.org)

2015 International Building Code

Revise as follows:

602.4 Type IV. Type IV construction (Heavy Timber, HT) is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of solid orwood, laminated wood or structural composite lumber (SCL) without concealed spaces. The details of Type IV construction shall comply with the provisions of this section and Section 2304.11. Exterior walls complying with Section 602.4.1 or 602.4.2 shall be permitted. Minimum soliddimensions for building elements are as follows:

1. Solid sawn building elements shall be not less than the nominal dimensions are required for structures built using Type IV construction (HT)in Sections 602.4.3 through 602.4.6.

2. For gluedlaminatedGlued-laminated members and structural composite lumber (SCL) members,members shall be the equivalent net finished width and depthsdepth corresponding to the minimum nominal width and depthsdepth of solid sawn lumber are required as specified in Table 602.4.*Cross-laminated*

3. Cross-laminated timber (CLT) dimensions used in this section are actual dimensions and shall be not less than the dimensions required in Sections 602.4.6.2, 602.4.7, and 602.4.6.8.2, as applicable.

Reason:
In the last code cycle, the Heavy Timber section saw 5 code change proposals. The correlation of these changes was very difficult. We are submitting several changes which are intended to make this chapter more understandable. One of the issues to be clarified is the "minimum dimensions of the exterior walls. Another item is to make it absolutely clear that Structural Composite Lumber of the minimum dimensions for this chapter is, in fact, considered heavy timber. So this proposal will point the user to the proper sections to accomplish these tasks.
For a complete list of AWC code change proposals and additional information please go to http://www.awc.org/Code-Officials/2015-IBC-Code-Changes.

Cost Impact: Will not increase the cost of construction
This is an editorial rewrite and will have no cost impact other than to lower costs by making the minimum requirements more clear.

G 178-15 : 602.4-FRANCIS4679

G 179-15

602.4, TABLE 602.4, 602.4.1, 602.4.2, 602.4.3, 602.4.4, 602.4.5, 602.4.9, 2304.11, 2304.11.1, TABLE 2304.11.1.1, 2304.11.2, 2304.11.3, 602.4.8, 602.4.8.2, 602.4.8.1, 602.4.6, 602.4.6.2, 602.4.6.1, 2304.11.4, 2304.11.5, 602.4.7, 2304.11.4.2 (New)

Proponent: Dennis Richardson, representing American Wood Council

2015 International Building Code

Revise as follows:

602.4 Type IV. Type IV construction ~~(Heavy Timber, HT)~~ is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of solid or laminated ~~wood~~heavy timber (HT), without concealed spaces. The minimum dimensions for permitted materials including solid timber, glued-laminated timber, structural composite lumber (SCL), and cross liminated timber (CLT) and details of Type IV construction shall comply with the provisions of this section and Section 2304.11. Exterior walls complying with Section 602.4.1 or 602.4.2 shall be permitted. ~~Minimum solid sawn nominal dimensions are required for structures built using Type IV construction (HT). For gluedlaminated members~~Interior walls and ~~structural composite lumber (SCL) members, the equivalent net finished width and depths corresponding to the minimum nominal width and depths~~partitions of ~~solid sawn lumber are required as specified in Table 602.4.~~not less than one hour~~Cross~~*fire-resistance rating*~~-laminated~~ or heavy *timber* ~~(CLT) dimensions used in this section are actual dimensions.~~ conforming with Section 2304.11.2.2 shall be permitted.

602.4.1 Fire-retardant-treated wood in exterior walls. *Fire-retardant-treated wood* framing complying with Section 2303.2 shall be permitted within exterior wall assemblies not less than 6 inches (152 mm) in thickness with a 2-hour rating or less.

602.4.2 Cross-laminated timber in exterior walls. *Cross-laminated timber* complying with Section 2303.1.4 shall be permitted within exterior wall assemblies not less than 6 inches (152 mm) in thickness with a 2-hour rating or less, provided the exterior surface of the cross-laminated timber is protected by one the following:

1. *Fire-retardant-treated wood* sheathing complying with Section 2303.2 and not less than $^{15}/_{32}$ inch (12 mm) thick;
2. *Gypsum board* not less than $^{1}/_{2}$ inch (12.7 mm) thick; or
3. A noncombustible material.

Delete without substitution:

~~**602.4.3 Columns.** Wood columns shall be sawn or glued laminated and shall be not less than 8 inches (203 mm), nominal, in any dimension where supporting floor loads and not less than 6 inches (152 mm) nominal in width and not less than 8 inches (203 mm) nominal in depth where supporting roof and ceiling loads only. Columns shall be continuous or superimposed and connected in an *approved* manner. Protection in accordance with Section 704.2 is not required.~~

~~**602.4.4 Floor framing.** Wood beams and girders shall be of sawn or glued-laminated timber and shall be not less than 6 inches (152 mm) nominal in width and not less than 10 inches (254 mm) nominal in depth. Framed sawn or glued-laminated timber arches, which spring from the floor line and support floor loads, shall be not less than 8 inches (203 mm) nominal in any dimension. Framed timber trusses supporting floor loads shall have members of not less than 8 inches (203 mm) nominal in any dimension.~~

~~**602.4.5 Roof framing.** Wood-frame or glued-laminated arches for roof construction, which spring from the floor line or from grade and do not support floor loads, shall have members not less than 6 inches (152 mm) nominal in width and have not less than 8 inches (203 mm) nominal in depth for the lower half of the height and not less than 6 inches (152 mm) nominal in depth for the upper half. Framed or glued laminated arches for roof construction that spring from the top of walls or wall abutments, framed timber trusses and other roof framing, which do not support floor loads, shall have members not less than 4 inches (102 mm) nominal in width and not less than 6 inches (152 mm) nominal in depth. Spaced members shall be permitted to be composed of two or more pieces not less than 3 inches (76 mm) nominal in thickness where blocked solidly throughout their intervening spaces or where spaces are tightly closed by a continuous wood cover plate of not less than 2 inches (51 mm) nominal in thickness secured to the underside of the members. Splice plates shall be not less than 3 inches (76 mm) nominal in thickness. Where protected by *approved* automatic sprinklers under the roof deck, framing members shall be not less than 3 inches (76 mm) nominal in width.~~

Revise as follows:

~~**602.4.9**~~**602.4.3 Exterior structural members.** Where a horizontal separation of 20 feet (6096 mm) or more is provided, wood columns and arches conforming to heavy timber sizes complying with 2304.11 shall be permitted to be used externally.

2304.11 Heavy timber construction. Where a structure ~~or~~, portion thereof ~~is~~, or individual structural elements are required to be of ~~Type IV construction~~heavy timber by ~~other~~ provisions of this code, the building elements therein shall comply with the applicable provisions of Sections 2304.11.1 through ~~2304.11.5~~2304.11.4. Minimum dimensions of heavy timber shall comply as applicable in Table 2304.11 based on roofs or floors supported and the configuration of each structural element, or as applicable in Sections 2304.11.2 through 2304.11.4.

2304.11.1 ~~Columns~~Details of heavy timber structural members. ~~Columns~~
Heavy timber structural members shall be ~~continuous or superimposed throughout all stories by means of reinforced concrete or metal caps~~detailed and constructed in accordance with ~~brackets, or shall be connected by properly designed steel or iron caps, with pintles and base plates, or by timber splice plates affixed to the columns by metal connectors housed within the contact faces, or by other *approved* methods.~~Sections 2304.11.1.1 through 2304.11.1.3.

2304.11.1.1 ~~Column connections~~Columns. Minimum dimensions of columns shall be in accordance with Table 2304.11. Columns shall be continuous or superimposed throughout all stories and connected in an *approved* manner. Girders and beams at column connections shall be closely fitted around columns and adjoining ends shall be cross tied to each other, or intertied by caps or ties, to transfer horizontal loads across joints. Wood bolsters shall not be placed on tops of columns unless the columns support roof loads only. Where traditional heavy timber detailing is used, connections shall be permitted to be by means of reinforced concrete or metal caps with brackets, or shall be connected by properly designed steel or iron caps, with pintles and base plates, or by timber splice plates affixed to the columns by metal connectors housed within the contact faces, or by other approved methods.

~~2304.11.2~~2304.11.1.2 **Floor framing.** Minimum dimensions of floor framing shall be in accordance with Table 2304.11. *Approved* wall plate boxes or hangers shall be provided where wood beams, girders or trusses rest on masonry or concrete walls. Where intermediate beams are used to support a floor, they shall rest on top of girders, or shall be supported by ~~ledgers or blocks securely fastened to the sides of the girders, or they shall be supported by~~ an *approved* metal hanger into which the ends of the beams shall be closely fitted. Where traditional heavy timber detailing is used, these connections shall be permitted to be supported by ledgers or blocks securely fastened to the sides of the girders.

~~2304.11.3~~2304.11.1.3 **Roof framing.** Minimum dimensions of roof framing shall be in accordance with Table 2304.11. Every roof girder and at least every alternate roof beam shall be anchored to its supporting member~~; and every monitor and every sawtooth construction shall be anchored to the main roof construction. Such anchors shall consist of steel or iron bolts of sufficient strength~~ to resist ~~vertical uplift of the roof.~~forces as required in Chapter 16.

~~602.4.8~~2304.11.2 **Partitions and walls.** Partitions and walls shall comply with Section ~~602.4.8.1~~2304.11.2.1 or ~~602.4.8.2~~2304.11.2.2.

~~602.4.8.2~~2304.11.2.1 **Exterior walls.** Exterior walls shall permitted to be ~~of one of the following:~~

~~1. Noncombustible materials.~~
1. ~~Not less than 6 inches (152 mm) in thickness and constructed of one of the following:~~
   ~~1.1. *Fire-retardant-treated wood* in accordance with Section 2303.2 and complying with Section 602.4.1.~~
   1.1. *Cross-laminated timber*~~complying with~~meeting the requirements of Section ~~602.4.2~~2303.1.4.

~~602.4.8.1~~2304.11.2.2 **Interior walls and partitions.** *No change to text.*

~~602.4.6~~2304.11.3 **Floors.** Floors shall be without concealed spaces. Wood floors shall be constructed in accordance with Section ~~602.4.6.1~~2304.11.3.1 or ~~602.4.6.2~~2304.11.3.2.

~~602.4.6.2~~2304.11.3.1 **Cross-laminated timber floors.** *Cross-laminated timber* shall be not less than 4 inches (102 mm) in actual thickness. *Cross-laminated timber* shall be continuous from support to support and mechanically fastened to one another. *Cross-laminated timber* shall be permitted to be connected to walls without a shrinkage gap providing swelling or shrinking is considered in the design. Corbelling of masonry walls under the floor shall be permitted to be used.

~~602.4.6.1~~2304.11.3.2 **Sawn or glued-laminated plank floors.** *No change to text.*

Delete without substitution:

~~**2304.11.4 Floor decks.** Floor decks and covering shall not extend closer than $^1/_2$ inch (12.7 mm) to walls. Such $^1/_2$-inch (12.7 mm) spaces shall be covered by a molding fastened to the wall either above or below the floor and arranged such that the molding will not obstruct the expansion or contraction movements of the floor. Corbeling of masonry walls under floors is permitted in place of such molding.~~

Revise as follows:

~~2304.11.5~~2304.11.4 **Roof decks.** Roofs shall be without concealed spaces and roof decks shall be constructed in accordance with Section 2304.11.4.1 or 2304.11.4.2. Other types of decking shall be permitted to be used where equivalent fire resistance and structural properties are being provided. Where supported by a wall, roof decks shall be anchored to walls to resist ~~uplift~~ forces determined in accordance with Chapter 16. Such anchors shall consist of steel bolts, lags, screws or ~~iron bolts~~*approved* hardware of sufficient strength to resist ~~vertical uplift of the roof.~~prescribed forces.

~~602.4.7~~2304.11.4.1 ~~**Roofs**~~**Cross-laminated timber roofs.** ~~Roofs shall be without concealed spaces and wood roof decks shall be sawn or glued laminated, splined or tongue-and-groove plank, not less than 2 inches (51 mm) nominal in thickness; $1^1/_8$-inch-thick (32 mm) wood structural panel (exterior glue); planks not less than 3 inches (76 mm) nominal in width, set on edge close together and laid as required for floors; or of cross-laminated timber. Other types of decking shall be permitted to be used if providing equivalent fire resistance and structural properties.~~
Cross-laminated timber roofs shall be not less than 3 inches (76 mm) ~~nominal in~~in actual thickness and shall be continuous from support to support and mechanically fastened to one another.

Add new text as follows:

2304.11.4.2 Sawn, wood structural panel, or glued-laminated plank roofs.
Sawn, wood structural panel, or glued-laminated plank roofs shall be one of the following:

1. Sawn or glued laminated, splined or tongue-and-groove plank, not less than 2 inches (51 mm) nominal in thickness;
2. 11 /8-inch-thick (32 mm) wood structural panel (exterior glue);
3. Planks not less than 3 inches (76 mm) nominal in width, set on edge close together and laid as required for floors.

Revise as follows:

TABLE 2304.11
~~WOOD MEMBER SIZE EQUIVALENCIES~~MINIMUM DIMENSIONS OF HEAVY TIMBER STRUCTURAL MEMBERS

		MINIMUM NOMINAL SOLID SAWN SIZE		MINIMUM GLUED-LAMINATED NET SIZE		MINIMUM STRUCTURAL COMPOSITE LUMBER NET SIZE	
Supporting	Heavy Timber Structural Element	Width, inch	Depth, inch	Width, inch	Depth, inch	Width, inch	Depth, inch

Floor loads only or combined floor and roof loads	Columns: Framed sawn or glued-laminated timber arches which spring from the floor line: Framed timber trusses	8	8	6 3/4	8 1/4	7	7 1/2
	Wood beams and girders	6	10	5	10 1/2	5 1/4	9 1/2
Roof loads only	Columns (roof and ceiling loads): Lower half of: Wood-frame or glued-laminated arches which spring from the floor line or from grade	6	8	5	8 1/4	5 1/4	7 1/2
	Upper half of: Wood-frame or glued-laminated arches which spring from the floor line or from grade	6	6	5	6	5 1/4	5 1/2
	Framed timber trusses and other roof framing:[a] Framed or glued-laminated arches that spring from the top of walls or wall abutments	4[b]	6	3[b]	6 7/8	3 1/2 [b]	5 1/2

For SI:1 inch = 25.4 mm.

[a] Spaced members shall be permitted to be composed of two or more pieces not less than 3 inches (76 mm) nominal in thickness where blocked solidly throughout their intervening spaces or where spaces are tightly closed by a continuous wood cover plate of not less than 2 inches (51 mm) nominal in thickness secured to the underside of the members. Splice lates shall be not less than 3 inches (76 mm) nominal in thickness.

[b] Where protected by approved automatic sprinklers under the roof deck, framing members shall be not less than 3 inches (76 mm) nominal in width.

Reason: The cross laminated timber product standard was approved in the 2015 IBC in addition to a code change allowing this material to be utilized for the construction of 2 hour exterior walls in type IV-HT construction.
Cross Laminated Timber has been manufactured for over 30 years in Europe and has just recently caught hold on the American Continent where some major structures are under way in Canada and smaller buildings are being built in the US. In Europe buildings of 8 to 10 stories and above are regularly constructed. The following link gives examples of CLT buildings throughout the world. http://www.rethinkwood.com/tall-wood-survey
Because of the high level of carbon sequestration and low embodied energy, it is anticipated there will be a renewed interest in the use of type IV heavy timber as a type of construction. One bit of feedback American Wood Council received after CLT was approved in the 2015 IBC was the observation from one building department that the heavy timber and type IV provisions are confusing, sometimes redundant and spread across different sections of the building code.
This code change is an attempt to address that concern without making any change in the substance of the requirements. Currently type IV construction and heavy timber requirements are found in Sections 602.4 and 2304.11 of the IBC. The clean up and reorganization of those sections is part one of this effort. Part two is the identification and update of many references to type IV construction and heavy timber found throughout the code.

In order to pare down Section 602.4, only the provisions specific to type IV construction remain along with a list of the types of materials found in heavy timber and the reference to the requirements for those materials in Section 2304.11. Requirements specific to type IV remain in 602.4.

Section 2304.11 can best be described as "all things heavy timber". Heavy timber structural elements have long been referenced throughout other parts of the code where a specific heavy timber structural element is detailed for use incorporated in another type of construction. The most general example of this is table 601 footnote c allowing the use of heavy timber roof construction in place of one hour fire resistance rated roof construction in types IB, II, IIIA, and VA construction. The design professional may detail heavy timber as the roof structure and assembly for these different types of construction and they are treated as building elements but the type of construction for the overall structure does not change from the type IB, II, IIIA, or VA.

Heavy timber requirements removed from Section 602.4 are combined and organized with the existing content of Section 2304. Table 602.4 is moved and renamed Table 2304.11. It is updated with information placing a description of the elements that are applicable for a given size timber element based on whether the element supports roof loads and floor loads or only roof loads. Specific footnotes about the size and protection of spaced truss elements and the reduction of roof beam width for sprinklers are noted where applicable.

The non-size related detailing provisions for framing members and connections (columns, floor framing and roof framing) are coalesced into Sections 2304.11.1.1, 2304.11.1.2 and 2304.11.1.3. All of the information in table 2304.11 and the following sections are organized so that the most pertinent information for most designs is found first.

Finally, some of the detailing provisions for traditional heavy timber are identified as such and relocated later in each section while some other information that is archaic and better replaced by reference is removed. A good example of this is the removal of the requirement for the anchorage of "every monitor and every sawtooth construction" to the main roof construction in Section 2304.11.3. New Section 2304.11.1.3 requires roof girders and alternate roof beams to be anchored to their supports as required by Chapter 16.

Finally, Sections 2304.11.2 through 2304.11.4 contain pertinent thickness and detailing requirements for walls, roof and floor deck construction.

The following table gives a more detailed description of where specific requirements are moved.

Since this change is intended not to create any new requirements or delete pertinent content, there are other code changes which contain specific code changes to this information. It is intended this code change will serve as a template for the relocation of those other specific changes through the correlation process should other specific changes be approved.

Part 2 of this effort follows with the change to specific code references to: Section 602.4, type IV construction, heavy timber and Section 2304.11.

The following link provides access to additional information regarding this or other code changes proposed by American Wood Council.

http://www.awc.org/Code-Officials/2015-IBC-Code-Changes/

Section in 2015 IBC	Location in proposed change	Comments
602.4 Type IV	602.4 (same location)	modified to direct users to news section on heavy timber details; retains essentials for Type IV construction
Table 602.4	Table 2304.11	additional content is added describing the thickness of structural elements based on loading and configuration from 602.4.3 through 602.4.5
602.4.1 Fire-retardant treated wood in exterior walls, and 602.4.2 Cross-laminated timber in exterior walls	602.4.1 and 602.4.2 (same location)	thickness of wall assembly added from 602.4.8.2 item 2.
602.4.3 Columns	2304.11, Table 2304.11, and Section 2304.11.1.1	requirements combined with existing 2304.11.1 Columns; dimensions in new Table 2304.11.1
602.4.4 Floor framing	2304.11, Table 2304.11	
602.4.5 Roof framing	2304.11, Table 2304.11	
602.4.6 Floors	2304.11.3	
602.4.6.1 Sawn or glued-laminated plank floors	2304.11.3.2	the end of proposed Section 2304.11.3.2 comes from current 2304.11.2
602.4.6.2 Cross-laminated timber floors	2304.11.3.1	
602.4.7 Roofs	2304.11.4 and subsections 2304.11.4.1 and 2304.11.4.2	the current provisions of current section 2304.11.5 are folded into these sections
602.4.8 Partitions and walls and subsections 602.4.8.1 Interior walls and partitions and 602.4.8.2 Exterior walls	602.for exterior wall thickness in type IV; heavy timber in 2304.11.2 2304.11.2.1 and 2304.11.2.2	kept essentials for a Type IV building in 602.4; essentials for heavy timber in proposed section 2304.11.2
602.4.9 Exterior structural members	602.4.3	Unchanged but references proposed heavy timber section
2304.11 Heavy timber construction	2304.11 (same location)	Modified to become charging language for all heavy timber, not just Type IV construction; adds

		charging language for proposed Table 2304.11
2304.11.1 Columns	2304.11.1.1	new section 2304.11.1.1 combines current sections 2304.11.1 and 2304.11.1.1; updates text to be more design focused; retains traditional details
2304.11.1.1 Column connections	2304.11.1.1	incorporated in 2304.11.1
2304.11.2 Floor framing	2304.11.1.2	modifies text to make lesser-used methods a permitted option
2304.11.3 Roof framing	2304.11.1.3	modifies text to refer to design for all forces, not just uplift, archaic language deleted
2304.11.4 Floor decks	2304.11.3.2	current text appears at the end of the proposed section with hardware choices updated; this section incorporates requirements for floors moved from Chapter 6
2304.11.5 Roof decks	2304.11.4	current text appears at end of proposed section, and updates language to reflect current methods and to include consideration of all forces

Cost Impact: Will not increase the cost of construction
Since this is a reorganization of existing requirements, not the creation of new requirements, this code change will not increase the cost of construction.

G 179-15 : 602.4-RICHARDSON5194

Final Action: AS (Approved as Submitted

G 179-15

Committee Action: **Approved as Submitted**

Committee Reason: The proposal provides necessary consolidation and eliminates duplicative text between Chapters 6 and 23. The revised table is sorely needed to make help the users of the code. Moving the table to Chapter 23 is totally appropriate. The was comfort that with a detailed comparision this is a good clean up with no technical changes. As with any major revision, there remained concerns that all pieces have been maintained and there might be some unintended consequences. The new organization provides better logic for the requirements.

Assembly Action : **None**

S7501

Date Submitted	11/28/2018	**Section**	721.1	**Proponent**	Paul Coats
Chapter	7	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Mod 7496 - There is a related modification doing the same correction to row 30 of Table 721.1 (3)

Summary of Modification

Corrects an assembly description error in Table 721.1(3)

Rationale

This modification corrects a mistake in the table and was approved by the ICC committee and membership for the 2018 International Building Code. The current text entry as published in the 2015 IBC is not correctly shown since it does not specify the resilient channel as shown in the link below. The correct description and associated diagram can be found at the following location: https://awc.org/pdf/codes-standards/publications/dca/AWC-DCA3-FRR-Assemblies-1802.pdf

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact since it is a correction of a detail.

Impact to building and property owners relative to cost of compliance with code

No impact since it a correction of a detail.

Impact to industry relative to the cost of compliance with code

No impact since it is a correction of a detail.

Impact to small business relative to the cost of compliance with code

No impact since it is a correction of a detail.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Having the correct description in the code will prevent confusion and consistent compliance.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Corrects an incorrect detail.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Improves effectiveness of code.

TABLE 721.1(3)

MINIMUM PROTECTION FOR FLOOR AND ROOF SYSTEMS[a, q]

Revise row 27 of the Table as follows:

Minimum 0.019" thick resilient channel16" o.c. (channels doubled at wallboardend joints), placed perpendicular to thejoist and attached to each joist by 1 1/4"Type S drywall screws. Two layers of 1/2"Type X gypsum wallboard applied withthe long dimension perpendicular to the ~~I-joists~~ resilient channels with end joints staggered. The baselayer is fastened with 1 1/4" Type S drywallscrews spaced 12" o.c. and the face layeris fastened with 1 5/8" Type S drywallscrews spaced 12" o.c. Face layer endjoints shall not occur on the same I-joistas base layer end joints and edge jointsshall be offset 24" from base layer joints.Face layer to also be attached to baselayer with 1 1/2" Type G drywall screwsspaced 8" o.c. placed 6" from face layerend joints. Face layer wallboard joints tobe taped and covered with joint compound.

Revise as follows:

TABLE 721.1 (3)
MINIMUM PROTECTION FOR FLOOR AND ROOF SYSTEMS[a, q]

FLOOR OR ROOF CONSTRUCTION	ITEM NUMBER	CEILING CONSTRUCTION	THICKNESS OF FLOOR OR ROOF SLAB (inches)				MINIMUM THICKNESS OF CEILING (inches)			
			4 hours	3 hours	2 hours	1 hour	4 hours	3 hours	2 hours	1 hour

27. Wood I-joist (minimum I-joist depth $9\frac{1}{2}$" with a minimum flange depth of $1\frac{5}{16}$" and a minimum flange cross-sectional area of 1.95 square inches; minimum web thickness of $\frac{3}{8}$") @ 24" o.c.	27-1.1	Minimum 0.019" thick resilient channel 16" o.c. (channels doubled at wallboard end joints), placed perpendicular to the joist and attached to each joist by $1\frac{1}{4}$" Type S drywall screws. Two layers of $\frac{1}{2}$" Type X gypsum wallboard applied with the long dimension perpendicular to the ~~I-joists~~resilent channels with end joints staggered. The base layer is fastened with $1\frac{1}{4}$" Type S drywall screws spaced 12" o.c. and the face layer is fastened with $1\frac{5}{8}$" Type S drywall screws spaced 12" o.c. Face layer end joints shall not occur on the same I-joist as base layer end joints and edge joints shall be offset 24" from base layer joints. Face layer to also be attached to base layer with $1\frac{1}{2}$" Type G drywall screws spaced 8" o.c. placed 6" from face layer end joints. Face layer wallboard joints to be taped and covered with joint compound.	—	—	—	Varies	—	—	—	1

(Portions of table and footnotes not shown remain unchanged)

Mod 7501 Rationale

FS 130-15

Table 721.1 (3)

Proponent: David Tyree, representing American Wood Council (dtyree@awc.org); Sam Francis (sfrancis@awc.org)

2015 International Building Code

Revise as follows:

TABLE 721.1 (3)
MINIMUM PROTECTION FOR FLOOR AND ROOF SYSTEMS[a, q]

FLOOR OR ROOF CONSTRUCTION	ITEM NUMBER	CEILING CONSTRUCTION	THICKNESS OF FLOOR OR ROOF SLAB (inches)				MINIMUM THICKNESS OF CEILING (inches)			
			4 hours	3 hours	2 hours	1 hour	4 hours	3 hours	2 hours	1 hour

27. Wood I-joist (minimum I-joist depth $9\frac{1}{2}$" with a minimum flange depth of $1\frac{5}{16}$" and a minimum flange cross-sectional area of 1.95 square inches; minimum web thickness of $\frac{3}{8}$") @ 24" o.c.	27-1.1	Minimum 0.019" thick resilient channel 16" o.c. (channels doubled at wallboard end joints), placed perpendicular to the joist and attached to each joist by $1\frac{1}{4}$" Type S drywall screws. Two layers of $\frac{1}{2}$" Type X gypsum wallboard applied with the long dimension perpendicular to the ~~I-joists~~resilient channels with end joints staggered. The base layer is fastened with $1\frac{1}{4}$" Type S drywall screws spaced 12" o.c. and the face layer is fastened with $1\frac{5}{8}$" Type S drywall screws spaced 12" o.c. Face layer end joints shall not occur on the same I-joist as base layer end joints and edge joints shall be offset 24" from base layer joints. Face layer to also be attached to base layer with $1\frac{1}{2}$" Type G drywall screws spaced 8" o.c. placed 6" from face layer end joints. Face layer wallboard joints to be taped and covered with joint compound.	—	—	—	Varies	—	—	—	1

(Portions of table and footnotes not shown remain unchanged)

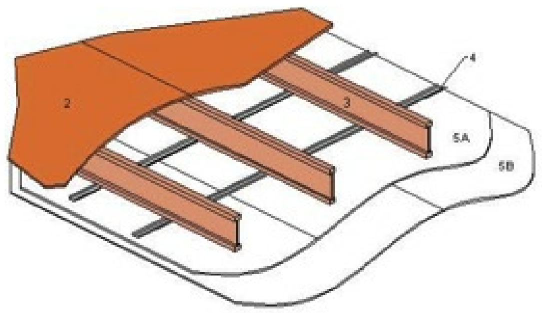
Reason: This proposal, in our opinion, is an editoral change as it simply is provided to correct what is currently specified in the 2015 IBC. The current text entry as published in the 2015 IBC is not correctly shown as the current code does not specify the resilient channel requirement as shown in the following link and the figure shown in the reason. This figure was referenced in the AWC code proposal submitted last code cycle and approved by the membership. (http://www.awc.org/publications/dca/dca3/WIJ-1.6.I-joist_2-layers_with_RCs.htm)
The reason statement for including this proposal previously in the 2015 IBC stated:

Reason: Many code officials have come to rely upon Table 720 as the preferred source of information regarding fire resistance rated assemblies. Because of its importance, we believe that the table should offer the most common generic assemblies. Floor systems utilizing I-joists have increased from less than 10 percent in 1990 to more than 50 percent. With the increased prevalence of I-joist floor/ceiling assemblies, including this assembly in the table will make the IBC more complete and it will be more useful to code officials. It is also expected that the document will be "user friendly", particularly for designers. In an effort to fulfill this expectation, we propose this common assembly for incorporation into Table 720.1(3). It is supported by ASTM E-119 test results as shown on the attached page. The following information and test results are provided with the understanding that their inclusion does not place them within the copyright release requirements of the signature statement. For a complete list of AWC code change proposals and additional information please go to http://www.awc.org/Code-Officials/2015-IBC-Code-Changes. For more information concerning CLT lumber and construction, please go to http://www.rethinkwood.com/tall-wood-survey.

For a complete list of AWC code change proposals and additional information please go to http://www.awc.org/Code-Officials/2015-IBC-Code-Changes.

WIJ-1.6 One-Hour Fire-Resistive Ceiling Assembly

Floor[a]/Ceiling - 100% Design Load - 1 Hour Rating - ASTM E 119 / NFPA 251



1. Floor Topping (optional, not shown): Gypsum concrete, lightweight or normal concrete topping.
2. Floor Sheathing: Minimum 23/32 inch thick tongue-and-groove wood sheathing (Exposure 1). Installed per code requirements with minimum 8d common nails.
3. Structural Members: Wood I-joists spaced a maximum of 24 inches on center.

Minimum I-joist flange depth: 1-5/16 inches — Minimum I-joist flange area: 1.95 $inches^2$
Minimum I-joist web thickness: 3/8 inch — Minimum I-joist depth: 9-1/2 inches

See ASTM D 5055-07 for qualification requirements.

4. Resilient Channels[b]: Minimum 0.019 inch thick galvanized steel resilient channel attached perpendicular to the bottom flange of the I-joists with one 1-1/4 inch drywall screw. Channels spaced a maximum of 16 inches on center [24 inches on center when I-joists are spaced a maximum of 16 inches on center].
5. Gypsum Wallboard: Two layers of minimum 1/2 inch Type X gypsum wallboard attached with the long dimension perpendicular to the resilient channels as follows:

5a. Wallboard Base Layer: Base layer of wallboard attached to resilient channels using 1-1/4 inch Type S drywall screws at 12 inches on center.

5b. Wallboard Face Layer: Face layer of wallboard attached to resilient channels through base layer using 1-5/8 inch Type S drywall screws spaced 12 inches on center. Edge joints of wallboard face layer offset 24 inches from those of base layer. Additionally, wallboard face layer attached to base layer with 1-1/2 inch Type G drywall screws spaced 8 inches on center, placed 1-1/2 inches from face layer end joints.

6. Finish System (not shown): Face layer joints covered with tape and coated with joint compound. Screw heads covered with joint compound.

Fire Test conducted at National Research Council of Canada — Report No: A-4440.1 — June 24, 1997

STC and IIC Sound Ratings for Listed Assembly							
Without Gypsum Concrete				**With Gypsum Concrete**			
Cushioned Vinyl		**Carpet & Pad**		**Cushioned Vinyl**		**Carpet & Pad**	
STC	**IIC**	**STC**	**IIC**	**STC**	**IIC**	**STC**	**IIC**
-	-	**54**	**68**	-	-	**58[c]**	**55[c]**

[a] This assembly may also be used in a fire-rated roof/ceiling application, but only when constructed exactly as described.
[b] Direct attachment of gypsum wallboard in lieu of attachment to resilient channels is typically deemed acceptable. When gypsum wallboard is directly attached to the I-joists, the wallboard should be installed with long dimension perpendicular to the I-joists and sound ratings for WIJ-1.5 should be used.
[c] STC and IIC values estimated by David L. Adams Associates, Inc.

Cost Impact: Will not increase the cost of construction
Editoral correction to existing code language.

FS 130-15 : T721.1-TYREE5066

S7510

Date Submitted	11/28/2018	**Section**	1207.2	**Proponent**	Paul Coats
Chapter	12	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Provides an alternative for establishing the sound transmission of assemblies by using an engineering analysis.

Rationale

This change was approved by the ICC General Code Development Committee and the ICC membership, and appears in the 2018 IBC. The proposed performance alternative recognizes the current practice of STC and IIC interpolation based on data from testing performed in accordance with ASTM E90 and ASTM E492. It mirrors provisions of Section 703.3, which provides a similar engineering analysis alternative for establishing fire resistance ratings, thereby providing flexibility for designers.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Would permit code official to accept an engineering analysis for sound transmission similarly to alternative methods and materials approvals as for many other provisions of the code.

Impact to building and property owners relative to cost of compliance with code

Could reduce cost of compliance since an engineering analysis could be more economical than individual testing.

Impact to industry relative to the cost of compliance with code

No impact.

Impact to small business relative to the cost of compliance with code

May be more economical to comply with the code through an engineering anaysis instead of testing of individual assemblies.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Provides for equivalent sound transmission performance in buildings, and therefore the welfare of occupants.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by providing flexibility of compliance without sacrificing performance.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code since the performance must be maintained.

1207.2 Air-borne sound. Walls, partitions and floor/ceiling assemblies separating *dwelling units* and *sleeping units* from each other or from public or service areas shall have a sound transmission class of not less than 50, or not less than 45 if field tested, for air-borne noise when tested in accordance with ASTM E90. Alternatively, the sound transmission class of walls, partitions and floor/ceiling assemblies shall be established by engineering analysis based on a comparison of walls, partitions and floor/ceiling assemblies having sound transmission class ratings as determined by the test procedures set forth in ASTM E 90.Penetrations or openings in construction assemblies for piping; electrical devices; recessed cabinets; bathtubs; soffits; or heating, ventilating or exhaust ducts shall be sealed, lined, insulated or otherwise treated to maintain the required ratings. This requirement shall not apply to entrance doors; however, such doors shall be tight fitting to the frame and sill.

1207.3 Structure-borne sound. Floor/ceiling assemblies between *dwelling units* and *sleeping units* or between a *dwelling unit* or *sleeping unit* and a public or service area within the structure shall have an impact insulation class rating of not less than 50, or not less than 45 if field tested, when tested in accordance with ASTM E492. Alternatively, the impact insulation class of floor/ceiling assemblies shall be established by engineering analysis based on a comparison of floor/ceiling assemblies having impact insulation class ratings as determined by the test procedures set forth in ASTM E492.

G 190-15

1207.2, 1207.3

Proponent: David Tyree, representing American Wood Council (dtyree@awc.org); Jason Smart (jsmart@awc.org); Kenneth Bland (kbland@awc.org); Sam Francis (sfrancis@awc.org); Bradford Douglas (bdouglas@awc.org)

2015 International Building Code

Revise as follows:

1207.2 Air-borne sound. Walls, partitions and floor/ceiling assemblies separating *dwelling units* and *sleeping units* from each other or from public or service areas shall have a sound transmission class of not less than 50, or not less than 45 if field tested, for air-borne noise when tested in accordance with ASTM E 90. Alternatively, the sound transmission class of walls, partitions and floor/ceiling assemblies shall be established by engineering analysis based on a comparison of walls, partitions and floor/ceiling assemblies having sound transmission class ratings as determined by the test procedures set forth in ASTM E 90. Penetrations or openings in construction assemblies for piping; electrical devices; recessed cabinets; bathtubs; soffits; or heating, ventilating or exhaust ducts shall be sealed, lined, insulated or otherwise treated to maintain the required ratings. This requirement shall not apply to entrance doors; however, such doors shall be tight fitting to the frame and sill.

1207.3 Structure-borne sound. Floor/ceiling assemblies between *dwelling units* and *sleeping units* or between a *dwelling unit* or *sleepingunit* and a public or service area within the structure shall have an impact insulation class rating of not less than 50, or not less than 45 if field tested, when tested in accordance with ASTM E 492. Alternatively, the impact insulation class of floor/ceiling assemblies shall be established by engineering analysis based on a comparison of floor/ceiling assemblies having impact insulation class ratings as determined by the test procedures set forth in ASTM E492.

Reason: Reason: The proposed performance alternative recognizes the current practice of STC and IIC interpolation based on data from testing performed in accordance with ASTM E90 and ASTM E492. It mirrors provisions of Section 703.3, which provides a similar engineering analysis alternative for establishing fire resistance ratings, thereby providing flexibility for designers. For a complete list of AWC code change proposals and additional information please go to http://www.awc.org/Code-Officials/2015-IBC-Code-Changes.

Cost Impact: Will not increase the cost of construction
This proposal does not increase the cost of construction as it only recognizes the use of ASTM E90 and E492.

G 190-15 : 1207.2-TYREE4803

S7846

Date Submitted	12/10/2018	**Section**	1404.3	**Proponent**	Paul Coats
Chapter	14	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

yes

Summary of Modification

Modifies the names of American Hardboard Association referenced standards for accuracy of current titles as ANSI standards.

Rationale

This modification was approved by the ICC committees and membership and appears in the 2018 edition of the International Building Code. This proposal corrects references to various American Hardboard Association standards in a consistent manner for accuracy related to their current titles as ANSI standards. There is no technical change.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact.

Impact to building and property owners relative to cost of compliance with code

No impact.

Impact to industry relative to the cost of compliance with code

No impact.

Impact to small business relative to the cost of compliance with code

No impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Editorial correction.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code by editorial correction.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does no discriminate.

Does not degrade the effectiveness of the code

Does not degrade.

[BS]1404.3 Wood.

Exterior walls of wood construction shall be designed and constructed in accordance with Chapter 23.

[BS]1404.3.1 Basic hardboard.

Basic hardboard shall conform to the requirements of ~~AHA~~ ANSI A135.4.

[BS]1404.3.2 Hardboard siding.

Hardboard siding shall conform to the requirements of ~~AHA~~ ANSI A135.6 and, where used structurally, shall be so identified by the *label* of an *approved* agency.

S258-16

IBC: 2303.1.7, [BS] 1404.3, [BS] 1404.3.1, [BS] 1404.3.2.

Proponent : David Tyree, representing American Wood Council (dtyree@awc.org)

2015 International Building Code

Revise as follows:

[BS] 1404.3 Wood. *Exterior walls* of wood construction shall be designed and constructed in accordance with Chapter 23.

[BS] 1404.3.1 Basic hardboard. Basic hardboard shall conform to the requirements of ~~AHA~~ ANSI A135.4.

[BS] 1404.3.2 Hardboard siding. Hardboard siding shall conform to the requirements of ~~AHA~~ ANSI A135.6 and, where used structurally, shall be so identified by the *label* of an *approved* agency.

2303.1.7 Hardboard. Hardboard siding shall conform to the requirements of ANSI A135.6 and, where used structurally shall be identified by the label of an *approved agency*. ~~conforming to CPA/ANSI A135.6.~~ Hardboard underlayment shall meet the strength requirements of $^7/_{32}$-inch (5.6 mm) or $^1/_4$-inch (6.4 mm) service class hardboard planed or sanded on one side to a uniform thickness of not less than 0.200 inch (5.1 mm). Prefinished hardboard paneling shall meet the requirements of ~~CPA/~~ANSI A135.5. Other basic hardboard products shall meet the requirements of ~~CPA/~~ANSI A135.4. Hardboard products shall be installed in accordance with manufacturer's recommendations.

Reason: This proposal references various CPA stadnards in a consistent manner and also clarifies that hardboard siding must conform to the requirements of A135.6 in 2303.1.7 in a consistent manner with reference to hardboard siding in 1404.3.2.

Cost Impact: Will not increase the cost of construction
This proposal clarifies the code and does not place any additional costs on the user.

S258-16 : 2303.1.7-TYREE11261

Final action: AS (Approved as Submitted)

S7234

Date Submitted	11/12/2018	**Section**	1504.5	**Proponent**	T Stafford
Chapter	15	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**   **Alternate Language** **No**

Related Modifications

7226

Summary of Modification

Revises references to the wind speed maps in the body of the code for correlation with ASCE 7-16.

Rationale

This code change revises references in Chapter 15 for correlation with the newly referenced ASCE 7-16. During Phase I of the 2020 update of the FBC, the Commission voted to update ASCE 7 from the 2010 edition to the 2016 edition (ASCE 7-16). ASCE 7-16 provides separate wind speed maps for Risk Category III and Risk Category IV buildings and other structures, recognizing the higher reliabilities required for essential facilities and facilities whose failure could pose a substantial hazard to the community. Modification 7226 proposes to update the wind speed maps for correlation with ASCE 7-16. This code change simply revises the references to the wind speeds maps to correlate with Modification 7226.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This code change correlates the code with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This code change improves the code by providing correlation with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This code change dos not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This code change does not degrade the effectiveness of the code.

1504.5 Edge securement for low-slope roofs. Low-slope built-up, modified bitumen and single-ply roof system metal edge securement, except gutters, shall be designed and installed for wind loads in accordance with Chapter 16 and tested for resistance in accordance with Test Methods RE-1, RE-2 and RE-3 of ANSI/SPRI ES-1, or RAS 111 except V_{ult} wind speed shall be determined from Figure 1609.3(1), 1609.3(2), ~~or~~ 1609.3(3), or 1609.3(4) as applicable.

S7427

Date Submitted	11/25/2018	**Section**	1510.7.1	**Proponent**	T Stafford
Chapter	15	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No | **Alternate Language** No

Related Modifications

Summary of Modification

Correlates the wind loading requirements in the code for rooftop PV with ASCE 7-16.

Rationale

This proposal correlates the wind loading requirements on roof mounted photovoltaic systems with the newly referenced ASCE 7-16. During Phase I of the 2020 update of the FBC, the Commission voted to update ASCE 7 from the 2010 edition to the 2016 edition (ASCE 7-16). ASCE 7-16 contains two new methods for wind loads on photovoltaic systems. One method is based on the component and cladding loads applicable to the roof. The other method is based on entirely different criteria and research. Therefore, for clarification, this proposal simply references ASCE 7 for wind loads on rooftop PV systems.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to industry relative to the cost of compliance with code

No impact to building and property owners relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This code change correlates the code with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This code change improves the code by providing correlation with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This code change dos not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This code change does not degrade the effectiveness of the code.

1510.7.1 Wind resistance. Rooftop-mounted *photovoltaic* systems shall be designed for wind loads in accordance with ASCE 7 ~~for component and cladding in accordance with Chapter 16 using an effective wind area based on the dimensions of a single unit frame~~.

S7830

Date Submitted	12/10/2018	**Section**	1504	**Proponent**	Michael Silvers (FRSA)
Chapter	15	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Changes to 1502, 1609.5 and Chapter 35 are included in this modification.

Summary of Modification

This modification moves ASCE 7 as it applies to roof coverings from Chapter 16 to Chapter 15

Rationale

This modification will maintain the current familiar and proven provisions of ASCE 7-10 as it pertains to roof coverings and roof systems by moving applicable portions of Chapter 16 to Chapter 15.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification will help with enforcement by maintaining the current familiar and proven provisions of ASCE 7-10 as it pertains to roof coverings and roof systems.

Impact to building and property owners relative to cost of compliance with code

This modification will not increase cost of compliance. It maintains the current familiar and proven provisions of ASCE 7-10 as it pertains to roof coverings and roof systems.

Impact to industry relative to the cost of compliance with code

This modification will not increase the cost of compliance. It maintains the current familiar and proven provisions of ASCE 7-10 as it pertains to roof coverings and roof systems. It will reduce the cost of training and implementing the extremely complex provisions of ASCE 7-16 for roof coverings.

Impact to small business relative to the cost of compliance with code

Will not increase cost of compliance. It maintains the current familiar and proven provisions of ASCE 7-10 as it pertains to roof coverings and roof systems. It will reduce the cost of complying with the complex and burdensome provisions of ASCE 7-16 as it applies to roof coverings.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This modification will maintain the current familiar and proven provisions of ASCE 7-10 as it pertains to roof coverings and roof systems.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This modification provides equivalence by maintaining the current familiar and proven provisions of ASCE 7-10 as it pertains to roof coverings and roof systems.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This modification does not discriminate against materials, methods, or systems of construction.

Does not degrade the effectiveness of the code

This modification does not degrade the effectiveness of the code. It remains effective by maintaining the codes familiar and proven provisions of ASCE 7-10 as it pertains to roof coverings and roof systems.

CHAPTER 15 ROOF ASSEMBLIES AND ROOFTOP STRUCTURES

SECTION1502
DEFINITIONS AND NOTATIONS

NOTATIONS

V_{asd}
= Nominal design wind speed (3-second gust), miles per hour (mph) (km/hr) where applicable.

V_{ult}
= Ultimate design wind speeds (3-second gust), miles per hour (mph) (km/hr) determined from Figure 16509.3(1), 16509.3(2), 16509.3(3) or ASCE 7.

SECTION 1504
PERFORMANCE REQUIREMENTS

1504.1 Wind resistance of roofs.

Roof ~~decks and roof~~ coverings shall be designed for wind loads in accordance with Chapter 15 Sections 1504.1, 1504.2, 1504.3 and 1504.4.

1504.1.1 Wind resistance of asphalt shingles.

Asphalt shingles shall be designed for wind speeds in accordance with Section 1507.2.7.

1504.2 Wind resistance of clay and concrete tile.

Wind loads on clay and concrete tile roof coverings shall be in accordance with –Section ~~1609.5~~.

(Equation 15-34)

For SI:

where:

b = Exposed width, feet (mm) of the roof tile.

C_L = Lift coefficient. The lift coefficient for concrete and clay tile shall be 0.2 or shall be determined by test in accordance with Section 1504.2.1.

GC_p = Roof pressure coefficient for each applicable roof zone determined from Chapter 30 of ASCE 7. Roof coefficients shall not be adjusted for internal pressure.

L = Length, feet (mm) of the roof tile.

L_a = Moment arm, feet (mm) from the axis of rotation to the point of uplift on the roof tile. The point of uplift shall be taken at 0.76L from the head of the tile and the middle of the exposed width. For roof tiles with nails

or screws (with or without a tail clip), the axis of rotation shall be taken as the head of the tile for direct deck application or as the top edge of the batten for battened applications. For roof tiles fastened only by a nail or screw along the side of the tile, the axis of rotation shall be determined by testing. For roof tiles installed with battens and fastened only by a clip near the tail of the tile, the moment arm shall be determined about the top edge of the batten with consideration given for the point of rotation of the tiles based on straight bond or broken bond and the tile profile.

M_a = Aerodynamic uplift moment, feet-pounds (N-mm) acting to raise the tail of the tile.

q_h = Wind velocity pressure, psf (kN/m^2) determined from Section 27.3.2 of ASCE 7.

Concrete and clay roof tiles complying with the following limitations shall be designed to withstand the aerodynamic uplift moment as determined by this section.

1. The roof tiles shall be ~~either loose laid on battens~~, mechanically fastened, mortar set or adhesive set.

The roof tiles shall be installed on solid sheathing that has been designed as components and cladding.

3. An underlayment shall be installed in accordance with Chapter 15.
4. The tile shall be single lapped interlocking with a minimum head lap of not less than 2 inches (51 mm).
5. The length of the tile shall be between 1.0 and 1.75 feet (305 mm and 533 mm).
6. The exposed width of the tile shall be between 0.67 and 1.25 feet (204 mm and 381 mm).
7. The maximum thickness of the tail of the tile shall not exceed 1.3 inches (33 mm).
8. Roof tiles using mortar set or adhesive set systems shall have at least two-thirds of the tile's area free of mortar or adhesive contact.

1504.2.1 Testing.

Testing of concrete and clay roof tiles shall be in accordance with Sections 1504.2.1.1 and 1504.2.1.2.

1504.2.1.1 Overturning resistance.

Concrete and clay roof tiles shall be tested to determine their resistance to overturning due to wind in accordance with SBCCI SSTD 11 and Chapter 15.

1504.2.1.2 Wind tunnel testing.

Where concrete and clay roof tiles do not satisfy the limitations in 1504.2 ~~Chapter 16~~ for rigid tile, a wind tunnel test shall be used to determine the wind characteristics of the concrete or clay tile roof covering in accordance with SBCCI SSTD 11 and Chapter 15.

1504.3 Wind resistance of nonballasted roofs.

Roof coverings installed on roofs in accordance with Section 1507 that are mechanically attached or adhered to the roof deck shall be designed to resist the design wind load pressures for components and cladding in accordance with Section 1504.

1504.3.1 Other roof systems.

Built-up, modified bitumen, fully adhered or mechanically attached single-ply roof systems, metal panel roof systems applied to a solid or closely fitted deck and other types of membrane roof coverings shall be tested in accordance with FM 4474, UL 580 or UL 1897.

1504.3.2 Metal panel roof systems.

Metal panel roof system through fastened or standing seam shall be tested in accordance with UL 580 or ASTM E1592 or TAS 125.

Exceptions: Metal roofs constructed of cold-formed steel, where the roof deck acts as the roof covering and provides both weather protection and support for structural loads, shall be permitted to be designed and tested in accordance with the applicable referenced structural design standard in Section 2210.1.

1504.4 Ballasted low-slope roof systems.

Ballasted low-slope (roof slope < 2:12) single-ply roof system coverings installed in accordance with Sections 1507.12 and 1507.13 shall be designed in accordance with Section 1504.8 and ANSI/SPRI RP-4.

1504.5 Edge securement for low-slope roofs.

Low-slope built-up, modified bitumen and single-ply roof system metal edge securement, except gutters, shall be designed and installed for wind loads in accordance with Chapter 15 ~~16~~ and tested for resistance in accordance with Test Methods RE-1, RE-2 and RE-3 of ANSI/SPRI ES-1, or RAS 111 except V_{ult} wind speed shall be determined from Figure Wind Maps in Chapter 15 1504.6(1), 1504.6 (2) or 1504.6 (3) as applicable.

1504.6 Wind Load Applications.

Buildings, structures and parts thereof shall be designed to withstand the minimum wind loads prescribed herein. Decreases in wind loads shall not be made for the effect of shielding by other structures.

1504.6.1 Determination of wind loads.

Wind loads on every building or structure shall be determined in accordance with Chapters 26 to 30 of ASCE 7 or provisions of the alternate all-heights method in Chapter 16. Wind shall be assumed to come from any horizontal direction and wind pressures shall be assumed to act normal to the surface considered.

Exceptions:

1. 1.Subject to the limitations of Section 1504.6.2 the provisions of ICC 600 shall be permitted for applicable Group R-2 and R-3 buildings.
2. 2.Subject to the limitations of Section 1504.6.2 residential structures using the provisions of AWC WFCM.
3. 3.Subject to the limitations of Section 1504.6.2 residential structures using the provisions of AISI S230.
4. 4.Designs using NAAMM FP 1001.
5. Wind tunnel tests in accordance with ASCE 49 and Sections 31.4 and 31.5 of ASCE 7.
6. 8.Exposed mechanical equipment or appliances fastened to a roof or installed on the ground in compliance with the code using rated stands, platforms, curbs, slabs, walls, or other means are deemed to comply with the wind resistance requirements of the 2007 Florida Building Code, as amended. Further support or enclosure of such mechanical equipment or appliances is not required by a state or local official having authority to enforce the *Florida Building Code*.

The wind speeds in Figures 1504.6(1),1504.6(2), and 1504.6 (3) are ultimate design wind speeds, V_{ult}, and shall be converted in accordance with Section 1609.3.1 to nominal design wind speeds, V_{asd}, when the provisions of the standards referenced in Exceptions 4 and 5 are used.

1504.6.2 Applicability.

The provisions of ICC 600 are applicable only to buildings located within Exposure B or C as defined in Section 1504.7. The provisions of ICC 600, AWC WFCM and AISI S230 shall not apply to buildings sited on the upper half of an isolated hill, ridge or escarpment meeting the following conditions:

1. 1. The hill, ridge or escarpment is 60 feet (18 288 mm) or higher if located in Exposure B or 30 feet (9144 mm) or higher if located in Exposure C;

2. 2. The maximum average slope of the hill exceeds 10 percent; and

3. The hill, ridge or escarpment is unobstructed upwind by other such topographic features for a distance from the high point of 50 times the height of the hill or 1 mile (1.61 km), whichever is greater.

1504.6.2 Ultimate design wind speed.

The ultimate design wind speed, V_{ult}, in mph, for the determination of the wind loads shall be determined by Figures 1609.3(1), 1609.3(2) and 1609.3(3). The ultimate design wind speed, V_{ult}, for use in the design of Risk Category II buildings and structures shall be obtained from Figure 1609.3(1). The ultimate design wind speed, V_{ult}, for use in the design of Risk Category III and IV buildings and structures shall be obtained from Figure 1609.3(2). The ultimate design wind speed, V_{ult}, for use in the design of Risk Category I buildings and structures shall be obtained from Figure 1609.3(3). The ultimate design wind speed, V_{ult}, for the special wind regions indicated near mountainous terrain and near gorges shall be in accordance with local jurisdiction requirements. The ultimate design wind speeds, V_{ult}, determined by the local jurisdiction shall be in accordance with Section 26.5.1 of ASCE 7. The exact location of wind speed lines shall be established by local ordinance using recognized physical landmarks such as major roads, canals, rivers and lake shores wherever possible.

In nonhurricane-prone regions, when the ultimate design wind speed, V_{ult}, is estimated from regional climatic data, the ultimate design wind speed, V_{ult}, shall be determined in accordance with Section 26.5.3 of ASCE 7.

FIGURE 1504.6(1)

ULTIMATE DESIGN WIND SPEEDS, V_{ULT}, FOR RISK CATEGORY II BUILDINGS AND OTHER STRUCTURES

FIGURE 1504.6(2)

ULTIMATE DESIGN WIND SPEEDS, V_{ULT}, FOR RISK CATEGORY III AND IV BUILDINGS AND OTHER STRUCTURES

FIGURE 1504.6(3)

ULTIMATE DESIGN WIND SPEEDS, V_{ULT}, FOR RISK CATEGORY I BUILDINGS AND OTHER STRUCTURES

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1504.6.3 Wind speed conversion.

When required, the ultimate design wind speeds of Figures ~~16~~1509.3(1), ~~16~~1509.3(2) and ~~16~~1509.3(3) shall be converted to nominal design wind speeds, V_{asd}, using Table ~~16~~1509.3.1 or Equation 16-33.

(Equation 15-01)

where:

V_{asd} **= Nominal design wind speed applicable to methods specified in Exceptions 4 and 5 of Section 1504.6.1**

V_{ult} **= Ultimate design wind speeds determined from Figures 1504.6.3(1), 1504.6.3(2) or 1504.6.3(3).**

TABLE 1504.6.3

WIND SPEED CONVERSIONS [a, b, c]

V_{ult}	100	110	120	130	140	150	160	170	180	190	200
V_{asd}	78	85	93	101	108	116	124	132	139	147	155

For SI: 1 mile per hour = 0.44 m/s.

1. a. Linear interpolation is permitted.
2. b. V_{asd} = nominal design wind speed applicable to method specified in Exceptions 1 through 4

   of Section 1504.6.1
3. c. V_{ult} = ultimate design wind speeds determined from Figure 1609.3(1), 1609.3(2) or 1609.3(3).

1504.6.4 Exposure category.

For each wind direction considered, an exposure category that adequately reflects the characteristics of ground surface irregularities shall be determined for the site at which the building or structure is to be constructed. Account shall be taken of variations in ground surface roughness that arise from natural topography and vegetation as well as from constructed features.

1504.6.5 Wind directions and sectors.

For each selected wind direction at which the wind loads are to be evaluated, the exposure of the building or structure shall be determined for the two upwind sectors extending 45 degrees (0.79 rad) either side of the selected wind direction. The exposures in these two sectors shall be determined in accordance with Sections 1609.4.2 and 1609.4.3 and the exposure resulting in the highest wind loads shall be used to represent winds from that direction.

1504.6.6 Surface roughness categories.

A ground surface roughness within each 45-degree (0.79 rad) sector shall be determined for a distance upwind of the site as defined in Section 1504.6.7 from the categories defined below, for the purpose of assigning an exposure category as defined in Section 1504.6.7.

1. **Surface Roughness B.** Urban and suburban areas, wooded areas or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger.

2. **Surface Roughness C.** Open terrain with scattered obstructions having heights generally less than 30 feet (9144 mm). This category includes flat open country, and grasslands.
3. **Surface Roughness D.** Flat, unobstructed areas and water surfaces. This category includes smooth mud flats, salt flats and unbroken ice.

1504.6.7 Exposure categories.

An exposure category shall be determined in accordance with the following:

1. **Exposure B.** For buildings with a mean roof height of less than or equal to 30 feet (9144 mm), Exposure B shall apply where the ground surface roughness, as defined by Surface Roughness B, prevails in the upwind direction for a distance of at least 1,500 feet (457 m). For buildings with a mean roof height greater than 30 feet (9144 mm), Exposure B shall apply where Surface Roughness B prevails in the upwind direction for a distance of at least 2,600 feet (792 m) or 20 times the height of the building, whichever is greater.
2. **Exposure C.** Exposure C shall apply for all cases where Exposure B or D does not apply.
3. **Exposure D.** Exposure D shall apply where the ground surface roughness, as defined by Surface Roughness D, prevails in the upwind direction for a distance of at least 5,000 feet (1524 m) or 20 times the height of the building, whichever is greater. Exposure D shall also apply where the ground surface roughness immediately upwind of the site is B or C, and the site is within a distance of 600 feet (183 m) or 20 times the building height, whichever is greater, from an Exposure D condition as defined in the previous sentence.

1504.~~6~~7 Physical properties.

Roof coverings installed on low-slope roofs (roof slope < 2:12) in accordance with Section 1507 shall demonstrate physical integrity over the working life of the roof based upon 2,000 hours of exposure to accelerated weathering tests conducted in accordance with ASTM G152, ASTM G153, ASTM G154 or ASTM G155. Those roof coverings that are subject to cyclical flexural response due to wind loads shall not demonstrate any significant loss of tensile strength for unreinforced membranes or breaking strength for reinforced membranes when tested as herein required.

Remaining numbers to progress. Balance of text unchanged.

CHAPTER 16 STRUCTURAL DESIGN

1609.5 Roof systems.

Roof systems shall be designed and constructed in accordance with ~~Sections~~ Chapter 15 ~~1609.5.1 through 1609.5.3, as applicable~~.

1609.5.1 Roof deck.

The roof deck shall be designed to withstand the wind pressures determined in accordance with ASCE 7.

1609.5.2 Roof coverings.

Roof coverings shall comply with Section 1504. ~~1609.5.1.~~

~~**Exception:** Rigid tile roof coverings that are air permeable and installed over a roof deck complying with Section 1609.5.1 are permitted to be designed in accordance with Section 1609.5.3.~~

Asphalt shingles installed over a roof deck complying with Section 1609.5.1 shall comply with the wind-resistance requirements of Section 1504.1.1.

1609.5.3Rigid tile.

Rigid tile installed over a roof deck complying with Section 1609.5.1 shall comply with the wind-resistance requirements of Section 1504.2

~~Wind loads on rigid tile roof coverings shall be determined in accordance with the following equation:~~

~~**(Equation 16-34)**~~

~~**For SI:**~~

~~**where:**~~

~~***b* = Exposed width, feet (mm) of the roof tile.**~~

~~**C_L = Lift coefficient. The lift coefficient for concrete and clay tile shall be 0.2 or shall be determined by test in accordance with Section 1504.2.1.**~~

~~**GC_p = Roof pressure coefficient for each applicable roof zone determined from Chapter 30 of ASCE 7. Roof coefficients shall not be adjusted for internal pressure.**~~

~~***L* = Length, feet (mm) of the roof tile.**~~

~~**L_a = Moment arm, feet (mm) from the axis of rotation to the point of uplift on the roof tile. The point of uplift shall be taken at 0.76*L* from the head of the tile and the middle of the exposed width. For roof tiles with nails or screws (with or without a tail clip), the axis of rotation shall be taken as the head of the tile for direct deck application or as the top edge of the batten for battened applications. For roof tiles fastened only by a nail or screw along the side of the tile, the axis of rotation shall be determined by testing. For roof tiles installed with battens and fastened only by a clip near the tail of the tile, the moment arm shall be determined about the top edge of the batten with consideration given for the point of rotation of the tiles based on straight bond or broken bond and the tile profile.**~~

~~**M_a = Aerodynamic uplift moment, feet-pounds (N-mm) acting to raise the tail of the tile.**~~

~~**q_h = Wind velocity pressure, psf (kN/m^2) determined from Section 27.3.2 of ASCE 7.**~~

~~Concrete and clay roof tiles complying with the following limitations shall be designed to withstand the aerodynamic uplift moment as determined by this section.~~

~~The roof tiles shall be either loose laid on battens, mechanically fastened, mortar set or adhesive set.~~

~~The roof tiles shall be installed on solid sheathing that has been designed as components and cladding.~~

3. ~~An underlayment shall be installed in accordance with Chapter 15.~~
4. ~~The tile shall be single lapped interlocking with a minimum head lap of not less than 2 inches (51 mm).~~

5. ~~The length of the tile shall be between 1.0 and 1.75 feet (305 mm and 533 mm).~~
6. ~~The exposed width of the tile shall be between 0.67 and 1.25 feet (204 mm and 381 mm).~~
7. ~~The maximum thickness of the tail of the tile shall not exceed 1.3 inches (33 mm).~~
8. ~~Roof tiles using mortar set or adhesive set systems shall have at least two-thirds of the tile's area free of mortar or adhesive contact.~~

Remaining text unchanged.

CHAPTER 35 REFERENCED STANDARDS

ASCE/SEI

American Society of Civil Engineers Structural Engineering Institute 1801 Alexander Bell Drive Reston, VA 20191-4400

Standard reference number	Title	Referenced in code section number

5—13

Building Code Requirements for Masonry Structures

1405.61405.6.11405.6.21405.101604.3.41807.1.6.31807.1.6.3.21808.92101.22105.12106.12107.12107.22107.32107.42107.62108.12108.22108.32108.42109.12109.1.12109.22109.2.12109.32110.12114.22122.12122.42122.52122.72122.8.22122.8.42122.10

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Specification for Masonry Structures1405.6.11807.1.6.32103.12103.2.12103.32103.42104.12105.12107.12108.12121.62122.12122.2.32122.2.32122.42122.7.42122.8.12122.8.22122.8.32122.8.42122.8.62122.8.8

7—10

Minimum Design Loads for Buildings and Other Structures (with Errata dated January 11. 2011)

1504~~.8~~ 1514.4 1525

7—16

MinimumDesignLoadsforBuildingsandOtherStructures202449.4.2.2.6450.4.2.2.6453.4.7453.9.1453.25.4Table~~1504.81514.41525~~1602.11604.3Table 1604.51604.8.21604.101605.11605.2.11605.3.11605.3.1.21605.3.21605.3.2.11607.8.11607.8.1.11607.8.1.21607.8.31607.12.11608.11608.21608.31609.1.11609.1.21609.1.2.4.11609.1.2.4.21609.31609.5.11609.5.31609.61609.6.11609.6.1.11609.6.2Table 1609.6.21609.6.31609.6.4.11609.6.4.21609.6.4.4.11609.81611.21612.41613.11613.3.2Table 1613.3.3(1)Table 1613.3.3(2)1613.3.51613.3.5.11613.3.5.21613.41613.4.11613.5.11613.61614.11616.51620.11620.31620.61621.11621.21622.1.1Table1625.4 1626.1 Table 16261709.8.31803.5.121808.3.11810.3.6.11810.3.9.41810.3.11.21810.3.121905.1.11905.1.21905.1.82205.2.1.12205.2.1.22205.2.22206.2.12209.12210.22304.6.12404.12505.12505.22506.2.13109.3.1

Remaining text unchanged.

Moving ASCE 7 as it applies roof coverings from Chapter 16 to Chapter 15 Rationale

This modification will maintain the current familiar and proven provisions of ASCE 7-10 as it pertains to roof coverings and roof systems by moving applicable portions of Chapter 16 to Chapter 15.

The increased pressure coefficients and complexities of ASCE 7-16 will have a disproportional effect on Florida. This standard was heavily debated and was passed by a narrow majority by the International Code Council (ICC). It faced strong opposition from jurisdictions throughout the country even though none of these areas will be impacted by the standard to the degree that Florida will. A majority of the Florida Building Commissioners voted to give its adoption further consideration, but the failure to reach a 75% threshold to allow further consideration thwarted this opportunity even though it was widely supported by the roofing industry.

Florida's roofing industry like many other construction disciplines is experiencing severe workforce shortages. Also like many other construction disciplines, much of Florida's required roofing skills are learned by experience in the field (this is in addition to classroom training that is a foundation but not the only knowledge that is needed). As described by engineers and others, ASCE 7-16 is exceptionally complex and implementation calls for more than a minor amount of training and added experience for construction contractors, construction workers and, importantly building code administrators and inspectors.

ASCE 7-10 has proven to be very effective and meaningfully compliant with Florida's strengthening and mitigation needs. A recent report titled "Rating the States" published by the Insurance Institute for Business & Home Safety (IBHS) states that Florida has the highest score of 18 states included in the report. Florida's score is also higher in 2018 than in 2015. Numerous other reports have touted how well buildings built in compliance with our current Florida Building Code – which includes ASCE 7-10 – performed. From our research and review as well as our observations of the ICC hearings on this subject, we are very concerned that the only reason for adopting ASCE 7-16 is change for the sake of change with very little real benefit, but some measurable, tangible and very real detrimental effects on roofing standards and fiscal impacts for building owners

S8080

Date Submitted	12/13/2018	**Section**	1507.3	**Proponent**	T Stafford
Chapter	15	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** | **Alternate Language** **No**

Related Modifications

Summary of Modification

Revises the roof tile section to clarify that wind loads on tile have to comply with ASCE 7-16.

Rationale

This proposal is primarily a correlation. During Phase I of the 2020 update of the FBC, the Commission voted to update ASCE 7 from the 2010 edition to the 2016 edition (ASCE 7-16). In ASCE 7-16, the component and cladding loads and roof zones for roofs with a MRH of 60 feet and less have changed. The code currently refers to the FRSA/TRI manual for tile. However Table 1A (uplift loads for underlayment and hip/ridge tiles) and Tables 2A and 2B (aerodynamic uplift moment) are still based on ASCE 7-10. This proposal simply clarifies that these loads have to be determined in accordance with ASCE 7-16. Clarifying language has also been added with regards to the manufacturer's product approval installation instructions.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners. While there may be cost impacts for certain buildings due to the adoption of ASCE 7-16, this code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to industry relative to the cost of compliance with code

No impact to industry. While there may be cost impacts for certain buildings due to the adoption of ASCE 7-16, this code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to small business relative to the cost of compliance with code

No impact to small business. While there may be cost impacts for certain buildings due to the adoption of ASCE 7-16, this code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This code change correlates the code with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This code change improves the code by providing correlation with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This code change dos not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This code change does not degrade the effectiveness of the code.

Revise as follows:

1507.3.2 Deck slope. Clay and concrete roof tile shall be installed in ~~accordance~~ compliance with the manufacturer's product approval installation instructions in accordance with the recommendations of FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual, Fifth Edition where the Vasd as determined in accordance with Section 1609.3.1 or the recommendations of RAS 118, 119 or 120.

1507.3.3 Underlayment. Unless otherwise noted, underlayment shall be applied according to the underlayment manufacturer's product approval installation instructions in accordance with ~~or~~ the recommendations of the FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual, Fifth Edition, except as modified in Section 1507.3.3.1, where the basic wind speed, V_{asd}, is determined in accordance with Section 1609.3.1 or the recommendations of RAS 118, 119 or 120.

1507.3.3.1 FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual,* Fifth Edition. Delete Table 1A in the FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual*, Fifth Edition. Required design pressures for underlayments for tile systems shall be determined in accordance with ASCE 7.

~~**1507.3.3.1 Slope and underlayment requirements.** Refer to FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual, Fifth Edition (2012) where the basic wind speed Vasd is determined in accordance with Section 1609.3.1 for underlayment and slope requirements for specific roof tile systems or the recommendations of RAS 118, 119 or 120.*~~

Revise as follows:

1507.3.7 Attachment. Clay and concrete roof tiles shall be fastened in compliance ~~accordance~~ with Section 1609 or the manufacturer's product approval installation instructions ~~or~~ in accordance with *FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual,* Fifth Edition, except as modified in Section 1507.3.7.1, where the basic wind speed, *Vasd,* is determined in accordance with Section 1609.3.1.

1507.3.7.1 FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual,* Fifth Edition. Delete Tables 2A and 2B in the FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual*, Fifth Edition. The required aerodynamic uplift moment shall be determined in accordance with Section 1504.2. Required design pressures for hip and ridge tiles shall be determined in accordance with ASCE 7.

S7226

Date Submitted 11/12/2018
Chapter 16
Section 1609
Affects HVHZ No
Proponent T Stafford
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments
General Comments Yes
Alternate Language No

Related Modifications

Summary of Modification

Adds the Risk Category IV wind speed map from ASCE 7-16 into the body of the code and updates required references throughout Chapter 16.

Rationale

This code change correlates the wind loading criteria in Chapter 16 with the newly referenced ASCE 7-16. During Phase I of the 2020 update of the FBC, the Commission voted to update ASCE 7 from the 2010 edition to the 2016 edition (ASCE 7-16). ASCE 7-16 provides separate wind speed maps for Risk Category III and Risk Category IV buildings and other structures, recognizing the higher reliabilities required for essential facilities and facilities whose failure could pose a substantial hazard to the community. This code change simply makes the necessary updates to the body of the code for correlation with ASCE 7-16.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This code change correlates the code with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This code change improves the code by providing correlation with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This code change dos not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This code change does not degrade the effectiveness of the code.

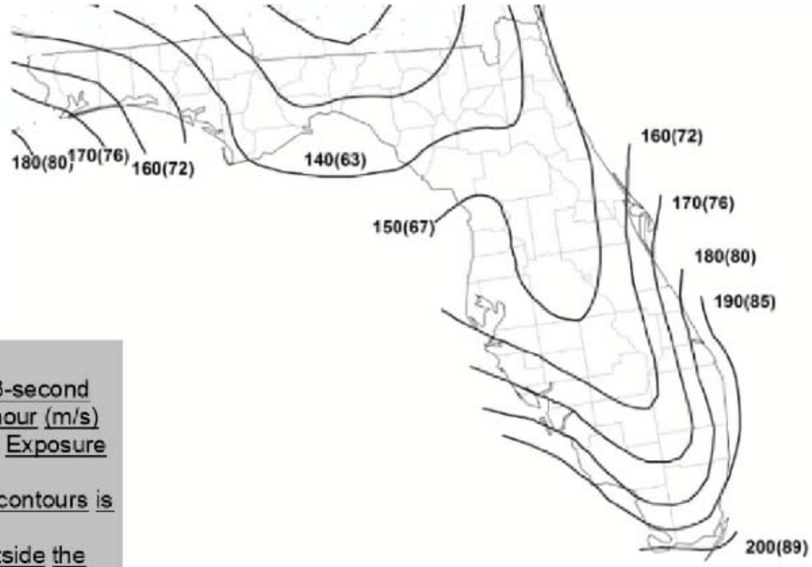
1st Comment Period History

S7226-G1

Proponent Michael LaFevre **Submitted** 1/11/2019 **Attachments** No

Comment:

Seeing that the ASCE 7-10 wind speed line of 120 mph has been lowered to 115 in ASCE 7-16 in the area that Michael recently devastated (Risk Category II), I think we should reconsider adopting the newer version of ASCE 7 until a better review.



Notes:
1. Values are ultimate design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation betwen contours is permitted.
3. Island and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 1.6% chance of exceedence in 50 years (Annual Exceedence Probability = 0.00033, MRI = 3000 years.

FIGURE 1609.3(3)

ULTIMATE DESIGN WIND SPEEDS, V_{ULT}, FOR RISK CATEGORY IV BUILDINGS AND OTHER STRUCTURES

Renumber existing Figure 1609.3(3)

(figure not shown for brevity)

FIGURE 1609.3(4) ~~1609.3(3)~~

ULTIMATE DESIGN WIND SPEEDS, *VULT*, FOR RISK CATEGORY I BUILDINGS AND OTHER STRUCTURES

1602.1 Definitions. The following terms are defined in Chapter 2:

V_{ult} = Ultimate design wind speeds (3-second gust), miles per hour (mph) (km/hr) determined from Figure 1609.3(1), 1609.3(2), 1609.3(3), 1609.3(4) or ASCE 7.

1609.1.1 Determination of wind loads. Wind loads on every building or structure shall be determined in accordance with Chapters 26 to 30 of ASCE 7 or provisions of the alternate all-heights method in Section

1609.6. Wind shall be assumed to come from any horizontal direction and wind pressures shall be assumed to act normal to the surface considered.

Exceptions:

(exceptions not shown for brevity)

The wind speeds in Figures 1609.3(1), 1609.3(2) ~~and~~ 1609.3(3), and 1609.3(4) are ultimate design wind speeds, V_{ult}, and shall be converted in accordance with Section 1609.3.1 to nominal design wind speeds, V_{asd}, when the provisions of the standards referenced in Exceptions 4 and 5 are used.

1609.3 Ultimate design wind speed. The ultimate design wind speed, V_{ult}, in mph, for the determination of the wind loads shall be determined by Figures 1609.3(1), 1609.3(2) ~~and~~ 1609.3(3), and 1609.3(4). The ultimate design wind speed, V_{ult}, for use in the design of Risk Category II buildings and structures shall be obtained from Figure 1609.3(1). The ultimate design wind speed, V_{ult}, for use in the design of Risk Category III ~~and IV~~ buildings and structures shall be obtained from Figure 1609.3(2). The ultimate design wind speed, V_{ult}, for use in the design of Risk Category IV buildings and structures shall be obtained from Figure 1609.3(3). The ultimate design wind speed, V_{ult}, for use in the design of Risk Category I buildings and structures shall be obtained from Figure 1609.3(4) ~~1609.3(3)~~. The ultimate design wind speed, *Vult*, for the special wind regions indicated near mountainous terrain and near gorges shall be in accordance with local jurisdiction requirements. The ultimate design wind speeds, V_{ult}, determined by the local jurisdiction shall be in accordance with Chapter 26 ~~Section 26.5.1~~ of ASCE 7. The exact location of wind speed lines shall be established by local ordinance using recognized physical landmarks such as major roads, canals, rivers and lake shores wherever possible.

~~In nonhurricane-prone regions, when the ultimate design wind speed, *Vult*, is estimated from regional climatic data, the ultimate design wind speed, V_{ult}, shall be determined in accordance with Section 26.5.3 of ASCE 7.~~

1609.3.1 Wind speed conversion. When required, the ultimate design wind speeds of Figures 1609.3(1), 1609.3(2), ~~and~~ 1609.3(3) and 1609.3(4) shall be converted to nominal design wind speeds, V_{asd}, using Table 1609.3.1 or Equation 16-33.

$V_{asd} = V_{ult} \sqrt{0.6}$ (Equation 16-33)

where:
V_{asd} = Nominal design wind speed applicable to methods specified in Exceptions 4 and 5 of Section 1609.1.1.
V_{ult} = Ultimate design wind speeds determined Figures 1609.3(1), 1609.3(2), ~~or~~ 1609.3(3) or 1609.3(4).

TABLE 1609.3.1

WIND SPEED CONVERSIONS[a, b, c]

(table not shown for brevity)

For SI: 1 mile per hour = 0.44 m/s.

a. Linear interpolation is permitted.

b. *Vasd* = nominal design wind speed applicable to methods specified in Exceptions 1 through 5 of Section 1609.1.1.

c. *Vult* = ultimate design wind speeds determined from Figure 1609.3(1), 1609.3(2), ~~or~~ 1609.3(3) or 1609.2(4).

S7410

Date Submitted	11/23/2018	**Section**	1606	**Proponent**	Joseph Crum
Chapter	16	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No **Alternate Language** No

Related Modifications

S76-16 &
S126-16
Combined per Mo to both being issued the same MOD # by the system.

Summary of Modification

S76-16 - Adding an exception, so an entire building will not be classified as Risk Category IV just to put in a storm shelter S205-16 - Clarification of requirements that apply to high-rise construction.

Rationale

S76-16 - Adding an exception, so an entire building will not be classified as Risk Category IV just to put in a storm shelter.
S205-16 - As currently written, one could mistakenly interpret that all of section 1615.1 applies to all High-rise buildings that are assigned to Risk Category III or IV. That is incorrect. Only section 1615.3 or 1615.4 apply based on the type of structure for such buildings. In addition, as currently written, one could mistakenly interpret that Section 1615.3 applies to all frame structures and that Section 1615.4 applies to all bearing wall structures. That also is incorrect, and when these provisions were added into the FBC, the requirements of 1615.3 were to apply to frame structures that were High-rise buildings and that were assigned to Risk Category III or IV. Likewise the requirements of 1615.4 were to apply to bearing wall structures that were High-rise buildings and that were assigned to Risk Category III or IV. This proposed change corrects the section to be consistent with the intent and clarifies the provisions. A designer or owner still has the option to apply these provisions to other buildings in other risk categories, but it would not be required.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Provides clarification of code requirements to assist in interpretation and enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

These change are clarification only and will not effect the cost of construction.

Impact to industry relative to the cost of compliance with code

These change are clarification only and will not effect the cost of construction.

Impact to small business relative to the cost of compliance with code

These change are clarification only and will not effect the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

These changes are for clarification only but will assist in the interpretation and enforcement of the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

These changes are clarification only and improves interpretation and implementation of the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

These changes are for clarification only and do not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

These changes are for clarification only and does not degrade the effectiveness of the code.

S76-16

Section:1604.5.1 - Revise as follows:

1604.5.1Multipleoccupancies.Whereabuildingorstructureisoccupiedbytwoormoreoccu pancies not included in the same *risk category*, it shall be assigned the classification of the highest *risk category* corresponding to the various occupancies. Where buildings or structures have two or more portions that are structurally separated, each portion shall be separately classified. Where a separated portion of a building or structure provides required access to, required egress from or shares life safety components with another portion having a higher *risk category*, both portions shall be assigned to the higher *riskcategory*.

Exception: Where a *storm shelter* designed and constructed in accordance with ICC 500 is provided in a building, structure or portion thereof normally occupied for other purposes, the *risk category* for the normal occupancy of the building shall apply unless the *storm shelter* is a designated emergency shelter in accordance with Table 1604.5.

S205-16

Section 1615.1 - Revise as follows:

1615.1 General. *High-rise buildings* that are assigned to *Risk Category* III or IV shall comply with the requirements of ~~this section. Frame~~ Section 1615.3 if they are frame structures ~~shall comply with the requirements of~~, or Section ~~1615.3. Bearing~~ 1615.4 if they are bearing wall structures ~~shall comply with the requirements of Section 1615.4~~.

S7424

Date Submitted	11/25/2018	**Section**	1603.1	**Proponent**	Ann Russo8
Chapter	16	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

S58-16

Summary of Modification

The revised code section is a list of information to be placed on the construction documents for use with the conventional light-frame construction provisions of Section 2308.

Rationale

The revised code section is a list of information to be placed on the construction documents for use with the conventional light-frame construction provisions of Section 2308. The estimated dead loads are necessary to use the span Tables in Section 2308. The estimated dead loads specified on the construction documents can also be confirmed by the plans examiner.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Code clarification with additional required information will assist in code review.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction

The proposal will add an additional item to the required list of information on the construction documents. This should be indicated on the construction documents for the building official to review and will not impact the cost of construction

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction

The proposal will add an additional item to the required list of information on the construction documents. This should be indicated on the construction documents for the building official to review and will not impact the cost of construction

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction

The proposal will add an additional item to the required list of information on the construction documents. This should be indicated on the construction documents for the building official to review and will not impact the cost of construction

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Provides information required for proper plan review and inspections.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Code clarification with added required information on construction documents only and will strengthen the code by requiring this needed information on the construction documents.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Code clarification with added required information on construction documents only so will not have any impact or discriminate against materials, products, etc.

Does not degrade the effectiveness of the code

Code clarification with added required information on construction documents only so will not degrade the effectiveness of the code.

Revise as follows:

1603.1 General. *Construction documents* shall show the size, section and relative locations of structural members with floor levels, column centers and offsets dimensioned. The design loads and other information pertinent to the structural design required by Sections 1603.1.1 through 1603.1.8 shall be indicated on the *construction documents*.

Exception: *Construction documents* for buildings constructed in accordance with the *conventional light-frame construction* provisions of Section 2308 shall indicate the following structural design information:

1. **Floor and roof <u>dead and</u> liveloads.**
2. Ground snow load, P_g.
3. Ultimate design wind speed, V_{ult}, (3-second gust), miles per hour (mph) (km/hr) and nominal design wind speed, V_{asd}, as determined in accordance with Section 1609.3.1 and wind exposure.
4. *Seismic design category* and *siteclass*.
5. Flood design data, if located in *flood hazard areas* established in Section1612.3.
6. **Design load-bearing values ofsoils.**

S7425

Date Submitted	11/25/2018	**Section**	1603.1.8	**Proponent**	Ann Russo8
Chapter	16	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

S62-16

Summary of Modification

This statement clarifies the communication of the designs direct to the builders and installers and allows the installer to provide feedback if the special load element exceeds the loads or requires a different location than was designed.

Rationale

Machinery, equipment, planters, art structures and other elements impose loads that commonly exceed the capacity of the specified floor area loads. Structural engineers design these elements in specific locations with specific loads. This statement clarifies the communication of the designs direct to the builders and installers and allows the installer to provide feedback if the special load element exceeds the loads or requires a different location than was designed.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This will enhance the code by putting this information in the construction documents to allow the loads to be applied to the actual area where the load is present.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction

Most current practice currently follows this intent, even though it is not clearly stated in the code. The cost of construction will not increase by specifying the loads and locations.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction

Most current practice currently follows this intent, even though it is not clearly stated in the code. The cost of construction will not increase by specifying the loads and locations.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction

Most current practice currently follows this intent, even though it is not clearly stated in the code. The cost of construction will not increase by specifying the loads and locations.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This may speed up permitting and construction by ensuring the designer provides the information to the authority having jurisdiction and the contractor and insure loads are provided in the correct locations.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This may speed up permitting and construction by ensuring the designer provides the information to the authority having jurisdiction and the contractor and insure loads are provided in the correct locations.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Clarification with added language only so Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities,

Does not degrade the effectiveness of the code

Clarification with added language only so does not degrade the effectiveness of the code and should actually strengthen the code.

Revise as follows:

1603.1.8 Special loads. Special loads that are applicable to the design of the building, structure or portions thereof, including but not limited to the loads of machinery or equipment, which are of greater magnitude than the loads defined in the specified floor and roof loads shall be ~~indicated along with~~ specified ~~the specified section of this code that addresses the special loading condition.~~ by their descriptions and locations

Date Submitted	11/25/2018	**Section**	1609.6	**Proponent**	T Stafford
Chapter	16	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No **Alternate Language** No

Related Modifications

Summary of Modification

Deletes the alternate wind provisions of Section 1609.6 because the roof component and cladding loads are not correlated with ASCE 7-16.

Rationale

This proposal deletes alternate all heights method in the code. The pressure coefficients in ASCE 7-16 for roofs with mean roof heights of 60 feet and less have been revised significantly. As a result, this alternate method is no longer correlated with ASCE 7-16 which was adopted by the Commission during Phase I of the 2020 FBC update. Additionally, surveys by NCSEA and discussions with local engineers in Florida, show that most engineers do not use the alternate all heights method and instead rely on one of the methods in ASCE 7. Additionally, this method technically was not an alternate to ASCE 7 as Section 1609.6.4.2 required ASCE 7 to determine Kz and Kzt.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to the cost of compliance with the code. This code change simply deletes an alternate method in the code that is inconsistent with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with the code. This code change simply deletes an alternate method in the code that is inconsistent with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with the code. This code change simply deletes an alternate method in the code that is inconsistent with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This code change correlates the code with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This code change improves the code by providing correlation with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This code change dos not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This code change does not degrade the effectiveness of the code.

Revise as follows:

1609.1.1 Determination of wind loads. Wind loads on every building or structure shall be determined in accordance with Chapters 26 to 30 of ASCE 7 ~~or provisions of the alternate all-heights method in Section 1609.6~~. Wind shall be assumed to come from any horizontal direction and wind pressures shall be assumed to act normal to the surface considered.

Exceptions: (exceptions not shown for brevity)

Delete Section 1609.6 in its entirety, including Sections 1609.6.1 through 1609.6.4.4.1, and Table 1609.6.2:

~~**1609.6 Alternate all-heights method.** The alternate wind design provisions in this section are simplifications of the ASCE 7 Directional Procedure.~~

~~**1609.6.1 Scope.** As an alternative to ASCE 7 Chapters 27 and 30, the following provisions are permitted to be used to determine the wind effects on regularly shaped buildings, or other structures that are regularly shaped, that meet all of the following conditions:~~

~~1. The building or other structure is less than or equal to 75 feet (22 860 mm) in height with a height- to-least-width ratio of 4 or less, or the building or other structure has a fundamental frequency greater than or equal to 1 hertz.~~
~~2. The building or other structure is not sensitive to dynamic effects.~~
~~3. The building or other structure is not located on a site for which channeling effects or buffeting in the wake of upwind obstructions warrant special consideration.~~
~~4. The building shall meet the requirements of a simple diaphragm building as defined in ASCE 7 Section 26.2, where wind loads are only transmitted to the main windforce-resisting system (MWFRS) at the diaphragms.~~
~~5. For open buildings, multispan gable roofs, stepped roofs, sawtooth roofs, domed roofs, roofs with slopes greater than 45 degrees (0.79 rad), solid free-standing walls and solid signs, and rooftop equipment, apply ASCE 7 provisions.~~

~~**1609.6.1.1 Modifications.** The following modifications shall be made to certain subsections in ASCE 7: in Section 1609.6.2, symbols and notations that are specific to this section are used in conjunction with the symbols and notations in ASCE 7 Section 26.3.~~

~~**1609.6.2 Symbols and notations.** Coefficients and variables used in the alternative all-heights method equations are as follows:~~

~~Cnet = Net-pressure coefficient based on Kd [(G) (Cp) - (GCpi)], in accordance with Table 1609.6.2. G = Gust effect factor for rigid structures in accordance with ASCE 7 Section 26.9.1.~~
~~Kd = Wind directionality factor in accordance with ASCE 7 Table 26-6.~~
~~Pnet = Design wind pressure to be used in determination of wind loads on buildings or other structures or their components and cladding, in psf (kN/m2).~~

~~**1609.6.3 Design equations.** When using the alternative all-heights method, the MWFRS, and components and cladding of every structure shall be designed to resist the effects of wind pressures on the building envelope in accordance with Equation 16-35.~~

~~Pnet = 0.00256V2KzCnetKzt (Equation 16-35)~~
-

~~Design wind forces for the MWFRS shall be not less than 16 psf (0.77 kN/m2) multiplied by the area of the structure projected on a plane normal to the assumed wind direction (see ASCE 7 Section 27.4.7 for criteria). Design net wind pressure for components and cladding shall be not less than 16 psf (0.77 kN/m2) acting in either direction normal to the surface.~~

~~**1609.6.4 Design procedure.** The MWFRS and the components and cladding of every building or other structure shall be designed for the pressures calculated using Equation 16-35.~~

~~**1609.6.4.1 Main windforce-resisting systems.** The MWFRS shall be investigated for the torsional effects identified in ASCE 7 Figure 27.4-8.~~

~~**1609.6.4.2 Determination of Kz and Kzt.** Velocity pressure exposure coefficient, Kz, shall be determined in accordance with ASCE 7 Section 27.3.1 and the topographic factor, Kzt, shall be determined in accordance with ASCE 7 Section 26.8.~~

~~1. For the windward side of a structure, Kzt and Kz shall be based on height z.~~
~~2. For leeward and sidewalls, and for windward and leeward roofs, Kzt and Kz shall be based on mean roof height h.~~

~~**1609.6.4.3 Determination of net pressure coefficients, Cnet.** For the design of the MWFRS and for components and cladding, the sum of the internal and external net pressure shall be based on the net pressure coefficient, Cnet.~~

1. The pressure coefficient, Cnet, for walls and roofs shall be determined from Table 1609.6.2.
2. Where C net has more than one value, the more severe wind load condition shall be used for design.

1609.6.4.4 Application of wind pressures. When using the alternative all-heights method, wind pressures shall be applied simultaneously on, and in a direction normal to, all building envelope wall and roof surfaces.

1609.6.4.4.1 Components and cladding. Wind pressure for each component or cladding element is applied as follows using Cnet values based on the effective wind area, A, contained within the zones in areas of discontinuity of width and/or length "a," "2a" or "4a" at: corners of roofs and walls; edge strips for ridges, rakes and eaves; or field areas on walls or roofs as indicated in figures in tables in ASCE 7 as referenced in Table 1609.6.2 in accordance with the following:

1. Calculated pressures at local discontinuities acting over specific edge strips or corner boundary areas.
2. Include "field" (Zone 1, 2 or 4, as applicable) pressures applied to areas beyond the boundaries of the areas of discontinuity.
3. Where applicable, the calculated pressures at discontinuities (Zone 2 or 3) shall be combined with design pressures that apply specifically on rakes or eave overhangs.

TABLE 1609.6.2
NET PRESSURE COEFFICIENTS, Cnet a,

S7429

Date Submitted	11/25/2018	**Section**	1607.8	**Proponent**	Ann Russo8
Chapter	16	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

S89-16
1607.8.3

Summary of Modification

This proposal is intended to be a clarification. The current language only brings up benches in dressing rooms. 2009 A117.1 require accessible benches in dressing rooms, locker rooms and steam rooms and saunas.

Rationale

This proposal is intended to be a clarification. The current language only brings up benches in dressing rooms. 2009 A117.1 require accessible benches in dressing rooms, locker rooms and steam rooms and saunas. The loads of 250 lbs. should be applied to grab bars and shower seats wherever they are provided. The load of 250 pounds should not be required for all benches in any dressing room, but should be required for accessible benches in all three locations.
The suggested language in 1607.8.2 is because the rooms are scoped in Chapter 11, but the benches themselves are specified in ICC A117.1. The need to be so specific is that if the requirement was just for bench seats, it could be misinterpreted to be applicable to any bench seating, accessible or not, fixed or loose. The current language follows the grouping of ASCE 7 which also includes fixed ladders.

Existing load requirements for vehicle barriers are located in 1607.8.3

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Code clarification only no impact.

Impact to building and property owners relative to cost of compliance with code

As this is intended as a clarification, there will be no increase in construction cost.

Impact to industry relative to the cost of compliance with code

As this is intended as a clarification, there will be no increase in construction cost.

Impact to small business relative to the cost of compliance with code

As this is intended as a clarification, there will be no increase in construction cost.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Code clarification only and will assist in interpretation and implementation of the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Code clarification only and will assist in interpretation and implementation of the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Code clarification only so Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

Code clarification only so does not degrade the effectiveness of the code

Revise as follows:

1607.8 Loads on handrails, guards, grab bars, and seats ~~and vehicle barriers~~. Handrails~~, *guards*, grab bars, accessible seats, accessible benches~~ and ~~vehicle barriers~~ guards, shall be designed and constructed for the structural loading conditions set forth in ~~this section~~ Section 1607.8.1. Grab bars, shower seats, and accessible benches shall be designed and constructed for structural loading conditions set forth in Section 1607.8.2.

S7610

Date Submitted	11/30/2018	**Section**	1609.7	**Proponent**	Joseph Hetzel
Chapter	16	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No **Alternate Language** No

Related Modifications

Summary of Modification

Establishes a minimum positive wind load of 10 PSF, and a minimum negative wind load of 10 PSF, when using Table 1609.7(1).

Rationale

Per ASCE 7-16 Section 30.2.2, design wind loads for components and cladding of buildings shall not be less than 16 PSF, which is ultimate design strength based. Converting to allowable stress design, which the values in Table 1609.7(1) are based on, minimum positive and negative design wind loads shall be multiplied by the 0.6 load reduction factor resulting in +/-10 PSF rounded up from the calculated value of +/-9.6 PSF.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Cost increase would be minimal overall, since the tabulated values are being increased a relatively minimal amount. The cost increase is offset by the public benefit since the code is strengthened through implementing an ASCE 7-16 requirement.

Impact to building and property owners relative to cost of compliance with code

Cost increase would be minimal overall, since the tabulated values are being increased a relatively minimal amount. The cost increase is offset by the public benefit since the code is strengthened through implementing an ASCE 7-16 requirement.

Impact to industry relative to the cost of compliance with code

Cost increase would be minimal overall, since the tabulated values are being increased a relatively minimal amount. The cost increase is offset by the public benefit since the code is strengthened through implementing an ASCE 7-16 requirement.

Impact to small business relative to the cost of compliance with code

Cost increase would be minimal overall, since the tabulated values are being increased a relatively minimal amount. The cost increase is offset by the public benefit since the code is strengthened through implementing an ASCE 7-16 requirement.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The public will benefit by the code being strengthened, through implementing an ASCE 7-16 requirement.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The code is strengthened by implementing an ASCE 7-16 requirement.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The proposal is neutral with respect to materials, products, methods, or systems.

Does not degrade the effectiveness of the code

The code is strengthened by implementing an ASCE 7-16 requirement.

1609.7 Garage doors and rolling doors.
Pressures from Table 1609.7(1) for wind loading actions on garage doors and rolling doors for buildings designed as enclosed shall be permitted.

TABLE 1609.7(1)

NOMINAL (ASD) GARAGE DOOR AND ROLLING DOOR WIND LOADS FOR A BUILDING WITH A MEAN ROOF HEIGHT OF 30 FEET LOCATED IN EXPOSURE B (PSF) 1, 2, 3, 4, 5

ULTIMATE DESIGN WIND SPEED (V_{ult}) DETERMINED IN ACCORDANCE WITH SECTION 1609.3 (MPH - 3 SECOND GUST)																							
Width(ft)	Height(ft)	100 MPH		110 MPH		120 MPH		130 MPH		140 MPH		150 MPH		160 MPH		170 MPH		180 MPH		190 MPH		200 MPH	
Roof Angle 0 – 10 degrees																							
8	8	+ ~~8.7~~10.0	- ~~9.8~~10.0	+ 10.5	- 11.9	+ 12.5	- 14.2	+ 14.7	- 16.6	+ 17.1	- 19.3	+ 19.6	- 22.2	+ 22.3	- 25.2	+ 25.1	- 28.5	+ 28.2	- 31.9	+ 31.4	- 35.5	+ 34.8	- 39.4
10	10	+ ~~8.4~~10.0	- ~~9.4~~10.0	+ 10.2	- 11.4	+ 12.1	- 13.6	+ 14.2	- 16.0	+ 16.5	- 18.5	+ 18.9	- 21.2	+ 21.5	- 24.2	+ 24.3	- 27.3	+ 27.3	- 30.6	+ 30.4	- 34.1	+ 33.7	- 37.8
14	14	+ ~~8.0~~10.0	- ~~8.9~~10.0	+ ~~9.7~~10.0	- 10.8	+ 11.5	- 12.8	+ 13.5	- 15.0	+ 15.7	- 17.4	+ 18.0	- 20.0	+ 20.5	- 22.8	+ 23.1	- 25.7	+ 25.9	- 28.8	+ 28.9	- 32.1	+ 32.0	- 35.6
Roof Angle > 10 degrees																							
9	7	+ ~~9.6~~10.0	- 10.9	+ 11.4	- 12.9	+ 13.7	- 15.5	+ 16.1	- 18.2	+ 18.5	- 20.9	+ 21.3	- 24.1	+ 24.3	- 27.5	+ 27.6	- 31.2	+ 30.6	- 34.6	+ 34.2	- 38.6	+ 38.0	- 43.0
16	7	+ ~~9.2~~10.0	- 10.3	+ 10.9	- 12.2	+ 13.1	- 14.6	+ 15.5	- 17.2	+ 17.7	- 19.7	+ 20.4	- 22.7	+ 23.3	- 26.0	+ 26.4	- 29.4	+ 29.3	- 32.6	+ 32.7	- 36.5	+ 36.4	- 40.6
78 MPH		85 MPH		93 MPH		101 MPH		108 MPH		116 MPH		124 MPH		132 MPH		139 MPH		147 MPH		155 MPH			

For SI: 1 foot = 304.8 mm, 1 mile per hour = 1.609 km/h, 1 psf = 47.88 N/m2.

Nominal Design Wind Speed (Vasd) converted from Ultimate Design Wind Speed per Section 1609.3.1

.

1.For door sizes or wind speeds between those given above the load may be interpolated, otherwise use the load associated with the lower door size.

.

2.Table values shall be adjusted for height and exposure by multiplying by the adjustment coefficient in Table 1609.7(2). Minimum positive wind load shall be 10 PSF and minimum negative wind load shall be 10 PSF.

3.Plus and minus signs signify pressures acting toward and away from the building surfaces.

4.Negative pressures assume door has 2 feet of width in building's end zone.

5.Table values include the 0.6 load reduction factor.

S7663

Date Submitted	12/3/2018	**Section**	1609.1.1	**Proponent**	Scott McAdam
Chapter	16	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

adds name of reference standard for clarification

Rationale

adds name of standard, without the name it is not well known that the standard is for metal flagpoles. simple clarification that allows uses to quickly determine flagpoles also need to meet design criteria.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

help to enforce design criteria for flagpoles

Impact to building and property owners relative to cost of compliance with code

help to enforce design criteria for flagpoles, clarification may save money for compliance by noting reference standard

Impact to industry relative to the cost of compliance with code

help to enforce design criteria for flagpoles, clarification may save money for compliance by noting reference standard

Impact to small business relative to the cost of compliance with code

help to enforce design criteria for flagpoles, clarification may save money for compliance by noting reference standard

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

help to enforce design criteria for flagpoles, clarification may save money for compliance by noting reference standard

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

help to enforce design criteria for flagpoles, clarification may save money for compliance by noting reference standard

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

help to enforce design criteria for flagpoles, clarification may save money for compliance by noting reference standard

Does not degrade the effectiveness of the code

help to enforce design criteria for flagpoles, clarification may save money for compliance by noting reference standard

1609.1.1Determination of wind loads.

Wind loads on every building or structure shall be determined in accordance with Chapters 26 to 30 of ASCE 7 or provisions of the alternate all-heights method in Section 1609.6. Wind shall be assumed to come from any horizontal direction and wind pressures shall be assumed to act normal to the surface considered.

Exceptions:

1. 1.Subject to the limitations of Section 1609.1.1.1, the provisions of ICC 600 shall be permitted for applicable Group R-2 and R-3 buildings.
2. 2.Subject to the limitations of Section 1609.1.1.1, residential structures using the provisions of AWC WFCM.
3. 3.Subject to the limitations of Section 1609.1.1.1, residential structures using the provisions of AISI S230.
4. 4.Designs using NAAMM FP 1001., Guide Specifications for Design of Metal Flag Poles
5. 5.Designs using TIA-222 for antenna-supporting structures and antennas, provided the horizontal extent of Topographic Category 2 escarpments in Section 2.6.6.2 of TIA-222 shall be 16 times the height of the escarpment. Design using this standard shall be permitted for communication tower and steel antenna support structures.
6. 6.Wind tunnel tests in accordance with ASCE 49 and Sections 31.4 and 31.5 of ASCE 7.
7. 7.Wind loads for screen enclosures shall be determined in accordance with Section 2002.4.
8. 8.Exposed mechanical equipment or appliances fastened to a roof or installed on the ground in compliance with the code using rated stands, platforms, curbs, slabs, walls, or other means are deemed to comply with the wind resistance requirements of the 2007 Florida Building Code, as amended. Further support or enclosure of such mechanical equipment or appliances is not required by a state or local official having authority to enforce the Florida Building Code.

The wind speeds in Figures 1609.3(1), 1609.3(2) and 1609.3(3) are ultimate design wind speeds, *Vult*, and shall be converted in accordance with Section 1609.3.1 to nominal design wind speeds, *Vasd*, when the provisions of the standards referenced in Exceptions 4 and 5 are used.

S7845

Date Submitted	12/10/2018	**Section**	1604.3	**Proponent**	Paul Coats
Chapter	16	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No | **Alternate Language** No

Related Modifications

Summary of Modification

Revises footnote "d" of Table 1604.3 Deflection Limits to recognize different creep behavior of specific wood products in accordance with the AWC NDS.

Rationale

This modification was approved by the ICC committee and membership and appears in the 2018 International Building Code. Revisions are proposed to recognize different creep behavior of specific wood products in accordance with the NDS. Specifically, creep deformation of seasoned lumber, structural glued laminated timber, prefabricated wood I-joists, and structural composite lumber members that are installed and used in dry conditions can be approximated by calculation of immediate deflection resulting from the use of 0.5D. For seasoned lumber and structural glued laminated timber that are installed and used in wet conditions and unseasoned lumber used in any conditions, creep deformation is larger and can be approximated by the immediate deflection resulting from the use of 1.0D. For cross-laminated timber and wood structural panels used in dry conditions, creep deformation can be approximated by the immediate deflection resulting from the use of 1.0D. The 0.5D and 1.0D approach in footnote d are associated and consistent with NDS 3.5.2 creep factors of 1.5 and 2.0. The NDS creep factors represent the combined deformation resulting from the immediate deformation under dead load plus long-term creep deformation.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Change in existing design provisions already in the referenced standards, no impact.

Impact to building and property owners relative to cost of compliance with code

No cost-related impact.

Impact to industry relative to the cost of compliance with code

No cost-related impact.

Impact to small business relative to the cost of compliance with code

No cost-related impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Pertains to structural design which is connected with the performance and longevity of structures.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code with appropriate design criteria.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

?TABLE 1604.3 DEFLECTION LIMITS *(no change to body of table, only the content of footnote "d":)*

d. The deflection limit for the D+L load combination only applies to the deflection due to the creep component of long-term dead load deflection plus the short-term live load deflection. For ~~wood~~ lumber, structural glued laminated timber, prefabricated wood I-joists, and structural composite lumber members that are dry at time of installation and used under dry conditions in accordance with the ANSI/AWC NDS, the creep component of the long-term deflection shall be permitted to be estimated as the immediate dead load deflection resulting from 0.5D. For ~~wood structural~~ lumber and glued laminated timber members installed or used at all other moisture conditions or cross laminated timber and wood structural panels that are dry at time of installation and used under dry conditions in accordance with the ANSI/AWC NDS, the creep component of the long-term deflection is permitted to be estimated as the immediate dead load deflection resulting from D. The value of 0.5D shall not be used in combination with ANSI/AWC NDS provisions for long-term loading.

S67-16

IBC: 1604.3.

Proponent : Dennis Richardson, American Wood Council, representing American Wood Council (drichardson@awc.org)

2015 International Building Code

Revise as follows:

TABLE 1604.3
DEFLECTION LIMITS[a,b,c,h,i]

(Portions of table remain unchanged)

For SI: 1 foot = 304.8 mm.

a. For structural roofing and siding made of formed metal sheets, the total load deflection shall not exceed l/60. For secondary roof structural members supporting formed metal roofing, the live load deflection shall not exceed l/150. For secondary wall members supporting formed metal siding, the design wind load deflection shall not exceed l/90. For roofs, this exception only applies when the metal sheets have no roof covering.

b. Flexible, folding and portable partitions are not governed by the provisions of this section. The deflection criterion for interior partitions is based on the horizontal load defined in Section 1607.14.

c. See Section 2403 for glass supports.

d. The deflection limit for the $D+L$ load combination only applies to the deflection due to the creep component of long-term dead load deflection plus the short-term live load deflection. For ~~wood~~ lumber, structural glued laminated timber, prefabricated wood I-joists, and structural composite lumber members that are dry at time of installation and used under dry conditions in accordance with the ANSI/AWC NDS, the creep component of the long-term deflection shall be permitted to be estimated as the immediate dead load deflection resulting from 0.5 D . For ~~wood structural~~ lumber and glued laminated timber members installed or used at all other moisture conditions or cross laminated timber and wood structural panels that are dry at time of installation and used under dry conditions in accordance with the ANSI/AWC NDS, the creep component of the long-term deflection is permitted to be estimated as the immediate dead load deflection resulting from D . The value of 0.5 D shall not be used in combination with ANSI/AWC NDS provisions for long-term loading.

e. The above deflections do not ensure against ponding. Roofs that do not have sufficient slope or camber to ensure adequate drainage shall be investigated for ponding. See Section 1611 for rain and ponding requirements and Section 1503.4 for roof drainage requirements.

f. The wind load is permitted to be taken as 0.42 times the "component and cladding" loads for the purpose of determining deflection limits herein. Where members support glass in accordance with Section 2403 using the deflection limit therein, the wind load shall be no less than 0.6 times the "component and cladding" loads for the purpose of determining deflection.

g. For steel structural members, the dead load shall be taken as zero.

h. For aluminum structural members or aluminum panels used in skylights and sloped glazing framing, roofs or walls of sunroom additions or patio covers not supporting edge of glass or aluminum sandwich panels, the total load deflection shall not exceed l/60. For continuous aluminum structural members supporting edge of glass, the total load deflection shall not exceed l/175 for each glass lite or l/60 for the entire length of the member, whichever is more stringent. For aluminum sandwich panels used in roofs or walls of sunroom additions or patio covers, the total load deflection shall not exceed 1 /120.

i. For cantilever members, l shall be taken as twice the length of the cantilever.

Reason: Revisions are proposed to recognize different creep behavior of specific wood products in accordance with the NDS. Specifically, creep deformation of seasoned lumber, structural glued laminated timber, prefabricated wood I-joists, and structural composite lumber members that are installed and used in dry conditions can be approximated by calculation of immediate deflection resulting from the use of 0.5D. For seasoned lumber and structural glued laminated timber that are installed and used in wet conditions and unseasoned lumber used in any conditions, creep deformation is larger and can be approximated by the immediate deflection resulting from the use of 1.0D. For cross-laminated timber and wood structural panels used in dry conditions, creep deformation can be approximated by the immediate deflection resulting from the use of 1.0D. The 0.5D and 1.0D approach in footnote d are associated and consistent with with NDS 3.5.2 creep factors of 1.5 and 2.0. The NDS creep factors represent the combined deformation resulting from the immediate deformation under dead load plus long-term creep deformation.

Cost Impact: Will not increase the cost of construction
This change correlates structural provisions with a new product in the applicable standard and will not increase the

cost of construction.

Final action: AS (Approved as Submitted)

S7982

Date Submitted	12/14/2018	**Section**	1626	**Proponent**	Amanda Hickman
Chapter	16	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No **Alternate Language** No

Related Modifications

Summary of Modification

This modification revises and adds language to Section 1626 of the Florida Building Code.

Rationale

AMCA 540 - Test Method for Louvers Impacted by Wind Borne Debris has been referenced in Florida's Building Code since 2010. This standard is the appropriate standard for properly testing louvers for impact. As such it is critical that it also be recognized in the High Velocity Hurricane Zone (HVHZ) section of Florida's code. The current 2013 edition which is already referenced in the 7th edition of the Florida Code includes cycling requirements that make it even more robust. This modification seeks to add AMCA 540 standard to the HVHZ section of the code as an alternative to the comparative TAS 201 protocol.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

There will be little impact to enforcement, as this modification will only provide another test standard for impact testing of louvers in the HVHZ zone.

Impact to building and property owners relative to cost of compliance with code

This modification could decrease the cost to building owners as this will streamline the louver impact testing and could decrease the cost of the products in some cases.

Impact to industry relative to the cost of compliance with code

This modification will decrease the cost to the industry as this will streamline the louver impact testing.

Impact to small business relative to the cost of compliance with code

This modification could decrease the cost to small business as this will streamline the louver impact testing and could decrease the cost of the products in some cases.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This modification will recognize an impact standard that is more stringent for testing louvers than the current protocol, thereby promoting the health, safety and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This modification will recognize an impact standard that is more stringent for testing louvers than the current protocol, thereby strengthening the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This modification does not discriminate against any products or methods or systems of construction, as it only provide another test standard for impact testing of louvers in the HVHZ zone.

Does not degrade the effectiveness of the code

This modification does not degrade the effectiveness of the code, as it only provide another test standard for impact testing of louvers in the HVHZ zone.

Revise and add language as follows:

1626.1
All parts or systems of a building or structure envelope such as, but not limited, to exterior walls, roof, outside doors, skylights, glazing and glass block shall meet impact test criteria or be protected with an external protection device that meets the impact test criteria. Test procedures to determine resistance to wind-borne debris of wall cladding, outside doors, skylights, glazing, glass block, shutters and any other external protection devices shall be performed in accordance with this section.

Exception: The following structures or portion of structures shall not be required to meet the provisions of this section:

1. a.Roof assemblies for screen rooms, porches, canopies, etc., attached to a building that do not breach the exterior wall or building envelope and have no enclosed sides other than screen.
2. b.Soffits, soffit vents and ridge vents. Size and location of such vents shall be detailed by the designer and shall not compromise the integrity of the diaphragm boundary.
3. c.Vents in a garage with four or fewer cars. Size and location of such vents shall be detailed by the designer and shall not exceed the minimum required area by more than 25 percent.
4. d.Exterior wall or roof openings for wall- or roof-mounted HVAC equipment.
5. e.Openings for roof-mounted personnel access roof hatches.
6. f.Storage sheds that are not designed for human habitation and that have a floor area of 720 square feet (67 m^2) or less are not required to comply with the mandatory windborne debris impact standards of this code.
7. g.Louvers as long as they properly considered ASCE 7 in the design of the building and that meet the requirements of Section 1626.5.
8. h.Buildings and structures for marinas, cabanas, swimming pools, and greenhouses.
9. i.Exterior balconies or porches under existing roofs or decks enclosed with screen or removable vinyl and acrylic panels complying with Section 1622.1 or 1622.2 shall not be required to be protected and openings in the wall separating the unit from the balcony or porch shall not be required to be protected unless required by other provisions of this code.

1626.5 Louvers.
Louvers protecting intake and exhaust ventilation ducts not assumed to be open that are located within 30 feet (9144 mm) of grade shall meet the requirements of AMCA 540 or shall be protected by an impact-resistant cover complying with the large missile test of TAS 201, TAS 202, TAS 203 or an approved impact-resistance standard. Louvers required to be open for life safety purposes such as providing a breathable atmosphere shall meet the requirements of AMCA 540. Open and closed louvers shall also comply with uniform air pressure testing per TAS 202 protocol and cyclical wind pressure loading per TAS 203 protocol. This test shall be applicable to the construction unit of each louver type and material. A minimum of two test specimens made up of hidden (Architectural joints) and visible mullioned assembliesshall be utilized in verification of all specimen assembly conditions.

S8094

Date Submitted	12/14/2018	**Section**	1612.4	**Proponent**	Kari Hebrank
Chapter	16	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments Yes **Alternate Language** Yes

Related Modifications

Summary of Modification

This modification specifies the location, anchoring and safety requirements to resist flood forces and prevent flotation for pool, spa and water feature equipment.

Rationale

This ensures pool, spa and water feature equipment is installed safely in floodplain areas consistent with their design specifications.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

There could potentially be cost-savings by ensuring pool equipment is located and anchored to ensure safety and design functionality, thus preventing malfunction.

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This provision ensures pools and equipment can be built and installed safely in floodplains.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This provision will provide equivalent protection through the use of branch circuits that have ground-fault circuit interrupter protection. Further, with the equipment being located near the ground, there is less chance of falling injuries to homeowners and contractors.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This revision does not discriminate against materials, products, methods or systems of demonstrated capabilities.

Does not degrade the effectiveness of the code

This provision does not degrade the effectiveness of the code.

Alternate Language

1st Comment Period History

8094-A1

Proponent Gregory Wilson **Submitted** 2/13/2019 **Attachments** Yes

Rationale

The proposed amendment is not consistent with published FEMA guidance. This proposed change to further modify the amendment to ASCE 24, Section 9.6 makes it consistent with National Flood Insurance Program Guidance which advises pool equipment should be fully elevated where possible, but if elevation would result in problems with pump function and performance, equipment is to be elevated as high as possible while allowing safe functioning. Reference FEMA P-348 Protecting Building Utilities From Flood Damage. There are other places in the code where judgement to determine practicality is required.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

Some may have costs for partial elevation.

Impact to industry relative to the cost of compliance with code

None

Impact to Small Business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Allows safe functioning while reducing exposure to flooding.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, consistent with NFIP guidance

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Modification does not discriminate against materials, products or methods of systems of construction

Does not degrade the effectiveness of the code

Modification does not degrade effectiveness of the code.

1st Comment Period History

S8094-G1

Proponent Kari Hebrank **Submitted** 2/13/2019 **Attachments** No

Comment:

The Florida Swimming Pool Association (FSPA) SUPPORTS this code proposal which addresses pool equipment in floodplain areas.

1612.4.2 Modification of ASCE 24 9.6 Pools.

In-ground and aboveground pools shall be designed to withstand all flood-related loads and load combinations. Mechanical equipment for pools such as pumps, heating systems, and filtering systems, and their associated electrical systems shall comply with Chapter 7.

Exception: Equipment for pools, spas and water features shall be permitted below the elevation required in Table 7-1 provided it is anchored to prevent flotation and resist flood forces and is supplied by branch circuits that have ground-fault circuit interrupter protection.

Exception: Equipment for pools, spas and water features shall be permitted below the elevation required in Table 7-1 provided it is elevated to the extent practical, is anchored to prevent flotation and resist flood forces and is supplied by branch circuits that have ground-fault circuit interrupter protection.

Date Submitted 11/28/2018
Chapter 17
Section 1710
Affects HVHZ No
Proponent Scott McAdam
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No | **Alternate Language** Yes

Related Modifications

Summary of Modification

Add back into the code a Florida specific section that was not brought forward from the 2010 FBC section 1717.5.4 Anchorage methods

Rationale

During the code change process for the 5th Edition 2014 code cycle there were many code section that were not proposed to continue to be brought forward and were not included in the 5th Edition or the 6th Edition codes. This anchorage section is needed in the Building Code it still remains in the Residential Code. Section needed for consistency.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact needed removed code section that is Florida specific and was not brought forward.

Impact to building and property owners relative to cost of compliance with code

No impact needed removed code section that is Florida specific and was not brought forward.

Impact to industry relative to the cost of compliance with code

No impact needed removed code section that is Florida specific and was not brought forward.

Impact to small business relative to the cost of compliance with code

No impact needed removed code section that is Florida specific and was not brought forward.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

No impact needed removed code section that is Florida specific and was not brought forward.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

No impact needed removed code section that is Florida specific and was not brought forward.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No impact needed removed code section that is Florida specific and was not brought forward.

Does not degrade the effectiveness of the code

No impact needed removed code section that is Florida specific and was not brought forward.

Alternate Language

1st Comment Period History

7500-A1

Proponent Anthony Miller **Submitted** 2/15/2019 **Attachments** Yes

Rationale

This proposal brings back a code section that was inadvertently left out of the 2014 and 2017 Florida Building Code. It is necessary for consistency with similar language in Section R609.7.2.1.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact needed removed code section that is Florida specific and was not brought forward.

Impact to building and property owners relative to cost of compliance with code

No impact needed removed code section that is Florida specific and was not brought forward.

Impact to industry relative to the cost of compliance with code

No impact needed removed code section that is Florida specific and was not brought forward.

Impact to Small Business relative to the cost of compliance with code

No impact needed removed code section that is Florida specific and was not brought forward.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Provides safety and welfare of the general public by strengthening window and door installation requirements.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens Code as it clarifies proper installation of windows and doors

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

1710 Anchorage

1710.1 Anchorage methods. The methods cited in this section apply only to anchorage of window and door assemblies to the main wind force resisting system.

-

1710.2 Anchoring requirements. Window and door assemblies shall be anchored in accordance with the published manufacturer's recommendations to achieve the design pressure specified. Substitute anchoring systems used for substrates not specified by the fenestration manufacturer shall provide equal or greater anchoring performance as demonstrated by accepted engineering practice.

-

1710.3 Masonry, concrete or other structural substrate. Where the wood shim or buck thickness is less than 11/2 inches (38 mm), window and door assemblies shall be anchored through the main frame or by jamb clip or subframe system, in accordance with the manufacturer's published installation instructions. Anchors shall be securely fastened directly into the masonry, concrete or other structural substrate material. Unless otherwise tested, bucks shall extend beyond the interior face of the window or door frame such that full support of the frame is provided. Shims shall be made from materials capable of sustaining applicable loads, located and applied in a thickness capable of sustaining applicable loads. Anchors shall be provided to transfer load from the window or door frame to the rough opening substrate.

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Where the wood buck thickness is 11/4 inches (38 mm) or greater, the buck shall be securely fastened to transfer load to the masonry, concrete or other structural subtrate and the buck shall extend beyond the interior face of the window or door frame. Window and door assemblies shall be anchored through the main frame or by jamb clip or subframe system or through the flange to the secured wood buck in accordance with the manufacturer's published installation instructions. Unless otherwise tested, bucks shall extend beyond the interior face of the window or door frame such that full support of the frame is provided. Shims shall be made from materials capable of sustaining applicable loads, located and applied in a thickness capable of sustaining applicable loads. Anchors shall be provided to transfer load from the window or door frame assembly to the secured wood buck.

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1710.4 Wood or other approved framing materials. Where the framing material is wood or other approved framing material, window and glass door assemblies shall be anchored through the main frame or by jamb clip or subframe system or through the flange in accordance with the manufacturer's published installation instructions. Shims shall be made from materials capable of sustaining applicable loads, located and applied in a thickness capable of sustaining applicable loads. Anchors shall be provided to transfer load from the window or door frame to the rough opening substrate.

1710 Anchorage

1710.1 Anchorage methods.

The methods cited in this section apply only to anchorage of window and door assemblies to the main wind force resisting system.

1710.2 Anchoring requirements.

Window and door assemblies shall be anchored in accordance with the published manufacturer's recommendations to achieve the design pressure specified. Substitute anchoring systems used for substrates not specified by the fenestration manufacturer shall provide equal or greater anchoring performance as demonstrated by accepted engineering practice.

1710.3 Masonry, concrete or other structural substrate.

Where the wood shim or buck thickness is less than 1-1/2 inches (38 mm), window and door assemblies shall be anchored through the main frame or by jamb clip or subframe system, in accordance with the manufacturer's published installation instructions. Anchors shall be securely fastened directly into the masonry, concrete or other structural substrate material. Unless otherwise tested, bucks shall fully support the window or door frame. Shims shall be made from materials capable of sustaining applicable loads, located and applied in a thickness capable of sustaining applicable loads. Anchors shall be provided to transfer load from the window or door frame to the rough opening substrate.

Where the wood buck thickness is 1-1/4 inches (38 mm) or greater, the buck shall be securely fastened to transfer load to the masonry, concrete or other structural substrate and the buck shall fully support the window or door frame. Window and door assemblies shall be anchored through the main frame or by jamb clip or subframe system or through the flange to the secured wood buck in accordance with the manufacturer's published installation instructions. Unless otherwise tested, bucks shall fully support the window or door. Shims shall be made from materials capable of sustaining applicable loads, located and applied in a thickness capable of sustaining applicable loads. Anchors shall be provided to transfer load from the window or door frame assembly to the secured wood buck.

1710.4 Wood or other approved framing materials.

Where the framing material is wood or other approved framing material, window and door assemblies shall be anchored through the main frame or by jamb clip or subframe system or through the flange in accordance with the manufacturer's published installation instructions. Shims shall be made from materials capable of sustaining applicable loads, located and applied in a thickness capable of sustaining applicable loads. Anchors shall be provided to transfer load from the window or door frame to the rough opening substrate.

1710 Anchorage

1710.1 Anchorage methods.
The methods cited in this section apply only to anchorage of window and door assemblies to the main wind force resisting system.

1710.2 Anchoring requirements.
Window and door assemblies shall be anchored in accordance with the published manufacturer's recommendations to achieve the design pressure specified. Substitute anchoring systems used for substrates not specified by the fenestration manufacturer shall provide equal or greater anchoring performance as demonstrated by accepted engineering practice.

1710.3 Masonry, concrete or other structural substrate.
Where the wood shim or buck thickness is less than 1-1/2 inches (38 mm), window and door assemblies shall be anchored through the main frame or by jamb clip or subframe system, in accordance with the manufacturer's published installation instructions. Anchors shall be securely fastened directly into the masonry, concrete or other structural substrate material. Unless otherwise tested, bucks shall fully support the window or door frame. Shims shall be made from materials capable of sustaining applicable loads, located and applied in a thickness capable of sustaining applicable loads. Anchors shall be provided to transfer load from the window or door frame to the rough opening substrate.

Where the wood buck thickness is 1-1/4 inches (38 mm) or greater, the buck shall be securely fastened to transfer load to the masonry, concrete or other structural substrate and the buck shall fully support the window or door frame. Window and door assemblies shall be anchored through the main frame or by jamb clip or subframe system or through the flange to the secured wood buck in accordance with the manufacturer's published installation instructions. Unless otherwise tested, bucks shall fully support the window or door. Shims shall be made from materials capable of sustaining applicable loads, located and applied in a thickness capable of sustaining applicable loads. Anchors shall be provided to transfer load from the window or door frame assembly to the secured wood buck.

1710.4 Wood or other approved framing materials.
Where the framing material is wood or other approved framing material, window and door assemblies shall be anchored through the main frame or by jamb clip or subframe system or through the flange in accordance with the manufacturer's published installation instructions. Shims shall be made from materials capable of sustaining applicable loads, located and applied in a thickness capable of sustaining applicable loads. Anchors shall be provided to transfer load from the window or door frame to the rough opening substrate.

S8057

Date Submitted	12/13/2018	**Section**	1708.1	**Proponent**	Ann Russo4
Chapter	17	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No | **Alternate Language** No

Related Modifications

1708.2
1708.3 1708.3.1 1708.3.2

Summary of Modification

This is an editorial tune-up of the in-situ load tests. The first change deletes a superfluous phrase. The second change (deletion of 1708.2) is intended to eliminate a duplicative provision. The third change (addition of the word "material" in two locations)

Rationale

This is an editorial tune-up of the in-situ load tests. As an editorial change, this proposal is intended to clarify and make the load test requirements more concise. It should have no measurable impact on the cost of construction.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity as this is already a code requirement

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners as this is already a code requirement

Impact to industry relative to the cost of compliance with code

No impact to industry as this is already a code requirement

Impact to small business relative to the cost of compliance with code

No impact to small businesses as this is already a code requirement

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by cleaning up wording that could cause confusion

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by clarifying and making the load test requirements more concise

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities, this is a current code requirement that does not limit materials, products, methods, or systems of construction

Does not degrade the effectiveness of the code

It make the effectiveness of the code better by clarifying and making the load test requirements more concise

Revise as follows:

1708.1 General. Whenever there is a reasonable doubt as to the stability or load-bearing capacity of a completed building, structure or portion thereof for the expected loads, an engineering assessment shall be required. The engineering assessment shall involve either a structural analysis or an in-situ load test, or both. The structural analysis shall be based on actual material properties and other as-built conditions that affect stability or load-bearing capacity, and shall be conducted in accordance with the applicable design standard. ~~If the structural assessment determines that the load-bearing capacity is less than that required by the code,~~ The in-situ load tests shall be conducted in accordance with Section 1708.2. If the building, structure or portion thereof is found to have inadequate stability or load-bearing capacity for the expected loads, modifications to ensure structural adequacy or the removal of the inadequate construction shall be required.

~~**1708.2 Test standards.** Structural components and assemblies shall be tested in accordance with the appropriate referenced standards. In the absence of a standard that contains an applicable load test procedure, the test procedure shall be developed by a *registered design professional* and *approved*. The test procedure shall simulate loads and conditions of application that the completed structure or portion thereof will be subjected to in normal use.~~

~~**1708.3**~~ **1708.2 In-situ load tests.** In-situ load tests shall be conducted in accordance with Section ~~1708.3.1~~ 1708.2.1 or ~~1708.3.2~~ 1708.2.2 and shall be supervised by a *registered design professional*. The test shall simulate the applicable loading conditions specified in Chapter 16 as necessary to address the concerns regarding structural stability of the building, structure or portion thereof.

~~**1708.3.1**~~ **1708.2.1 Load test procedure specified.** Where a referenced material standard contains an applicable load test procedure and acceptance criteria, the test procedure and acceptance criteria in the standard shall apply. In the absence of specific load factors and acceptance criteria in Section ~~1708.3.2~~ 1708.2.2 shall apply.

~~**1708.3.2**~~ **1708.2.2 Load test procedure not specified.** In the absence of applicable load test procedures contained within a a material standard referenced by this code or acceptance criteria for a specific material or method of construction, such *existing structure* shall be subjected to ~~a~~ an *approved* test procedure developed by a *registered design professional* that simulates applicable loading and deformation conditions. For components that are not a part of the seismic force-resisting system, at a minimum the test load shall be equal to the specified factored design loads. For materials such as wood that have strengths that are dependent on load duration, the test load shall be adjusted to account for the difference in load duration of the test compared to the expected duration of the design loads being considered. For statically loaded components, the test load shall be left in place for a period of 24 hours. For components that carry dynamic loads(e.g.,machine supports or fall arrest anchors),the load shall be left in place for a period consistent with the component's actual function. The structure shall be considered to have successfully met the test requirements where the following criteria are satisfied:

1. Under the design load, the deflection shall not exceed the limitations specified in Section1604.3. within 24 hours after removal of the test load, the structure shall have recovered not less than 75.2 percent of the maximum deflection.
2. During the immediately after the test, the structure shall not show evidence of failure

S7391

Date Submitted 11/21/2018
Chapter 18
Section 1803.3
Affects HVHZ No
Proponent Hill Kevin
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Add settlement to evaluation list

Rationale

Adding clarification that settlement should be considered.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Building settlement analysis promotes greater structural safety.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Clarifies that any soil condition that causes settlement should be analyzed, not just whether or not the soil is "compressible".

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate

Does not degrade the effectiveness of the code

Does not affect the effectiveness.

Soil classification shall be based on observation and any necessary tests of the materials disclosed by borings, test pits or other subsurface exploration made in appropriate locations. Additional studies shall be made as necessary to evaluate slope stability, soil strength, position and adequacy of load-bearing soils, the effect of moisture variation on soil-bearing capacity, compressibility (settlement), liquefaction and expansiveness.

Date Submitted 11/21/2018
Chapter 18
Section 1803.6
Affects HVHZ No
Proponent Hill Kevin
Attachments Yes
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

Summary of Modification

Adding highly organic and total settlement to foundation recommendations for reporting.

Rationale

Highly organic soils and total settlement should be also considered when providing geotechnical recommendations for foundations. You can have 6 inches of total settlement with only 1/2 inch of differential settlement then total settlement can be more important than differential. This can be the case for poor, but uniform, soil conditions.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Increase safety for foundation stability in that geotechnical reports should also consider poor soil conditions such as highly organic soils and also consider total settlement which can cause more substantial problems than differential settlement.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens code by adding additional considerations for geotechnical report.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

1803.6 Reporting.

Where geotechnical investigations are required, a written report of the investigations shall be submitted to the *building official* by the permit applicant at the time of permit application. This geotechnical report shall include, but need not be limited to, the following information:

1. 1.A plot showing the location of the soil investigations.
2. 2.A complete record of the soil boring and penetration test logs and soil samples.
3. 3.A record of the soil profile.
4. 4.Elevation of the water table, if encountered.
5. 5.Recommendations for foundation type and design criteria, including but not limited to: bearing capacity of natural or compacted soil; provisions to mitigate the effects of expansive or highly organic soils; mitigation of the effects of liquefaction, total and differential settlement and varying soil strength; and the effects of adjacent loads.
6. 6.Expected total and differential settlement.
7. 7.Deep foundation information in accordance with Section 1803.5.5.
8. 8.Special design and construction provisions for foundations of structures founded on expansive soils, as necessary.
9. 9.Compacted fill material properties and testing in accordance with Section 1803.5.8.
10. 10.Controlled low-strength material properties and testing in accordance with Section 1803.5.9.

Designation: D2974 − 14

Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils[1]

This standard is issued under the fixed designation D2974; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 These test methods cover the measurement of moisture content, ash content, and organic matter in peats and other organic soils, such as organic clays, silts, and mucks. Test Method D2216 provides an alternative method for determining moisture content in mineral soils and rock.

1.1.1 *Test Method A*—Moisture is determined by drying peat or organic sample at 110 ± 5°C.

1.1.2 *Test Method B*—Alternative moisture method which removes the total moisture in two steps: (*1*) evaporation of moisture at room temperature, (*2*) subsequent oven drying of air dried sample at 110 ± 5°C. This method is used when the peat is to be used as fuel.

1.1.3 *Test Method C*—Ash content of a peat or organic soil sample, for general purposes, is determined by igniting oven dried sample from moisture content determination in a furnace at 440 ± 40°C.

1.1.4 *Test Method D*—Ash content of a peat or organic soil sample, for materials used for fuel, is determined by igniting oven dried sample from moisture content determination in a furnace at 750 ± 38°C.

1.2 Test Method A should be used for general classification, except for use of the peat as a fuel. Test Method B should be used when peats are being evaluated for use as a fuel

1.3 The values stated in SI units are to be regarded as the standard. No other units of measurement are included in this standard.

1.4 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026.

1.4.1 The procedures used to specify how data are collected/recorded or calculated in this standard are regarded as the industry standard. In addition, they are representative of the significant digits that generally should be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user's objectives; and it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations. It is beyone the scope of this standard to consider significant digits used in analysis methods for engineering design.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

D2944 Practice of Sampling Processed Peat Materials

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing

D6026 Practice for Using Significant Digits in Geotechnical Data

E145 Specification for Gravity-Convection and Forced-Ventilation Ovens

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of common technical terms in this standard, refer to Terminology D653.

4. Summary of Test Methods

4.1 *Test Method A*—Moisture is determined by drying a peat or organic soil sample at 110 ± 5°C. The moisture content is expressed as a percent of the oven dry mass.

[1] These test methods are under the jurisdiction of ASTM Committee D18 on Soil and Rock and are the direct responsibility of Subcommittee D18.22 on Soil as a Medium for Plant Growth.

Current edition approved Nov. 1, 2014. Published November 2014. Originally approved in 1971. Last previous edition approved in 2013 as D2974 – 13. DOI: 10.1520/D2974-14.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

*A Summary of Changes section appears at the end of this standard

4.2 *Test Method B*—This is an alternative moisture method which removes the total moisture in two steps: (*1*) evaporation of moisture in air at room temperature (air-drying), and (*2*) the subsequent oven drying of the air-dried sample at 110 ± 5°C. This method is used when the peat is to be used as fuel. The moisture content is expressed as both a percent of the oven dry mass and of the as received mass.

4.3 *Test Methods C and D*—Ash content of a peat or organic soil sample is determined by igniting the oven-dried sample from the moisture content determination in a furnace at 440 ± 40°C (Test Method C) or 750 ± 38°C (Test Method D). The substance remaining after ignition is the ash. The ash content is expressed as a percentage of the mass of the oven-dried sample.

4.4 Organic matter is determined by subtracting percent ash content from one hundred.

5. Significance and Use

5.1 This test method can be used to determine the moisture content, ash content, and percent organic matter in soil.

5.2 The percent organic matter is important in the following: (*1*) classifying peat or other organic soil, (*2*) geotechnical and general classification purposes, and (*3*) when peats are being evaluated as a fuel.

NOTE 1—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Oven*, meeting the requirements of E145 and capable of being regulated to a constant temperature of 110 ± 5°C.

6.2 The temperature of 110 ± 5°C is quite critical for organic soils. The oven should be checked for "hot spots" to avoid possible ignition of the specimen.

6.3 *Furnace*, capable of producing constant temperatures of 440 ± 40°C and 750 ± 38°C.

6.4 *Balance or Scale*, a balance or scale for determining the mass of the soil having a minimum capacity of 500 g and meeting the requirements of Guide D4753 for a balance or scale of 0.01 g readability.

6.5 *Rubber Sheet, Oil Cloth*, or other non-absorbent material.

6.6 *Evaporating Dishes*, of high silica or porcelain of not less than 100-mL capacity.

6.7 *Aluminum Foil*, heavy-duty.

6.8 *Porcelain Pan, Spoons*, and equipment of the like.

6.9 *Desiccator.*

7. Sampling and Test Specimens

7.1 Place a representative field sample on a rubber sheet, oil cloth, or equivalent material and mix thoroughly.

7.2 Reduce the sample to the quantity required for a test specimen by quartering.

7.3 Place the test specimen and the remaining sample in separate waterproof containers.

7.4 Work rapidly to prevent moisture loss or perform the operation in a room with a high humidity.

8. Procedure

8.1 *Moisture Content Determination:*

8.1.1 *Test Method A:*

8.1.1.1 Record to the nearest 0.01 g the mass of a high silica or porcelain evaporating dish fitted with a heavy-duty aluminum foil cover. The dish shall have a capacity of not less than 100 mL.

8.1.1.2 Following the instruction in Section 7 above, place a test specimen of at least 50 g in the container described in 8.1.1.1. Crush soft lumps with a spoon or spatula. The thickness of peat in the container should not exceed 3 cm.

8.1.1.3 Record the mass to the nearest 0.01 g.

8.1.1.4 Dry uncovered for at least 16 h at 110 ± 5°C or until there is less than 0.1 % change in mass of the sample per hour. Remove from the oven, cover tightly, cool in a desiccator, and record the mass to the nearest 0.01 g keeping exposure to the room atmosphere to a minimum.

8.1.2 *Calculations for Test Method A:*

8.1.2.1 Calculate the moisture content as follows:

$$\text{Moisture Content, \%} = [(A - B) \times 100]/B \qquad (1)$$

where:

A = mass of the as-received test specimen, g, and
B = mass of the oven-dried specimen, g.

(*1*) This calculation is used for general purposes (except when the peat is to be used as a fuel) and the result should be referred to as the moisture content as a percentage of oven-dried mass.

8.1.3 *Test Method B:*

8.1.3.1 This test method should be used if the peat is to be used as a fuel.

8.1.3.2 Following the instructions in Section 7, select a 100 to 300 g representative test specimen. Determine the mass of this test specimen to the nearest 0.01 g and spread it evenly on a large flat pan. Crush soft lumps with a spoon or spatula and let the sample come to moisture equilibrium with room air. This will require at least 24 h. Stir occasionally during the normal workday to maintain maximum air exposure of the entire sample. Continue drying until there is less than 0.1% change in mass per hour, then calculate the moisture removed during air drying as a percentage of the as-received mass.

8.1.3.3 After thoroughly mixing the air-dried sample, obtain 50 g of material and record to the nearest 0.01 g.

8.1.3.4 Place the sample in a container as described in 8.1.1 and proceed as in Test Method A.

8.1.4 *Calculations for Test Method B:*

8.1.4.1 Calculate the moisture content as follows:

$$\text{Moisture Content for Air-Dried Sample, \%} = ((A_D - B) \times 100)/B \qquad (2)$$

where:

A_D = mass of the air-dried sample, g, and
B = mass of the oven-dried sample, g.

(1) This calculation gives moisture content of the air dried sample as a percentage of oven-dried mass.

8.2 *Ash Content Determination:*

8.2.1 *Test Method C:*

8.2.1.1 Determine the mass of a covered high-silica or porcelain dish to the nearest 0.01 g.

8.2.1.2 Place a part or all of the oven-dried test specimen from a moisture determination in the dish and determine the mass of the dish and specimen to the nearest 0.01 g.

8.2.1.3 Remove the cover and place the dish in a furnace. Gradually bring the temperature in the furnace to 440 ± 40°C and hold until the specimen is completely ashed (no change of mass occurs after at least 1 hr period of heating).

8.2.1.4 Cool in a desiccator, and determine the mass to the nearest 0.01 g keeping the exposure to the room atmosphere to a minimum.

8.2.1.5 This test method should be used for general classification purposes, except the use of peat for fuel.

8.2.2 *Test Method D:*

8.2.2.1 Determine the mass of a covered high-silica or porcelain dish to the nearest 0.01 g.

8.2.2.2 Place a part of the oven-dried test specimen from a moisture determination in the dish and determine the mass of the dish and specimen to the nearest 0.01 g.

8.2.2.3 Remove the cover and place the dish in a furnace. Gradually bring the temperature in the furnace to 750 ± 38°C and hold until the specimen is completely ashed (no change in mass of the sample after further drying periods in excess of 1 h).

8.2.2.4 Cool in a desiccator, and determine the mass to the nearest 0.01 g keeping the exposure to the room atmosphere to a minimum.

8.2.2.5 This test method should be used when peats are being evaluated for use as a fuel.

8.2.3 *Calculation for Test Methods C and D:*

8.2.3.1 Calculate the ash content as follows:

$$\text{Ash Content, } \% = (C \times 100)/B \quad (3)$$

where:

C = mass of ash, g, and
B = oven-dried test specimen, g.

8.3 *Organic Matter Determination:*

8.3.1 *Calculation:*

8.3.1.1 Determine the amount of organic matter to the nearest 0.1 % by difference, as follows:

$$\text{Organic matter, } \% = 100.0 - D \quad (4)$$

where:

D = ash content, % (nearest 0.1 %).

9. Report: Test Data Sheet(s)/Form(s)

9.1 The methodology used to specify how data are recorded on the test data sheet(s)/form(s), as follows, is covered in 1.4.

9.2 Record as a minimum the following general information (data):

9.2.1 Sample/specimen identifying information, such as Project No., Boring No., Sample No., Depth, and alike.

9.2.2 Any special selection and preparation process, such as removal of gravel or other materials.

9.2.3 Technician name or initials, method used and date.

9.3 Record as a minimum the following test specimen data:

9.3.1 Results for organic matter and ash content, to the nearest 0.1 %.

9.3.2 Furnace temperature used for ash content determinations.

9.3.3 Express results for moisture content as a percentage of oven-dried mass as follows:

9.3.3.1 Below 100 % to the nearest 1 %.

9.3.3.2 Between 100 % and 500 % to the nearest 5 %.

9.3.3.3 Between 500 % and 1000 % to the nearest 10 %.

9.3.3.4 Above 1000 % to the nearest 20 %.

10. Precision and Bias

10.1 *Precision*—Test data on precision is not presented due to the nature of the soil materials tested by this test method. It is either not feasible or too costly at this time to have ten or more laboratories participate in a round-robin testing program.

10.1.1 The Subcommittee D18.22 is seeking any data from the users of this test method that might be used to make a limited statement on precision.

10.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

11. Keywords

11.1 ash content; moisture content; organic soil; peat; percent organic matter

SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (D2974 – 13) that may impact the use of this standard. (Approved November 1, 2014)

(1) Changes made throughout to clarify the uses of the different test methods contained in this standard.

(2) Reference to D2944 was added for sampling methodology.

S7396

Date Submitted	11/21/2018	**Section**	1803.5.3	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Adding highly organic soil to be tested (in addition to expansive soils) and defines highly organic soil.

Rationale

Highly organic soils have at least as much chance of causing settlement-related distress to a building than expansive soils and testing should be required when present.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Building Official can now require testing based on highly organic soils if present.

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

Rarely when testing may not have been required, geotechnical testing would be required for highly organic soils. Typically, these would be tested anyway, but this change would require it. Very little if any additional cost.

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Increases safety of structure by ensuring that buildings are not constructed over highly organic soils without testing.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens code by ensuring that buildings are not constructed over highly organic soils without testing.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

1803.5.3 Expansive or highly organic soil.

In areas likely to have expansive soil, the *building official* shall require soil tests to determine where such soils do exist.

Soils meeting all four of the following provisions shall be considered expansive, except that tests to show compliance with Items 1, 2 and 3 shall not be required if the test prescribed in Item 4 is conducted:

1. 1.Plasticity index (PI) of 15 or greater, determined in accordance with ASTM D4318.
2. 2.More than 10 percent of the soil particles pass a No. 200 sieve (75 μm), determined in accordance with ASTM D422.
3. 3.More than 10 percent of the soil particles are less than 5 micrometers in size, determined in accordance with ASTM D422.
4. 4.Expansion index greater than 20, determined in accordance with ASTM D4829.

Soils shall be considered highly organic if the Organic Content by weight, determined in accordance with ASTM D2974, is greater than 8 percent and the total thickness of organic layer(s) is greater than 12 inches.

Designation: D2974 – 14

Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils[1]

This standard is issued under the fixed designation D2974; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 These test methods cover the measurement of moisture content, ash content, and organic matter in peats and other organic soils, such as organic clays, silts, and mucks. Test Method D2216 provides an alternative method for determining moisture content in mineral soils and rock.

1.1.1 *Test Method A*—Moisture is determined by drying peat or organic sample at 110 ± 5°C.

1.1.2 *Test Method B*—Alternative moisture method which removes the total moisture in two steps: (*1*) evaporation of moisture at room temperature, (*2*) subsequent oven drying of air dried sample at 110 ± 5°C. This method is used when the peat is to be used as fuel.

1.1.3 *Test Method C*—Ash content of a peat or organic soil sample, for general purposes, is determined by igniting oven dried sample from moisture content determination in a furnace at 440 ± 40°C.

1.1.4 *Test Method D*—Ash content of a peat or organic soil sample, for materials used for fuel, is determined by igniting oven dried sample from moisture content determination in a furnace at 750 ± 38°C.

1.2 Test Method A should be used for general classification, except for use of the peat as a fuel. Test Method B should be used when peats are being evaluated for use as a fuel

1.3 The values stated in SI units are to be regarded as the standard. No other units of measurement are included in this standard.

1.4 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026.

1.4.1 The procedures used to specify how data are collected/recorded or calculated in this standard are regarded as the industry standard. In addition, they are representative of the significant digits that generally should be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user's objectives; and it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations. It is beyone the scope of this standard to consider significant digits used in analysis methods for engineering design.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids
D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
D2944 Practice of Sampling Processed Peat Materials
D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing
D6026 Practice for Using Significant Digits in Geotechnical Data
E145 Specification for Gravity-Convection and Forced-Ventilation Ovens

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of common technical terms in this standard, refer to Terminology D653.

4. Summary of Test Methods

4.1 *Test Method A*—Moisture is determined by drying a peat or organic soil sample at 110 ± 5°C. The moisture content is expressed as a percent of the oven dry mass.

[1] These test methods are under the jurisdiction of ASTM Committee D18 on Soil and Rock and are the direct responsibility of Subcommittee D18.22 on Soil as a Medium for Plant Growth.

Current edition approved Nov. 1, 2014. Published November 2014. Originally approved in 1971. Last previous edition approved in 2013 as D2974 – 13. DOI: 10.1520/D2974-14.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

*A Summary of Changes section appears at the end of this standard

4.2 *Test Method B*—This is an alternative moisture method which removes the total moisture in two steps: (*1*) evaporation of moisture in air at room temperature (air-drying), and (*2*) the subsequent oven drying of the air-dried sample at 110 ± 5°C. This method is used when the peat is to be used as fuel. The moisture content is expressed as both a percent of the oven dry mass and of the as received mass.

4.3 *Test Methods C and D*—Ash content of a peat or organic soil sample is determined by igniting the oven-dried sample from the moisture content determination in a furnace at 440 ± 40°C (Test Method C) or 750 ± 38°C (Test Method D). The substance remaining after ignition is the ash. The ash content is expressed as a percentage of the mass of the oven-dried sample.

4.4 Organic matter is determined by subtracting percent ash content from one hundred.

5. Significance and Use

5.1 This test method can be used to determine the moisture content, ash content, and percent organic matter in soil.

5.2 The percent organic matter is important in the following: (*1*) classifying peat or other organic soil, (*2*) geotechnical and general classification purposes, and (*3*) when peats are being evaluated as a fuel.

NOTE 1—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Oven*, meeting the requirements of E145 and capable of being regulated to a constant temperature of 110 ± 5°C.

6.2 The temperature of 110 ± 5°C is quite critical for organic soils. The oven should be checked for "hot spots" to avoid possible ignition of the specimen.

6.3 *Furnace*, capable of producing constant temperatures of 440 ± 40°C and 750 ± 38°C.

6.4 *Balance or Scale*, a balance or scale for determining the mass of the soil having a minimum capacity of 500 g and meeting the requirements of Guide D4753 for a balance or scale of 0.01 g readability.

6.5 *Rubber Sheet, Oil Cloth*, or other non-absorbent material.

6.6 *Evaporating Dishes*, of high silica or porcelain of not less than 100-mL capacity.

6.7 *Aluminum Foil*, heavy-duty.

6.8 *Porcelain Pan, Spoons*, and equipment of the like.

6.9 *Desiccator.*

7. Sampling and Test Specimens

7.1 Place a representative field sample on a rubber sheet, oil cloth, or equivalent material and mix thoroughly.

7.2 Reduce the sample to the quantity required for a test specimen by quartering.

7.3 Place the test specimen and the remaining sample in separate waterproof containers.

7.4 Work rapidly to prevent moisture loss or perform the operation in a room with a high humidity.

8. Procedure

8.1 *Moisture Content Determination:*

8.1.1 *Test Method A:*

8.1.1.1 Record to the nearest 0.01 g the mass of a high silica or porcelain evaporating dish fitted with a heavy-duty aluminum foil cover. The dish shall have a capacity of not less than 100 mL.

8.1.1.2 Following the instruction in Section 7 above, place a test specimen of at least 50 g in the container described in 8.1.1.1. Crush soft lumps with a spoon or spatula. The thickness of peat in the container should not exceed 3 cm.

8.1.1.3 Record the mass to the nearest 0.01 g.

8.1.1.4 Dry uncovered for at least 16 h at 110 ± 5°C or until there is less than 0.1 % change in mass of the sample per hour. Remove from the oven, cover tightly, cool in a desiccator, and record the mass to the nearest 0.01 g keeping exposure to the room atmosphere to a minimum.

8.1.2 *Calculations for Test Method A:*

8.1.2.1 Calculate the moisture content as follows:

$$\text{Moisture Content, \%} = [(A - B) \times 100]/B \tag{1}$$

where:

A = mass of the as-received test specimen, g, and
B = mass of the oven-dried specimen, g.

(*1*) This calculation is used for general purposes (except when the peat is to be used as a fuel) and the result should be referred to as the moisture content as a percentage of oven-dried mass.

8.1.3 *Test Method B:*

8.1.3.1 This test method should be used if the peat is to be used as a fuel.

8.1.3.2 Following the instructions in Section 7, select a 100 to 300 g representative test specimen. Determine the mass of this test specimen to the nearest 0.01 g and spread it evenly on a large flat pan. Crush soft lumps with a spoon or spatula and let the sample come to moisture equilibrium with room air. This will require at least 24 h. Stir occasionally during the normal workday to maintain maximum air exposure of the entire sample. Continue drying until there is less than 0.1% change in mass per hour, then calculate the moisture removed during air drying as a percentage of the as-received mass.

8.1.3.3 After thoroughly mixing the air-dried sample, obtain 50 g of material and record to the nearest 0.01 g.

8.1.3.4 Place the sample in a container as described in 8.1.1 and proceed as in Test Method A.

8.1.4 *Calculations for Test Method B:*

8.1.4.1 Calculate the moisture content as follows:

$$\text{Moisture Content for Air-Dried Sample, \%} = ((A_D - B) \times 100)/B \tag{2}$$

where:

A_D = mass of the air-dried sample, g, and
B = mass of the oven-dried sample, g.

(1) This calculation gives moisture content of the air dried sample as a percentage of oven-dried mass.

8.2 *Ash Content Determination:*

8.2.1 *Test Method C:*

8.2.1.1 Determine the mass of a covered high-silica or porcelain dish to the nearest 0.01 g.

8.2.1.2 Place a part or all of the oven-dried test specimen from a moisture determination in the dish and determine the mass of the dish and specimen to the nearest 0.01 g.

8.2.1.3 Remove the cover and place the dish in a furnace. Gradually bring the temperature in the furnace to 440 ± 40°C and hold until the specimen is completely ashed (no change of mass occurs after at least 1 hr period of heating).

8.2.1.4 Cool in a desiccator, and determine the mass to the nearest 0.01 g keeping the exposure to the room atmosphere to a minimum.

8.2.1.5 This test method should be used for general classification purposes, except the use of peat for fuel.

8.2.2 *Test Method D:*

8.2.2.1 Determine the mass of a covered high-silica or porcelain dish to the nearest 0.01 g.

8.2.2.2 Place a part of the oven-dried test specimen from a moisture determination in the dish and determine the mass of the dish and specimen to the nearest 0.01 g.

8.2.2.3 Remove the cover and place the dish in a furnace. Gradually bring the temperature in the furnace to 750 ± 38°C and hold until the specimen is completely ashed (no change in mass of the sample after further drying periods in excess of 1 h).

8.2.2.4 Cool in a desiccator, and determine the mass to the nearest 0.01 g keeping the exposure to the room atmosphere to a minimum.

8.2.2.5 This test method should be used when peats are being evaluated for use as a fuel.

8.2.3 *Calculation for Test Methods C and D:*

8.2.3.1 Calculate the ash content as follows:

$$\text{Ash Content, \%} = (C \times 100)/B \quad (3)$$

where:

C = mass of ash, g, and
B = oven-dried test specimen, g.

8.3 *Organic Matter Determination:*

8.3.1 *Calculation:*

8.3.1.1 Determine the amount of organic matter to the nearest 0.1 % by difference, as follows:

$$\text{Organic matter, \%} = 100.0 - D \quad (4)$$

where:

D = ash content, % (nearest 0.1 %).

9. Report: Test Data Sheet(s)/Form(s)

9.1 The methodology used to specify how data are recorded on the test data sheet(s)/form(s), as follows, is covered in 1.4.

9.2 Record as a minimum the following general information (data):

9.2.1 Sample/specimen identifying information, such as Project No., Boring No., Sample No., Depth, and alike.

9.2.2 Any special selection and preparation process, such as removal of gravel or other materials.

9.2.3 Technician name or initials, method used and date.

9.3 Record as a minimum the following test specimen data:

9.3.1 Results for organic matter and ash content, to the nearest 0.1 %.

9.3.2 Furnace temperature used for ash content determinations.

9.3.3 Express results for moisture content as a percentage of oven-dried mass as follows:

9.3.3.1 Below 100 % to the nearest 1 %.

9.3.3.2 Between 100 % and 500 % to the nearest 5 %.

9.3.3.3 Between 500 % and 1000 % to the nearest 10 %.

9.3.3.4 Above 1000 % to the nearest 20 %.

10. Precision and Bias

10.1 *Precision*—Test data on precision is not presented due to the nature of the soil materials tested by this test method. It is either not feasible or too costly at this time to have ten or more laboratories participate in a round-robin testing program.

10.1.1 The Subcommittee D18.22 is seeking any data from the users of this test method that might be used to make a limited statement on precision.

10.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

11. Keywords

11.1 ash content; moisture content; organic soil; peat; percent organic matter

SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (D2974 – 13) that may impact the use of this standard. (Approved November 1, 2014)

(1) Changes made throughout to clarify the uses of the different test methods contained in this standard.

(2) Reference to D2944 was added for sampling methodology.

S7397

Date Submitted	11/21/2018	**Section**	1804.6	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

Summary of Modification

Increasing minimum existing in-place soil density from 90 to 95 percent to not require an approved report.

Rationale

The existing text was not clear as to what soil (fill or native) had to meet the existing density requirements. Also, 90% of maximum dry density is too low for support of structures and is never recommended by geotechnical engineers. 95% is typically the minimum recommended for structures (often 98% is used).

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Should improve minimum soil compaction beneath structures without an approved report. Increases safety.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code by requiring a higher soil compaction without an approved report. Existing requirement was too low and is not up to the level recommended by geotechnical engineers.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

1804.6 Compacted fill material.

Where shallow foundations will bear on compacted fill material, the compacted fill shall comply with the provisions of an *approved* geotechnical report, as set forth in Section 1803.

> **Exception:** Compacted fill material 12 inches (305 mm) in depth or less need not comply with an *approved* report, provided the in-place dry density of existing native soils and new fill to a depth of at least 12 inches below footing or slab to be supported is not less than ~~90~~95 percent of the maximum dry density at optimum moisture content determined in accordance with ASTM D1557.

S7398

Date Submitted	11/21/2018	**Section**	1806.2	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Lower the presumptive bearing capacity for sandy soils from 2000psf to 1500psf. Florida soils, often with shallow water table, often do not meet 2000psf allowable bearing capacity with sufficient safety factor and a case can be made that there is no safety factor at all in certain circumstances.

Rationale

2000psf presumptive bearing pressure for sands and clayey sands is too high and does not allow adequate safety factor against bearing failure under a number of conditions. A primary example is when the water table is shallow. If the minimum footing width of 12 inches is used with the water table at the bottom of the footing and 12 inches of embedment, there litterally is no safety factor against failure. 1500psf is more commonly used for sandy soils in Florida for allowable bearing capacity but in some conditions that still may be too high depending on the water table depth. Typically a safety factor of 3 is used for bearing failure but 2 may be acceptable. Regardless, 2000psf is too high to assume without testing, particularly for an architect or contractor who does not understand what causes bearing failure. This is a Florida-specific condition.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

More projects may require a geotechnical report if presumptive bearing values are used or if the designer needs a higher bearing value than the presumptive values for sandy soils. Those already testing to verify the presumptive bearing value will require no additional work.

Impact to building and property owners relative to cost of compliance with code

Some projects may require a report where they may not have been required to do so previously. This could add a fee to the overall project cost. Additional report cost may range from $1000 to a few thousand dollars depending on what testing needs to be completed.

Impact to industry relative to the cost of compliance with code

Some projects may require a report where they may not have been required to do so previously. This could add a fee to the overall project cost. Additional report cost may range from $1000 to a few thousand dollars depending on what testing needs to be completed.

Impact to small business relative to the cost of compliance with code

No impact anticipated for typical projects.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Safety factor against soil bearing failure is increased which increases public safety. Under certain conditions, the current code has no safety factor and needed to be updated.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code by providing a lower presumptive bearing pressure for sandy soils.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

1806.2 Presumptive load-bearing values.

The load-bearing values used in design for supporting soils near the surface shall not exceed the values specified in Table 1806.2 unless data to substantiate the use of higher values are submitted and *approved*. Where the *building official* has reason to doubt the classification, strength or compressibility of the soil, the requirements of Section 1803.5.2 shall be satisfied.

Presumptive load-bearing values shall apply to materials with similar physical characteristics and dispositions when proper preparation and compaction efforts are applied (e.g. stripped, proof-rolled and compacted to at least 95% of modified Proctor maximum dry density). Mud, organic silt, organic clays, peat, unprepared in-situ soil or unprepared fill shall not be assumed to have a presumptive load-bearing capacity unless data to substantiate the use of such a value are submitted. Additionally, for foundation widths of 18 inches or narrower, if the seasonal high water level is within 12 inches of the bottom of the foundation (or higher), an approved geotechnical report shall be required to provide the allowable bearing pressure for those particular foundations.

Exception: A presumptive load-bearing capacity shall be permitted to be used where the *building official* deems the load-bearing capacity of mud, organic silt or unprepared fill is adequate for the support of lightweight or temporary structures.

TABLE 1806.2

PRESUMPTIVE LOAD-BEARING VALUES

CLASS OF MATERIALS	VERTICAL FOUNDATIONPRESSURE (psf)	LATERAL BEARINGPRESSURE(psf/ft below natural grade)	LATERAL SLIDING RESISTANCE	
			Coefficient of friction[a]	Cohesion (psf)[b]
1. Crystalline bedrock	12,000	1,200	0.70	—
2. Sedimentary and foliated rock	4,000	400	0.35	—
3. Sandy gravel and/or gravel (GW and GP)	3,000	200	0.35	—
4. ~~Sand, silty sand, clayey sand,~~ sSilty gravel and clayey gravel (~~SW, SP, SM, SC,~~ GM and GC)	2,000	150	0.25	—
5. Sand, silty sand and clayey sand (SW, SP, SM, SC)	1,500	100	0.25	—
56. Clay, sandy clay, silty clay, clayey silt, silt and sandy silt (CL, ML, MH	1,500	100	—	130

and CH)				

For SI: 1 pound per square foot = 0.0479kPa, 1 pound per square foot per foot = 0.157 kPa/m.

1. a.Coefficient to be multiplied by the dead load.
2. b.Cohesion value to be multiplied by the contact area, as limited by Section 1806.3.2.

S7399

Date Submitted	11/21/2018	**Section**	1808.2	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Adding requirements for design of foundations to include allowance for total settlement (not just differential settlement) and organic soils.

Rationale

Both total and differential settlement are important for the structure, not just differential. Foundations can be severely affected by highly organic soils, not just expansive soils. Construction over highly organic soils is never recommended without proper foundation design and settlement analysis to account for such conditions.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves public safety/welfare by ensuring that structures built where highly organic soils are located are properly constructed to resist settlement-related damages.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code to cover more types of settlement that may (and often do) occur in Florida.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

1808.2 Design for capacity and settlement.

Foundations shall be so designed that the allowable bearing capacity of the soil is not exceeded, and that total and differential settlement isare minimized. Foundations in areas with expansive or highly organic soils shall be designed in accordance with the provisions of Section 1808.6. Foundations in areas with highly organic soils or buried debris below any portion of the foundation or floor slab areas shall require a settlement analysis as well as satisfy the requirements of Section 1806 unless the organic soil or debris is removed in accordance with Section 1808.6.3 and replaced with clean compacted fill in accordance with Section 1804.

S7401

Date Submitted	11/21/2018	**Section**	1808.6	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation	Pending Review
Commission Action	Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Adds highly organic soils to expansive soils requiring special attention during foundation design.

Rationale

Highly organic soils should be included with expansive soils for needing additional attention during foundation design. Both are problematic soil conditions that can cause foundation movement.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improved public safety/welfare by requiring design of foundations to account for highly organic soils if present.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code by requiring special attention for highly organic soils, if present, during foundation design.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

1808.6 Design for expansive or highly organic soils.

Foundations for buildings and structures founded on expansive or highly organic soils shall be designed in accordance with Section 1808.6.1 or 1808.6.2.

Exception: Foundation design need not comply with Section 1808.6.1 or 1808.6.2 where one of the following conditions is satisfied:

1. 1.The expansive or highly organic soil is removed in accordance with Section 1808.6.3.
2. 2.The *building official* approves stabilization of the soil in accordance with Section 1808.6.4.

S7402

Date Submitted	11/21/2018	**Section**	1808.6.1	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No **Alternate Language** No

Related Modifications

7401

Summary of Modification

Adding consideration for highly organic soils to foundation design.

Rationale

Highly organic soils are some of the most common causes of settlement of structures in Florida. They should have the same consideration in the FBC as expansive soils. This condition is more prevalent in Florida than many parts of the world.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves public safety/welfare by requiring foundations to account for highly organic soils when present.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code by accounting for highly organic soil conditions which can cause foundation movement.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

1808.6.1 Foundations.

Foundations placed on or within the active zone of expansive or highly organic soils shall be designed to resist differential volume changes and to prevent structural damage to the supported structure. Foundations placed above, on, or within the zone of influence of highly organic soils shall be designed to resist differential and total settlement in consideration of both the immediate compressibility and long-term degradation/decay of organics over time. Deflection and racking of the supported structure shall be limited to that which will not interfere with the usability and serviceability of the structure.

Foundations placed below where volume change occurs or below expansive soil shall comply with the following provisions:

1. 1.Foundations extending into or penetrating expansive soils shall be designed to prevent uplift of the supported structure.
2. 2.Foundations penetrating expansive soils shall be designed to resist forces exerted on the foundation due to soil volume changes or shall be isolated from the expansive soil.

S7403

Date Submitted	11/21/2018	**Section**	1808.6.2	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

7401, 7402

Summary of Modification

Adds highly organic soils to expansive soils already in the code.

Rationale

Highly organic soils cause many of the same soil conditions that expansive soils create and both should be considered during design.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Increases safety/welfare by requiring foundations to consider highly organic soils.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code with additional requirement for highly organic soils.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

1808.6.2 Slab-on-ground foundations.

Moments, shears and deflections for use in designing slab-on-ground, mat or raft foundations on expansive or highly organic soils shall be determined in accordance with *WRI/CRSI Design of Slab-on-Ground Foundations* or *PTI DC 10.5.* Using the moments, shears and deflections determined above, nonprestressed slabs-on-ground, mat or raft foundations on expansive soils shall be designed in accordance with *WRI/CRSI Design of Slab-on-Ground Foundations* and post-tensioned slab-on-ground, mat or raft foundations on expansive soils shall be designed in accordance with *PTI DC 10.5*. It shall be permitted to analyze and design such slabs by other methods that account for soil-structure interaction, the deformed shape of the soil support, the plate or stiffened plate action of the slab as well as both center lift and edge lift conditions. Such alternative methods shall be rational and the basis for all aspects and parameters of the method shall be available for peer review.

S7404

Date Submitted	11/21/2018	**Section**	1808.6.3	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

7401, 7402, 7403

Summary of Modification

Adds removal of highly organic soils to the expansive soils of this section. Both soil types have similar needs for removal.

Rationale

Adds highly organic soil removal to expansive soil removal already in the code. Also defines when enough organic soil has been removed as it may be impossible to remove 100% of organics from soil.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves safety by ensuring proper removal of organic soils.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by adding organic soil removal and also defining how much organic soil needs to be removed.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

1808.6.3 Removal of expansive or highly organic soil.

Where expansive soil is removed in lieu of designing foundations in accordance with Section 1808.6.1 or 1808.6.2, the soil shall be removed to a depth sufficient to ensure a constant moisture content in the remaining soil. Fill material shall not contain expansive or highly organic soils and shall comply with Section 1804.5 or 1804.6. Removal of highly organic soil shall be considered complete when the total thickness of all organic layers remaining in the soil is no more than 12 inches thick and organic content of the remaining soil is less than 8 percent by weight. If highly organic soil is to be treated rather than removed, an approved geotechnical report shall be required that includes design of such treatment and recommendations for construction.

Exception: Expansive soil need not be removed to the depth of constant moisture, provided the confining pressure in the expansive soil created by the fill and supported structure exceeds the swell pressure.

S7405

Date Submitted	11/21/2018	**Section**	1808.6.4	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation	Pending Review
Commission Action	Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

7401, 7402, 7403

Summary of Modification

Adds clarification that soil stabilization plans must be designed by a PE. Also adds acceptance of underpinning in lieu of removal as acceptable technique for expansive and organic soil mitigation which also must be designed by a PE.

Rationale

Adds clarification that soil stabilization plans must be designed by a PE. Also adds acceptance of underpinning in lieu of removal as acceptable technique for expansive and organic soil mitigation which also must be designed by a PE.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves public safety/welfare by requiring stabilization plans to be designed by a PE.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Provides clarification to the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

1808.6.4 Stabilization.

All soil stabilization plans for foundations should be designed by a registered professional engineer based on site specific soil data collected. Where the active zone of expansive soils is stabilized in lieu of designing foundations in accordance with Section 1808.6.1 or 1808.6.2, the soil shall be stabilized by chemical, dewatering, presaturation or equivalent techniques. The use of properly designed bypass underpinning in lieu of complete removal is an acceptable technique for both expansive and highly organic soils and should also be designed by a registered professional engineer. Additional considerations for floor slab support may also be required based on the engineer's stabilization design.

S7406

Date Submitted	11/21/2018	**Section**	1809.2	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No **Alternate Language** No

Related Modifications

Summary of Modification

Clarifies the types of soils that foundations may be built upon. Primarily removes "undisturbed" soil as being allowed. Undisturbed soil in Florida is typically too loose to properly support a foundation.

Rationale

Undisturbed soil is Florida is typically very loose to loose sand and is definitely not competent enough for supporting structures. The current code is a carry-over from the IBC and does not properly apply to Florida soils and should be changed. All in-situ soils below foundations should require compacting.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This is a change from current code that allows constructing on undisturbed soil. Enforcement of this code will require some attention to new building plans for permits as default text used on plans may now incorrectly reference undisturbed soil.

Impact to building and property owners relative to cost of compliance with code

There should be no impact other than updating text on future plans.

Impact to industry relative to the cost of compliance with code

There should be no impact other than updating text on future plans.

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Helps protect public safety/welfare by requiring that all buildings be constructed on compacted soil.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by eliminating allowance of building on undisturbed (uncompacted) soil which can cause settlement if left uncompacted.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

1809.2 Supporting soils.

Shallow foundations shall be built on ~~undisturbed~~ compacted in-situ soil, compacted fill material or controlled low-strength material (CLSM). Compacted fill material shall be placed in accordance with Section 1804.5. CLSM shall be placed in accordance with Section 1804.6. Undisturbed soil shall not be considered suitable for supporting shallow foundations or slabs-on-grade without compaction unless an approved geotechnical report to recommend otherwise has been completed.

S7407

Date Submitted	11/21/2018	**Section**	1809.4	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

1809.2

Summary of Modification

Require footing depth 12" below final grade rather than 12" below undisturbed ground surface. Coincides with Mod 7406 to remove "undisturbed soil" from the Code as it doesn't apply to Florida soils.

Rationale

Similar to Mod 7406 where "undisturbed" soil (intending to mean "competent soil") does not properly apply to Florida's very loose to loose sandy soil conditions. Most geotechnical reports reference foundation embedment relative to final grade; thus the change is needed.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None. This may actually allow shallower footing depths in certain cases, which could slightly reduce costs.

Impact to industry relative to the cost of compliance with code

None. This may actually allow shallower footing depths in certain cases, which could slightly reduce costs.

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves safety (slightly) by clarifying the code language.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Clarifies the code language.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate

Does not degrade the effectiveness of the code

Does not significantly change the code, but clarifies the language specific to Florida soils.

1809.4 Depth and width of footings.

The minimum depth of footings below the ~~undisturbed ground surface~~ final grade shall be 12 inches (305 mm). Where applicable, the requirements of Section 1809.5 shall also be satisfied. The minimum width of footings shall be 12 inches (305 mm).

S7409

Date Submitted	11/23/2018	**Section**	1802.1	**Proponent**	Joseph Crum
Chapter	18	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

S205-16
FBC Building 1810.3.11 and 202 New Defination

Summary of Modification

This proposed code addition is to identify another commonly-used type of deep foundation along with drilled shafts, helical piles, and micropiles.

Rationale

There is no existing definition for this type of deep foundation. This proposed code addition is to identify another commonly-used type of deep foundation along with drilled shafts, helical piles, and micropiles. This term is added to the definitions because the term "combined pile-raft" is a proposed change in Section 1810.3.11.
Combined pile-rafts are increasingly common and can lower the foundation costs by relying partially on the soil under the raft.
The following definition is from the ISSMGE guideline for "Combined Pile Raft Foundations".
"The Combined Pile Raft Foundation is a geotechnical composite construction that combines the bearing effect of both foundation elements raft and piles by taking into account interactions between the foundation elements and the subsoil."

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Added new definition to address an additional type of deep foundation.

Impact to building and property owners relative to cost of compliance with code

The code change proposal to add a definition will not change the cost of construction since that is simply an addition of a definition.

Impact to industry relative to the cost of compliance with code

The code change proposal to add a definition will not change the cost of construction since that is simply an addition of a definition.

Impact to small business relative to the cost of compliance with code

The code change proposal to add a definition will not change the cost of construction since that is simply an addition of a definition.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Added new definition to address an additional type of deep foundation for review and inspections.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

No effect as this is only an added definition to address an additional type of deep foundation.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No effect as this is only an added definition to address an additional type of deep foundation.

Does not degrade the effectiveness of the code

No effect as this is only an added definition to address an additional type of deep foundation.

Add new definition as follows:

COMBINED PILE RAFT. A geotechnical composite construction that combines the bearing effect of both foundation elements, raft and piles, by taking into account interactions between the foundation elements and the subsoil.

Revise as follows:

1802.1 Definitions. The following words and terms are defined in Chapter 2:

COMBINED PILE RAFT
DEEP FOUNDATION.
DRILLED SHAFT.
Socketed drilled shaft.
HELICAL PILE.
MICROPILE.

SHALLOW FOUNDATION.

1810.3.11 Pile caps. Pile caps shall be of reinforced concrete, and shall include all elements to which vertical deep foundation elements are connected, including grade beams and mats. The soil immediately below the pile cap shall not be considered as carrying any vertical load, with the exception of a combined pile-raft. The tops of vertical deep foundation elements shall be embedded not less than 3 inches (76 mm) into pile caps and the caps shall extend at least 4 inches (102 mm) beyond the edges of the elements. The tops of elements shall be cut or chipped back to sound material before capping.

S7411

Date Submitted	11/23/2018	**Section**	1804.1	**Proponent**	Joseph Crum
Chapter	18	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

S167-16

Summary of Modification

Clarification that support of soil below foundations is required in all directions.

Rationale

Support of soil below foundations is required in all directions. The code notes that lateral support must be maintained, but if vertical support is reduced, the adjacent foundation will not have the required bearing.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Clarification will assist in interpretation and enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

Most current practice currently follows this method, even though it is not clearly stated in the code. The cost of construction will not increase by specifying that vertical support must be maintained.

Impact to industry relative to the cost of compliance with code

Most current practice currently follows this method, even though it is not clearly stated in the code. The cost of construction will not increase by specifying that vertical support must be maintained.

Impact to small business relative to the cost of compliance with code

Most current practice currently follows this method, even though it is not clearly stated in the code. The cost of construction will not increase by specifying that vertical support must be maintained.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Clarification will assist in interpretation and enforcement of the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Most current practice currently follows this method, even though it is not clearly stated in the code so this will have no effect.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Most current practice currently follows this method, even though it is not clearly stated in the code so this will have no effect.

Does not degrade the effectiveness of the code

Most current practice currently follows this method, even though it is not clearly stated in the code so this will have no effect.

Revise as follows:

1804.1 Excavation near foundations. Excavation for any purpose shall not reduce vertical or lateral support ~~from~~ for any foundation or adjacent foundation without first underpinning or protecting the foundation against detrimental lateral or vertical movement, or both.

S7412

Date Submitted	11/23/2018	**Section**	1804.4	**Proponent**	Joseph Crum
Chapter	18	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

S174-16

Summary of Modification

Clarification for consistency to allow for proper water drainage, to account for walking surfaces, door landings or ramp landings adjacent to a building to have a maximum cross slope of two percent.

Rationale

While the intent of this section is to require slope away from the building to allow for proper water drainage, it does not account for walking surfaces, door landings or ramp landings adjacent to a building to have a maximum cross slope of two percent. This leaves no room for error for construction purposes to provide not only drainage at a minimum of two percent but also the cross slope of no more than two percent. Designers often choose a cross slope of less than two percent in these areas, which according to this section, would not be compliant for site grading.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Clarification for existing code requirements only.

Impact to building and property owners relative to cost of compliance with code

No cost impact as this is a clarification for existing code requirements only.

Impact to industry relative to the cost of compliance with code

No cost impact as this is a clarification for existing code requirements only.

Impact to small business relative to the cost of compliance with code

No cost impact as this is a clarification for existing code requirements only.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

No impact as this is a clarification for existing code requirements only.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

No impact as this is a clarification for existing code requirements only.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No impact as this is a clarification for existing code requirements only.

Does not degrade the effectiveness of the code

No impact as this is a clarification for existing code requirements only.

Revise as follows:

1804.4 Site grading. The ground immediately adjacent to the foundation shall be sloped away from the building at a slope of not less than one unit vertical in 20 units horizontal (5-percent slope) for a minimum distance of 10 feet (3048 mm) measured perpendicular to the face of the wall. If physical obstructions or lot lines prohibit 10 feet (3048 mm) of horizontal distance, a 5-percent slope shall be provided to an *approved* alternative method of diverting water away from the foundation. Swales used for this purpose shall be sloped a minimum of 2 percent where located within 10 feet (3048 mm) of the building foundation. Impervious surfaces within 10 feet (3048 mm) of the building foundation shall be sloped a minimum of 2 percent away from the building, except as otherwise permitted in Section 1010.1.5, 1012.3 or 1012.6.1.

S7413

63

Date Submitted	11/23/2018	**Section**	1810.3.3.1.6	**Proponent**	Joseph Crum
Chapter	18	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

S215-16

Summary of Modification

This is a clarification to replace "capacity" with "load" since a safety factor is implied by "allowable" or "working", and "capacity" is by definition an "ultimate".

Rationale

- This is a clarification to replace "capacity" with "load" since a safety factor is implied by "allowable" or "working", and "capacity" is by definition an "ultimate". It is the maximum "load" that is being "allowed".
- The word "working" is confusing and further is redundant since "allowable" is always present.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Code clarification only no impact.

Impact to building and property owners relative to cost of compliance with code

Code clarification only no cost impact.

Impact to industry relative to the cost of compliance with code

Code clarification only no cost impact.

Impact to small business relative to the cost of compliance with code

Code clarification only no cost impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Code clarification only no impact.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Code clarification only no impact.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Code clarification only no impact.

Does not degrade the effectiveness of the code

Code clarification only no impact.

Revise as follows:

1810.3.3.1.6 ~~Uplift capacity~~ Allowable uplift load of grouped deep foundation elements. For grouped deep foundation elements subjected to uplift, the allowable ~~working~~ uplift load for the group shall be calculated by a generally accepted method of analysis. Where the deep foundation elements in the group are placed at a center-to-center spacing less than three times the least horizontal dimension of the largest single element, the allowable ~~working~~ uplift load for the group is permitted to be calculated as the lesser of:

1. The proposed individual allowable ~~working~~ uplift load times the number of elements in thegroup.

2. Two-thirdsoftheeffectiveweightofthegroupandthesoilcontainedwithinablock definedbythe perimeter of the group and the length of the element, plus two-thirds of the ultimate shear resistance along the soilblock.

S7414

Date Submitted	11/23/2018	**Section**	1810.3.5.2.1	**Proponent**	Joseph Crum
Chapter	18	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

S221-16

Summary of Modification

The section title is changed for consistency with the title and definition of main section 1810.3.5.2

Rationale

Reason: The section title is changed for consistency with the title and definition of main section 1810.3.5.2 to which this subsection belongs.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Code clarification only no impact.

Impact to building and property owners relative to cost of compliance with code

Code clarification only no cost impact.

Impact to industry relative to the cost of compliance with code

Code clarification only no cost impact.

Impact to small business relative to the cost of compliance with code

Code clarification only no cost impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Code clarification only no impact.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Code clarification only no impact.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Code clarification only no impact.

Does not degrade the effectiveness of the code

Code clarification only no impact.

Revise as follows:

1810.3.5.2.1 Cased. Cast-in-place or grouted-in-place deep foundation elements with a permanent casing shall have a nominal outside diameter of not less than 8 inches (203 mm).

Date Submitted	11/23/2018	**Section**	1810.3.5.2.2	**Proponent**	Joseph Crum
Chapter	18	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

S222-16

Summary of Modification

The wording is changed for consistency with the title and definition of main section 1810.3.5.2

Rationale

The wording is changed for consistency with the title and definition of main section 1810.3.5.2 to which this subsection belongs. The word "average" would require a physical measurement that is not possible, so it has been replaced with "specified" (this word is also added to the Exception condition for clarity).

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Clarification only no impact.

Impact to building and property owners relative to cost of compliance with code

Clarification only no cost impact.

Impact to industry relative to the cost of compliance with code

Clarification only no cost impact.

Impact to small business relative to the cost of compliance with code

Clarification only no cost impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Clarification only no impact.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Clarification only no impact.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Clarification only no impact.

Does not degrade the effectiveness of the code

Clarification only no impact.

Revise as follows:

1810.3.5.2.2 Uncased. Cast-in-place or grouted-in-place deep foundation elements without a permanent casing shall have a specified diameter of not less than 12 inches (305 mm). The element length shall not exceed 30 times the ~~average~~ specified diameter.

> **Exception:** The length of the element is permitted to exceed 30 times the specified diameter, provided the design and installation of the deep foundations are under the direct supervision of a *registered design professional* knowledgeable in the field of soil mechanics and deep foundations. The *registered design professional* shall submit a report to the *building official* stating that the elements were installed in compliance with the *approved construction documents*.

S7416

Date Submitted	11/23/2018	**Section**	1810.4.4	**Proponent**	Joseph Crum
Chapter	18	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments	**No**	**Alternate Language**	**No**

Related Modifications

S237-16

Summary of Modification

Pile types in addition to driven piles should also meet this requirement so this mod changes the word driven to advanced to cover all types of piles.

Rationale

This is a clarification as Pile types in addition to driven piles should also meet this requirement so this mod changes the word driven to advanced to cover all types of piles.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Code clarification only no impact.

Impact to building and property owners relative to cost of compliance with code

Code clarification only no cost impact.

Impact to industry relative to the cost of compliance with code

Code clarification only no cost impact.

Impact to small business relative to the cost of compliance with code

Code clarification only no cost impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Code clarification will enhance interpretation and implementation of the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Code clarification only no impact.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Code clarification only no impact.

Does not degrade the effectiveness of the code

Code clarification only no impact.

Revise as follows:

1810.4.4 Pre-excavation. The use of jetting, augering or other methods of pre-excavation shall be subject to the approval of the *building official*. Where permitted, pre-excavation shall be carried out in the same manner as used for deep foundation elements subject to load tests and in such a manner that will not impair the carrying capacity of the elements already in place or damage adjacent structures. Element tips shall be ~~driven~~ advanced below the pre-excevated depth until the required resistance or penetration is obtained.

S8141

Date Submitted	12/14/2018	**Section**	1810.3.3.1.4	**Proponent**	Dale Biggers
Chapter	18	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

The only change is a modification of wording for clarification. There is no change to the substance of the paragraph. This modification has been incorporated into IBC 2018.

Rationale

This clarifies the terminology by using the more common term " shaft ".
The phrase " a maximum of " is redundant.
This modification has been incorporated into IBC 2018.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

There is no impact.

Impact to building and property owners relative to cost of compliance with code

There is no impact.

Impact to industry relative to the cost of compliance with code

There is no impact.

Impact to small business relative to the cost of compliance with code

There is no inpact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it clarifies the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, this clarifies the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This does not discriminate.

Does not degrade the effectiveness of the code

This does not degrade the code.

1810.3.3.1.4 Allowable ~~frictional~~ shaft resistance.

The assumed ~~frictional~~ shaft resistance developed by any uncased cast-in-place deep foundation element shall not exceed one-sixth of the bearing value of the soil material at minimum depth as set forth in Table 1806.2, up to ~~a maximum of~~ 500 psf (24 kPa), unless a greater value is allowed by the *building official* on the basis of a geotechnical investigation as specified in Section 1803 or a greater value is substantiated by a load test in accordance with Section 1810.3.3.1.2. ~~Frictional~~ Shaft resistance and end-bearing resistance shall not be assumed to act simultaneously unless determined by a geotechnical investigation in accordance with Section 1803.

S8143

Date Submitted	12/14/2018	**Section**	1810.3.3.1.6	**Proponent**	Dale Biggers
Chapter	18	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

This only removes the extraneous word " working " which is no longer the common term. The meaning of the Section is not changed. This modification has been incorporated into IBC 2018.

Rationale

" Allowable uplift load " is the common term. The word " working " is unnecessary.
The Title now matches the code wording.

This modification has been incorporated into IBC 2018.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

There is no impact.

Impact to building and property owners relative to cost of compliance with code

There is no impact.

Impact to industry relative to the cost of compliance with code

There is no impact.
This clarifies the code.

Impact to small business relative to the cost of compliance with code

There is no impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This clarifies the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The code is clarified.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

There is no discrimination.

Does not degrade the effectiveness of the code

This does not degrade the code; it clarifies the code.

1810.3.3.1.6 ~~Uplift capacity~~ Allowable uplift load of grouped deep foundation elements.

For grouped deep foundation elements subjected to uplift, the allowable ~~working~~ uplift load for the group shall be calculated by a generally accepted method of analysis. Where the deep foundation elements in the group are placed at a center-to-center spacing less than three times the least horizontal dimension of the largest single element, the allowable ~~working~~ uplift load for the group is permitted to be calculated as the lesser of:

1. 1.The proposed individual allowable ~~working~~ uplift load times the number of elements in the group.
2. 2.Two-thirds of the effective weight of the group and the soil contained within a block defined by the perimeter of the group and the length of the element, plus two-thirds of the ultimate shear resistance along the soil block.

S8146

Date Submitted	12/14/2018	**Section**	1810.3.5.2.1	**Proponent**	Dale Biggers
Chapter	18	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

The Title of the Section is Cast-in-place or grouted-in-place. This modification adds " grouted-in-place " into the body of the code. This modification has been incorporated into IBC 2018.

Rationale

The body of the code matches the Section Title.

This modification has been incorporated into IBC 2018.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities.

Impact to building and property owners relative to cost of compliance with code

No impact to owners.

Impact to industry relative to the cost of compliance with code

No impact to industry

Impact to small business relative to the cost of compliance with code

No impact to small business.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes. The code is clarified.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This clarifies the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

There is no discrimination.

Does not degrade the effectiveness of the code

It does not degrade the code.

1810.3.5.2 Cast-in-place or grouted-in-place.

Cast-in-place and grouted-in-place deep foundation elements shall satisfy the requirements of this section.

1810.3.5.2.1 Cased.

Cast-in-place or grouted-in-place deep foundation elements with a permanent casing shall have a nominal outside diameter of not less than 8 inches (203 mm).

S8153

Date Submitted	12/14/2018	**Section**	1810.3.5.2.2	**Proponent**	Dale Biggers
Chapter	18	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Modification # 8146 (1810.3.5.2.1) has a similar change. That mod was for CASED; this mod is for UNCASED.

Summary of Modification

This adds the words " or grouted-in-place " that appear in the section title into the body of the code. It also clarifies " specified " diameter rather than " installed " diameter. This modification has been incorporated into IBC 2018.

Rationale

The code should match the title.

The code should refer to specified diameter; one might infer that installed diameter is meant if the change is not made.

This modification has been incorporated into IBC 2018.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

There is no impact.

Impact to building and property owners relative to cost of compliance with code

There is no impact.

Impact to industry relative to the cost of compliance with code

There is no impact. The code is clarified.

Impact to small business relative to the cost of compliance with code

There is no impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes. The code reads better.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes. the code is clearer.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

There is no discrimination.

Does not degrade the effectiveness of the code

The coe is not degraded.

1810.3.5.2 Cast-in-place or grouted-in-place.

Cast-in-place and grouted-in-place deep foundation elements shall satisfy the requirements of this section

1810.3.5.2.2 Uncased.

Cast-in-place or grouted-in-place deep foundation elements without a permanent casing shall have a specified diameter of not less than 12 inches (305 mm). The element length shall not exceed 30 times ~~the average~~ specified diameter.

Exception: The length of the element is permitted to exceed 30 times the specified diameter, provided that the design and installation of the deep foundations are under the direct supervision of a *registered design professional* knowledgeable in the field of soil mechanics and deep foundations. The *registered design professional* shall submit a report to the *building official* stating that the elements were installed in compliance with the *approved construction documents*.

S8156

Date Submitted 12/14/2018
Chapter 18
Section 1810.3.5.2.3
Affects HVHZ No
Proponent Dale Biggers
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

This modification replaces " outside " with " nominal ". This matches the common industry term.

Rationale

Outside diameter refers to actual installed diameter which might be slightly larger than the nominal diameter that the designer called for.

This modification has been incorporated into IBC 2018.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

There is no fiscal impact.

Impact to building and property owners relative to cost of compliance with code

There is no cost impact.

Impact to industry relative to the cost of compliance with code

There is no cost impact.

Impact to small business relative to the cost of compliance with code

There is no impact to small business.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This clarifies the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes. The code is clearer.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

There is no discrimination.

Does not degrade the effectiveness of the code

The code is not degraded.

1810.3.5.2.3 Micropiles.

Micropiles shall have ~~an outside~~ <u>a nominal</u> diameter of 12 inches (305 mm) or less. The minimum diameter set forth elsewhere in Section 1810.3.5 shall not apply to micropiles.

S8182

Date Submitted	12/14/2018	**Section**	1810.3.11	**Proponent**	Dale Biggers
Chapter	18	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No **Alternate Language** No

Related Modifications

Summary of Modification

This modifications permits the bearing capacity of the soil below the pile cap to be considered as carrying vertical load in some situations. This modification has been incorporated into IBC 2018.

Rationale

Large pile caps with significant space between piles can contribute to the vertical load capacity.
" not less than " is clearer than "at least "; this also is the same phrase used above in regards to embedment into the cap.
This modification has been incorporated into IBC 2018.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code
There is no impact.

Impact to building and property owners relative to cost of compliance with code
This may reduce the cost of foundations in some cases.

Impact to industry relative to the cost of compliance with code
There is no coat to compliance.

Impact to small business relative to the cost of compliance with code
There is no impact to small business.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public
This may be a cost savings to the public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction
This allows a sound engineernig concept to be added to the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities
This does not discriminate.

Does not degrade the effectiveness of the code
This does not degrade the code.

1810.3.11 Pile caps.

Pile caps shall be of reinforced concrete, and shall include all elements to which vertical deep foundation elements are connected, including grade beams and mats. The soil immediately below the pile cap shall not be considered as carrying any vertical load, with the exception of a combined pile raft. The tops of vertical deep foundation elements shall be embedded not less than 3 inches (76 mm) into pile caps and the caps shall extend ~~at least~~ not less than 4 inches (102 mm) beyond the edges of the elements. The tops of elements shall be cut or chipped back to sound material before capping.

S8183

Date Submitted	12/14/2018	**Section**	1807.1.4	**Proponent**	Joseph Crum
Chapter	18	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

S40-16 -2
TABLE 1507.9.6 - MOD 7380
2303.1.9

Summary of Modification

The existing text was outdated, requiring clarification and updates to current AWPA section numbering.

Rationale

The existing text was outdated, requiring clarification and updates to current AWPA section numbering.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Clarifies code due to updated language

Impact to building and property owners relative to cost of compliance with code

These changes merely clarify and update the existing text without any impact on the required specifications for materials used. Will not increase the cost of construction

Impact to industry relative to the cost of compliance with code

These changes merely clarify and update the existing text without any impact on the required specifications for materials used. Will not increase the cost of construction

Impact to small business relative to the cost of compliance with code

These changes merely clarify and update the existing text without any impact on the required specifications for materials used. Will not increase the cost of construction

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Updates the code with proper language

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Revises outdated language for clarification only.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Revises outdated language for clarification only. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

Revises outdated language for clarification only. Does not degrade the effectiveness of the code.

1807.1.4 Permanent wood foundation systems. Permanent wood foundation systems shall be designed and installed in accordance with AWC PWF. Lumber and plywood shall be preservative treated in accordance with AWPA U1 (Commodity Specification A, ~~Use Category 4B and Section 5.2~~ Special Requirement 4.2) and shall be identified in accordance with Section 2303.1.9.1.

Date Submitted	11/12/2018	**Section**	1909.1	**Proponent**	T Stafford
Chapter	19	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

7226

Summary of Modification

Revises references to the wind speed maps in the body of the code for correlation with ASCE 7-16.

Rationale

This code change revises references in Chapter 19 for correlation with the newly referenced ASCE 7-16. During Phase I of the 2020 update of the FBC, the Commission voted to update ASCE 7 from the 2010 edition to the 2016 edition (ASCE 7-16). ASCE 7-16 provides separate wind speed maps for Risk Category III and Risk Category IV buildings and other structures, recognizing the higher reliabilities required for essential facilities and facilities whose failure could pose a substantial hazard to the community. Modification 7226 proposes to update the wind speed maps for correlation with ASCE 7-16. This code change simply revises the references to the wind speeds maps to correlate with Modification 7226.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This code change correlates the code with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This code change improves the code by providing correlation with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This code change dos not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This code change does not degrade the effectiveness of the code.

1909.1 Reinforced concrete. The design and construction of reinforced concrete for buildings sited in areas where the ultimate design wind speed, V_{ult}, is equal to or greater than 115 mph (45 m/s) in accordance with Figure 1609.3(1), 1609.3(2), ~~or~~ 1609.3(3), or 1609.3(4) shall conform to the requirements of ACI 318 or with Section 1609.1.1, Exception 1, as applicable, except as modified in this section.

Date Submitted 11/24/2018
Chapter 21
Section 2101.2
Affects HVHZ No
Proponent Joseph Crum
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

S244-16
2103.1 & 2104.1

Summary of Modification

Add appropriate standards for Architectural cast stone.

Rationale

Architectural cast stone is a non-structural masonry system typically used as architectural accents such as balusters, quoins, sills, etc. While Chapter 21 requires architectural cast stone to comply with the material requirements of ASTM C1364 and Chapter 14 includes minimum criteria for the use of architectural cast stone as a cladding system, the vast majority of design, fabrication, and installation guidance for these systems has historically stemmed from industry-generated best practices; a gap now filled with the creation of these three new standards.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

The addition of these new standards simply provides consensus-based guidance for the design, fabrication, and installation of cast stone consistent with existing industry guidelines.

Impact to building and property owners relative to cost of compliance with code

The addition of these new standards simply provides consensus-based guidance for the design, fabrication, and installation of cast stone consistent with existing industry guidelines. There is no cost impact.

Impact to industry relative to the cost of compliance with code

The addition of these new standards simply provides consensus-based guidance for the design, fabrication, and installation of cast stone consistent with existing industry guidelines. There is no cost impact.

Impact to small business relative to the cost of compliance with code

The addition of these new standards simply provides consensus-based guidance for the design, fabrication, and installation of cast stone consistent with existing industry guidelines. There is no cost impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The addition of these new standards simply provides consensus-based guidance for the design, fabrication, and installation of cast stone consistent with existing industry guidelines. It will assist with the implementation of the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The addition of these new standards simply provides consensus-based guidance for the design, fabrication, and installation of cast stone consistent with existing industry guidelines. There is no impact.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The addition of these new standards simply provides consensus-based guidance for the design, fabrication, and installation of cast stone consistent with existing industry guidelines. There is no impact.

Does not degrade the effectiveness of the code

The addition of these new standards simply provides consensus-based guidance for the design, fabrication, and installation of cast stone consistent with existing industry guidelines. There is no impact.

Revise as follows:

2101.2 Design methods. Masonry shall comply with the provisions of TMS 402/ACI 530/ASCE 5, TMS 403, or TMS 404 as well as applicable requirements of this chapter.

2103.1 Masonry units. Concrete masonry units, clay or shale masonry units, stone masonry units, glass unit masonry and AAC masonry units shall comply with Article 2.3 of TMS 602/ACI 503.1/ASCE 6.

Architectural cast stone shall conform to ASTM C 1364 and TMS 504.

> **Exception:** Structural clay tile for nonstructural use in fireproofing of structural members and in wall furring shall not be required to meet the compressive strength specifications. The fire-resistance rating shall be determined in accordance with ASTM E 119 or UL 263 and shall comply with the requirements of Table 602.

2104.1 Masonry construction. Masonry construction shall comply with the requirements of Sections 2104.1.1 and 2104.1.2 and with the requirements of either TMS 602/ACI 530.1/ASCE 6 or TMS 604.

Reference standards type: This reference standard is new to the ICC Code Books

Add new standard(s) as follows:

TMS 404-16 – Standard for the Design of Architectural Cast Stone
TMS 504-16 – Standard for the Fabrication of Architectural Cast Stone
TMS 604-16 – Standard for the Installation of Architectural Cast Stone

S7420

Date Submitted	11/24/2018	**Section**	2107.4	**Proponent**	Joseph Crum
Chapter	21	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

S248-16

Summary of Modification

This code change removes a requirement that is now covered in the latest edition of the referenced standard for masonry design.

Rationale

TMS 402 contains two alternatives for the design of conventional masonry systems: allowable stress design (Chapter 8 of the reference standard) and strength design (Chapter 9 of the reference standard). In previous versions of TMS 402 limits on the maximum bar size were included for the strength design provisions consistent with the requirements of Section 2107.4, but were absent for the corresponding allowable stress design provisions; hence the modification language of Section 2107.4.
Recently the reference standard has been revised to include maximum bar size limits consistent with that of Section 2107.4 that is applied to both the allowable stress and strength design provisions of the reference standard (Section 6.1.2.2) making this modification redundant and unnecessary.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No technical change. Removes requirements now covered under the reference standard. Code clean up only.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction
No technical change. Removes requirements now covered under the reference standard.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction
No technical change. Removes requirements now covered under the reference standard.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction
No technical change. Removes requirements now covered under the reference standard.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

No technical change. Removes requirements now covered under the reference standard. Code clean up only.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

No technical change. Removes requirements now covered under the reference standard. Code clean up only.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No technical change. Removes requirements now covered under the reference standard. Code clean up only.

Does not degrade the effectiveness of the code

No technical change. Removes requirements now covered under the reference standard. Code clean up only.

Delete without substitution:

~~**2107.4 TMS 402/ACI 530/ASCE 5, Section 8.3.6, maximum bar size.** Add the following to Chapter 8: 8.3.6 – Maximum bar size. The bar diameter shall not exceed one-eighth of the nominal wall thickness and shall not exceed one-quarter of the least dimension of the cell, course or collar joint in which it is placed.~~

S8350

Date Submitted	12/15/2018	**Section**	2107.2	**Proponent**	Joseph Belcher for MAF
Chapter	21	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

2107.3, 2107.4, 2107.5, 2107.6, 2108.2, 2108.3, and 2108.4.

All references to ACI 530, ACI 530.1, ASCE 5, and ASCE 6 in FBC-B and FBC-R:

Summary of Modification

Updates section references and certain sections. Deletes organizations no longer publishing referenced standards.

Rationale

The primary purpose of the code change is to correct references to reflect the sections of TMS 402. Also, the references to ACI 530 and ASCE 5 were deleted as ACI and ASCE have turned over maintenance of the document to the Masonry Society. Starting with the 2016 Edition ACI and ASCE promote and sell TMS 402 and 602 for masonry construction and are not publishing a 2016 Edition.

2107.2.1 was modified to agree with a change to the IBC.

2107.4 was deleted because it is properly covered in TMS 402-16. The section was marked as reserved to allow continued use of the numbering format of the chapter.

2107.5 The pilaster provisions were stricken because they are now contained verbatim in TMS 402. The number of TMS 402 Section 5.4.1 was corrected to agree with TMS 402-16.

2107.7 TMS Section was modified to reflect the correct number.

Section 6.1.5.1.1 was modified to reflect the requirements of TMS 402 and text relating to Equation 6-1 was expanded to make certain the Notations for Equation 6-1 remained in TMS 402 unchanged.

2108.2 and 2108.3 were deleted and marked as Reserved. The issues have been addressed in TMA 402. The section was reserved to preserve the numbing format of the chapter.

2108.4 TMS Section was modified to reflect the correct number.

Section 6.1.5.1.1 was modified to reflect the requirements of TMS 402 and text relating to Equation 6-1 was expanded to make certain the Notations for Equation 6-1 remained in TMS 402 unchanged.

ACI and ASCE have stopped publishing these masonry documents and turned over maintenance of TMS 402 and 602 to the Masonry Society.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

The correct section references will improve the ability to find what is needed.

Impact to building and property owners relative to cost of compliance with code

No impact to cost.

Impact to industry relative to the cost of compliance with code

No impact to cost.

Impact to small business relative to the cost of compliance with code

No impact to cost.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The change impacts the welfare of the public by correcting references to the current edition of the referenced standard.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The change improves the code by correcting references to the current edition of the referenced standard.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The change does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The proposed change does not degrade the effectiveness of the code.

2107.2 TMS 402 ~~/ACI 530/ASCE 5~~, Section ~~8.1.6.7.1.1~~ <u>6.1.6.1.1</u>, lap splices. As an alternative to Section ~~8.1.6.7.1.1~~ <u>6.1.6.1.1</u>, it shall be permitted to design lap splices in accordance with Section 2107.2.1.

2107.2.1 Lap splices. The minimum length of lap splices for reinforcing bars in tension or compression, l_d, shall be

$$l_d = 0.002\, d_b f_s \qquad \text{(Equation 21-1)}$$

For SI: $l_d = 0.29 d_b f_s$

but not less than 12 inches (305 mm). In no case shall the length of the lapped splice be less than 40 bar diameters.

where:

d_b = Diameter of reinforcement, inches (mm).

f_s = Computed stress in reinforcement due to design loads, psi (MPa).

In regions of moment where the design tensile stresses in the reinforcement are greater than 80 percent of the allowable steel tension stress, F_s, the lap length of splices shall be increased not less than 50 percent of the minimum required length<u>, length, but need not be greater than 72 db</u>. Other equivalent means of stress transfer to accomplish the same 50 percent increase shall be permitted. Where epoxy-

coated bars are used, lap length shall be increased by 50 percent.

2107.3 TMS 402 ~~/ACI 530/ASCE 5~~, Section ~~8.1.6.7~~ 6.1.6.1, splices of reinforcement. Modify Section ~~8.1.6.7~~ 6.1.6.1 as follows:

~~8.1.6.7~~ 6.1.6.1 – Splices of reinforcement. Lap splices, welded splices or mechanical splices are permitted in accordance with the provisions of this section. All welding shall conform to AWS D1.4. Welded splices shall be of ASTM A706 steel reinforcement. Reinforcement larger than No. 9 (M #29) shall be spliced using mechanical connections in accordance with Section ~~8.1.6.7.3~~ 6.1.6.1.3.

-

2107.4 Reserved. ~~TMS 402 /ACI 530/ASCE 5, Section 8.3.6, maximum bar size. Add the following to Chapter 8:~~

-

~~8.3.6 Maximum bar size. The bar diameter shall not exceed one-eighth of the nominal wall thickness and shall not exceed one-quarter of the least dimension of the cell, course or collar joint in which it is placed~~.

2107.5 TMS 402 ~~/ACI 530/ASCE 5~~, Section 5.4 Pilasters.

Modify Section 5.4 as follows:

5.4 — Pilasters

~~**Walls interfacing with pilasters shall not be considered as flanges, unless the construction requirements of Sections 5.1.1.2.1 and 5.1.1.2.5 are met. When these construction requirements are met, the pilaster's flanges shall be designed in accordance with Sections 5.1.1.2.2 through 5.1.1.2.4.**~~

5.4.~~1~~ 3 Where vertical pilaster reinforcement is not provided to resist axial compressive stress, lateral ties are not required.

2107.6 TMS 402 ~~/ACI 530/ASCE 5~~, Section 6.1.5.1 Development of bar reinforcement in tension or compression.

Modify Section 6.1.5.1.1 as follows:

6.1.5.1.1 The required development length of reinforcing bars shall be determined by Equation (6-1), but shall not be less than 12 inches or 40 d_b and need not be greater than 72 d_b.

Equation 6-1 including the notations from TMS 402 are unchanged ~~/ACI 530/ASCE 5~~. Gamma factors are changed as follows:

REMAINDER UNCHANGED.

2108.2 Reserved. ~~TMS 402 /ACI 530/ASCE 5, Section 9.3.3.3 6.1.5.1.1, development.~~

~~**Modify the second first paragraph of Section 9.3.3.3 6.1.5.1.1 as**~~

~~follows:~~

-

~~The required development length of reinforcement shall be determined by Equation (9-16 6-1), but shall not be less than 12 inches (305 mm) and need not be greater than 72 *db*.~~

2108.3 Reserved. ~~TMS 402 /ACI 530/ASCE 5, Section 6.1.6.1, splices.~~

-

~~Modify items (c) and (d) of Section 9.3.3.4 as follows:~~

-

~~9.3.3.4 (c) A welded splice shall have the bars butted and welded to develop at least 125 percent of the yield strength, *fy*, of the bar in tension or compression, as required. Welded splices shall be of ASTM A706 steel reinforcement. Welded splices shall not be permitted in plastic hinge zones of intermediate or special reinforced walls.~~

-

~~9.3.3.4 (d) Mechanical splices shall be classified as Type 1 or 2 in accordance with Section 18.2.7.1 of ACI 318. Type 1 mechanical splices shall not be used within a plastic hinge zone or within a beam-column joint of intermediate or special reinforced masonry shear walls. Type 2 mechanical splices are permitted in any location within a member~~

2108.4 TMS 402 ~~/ACI 530/ASCE 5~~, Section 6.1.5.1 Development

of bar reinforcement in tension or compression.

Modify Section 6.1.5.1.1 as follows:

6.1.5.1.1 The required development length of reinforcing bars shall be determined by Equation (6-1), but shall not be less than 12 inches or 40 d_b and need not be greater than 72 db.

Equation 6-1 including the notations from TMS 402 /~~ACI 530/ASCE 5~~, are unchanged. Gamma factors are changed as follows:

REMAINDER UNCHANGED.

General change throughout the FBC-B and FBC-R to strike all references to ACI 530, ACI 530.1, ASCE 5, and ASCE 6. ACI and ASCE have stopped publishing these masonry documents and turned over maintenance of TMS 402 and 602 to the Masonry Society.

~~ACI 530, ACI 530.1, ASCE 5~~, and ~~ASCE 6.~~ in Chapter 35 and the following Sections:

~~ACI 530 -13 Building Code Requirements for Masonry Structures~~:

1405.6, 1405.6.1, 1405.6.2, 1405.10:

1604.3:

1705.4, 1705.4.1:

1807.1.6.3, 1807.1.6.3.2, 1808.9:

2101.2, 2106.1, 2107.1,2107.2, 2107.3, 2107.4, 2108.1, 2108.2, 2108.3, 2109.1, 2109.1.1, 2109.2, 2109.2.1, 2109.3, 2110.1, 2114.2, 2122.1, 2122.3, 2122.4, 2122.5, 2122.7, 2122.8, 2122.10.

~~ACI 530.1-13 Specifications for Masonry Structures:~~

1405.6.1:

1705.4:

1807.1.6.3:

2103.1, 2103. 2.1, 2103.3, 2103.4, 2105.1.

~~**ASCE 5 Building Code Requirements for Masonry Structures:**~~

1405.6, 1405.6.1, 1405.6.2, 1405.10:

1604.3.4:

1705.4, 1705.4.1:

1807.1.6.3, 1807.1.6.3.2, 1808.9:,

2101.2, 2105.1, 2106.1, 2107.1, 2107.2, 2107.3, 2107.4, 2107.6, 2108.1, 2108.2, 2108.3, 2108.4, 2109.1, 2109.1.1, 2109.2, 2109.2.1, 2109.3, 2110.1, 2114.2, 2122.1, 2122.4, 2122.5, 2122.7, 2122.8.2, 2122.8.4, 2122.10

~~**ASCE 6 Specification for Masonry Structures:**~~

1405.6.1:

1705.4:

1807.1.6.3:

2103.1, 2103.2.1, 2103.3, 2103.4, 2104.1, 2105.1, 2107.1, 2108.1, 2121.6, 2122.1, 2122.1.6, 2122.2.3, 2122.3, 2122.4, 2122.7.4, 2122.8.1, 2122.8.2, 2122.8.3, 2122.8.4, 2122.8.6, 2122.8.8

FBC-R 6th Edition (2017) Chapter 46 ACI:

~~**ACI 530-13 Building Code Requirements for Masonry Structures:**~~

R318.4:

R404.1.2:

R606.1, R606.1.1, R606.12.1, R606.12.2.3.2, R606.12.2.3.1, R606.12.3.1:

R703.8, R703.12

~~**530.1-13 Specification for Masonry Structures:**~~

R404.1.2:

R606.1, R606.1.1, R606.2.9, R606.2.12, R606.12.1, R606.12.2.3.2, R606.12.3.1:

703.12

~~**ASCE 5-13 Building Code Requirements for Masonry Structures:**~~

R404.1.2:

R606.1, R606.1.1, R606.12.1, R606.12.2.3.1, R606.12.2.3.2, R606.12.3.1:

R703.12

~~**ASCE 6-13 Specification for Masonry Structures:**~~

R404.1.2:

R606.1, R606.1.1, R606.2.9, R606.2.12, R606.12.1, R606.12.2.3.1, R606.12.2.3.2, R606.12.3.1: R703.12

S8368

Date Submitted	12/15/2018	**Section**	2101.2	**Proponent**	Joseph Belcher for MAF
Chapter	21	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

2103.1, 2104.1, and Chapter 35

Summary of Modification

Adds TMS Standards for architectural cast stone.

Rationale

Note: Except for the last sentence, the Reason is from the original ICC proponents.

Revise as follows:

2101.2 Design methods. Masonry shall comply with the provisions of TMS 402/ACI 530/ASCE 5, TMS 403, or TMS 403 404 as well as applicable requirements of this chapter.

2103.1 Masonry units. Concrete masonry units, clay or shale masonry units, stone masonry units, glass unit masonry and AAC masonry units shall comply with Article 2.3 of TMS 602/ACI 503.1/ASCE 6. Architectural cast stone shall conform to ASTM C 1364 and TMS 504.

Exception: Structural clay tile for nonstructural use in fireproofing of structural members and in wall furring shall not be required to meet the compressive strength specifications. The fire-resistance rating shall be determined in accordance with ASTM E 119 or UL 263 and shall comply with the requirements of Table 602.

2104.1 Masonry construction. Masonry construction shall comply with the requirements of Sections 2104.1.1 and 2104.1.2 and with the requirements of either TMS 602/ACI 530.1/ASCE 6 or TMS 604.

Chapter 35 - TMS

Add new standards as follows:

TMS 404-16 – Standard for the Design of Architectural Cast Stone
TMS 504-16 – Standard for the Fabrication of Architectural Cast Stone
TMS 604-16 – Standard for the Installation of Architectural Cast Stone

Removes references to ACI and ASCE standards no longer being published. The standards are also deleted in ADM94-16

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact on cost of enforcement of code. Will provide criteria for enforcement personnel to use to ensure compliance.

Impact to building and property owners relative to cost of compliance with code

No impact on cost to property owners. The addition of these new standards simply provides consensus-based guidance for the design, fabrication, and installation of cast stone consistent with existing industry guidelines.

Impact to industry relative to the cost of compliance with code

No impact on cost to industry. The industry has been following similar guidelines which were the basis for the standards.

Impact to small business relative to the cost of compliance with code

No impact on cost to small business. The industry has been following similar guidelines which were the basis for the standards.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The proposal adopts current standards promoting the health, safety, and welfare of the public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The proposal improves the code by adopting current standards and providing guidelines for the installation of architectural stone.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The change does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The proposed change does not degrade the effectiveness of the code.

Revise as follows:

2101.2 Design methods. Masonry shall comply with the provisions of TMS 402/~~ACI 530/ASCE 5~~, TMS403, or TMS 403 404 as well as applicable requirements of this chapter.

2103.1 Masonry units. Concrete masonry units, clay or shale masonry units, stone masonry units, glass unit masonry and AAC masonry units shall comply with Article 2.3 of TMS 602/~~ACI 503.1/ASCE 6~~. Architectural cast stone shall conform to ASTM C 1364 and TMS 504.

Exception: Structural clay tile for nonstructural use in fireproofing of structural members and in wall furring shall not be required to meet the compressive strength specifications. The fire-resistance rating shall be determined in accordance with ASTM E 119 or UL 263 and shall comply with the requirements of Table 602.

2104.1 Masonry construction. Masonry construction shall comply with the requirements of Sections 2104.1.1 and 2104.1.2 and with the requirements of either TMS 602/~~ACI 530.1/ASCE 6~~ or TMS 604.

Chapter 35 - TMS

Add new standards as follows:

TMS 404-16 – Standard for the Design of Architectural Cast Stone

TMS 504-16 – Standard for the Fabrication of Architectural Cast Stone

TMS 604-16 – Standard for the Installation of Architectural Cast Stone

Date Submitted	12/15/2018	**Section**	2103.1	**Proponent**	Joseph Belcher for MAF
Chapter	21	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Chapter 35

Summary of Modification

Adopts ASTM standard for materials used in manufactured stone.

Rationale

(Note: Except for last sentence, the Reason is from original ICC proponent.)

While commonly used as a cladding material, adhered manufactured stone masonry has historically not had a national, consensus-based specification governing the minimum properties for these products; which in turn has been a source of performance issues in the field. Topics covered by ASTM C1670 include:

1) Minimum requirements for constituent materials.
2) Sampling and testing criteria.
3) Minimum compressive strength, maximum absorption, minimum freeze-thaw durability, minimum bond strength, and maximum drying shrinkage requirements.

Removes references to ACI and ASCE standards no longer being published. The standards are also deleted in ADM94-16.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact on the cost of enforcement of code. Will provide criteria for the manufacturer to use to ensure minimum requirements for the materials are met.

Impact to building and property owners relative to cost of compliance with code

No impact on cost to property owners. The addition of the new standard establishes minimum physical properties for manufactured stone veneer units consistent with existing industry practices.

Impact to industry relative to the cost of compliance with code

No impact on cost to industry. The industry has been following similar guidelines which were the basis for the standards.

Impact to small business relative to the cost of compliance with code

No impact on cost to small business. The industry has been following similar guidelines which were the basis for the standards.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The proposal adopts current standards to make certain there is some quality control of materials used to manufacture stone veneer units promoting the health, safety, and welfare of the public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The proposal improves the code by adopting current standards for a common product that formerly had no standards.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The change does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The proposed change does not degrade the effectiveness of the code

Revise as follows:

2103.1 Masonry units. Concrete masonry units, clay or shale masonry units, stone masonry units, glass unit masonry and AAC masonry units shall comply with Article 2.3 of TMS 602/~~ACI 503.1/ASCE 6~~. Architectural cast stone shall conform to ASTM C 1364. Adhered manufactured stone masonry veneer units shall conform to ASTM C1670.

> **Exception:** Structural clay tile for nonstructural use in fireproofing of structural members and in wall furring shall not be required to meet the compressive strength specifications. The fire-resistance rating shall be determined in accordance with ASTM E 119 or UL 263 and shall comply with the requirements of Table 602

Chapter 35 - ASTM

Add new standard as follows:

ASTM C1670-16 Standard Specification for Adhered Manufactured Stone Masonry Veneer Units

S8381

Date Submitted	12/15/2018	**Section**	2109	**Proponent**	Joseph Belcher for MAF
Chapter	21	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Delete empirical provisions for masonry construction.

Rationale

The primary reason to remove the empirical provisions is that they are not useable in Florida due to the wind speeds throughout the state. The proponent's lengthy reason is uploaded as a support file.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact on cost of enforcement of code. The empirical provisions cannot be used in Florida because of the limitation on wind speeds.

Impact to building and property owners relative to cost of compliance with code

No impact on cost to property owners. The empirical provisions cannot be used in Florida because of the limitation on wind speeds.

Impact to industry relative to the cost of compliance with code

No impact on cost to industry. The empirical provisions cannot be used in Florida because of the limitation on wind speeds.

Impact to small business relative to the cost of compliance with code

No impact on cost to small business. The empirical provisions cannot be used in Florida because of the limitation on wind speeds.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The proposal is connected with safety because while the empirical provisions cannot be used, some, such as an owner-builder, may not realize that and try to build using the provisions.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The proposal improves the code by removing provisions not applicable to Florida.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The change does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The proposed change does not degrade the effectiveness of the code.

Delete without substitution:

~~SECTION 2109 EMPIRICAL DESIGN OF MASONRY~~

-

~~2109.1 General. Empirically designed masonry shall conform to the requirements of Appendix A of TMS 402/ACI 530/ASCE 5, except where otherwise noted in this section.~~

-

~~2109.1.1 Limitations. The use of empirical design of masonry shall be limited as noted in Section A.1.2 of TMS 402/ACI 530/ASCE 5. The use of dry-stacked, surface-bonded masonry shall be prohibited inRisk Category IV structures. In buildings that exceed one or more of the limitations of Section A.1.2 of TMS 402/ACI 530/ASCE 5, masonry shall be designed in accordance with the engineered design provisions of Section 2101.2 or the foundation wall provisions of Section 1807.1.5.~~

-

~~Section A.1.2.2 of TMS 402/ACI 530/ASCE 5 shall be modified as follows:~~

-

~~Wind. Empirical requirements shall not apply to the design or construction of masonry for buildings, parts of buildings, or other structures to be located in areas where Vasd as determined in accordance with Section 1609.3.1 of the International Building Code exceeds 110 mph.~~

-

~~2109.2 Surface-bonded walls. Dry-stacked, surface-bonded concrete masonry walls shall comply with the requirements of Appendix A of TMS 402/ACI 530/ASCE 5, except where otherwise noted in this section.~~

-

~~2109.2.1 Strength. Dry-stacked, surface-bonded concrete masonry walls shall be of adequate strength and proportions to support all superimposed loads without exceeding the allowable stresses listed in Table 2109.2.1. Allowable stresses not specified in Table 2109.2.1 shall comply with the requirements of TMS 402/ACI 530/ASCE 5.~~

-

~~TABLE 2109.2.1~~

~~ALLOWABLE STRESS GROSS CROSS-SECTIONAL AREA FOR DRY-STACKED, SURFACE-BONDED CONCRETE MASONRY WALLS~~

~~For SI: 1 pound per square inch = 0.006895 MPa.~~

~~2109.2.2 Construction. Construction of dry-stacked, surface-bonded masonry walls, including stacking and leveling of units, mixing and application of mortar and curing and protection shall comply with ASTM C 946.~~

-

-

-

~~**2109.3 Adobe construction. Adobe construction shall comply with this section and shall be subject to the requirements of this code for Type V construction, Appendix A of TMS 402/ACI 530/ASCE 5, and this section.**~~

-

~~**2109.3.1 Unstabilized adobe. Unstabilized adobe shall comply with Sections 2109.3.1.1 through 2109.3.1.4.**~~

-

~~**2109.3.1.1 Compressive strength. Adobe units shall have an average compressive strength of 300 psi (2068 kPa) when tested in accordance with ASTM C 67. Five samples shall be tested and no individual unit is permitted to have a compressive strength of less than 250 psi (1724 kPa).**~~

-

~~**2109.3.1.2 Modulus of rupture. Adobe units shall have an average modulus of rupture of 50 psi (345 kPa) when tested in accordance with the following procedure. Five samples shall be tested and no individual unit shall have a modulus of rupture of less than 35 psi (241 kPa).**~~

-

~~**2109.3.1.2.1 Support conditions. A cured unit shall be simply supported by 2-inch-diameter (51 mm) cylindrical supports located 2 inches (51 mm) in from each end and extending the full width of the unit.**~~

-

~~**2109.3.1.2.2 Loading conditions. A 2-inch-diameter (51 mm) cylinder shall be placed at midspan parallel to the supports.**~~

-

~~**2109.3.1.2.3 Testing procedure. A vertical load shall be applied to the cylinder at the rate of 500 pounds per minute (37 N/s) until failure occurs.**~~

-

~~**2109.3.1.2.4 Modulus of rupture determination. The modulus of rupture shall be determined by the**~~

~~**equation:**~~

-

~~**f r = 3 PLs /2 Sw (St2)**~~ ~~**(Equation 21-2)**~~

-

~~**where, for the purposes of this section only:**~~

-

~~Sw~~	=	~~Width of the test specimen measured parallel to the loading cylinder, inches (mm).~~
~~fr~~	=	~~Modulus of rupture, psi (MPa).~~
~~Ls~~	=	~~Distance between supports, inches (mm).~~
~~St~~	=	~~Thickness of the test specimen measured parallel to the direction of load, inches (mm).~~
~~P~~	=	~~The applied load at failure, pounds (N).~~

-

~~**2109.3.1.3 Moisture content requirements. Adobe units shall have a moisture content not exceeding 4 percent by weight.**~~

-

~~**2109.3.1.4 Shrinkage cracks. Adobe units shall not contain more than three shrinkage cracks and any single shrinkage crack shall not exceed 3 inches (76 mm) in length or 1/ 8 inch (3.2 mm) in width.**~~

-

~~**2109.3.2 Stabilized adobe. Stabilized adobe shall comply with Section 2109.3.1 for unstabilized adobe in addition to Sections 2109.3.2.1 and 2109.3.2.2.**~~

~~**2109.3.2.1 Soil requirements. Soil used for stabilized adobe units shall be chemically compatible with the stabilizing material.**~~

-

~~**2109.3.2.2 Absorption requirements. A 4-inch (102 mm) cube, cut from a stabilized adobe unit dried to a constant weight in a ventilated oven at 212°F to 239°F (100°C to 115°C), shall not absorb more than 21/ 2 percent moisture by weight when placed upon a constantly water-saturated, porous surface for seven days. A minimum of five specimens shall be tested and each specimen shall be cut from a separate unit.**~~

-

~~**2109.3.3 Allowable stress. The allowable compressive stress based on gross cross-sectional area of adobe shall not exceed 30 psi (207 kPa).**~~

-

~~**2109.3.3.1 Bolts. Bolt values shall not exceed those set forth in Table 2109.3.3.1.**~~

-

~~**TABLE 2109.3.3.1**~~

~~**ALLOWABLE SHEAR ON BOLTS IN ADOBE MASONRY**~~

~~**For SI: 1 inch = 25.4 mm, 1 pound = 4.448 N.**~~

-

~~2109.3.4 Detailed requirements. Adobe construction shall comply with Sections 2109.3.4.1 through 2109.3.4.9.~~

-

~~2109.3.4.1 Number of stories. Adobe construction shall be limited to buildings not exceeding one story, except that two-story construction is allowed when designed by a registered design professional.~~

-

~~2109.3.4.2 Mortar. Mortar for adobe construction shall comply with Sections 2109.3.4.2.1 and 2109.3.4.2.2.~~

-

~~2109.3.4.2.1 General. Mortar for stabilized adobe units shall comply with this chapter or adobe soil. Adobe soil used as mortar shall comply with material requirements for stabilized adobe. Mortar for unstabilized adobe shall be Portland cement mortar.~~

-

~~2109.3.4.2.2 Mortar joints. Adobe units shall be laid with full head and bed joints and in full running bond.~~

-

~~2109.3.4.3 Parapet walls. Parapet walls constructed of adobe units shall be waterproofed.~~

-

~~2109.3.4.4 Wall thickness. The minimum thickness of exterior walls in one-story buildings shall be 10 inches (254 mm). The walls shall be laterally supported at intervals not exceeding 24 feet (7315 mm). The minimum thickness of interior load-bearing walls shall be 8 inches (203 mm). In no case shall the unsupported height of any wall constructed of adobe units exceed 10 times the thickness of such wall.~~

-

~~2109.3.4.5 Foundations. Foundations for adobe construction shall be in accordance with Sections 2109.3.4.5.1 and 2109.3.4.5.2.~~

-

~~2109.3.4.5.1 Foundation support. Walls and partitions constructed of adobe units shall be supported by foundations or footings that extend not less than 6 inches (152 mm) above adjacent ground surfaces and are constructed of solid masonry (excluding adobe) or concrete. Footings and foundations shall comply with Chapter 18.~~

-

~~2109.3.4.5.2 Lower course requirements. Stabilized adobe units shall be used in adobe walls for the first 4 inches (102 mm) above the finished first-floor elevation.~~

-

~~2109.3.4.6 Isolated piers or columns. Adobe units shall not be used for isolated piers or columns in a load-bearing capacity. Walls less than 24 inches (610 mm) in length shall be considered isolated piers or columns.~~

~~2109.3.4.7 Tie beams. Exterior walls and interior load-bearing walls constructed of adobe units shall have a continuous tie beam at the level of the floor or roof bearing and meeting the following requirements.~~

~~2109.3.4.7.1 Concrete tie beams. Concrete tie beams shall be a minimum depth of 6 inches (152 mm) and a minimum width of 10 inches (254 mm). Concrete tie beams shall be continuously reinforced with a minimum of two No. 4 reinforcing bars. The specified compressive strength of concrete shall be at least 2,500 psi (17.2 MPa).~~

-

~~2109.3.4.7.2 Wood tie beams. Wood tie beams shall be solid or built up of lumber having a minimum nominal thickness of 1 inch (25 mm), and shall have a minimum depth of 6 inches (152 mm) and a minimum width of 10 inches (254 mm). Joints in wood tie beams shall be spliced a minimum of 6 inches (152 mm). No splices shall be allowed within 12 inches (305 mm) of an opening. Wood used in tie beams shall be approved naturally decay-resistant or preservative-treated wood.~~

-

~~2109.3.4.8 Exterior finish. Exterior walls constructed of unstabilized adobe units shall have their exterior surface covered with a minimum of two coats of Portland cement plaster having a minimum thickness~~

~~of 3/ 4 inch (19.1 mm) and conforming to ASTM C 926. Lathing shall comply with ASTM C 1063. Fasteners shall be spaced at 16 inches (406 mm) on center maximum. Exposed wood surfaces shall be treated with an approved wood preservative or other protective coating prior to lath application.~~

-

~~2109.3.4.9 Lintels. Lintels shall be considered structural members and shall be designed in accordance with the applicable provisions of Chapter 16.~~

Add new text as follows:

SECTION 2109

DRY-STACK MASONRY

2109.1 General. The design of dry-stack masonry structures shall comply with the requirements of Chapters 1 through 8 of TMS 402 except as modified by Sections 2109.2 through 2109.5.

2109.2 Limitations. Dry-stack masonry shall be prohibited in Risk Category IV structures.

2109.3 Materials. Concrete masonry units complying with ASTM C90 shall be used.

2109.4 Strength. Dry-stack masonry shall be of adequate strength and proportions to suport all superimposed loads without exceeding the allowable stresses listed in Table 2109.4. Allowable stresses not specified in Table 2109.1.1 shall comply with the requirements of Chapter 8 of TMS 402.

TABLE 2109.4

GROSS CROSS-SECTIONAL AREA ALLOWABLE STRESS FOR DRY-STACK MASONRY

DESCRIPTION	**MAXIMUM ALLOWABLE STRESS (psi)**
Compression	**45**
Flexural tension **Horizontal Span Vertical Span**	**30** **18**
Shear	**10**

For SI: 1 pound per square inch = 0.006895 MPa.

2109.5 Construction. Construction of dry-stack masonry shall comply with ASTM C946.

Section 2109 of the IBC currently addresses the design and construction of: empirically designed conventional masonry; dry-stack masonry, and adobe masonry construction. This change effectively removes the provisions for empirical design and adobe construction while retaining the existing dry-stack provisions. Adobe construction, while still used in some niche markets, is almost exclusively limited to single family construction and as such is proposed to be removed from the IBC. (A separate code change proposal addresses incorporating the adobe design and construction requirements into the IRC.)
Codified empirical design provisions for masonry have existed in the US for nearly a century. This cookbook methodology of laying out and proportioning masonry elements is largely based on lessons learned through field performance rather than any analytical or research-based approach to design. As such, some have begun to question the practicality as well as safety of this design methodology. Given these concerns as well as the restrictions placed on empirical design (low wind and seismic) limiting its use geographically combined with the design community gravitating away from this method, the general consensus is that it is time to sunset empirical design.

Currently the reference standard TMS 402 still contains an Appendix A covering empirically designed masonry. The Committee's intent is to remove empirical design, but did not want to do so until the requirements for adobe and dry-stack construction were appropriately resolved in the IBC.

The provisions for dry-stack construction proposed here, while reformatted and cleaned up, are technically consistent with the existing IBC requirements for dry-stack construction. Minor differences include:

1) The term 'dry-stacked' is replaced with 'dry-stack'; as this is consistent with existing industry terminology.
2) The existing IBC language simply requires that 'concrete masonry units' be used for dry-stack construction. An explicit reference to ASTM C90 for loadbearing concrete masonry units is added in this proposal to avoid any ambiguity.
3) The existing IBC provisions requires that the 'allowable stresses' of TMS 402 be used for stresses not specified in Table 2109.4. The reference to 'allowable stresses' is replaced with a direct reference to Chapter 8 of TMS 402 (allowable stress design of masonry).

S7277

Date Submitted	12/13/2018	**Section**	2201	**Proponent**	Bonnie Manley
Chapter	22	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

8072

Summary of Modification

This clarifies the relationship between the main body of Chapter 22 and the HVHZ provisions of Chapter 22.

Rationale

The HVHZ provisions of Chapter 22 shouldn't have to duplicate requirements that are provided in the base chapter in sections such as 2210, 2211, and 2212. Instead, the focus of the HVHZ sections should be on provisions that are critical for these areas of Florida.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

2201.1 Scope.

The provisions of this chapter govern the quality, design, fabrication and erection of steel used structurally in buildings or structures.

~~Exception:~~ Buildings and structures located within the high-velocity hurricane zone shall comply with the additional provisions of Sections ~~2204 through 2209 and~~ 2214 through 2224.

S7421

Date Submitted 11/24/2018
Chapter 22
Section 2208.2
Affects HVHZ No
Proponent Joseph Crum
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No
Alternate Language No

Related Modifications

S253-16

Summary of Modification

This proposal removes an obsolete requirement for steel cable from the code.

Rationale

This proposal is a coordination proposal to bring the 2018 FBC up to date with the provisions of the 2016 edition of ASCE 19 Structural Applications for Steel Cables in Buildings. The proposal removes the exceptions to ASCE 19 for seismic requirements for steel cables. The exceptions are no longer applicable because the load combinations in ASCE 19 have been harmonized with the load combinations in ASCE 7 Minimum Design Loads for Buildings and Other Structures as of the 2010 edition of that standard. The load combinations and safety factors in ASCE 19 have been updated for the past two cycles of the standard, yet this outdated exception remained in the code erroneously.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal is a coordination proposal to bring the 2018 FBC up to date with the provisions of the 2016 edition of ASCE 19 Structural Applications for Steel Cables in Buildings. It has no effect on enforcement.

Impact to building and property owners relative to cost of compliance with code

This proposal is a coordination proposal to bring the 2018 FBC up to date with the provisions of the 2016 edition of ASCE 19 Structural Applications for Steel Cables in Buildings. It has no cost impact.

Impact to industry relative to the cost of compliance with code

This proposal is a coordination proposal to bring the 2018 FBC up to date with the provisions of the 2016 edition of ASCE 19 Structural Applications for Steel Cables in Buildings. It has no cost impact.

Impact to small business relative to the cost of compliance with code

This proposal is a coordination proposal to bring the 2018 FBC up to date with the provisions of the 2016 edition of ASCE 19 Structural Applications for Steel Cables in Buildings. It has no cost impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal is a coordination proposal to bring the 2018 FBC up to date with the provisions of the 2016 edition of ASCE 19 Structural Applications for Steel Cables in Buildings. It has no effect on code enforcement.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal is a coordination proposal to bring the 2018 FBC up to date with the provisions of the 2016 edition of ASCE 19 Structural Applications for Steel Cables in Buildings. It has no effect on the code compliance.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal is a coordination proposal to bring the 2018 FBC up to date with the provisions of the 2016 edition of ASCE 19 Structural Applications for Steel Cables in Buildings. It does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not degrade the effectiveness of the code

This proposal is a coordination proposal to bring the 2018 FBC up to date with the provisions of the 2016 edition of ASCE 19 Structural Applications for Steel Cables in Buildings. It does not degrade the effectiveness of the code.

Delete without substitution:

~~**2208.2 Seismic requirements for steel cable.** The design strength of steel cables shall be determined by the provisions of ASCE 19 except as modified by these provisions.~~

~~1. **A load factor of 1.1 shall be applied to the prestress force included in T_3 and T_4 as defined in Section3.12.**~~

~~2. In Section 3.2.1, Item (c) shall be replaced with "1.5 T_3" and Item (d) shall be replaced with "1.5 T_4."~~

S7452

Date Submitted	11/26/2018	**Section**	2203	**Proponent**	Bonnie Manley
Chapter	22	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

7454, 7455, S299-16 (Structural, Structural, Chart #1), 7458

Summary of Modification

This proposal is one in a series adopting the latest generation of AISI standards for cold-formed steel.

Rationale

This proposal is one in a series adopting the latest generation of AISI standards for cold-formed steel. This particular proposal focuses on Chapter 22 by incorporating references to a new cold-formed steel standard -- AISI S240. The standard is published and available for a free download at: www.aisistandards.org.

AISI S240, North American Standard for Cold-Formed Steel Structural Framing, addresses requirements for construction with cold-formed steel structural framing that are common to prescriptive and engineered light frame construction. This comprehensive standard was formed by merging the following AISI standards:

1. AISI S200, North American Standard for Cold-Formed Steel Framing-General Provisions
2. AISI S210, North American Standard for Cold-Formed Steel Framing–Floor and Roof System Design
3. AISI S211, North American Standard for Cold-Formed Steel Framing–Wall Stud Design
4. AISI S212, North American Standard for Cold-Formed Steel Framing–Header Design
5. AISI S213, North American Standard for Cold-Formed Steel Framing– Lateral Design
6. AISI S214, North American Standard for Cold-Formed Steel Framing–Truss Design

Consequently, AISI S240 supersedes all previous editions of the above mentioned individual AISI standards. Specific modifications to Section 2203 recognize that requirements on identification and protection of cold-formed steel framing are now located in AISI S240.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

2203.1 Identification.

Identification of *structural steel elements* shall be in accordance with AISC 360. Identification of cold-formed steel members shall be in accordance with AISI S100. Identification of cold-formed steel light-frame construction shall also comply with the requirements contained in AISI S240~~S200~~ or AISI S220, as applicable. Other steel furnished for structural load-carrying purposes shall be properly identified for conformity to the ordered grade in accordance with the specified ASTM standard or other specification and the provisions of this chapter. Steel that is not readily identifiable as to grade from marking and test records shall be tested to determine conformity to such standards.

2203.2 Protection.

Painting of *structural steel elements* shall be in accordance with AISC 360. Painting of open-web steel joists and joist girders shall be in accordance with SJI CJ, SJI JG, SJI K and SJI LH/DLH. Individual structural members and assembled panels of cold-formed steel construction shall be protected against corrosion in accordance with the requirements contained in AISI S100. Protection of cold-formed steel light-frame construction shall be in accordance with AISI S240~~S200~~ or AISI S220, as applicable.

S7454

Date Submitted	11/26/2018	**Section**	2210.2	**Proponent**	Bonnie Manley
Chapter	22	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

7452, 7455, S299-16 (Structural, Structural, Chart #1), 7458

Summary of Modification

This proposal is one in a series adopting the latest generation of AISI standards for cold-formed steel.

Rationale

This proposal is one in a series adopting the latest generation of AISI standards for cold-formed steel. This particular proposal focuses on Chapter 22 by incorporating a reference to a new cold-formed steel standard -- AISI S400. The standard is published and available for a free download at: www.aisistandards.org.

AISI S400, North American Standard for Seismic Design of Cold-Formed Steel Structural Systems, addresses the design and construction of cold-formed steel structural members and connections used in the seismic force-resisting systems in buildings and other structures. This first edition primarily represents a merging of the requirements from AISI S110, Standard for Seismic Design of Cold- Formed Steel Structural Systems – Special Bolted Moment Frame, 2007 with Supplement No. 1-09, and the 2016 seismic portions of AISI S213, North American Standard for Cold-Formed Steel Framing – Lateral Design, 2007 with Supplement No. 1-09. The layout and many of the seismic design requirements are drawn from ANSI/AISC 341-10, Seismic Provisions for Structural Steel Buildings, which is developed by the American Institute of Steel Construction (AISC). AISI S400 supersedes AISI S110 and the seismic design provisions of AISI S213 and is intended to be applied in conjunction with both AISI S100 and AISI S240, as applicable.

Modifications specific to Section 2210.2 recognize that requirements for the cold-formed steel special-bolted moment frame are now located in AISI S400.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

2210.2 Seismic requirements for cold-formed steel structures.

Where a response modification coefficient, *R*, in accordance with ASCE 7, Table 12.2-1, is used for the design of cold-formed steel structures, the structures shall be designed and detailed in accordance with the requirements of AISI S100, ASCE 8, or, for cold-formed steel special-bolted moment frames, AISI S400~~S110~~.

S7455

Date Submitted	11/26/2018	**Section**	2211	**Proponent**	Bonnie Manley
Chapter	22	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **Yes**

Related Modifications

7452, 7454, S299-16 (Structural, Structural, Chart #1), 7458

Summary of Modification

This proposal is one in a series adopting the latest generation of AISI standards for cold-formed steel.

Rationale

Please see attached file for details.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

Alternate Language

1st Comment Period History

7455-A2

Proponent Bonnie Manley **Submitted** 1/7/2019 **Attachments** Yes

Rationale

A correction is needed in Section 2211.1. AISI S220 is for nonstructural cold-formed steel framing and is adopted in Section 2211.2. It's reference here is a mistake.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to Small Business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

2211.1 ~~General.~~Structural framing.

~~The~~For cold-formed steel light-frame construction, the design and installation of the following structural framing systems, including their members and ~~nonstructural members utilized in cold-formed steel light-frame construction where the specified minimum base steel thickness is not greater than 0.1180 inches (2.997 mm)~~connections, shall be in accordance with AISI S240 ~~S200~~ and Sections 2211.1.1~~2211.2~~ through 2211.1.3~~2211.7~~, or AISI S220, as applicable:~~.~~

1. Floor and roof systems,

2. Structural walls,

3. Shear walls, strap braced walls and diaphragms to resist in-plane lateral loads, and

4. Trusses.

2211.1.1 Seismic requirements for cold-formed steel structural systems. The design of cold-formed steel light frame construction to resist seismic forces shall be in accordance with the provisions of Section 2211.1.1.1 or 2211.1.1.2, as applicable.

2211.1.1.1 Seismic Design Categories B and C. Where a response modification coefficient, R, in accordance with ASCE 7, Table 12.2-1 is used for the design of cold-formed steel light frame construction assigned to Seismic Design Category B or C, the seismic force-resisting system shall be designed and detailed in accordance with the requirements of AISI S400.

Exception: The response modification coefficient, R, designated for "Steel systems not specifically detailed for seismic resistance, excluding cantilever column systems" in ASCE 7 Table 12.2-1 shall be permitted for systems designed and detailed in accordance with AISI S240 and need not be designed and detailed in accordance with AISI S400.

2211.1.1.2 Seismic Design Categories D through F. In cold-formed steel light frame construction assigned to Seismic Design Category D, E, or F, the seismic force-resisting system shall be designed and detailed in accordance with AISI S400.

2211.1.2~~2211.7~~Prescriptive framing. Detached one- and two-family *dwellings*and*townhouses*, less than or equal to three*stories above grade plane*, shall be permitted to be constructed in accordance withAISI S230subject to the limitations therein.

~~2211.2 Header design.~~

~~Headers, including box and back-to-back headers, and double and single L-headers shall be designed in accordance with AISI S212 or AISI S100.~~

2211.1.3~~2211.3~~ Truss design.

Cold-formed steel trusses shall comply with the additional provisions of Sections 2211.1.3.1 through 2211.1.3.3.~~be designed in accordance with AISI S214, Sections 2211.3.1 through 2211.3.4 and accepted engineering practice.~~

2211.1.3.1~~2211.3.1~~ Truss design drawings. The truss design drawings shall conform to the requirements of Section I1 of AISI S202 ~~B2.3 of AISI S214~~ and shall be provided with the shipment of trusses delivered to the job site. The truss design drawings shall include the details of permanent individual truss member restraint/bracing in accordance with Section I1.6 of AISI S202~~B6(a) or B 6(c) of AISI S214~~where these methods are utilized to provide restraint/bracing.

~~2211.3.2 Deferred submittals. AISI S214 Section B4.2 shall be deleted.~~

2211.1.3.2~~2211.3.3~~ Trusses spanning 60 feet or greater. The owner or the owner's authorized agent shall contract with a *registered design professional* for the design of the temporary installation restraint/bracing and the permanent individual truss member restraint/bracing for trusses with clear spans 60 feet (18 288 mm) or greater.

2211.1.3.3~~2211.3.4~~ Truss quality assurance. Reserved.

2211.2 Nonstructural Members. For cold-formed steel light frame construction, the design and installation of nonstructural members and connections shall be in accordance with AISI S220.

~~2211.4 Sructural wall stud design. Structural wall studs shall be designed in accordance with either AISI S211 or AISI S100.~~

~~2211.5 Floor and roof system design. Framing for floor and roof systems in buildings shall be designed in accordance with either AISI S210 or AISI S100.~~

~~**2211.6 Lateral design. Light-frame shear walls, diagonal strap bracing that is part of a structural wall and diaphragms used to resist wind, seismic and other in-plane lateral loads shall be designed in accordance with AISI S213.**~~

Further modify Section 2211.1:

2211.1 Structural framing.

For cold-formed steel light-frame construction, the design and installation of the following structural framing systems, including their members and connections, shall be in accordance with AISI S240 and Sections 2211.1.1 through 2211.1.3, ~~or AISI S220,~~ as applicable:

1. Floor and roof systems,

2. Structural walls,

3. Shear walls, strap braced walls and diaphragms to resist in-plane lateral loads, and

4. Trusses.

This proposal is one in a series adopting the latest generation of AISI standards for cold-formed steel. This particular proposal focuses on Chapter 22 by incorporating references to three new cold-formed steel standards -- AISI S240, AISI S400, and AISI S202. All three standards are published and available for a free download at: www.aisistandards.org.

AISI S240, *North American Standard for Cold-Formed Steel Structural Framing*, addresses requirements for construction with cold-formed steel structural framing that are common to prescriptive and engineered light frame construction. This comprehensive standard was formed by merging the following AISI standards:

1. AISI S200, *North American Standard for Cold-Formed Steel Framing-General Provisions*
2. AISI S210, *North American Standard for Cold-Formed Steel Framing–Floor and Roof System Design*
3. AISI S211, *North American Standard for Cold-Formed Steel Framing–Wall Stud Design*
4. AISI S212, *North American Standard for Cold-Formed Steel Framing–Header Design*
5. AISI S213, *North American Standard for Cold-Formed Steel Framing– Lateral Design*
6. AISI S214, *North American Standard for Cold-Formed Steel Framing–Truss Design*

Consequently, AISI S240 supersedes all previous editions of the above mentioned individual AISI standards.

AISI S400, *North American Standard for Seismic Design of Cold-Formed Steel Structural Systems*, addresses the design and construction of cold-formed steel structural members and connections used in the seismic force-resisting systems in buildings and other structures. This first edition primarily represents a merging of the requirements from AISI S110, *Standard for Seismic Design of Cold- Formed Steel Structural Systems – Special Bolted Moment Frame*, 2007 with Supplement No. 1-09, and the 2016 seismic portions of AISI S213, 2007 with Supplement No. 1-09. The layout and many of the seismic design requirements are drawn from ANSI/AISC 341-10, *Seismic Provisions for Structural Steel Buildings*, which is developed by the American Institute of Steel Construction (AISC). AISI S400 supersedes AISI S110 and the seismic design provisions of AISI S213 and is intended to be applied in conjunction with both AISI S100 and AISI S240, as applicable.

AISI S202, *Code of Standard Practice for Cold-formed Steel Structural Framing,* is intended to service as a state-of-the-art mandatory document for establishing contractual relationships between various parties in a construction project where coldformed steel structural materials, components and assemblies are used. While it is not specifically intended to be a direct reference in the building code, portions of AISI S202 are recommended for adoption in this proposal to establish the minimum requirements for cold-formed steel truss design drawings.

Modifications specific to Chapter 22 include the following:

- Section 2211: Requirements for cold-formed steel light-frame construction are now split into two major subsections – structural provisions are located in Section 2211.1 and nonstructural provisions are located in Section 2211.2.
- Section 2211.1: Reference to AISI S240 is made for the general design of cold-formed steel structural framing systems.
- Section 2211.1.1: Reference to AISI S400 is made for the design of cold-formed steel seismic force-resisting systems. Since the relationship between AISI S240 and AISI S400 is similar to that between AISC 360 and AISC 341, the charging language in IBC Section 2211.1.1 has been modified to parallel the language in Section 2205.2 for structural steel. It adopts AISI S400 and exempts seismic force-resisting systems only where the seismic design category is B or C and the seismic response modification coefficient, R, equals 3. This is done to recognize that ASCE 7, Table 12.2-1, Line H exempts steel systems from seismic detailing requirements as long as they are designed in accordance with AISI S240.
- Section 2211.1.2: No substantive changes are proposed for prescriptive framing.
- Section 2211.1.3: Requirements for cold-formed steel trusses are updated and streamlined to reflect changes in AISI S240. Additionally, in the process of merging the old AISI S214 into the new AISI S240, requirements for truss design drawings were relocated to AISI S202. Consequently, a direct pointer was added to Section 2211.1.3.1.

S8072

Date Submitted	12/13/2018	**Section**	2214	**Proponent**	Bonnie Manley
Chapter	22	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

7277

Summary of Modification

Clarifies application of requirements in Chapter 22.

Rationale

The purpose of this proposal is to clarify the relationship between the HVHZ requirements and the base chapter requirements. It also makes editorial modifications to the sentence on CFS so that it more closely parallels the sentence on structural steel.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

2214.2

The design, fabrication and erection of iron and steel for buildings and other structures shall be as set forth in this chapter. The additional requirements set forth in Sections 2215 through 2221 herein, inclusive, apply to structural steel for buildings and other structures located in high-velocity hurricane zones. The additional requirements set forth in Sections 2222 and 2223, herein, inclusive, apply to cold-formed members of sheet or strip steel and cold-formed steel light frame construction located in high-velocity hurricane zones.

S8099

Date Submitted	12/13/2018	**Section**	2214	**Proponent**	Bonnie Manley
Chapter	22	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **Yes**

Related Modifications

8102, 8103, 8104

Summary of Modification

Updates standards listed in HVHZ provisions of Chapter 22.

Rationale

This proposal is intended to clean up the section editorially and pick up references to the latest industry documents. AISI has recently combined several standards into the new AISI S240. This change coordinates with changes elsewhere in the building code, including Section 2211. With respect to the ASTM bolt standards – A325 and A490 – they are now both included as a Grade within ASTM F3125. SJI has recently issued a number of new technical documents; this change coordinates with a change in Section 2207. Finally, the Steel Tube Institute has split their HSS Design Manual into 4 volumes.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

1st Comment Period History

8099-A4

Proponent Thomas Sputo **Submitted** 1/8/2019 **Attachments** Yes

Rationale

These updates to the Chapter 35 references are needed to fully implement the changes in Mod S8099. The updates to the dates of the ANSI/SDI Standards are as included in the 2018 IBC. The 4th edition of the Diaphragm Design Manual is the most current edition.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None, the SDI Standards are available for free download.

Impact to building and property owners relative to cost of compliance with code

No impact.

Impact to industry relative to the cost of compliance with code

No impact

Impact to Small Business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Provides current provisions which maintain structural safety.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Provides current provisions which maintain structural safety.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate

Does not degrade the effectiveness of the code

Does not reduce the structural safety.

2214.3

The following standards, as set forth in Chapter 35 of this code, are hereby adopted.

1.American Institute of Steel Construction, AISC:

a.~~Reserved~~.

~~b.~~DG03, Serviceability Design Considerations for Steel Buildings, AISC.

b. DG09, Torsional Analysis of Structural Steel Members, AISC.

c. DG15, AISC Rehabilitation and Retrofit Guide A Reference for Historic Shapes and Specifications, AISC.

d. AISC Steel Construction Manual, AISC.

e~~d~~. Detailing for Steel Construction, AISC.

~~e.DG15, AISC Rehabilitation and Retrofit Guide A Reference for Historic Shapes and Specifications, AISC.~~

~~f. DG09, Torsional Analysis of Structural Steel Members, AISC.~~

2.American Iron and Steel Institute, AISI

a.AISI S100, North American Standard for the Design of Cold-Formed Steel Structural Members

b.~~ AISI S200, North American Standard for ColdFormed Steel Framing – General Provisions~~

~~c.AISI S210, North American Standard for ColdFormed Steel Framing – Floor and Roof System Design~~

~~d.AISI S211, North American Standard for ColdFormed Steel Framing – Wall Stud Design~~

~~e.AISI S212, North American Standard for ColdFormed Steel Framing – Header Design~~

~~f.AISI S213, North American Standard for ColdFormed Steel Framing – Lateral Design with Supplement 1~~

~~g.AISI S-214, North American Standard for ColdFormed Steel Framing – Truss Design~~

~~h.~~AISI S230, Standard for Cold-formed Steel Framing–Prescriptive Method for One-and Two Family Dwellings

c. AISI S240, *North American Standard for Cold-Formed Steel Structuring Framing*

3.~~American National Standards Institute/~~American Society of Civil Engineers, ~~ANSI/~~ASCE.

a.~~Reserved.~~

~~b.~~ASCE 8, Specifications for the Design of Cold-Formed Stainless Steel Structural Members~~, ANSI/ASCE 8~~.

~~c.Reserved.~~

4.American National Standards Institute/American Welding Society, ANSI/AWS.

a. Specification for Welding Procedure and Performance Qualification, AWS B2.1.

b. ~~Reserved.~~

~~c.~~Structural Welding Code–Steel, ANSI/AWS D1.1—D1.1M.

c~~d~~. Structural Welding Code–Sheet Metal, ANSI/AWS D1.3—D1.3M.

d~~e~~. Structural Welding Code–Reinforcing Steel, ANSI/AWS D1.4

e~~f~~. Sheet Metal Welding Code, AWS D9.1—D9.1M.

5.ASTM International.

a.Standard Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use, ASTM A6.

b.~~Standard Specifications for High-Strength Bolts for Structural Steel Joints, ASTM A325.~~

~~c.Standard Specification for Heat-Treated Steel Structural Bolts, Alloy Steel, Heat Treated 150 KSI Minimum Tensile Strength, ASTM A490.~~

~~d.~~Standard Specification for Sheet Steel, Carbon, Metallic, and Nonmetallic Coated for Cold-formed Steel Framing Members, ASTM A1003- A1003M.

c. Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions, ASTM F3125-F3125M

6.National Association of Architectural Metal Manufacturers, NAAMM.

a.NAAMM MBG 531, Metal Grating Manual.

7.~~Reserved.~~

~~8.~~Research Council on Structural Connections, RCSC.

a. Specification for Structural Joints Using High Strength Bolts, RSC.

~~9.Reserved.~~

8~~10~~.Steel Deck Institute, Inc., SDI.

a.~~Reserved.~~

~~b.Reserved.~~

~~c.Reserved.~~

~~d.Reserved.~~

~~e.Reserved.~~

~~f~~.Diaphragm Design Manual, SDI.

b~~g~~.SDI-C~~-2011~~ Standard for Composite Steel Floor Deck Slabs

c~~h~~.SDI-RD~~-2010~~ Standard for Steel Roof Deck

d~~i~~.SDI-NC~~-2010~~ Standard for Non-Composite Steel Floor Deck.

9~~11~~.Steel Joist Institute, SJI.

a. 44th~~43rd~~ Edition Standard Specifications ~~and~~ Load Tables and Weight Tables for Steel Joists and Joist Girders~~, which includes Errata No. 1 and No. 2~~, SJI.

b."Structural Design of Steel Joist Roofs to Resist Ponding Loads", Technical Digest No. 3, SJI.

c."Vibration of Steel Joist-Concrete Slab Floors", Technical Digest No. 5, SJI.

d."Design of Steel Joist Roofs to Resist Uplift Loads", Technical Digest No. 6, SJI.

e."Welding of Open Web Steel Joist and Joist Girders", Technical Digest No. 8, SJI.

f."Handling and Erection of Steel Joists and Joist Girders", Technical Digest No. 9, SJI.

g.~~85~~90 Years of Open Web Steel Joist Construction, SJI.

h."Design of Lateral Load Resisting Frames Using Steel Joists and Joist Girders", Technical Digest No. 11, SJI

-

~~12.Reserved.~~

~~a.Reserved.~~

~~b.Reserved.~~

~~13.Reserved.~~

-

~~11~~10.Steel Tube Institute, STI.

a.~~HSS Design Manual.~~ HSS Design Manual, Volume 1: Section Properties & Design Information

b. HSS Design Manual, Volume 2: Member Design

c. HSS Design Manual, Volume 3: Connections at HSS Members

d. HSS Design Manual, Volume 4: Truss & Bracing Connections

Updates to SDI section in Chapter 35

~~ANSI/NC1.0—10~~ ANSI/SDI NC-2017 Standard for Noncomposite Steel Floor Deck 2210.1.1.1

~~ANSI/RD1.0—10~~ ANSI/SDI RD-2017 Standard for Steel Roof Deck 2210.1.1.2

DDM—~~03~~ 04 Diaphragm Design Manual 2214.32222.4

ANSI/SDI-C—~~2011~~ 2017 Standard for Composite Steel Floor Deck Slabs 2210.1.1.3

ANSI/SDI-QA/QC—~~2011~~ 2017 Standard for Quality Control and Quality Assurance for Installation of Steel Deck

S8102

Date Submitted	12/13/2018	**Section**	2221	**Proponent**	Bonnie Manley
Chapter	22	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

8099, 8103, 8104

Summary of Modification

Editorially updates a cross-reference to industry documents.

Rationale

This proposal simply updates a cross-reference in Section 2214, which was edited in Proposal S8099.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

2221.6.3

The ends of joists shall have a minimum bearing, on reinforced concrete and steel supports as specified in the standard set forth in Section 2214.3(9~~11~~).

S8103

Date Submitted	12/13/2018	**Section**	2222	**Proponent**	Bonnie Manley
Chapter	22	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

8099, 8102, 8104

Summary of Modification

Editorially updates a cross-reference to industry documents.

Rationale

This proposal simply updates a cross-reference in Section 2214, which was edited in Proposal S8099.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

2222.2.1

Galvanizing as referred to herein is to be zinc coating conforming to the standard set forth in Section 2214.3(5)(bd).

S8104

Date Submitted	12/13/2018	**Section**	2222	**Proponent**	Bonnie Manley
Chapter	22	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

8099, 8102, 8103

Summary of Modification

Editorially updates a cross-reference to industry documents.

Rationale

This proposal simply updates a cross-reference in Section 2214, which was edited in Proposal S8099.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

2222.6.1

All steel sheets having a thickness of less than 20 gauge, i.e., materials of higher gauge, shall be galvanized in accordance with the standards of Section 2214.3(5)(bd) herein to provide a minimum coating designation of G90.

Date Submitted	11/24/2018	**Section**	2303.2.4	**Proponent**	Joseph Crum
Chapter	23	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

S265-16

Summary of Modification

This proposal provides a clarification of the labeling of fire-retardant-treated wood that aides verification in the field.

Rationale

There are products coming into the marketplace that have obscured the labels required by Section 2303.1.1 and 2303.1.5. This change clarifies that FRTW must have two labels: one for the grading of the wood the other for the treatment. There are also manufacturers making the claim for a lift of lumber or wood structural panel. The change clarifies each piece must be labeled with both marks.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal provides a clarification of the labeling of fire-retardant-treated wood that aides verification in the field.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction. Manufacturer's treating in accordance with the code requirement for pressure treatment or other means during manufacturer already mark each piece. The proposal clarifies, for others, what is already being done.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction. Manufacturer's treating in accordance with the code requirement for pressure treatment or other means during manufacturer already mark each piece. The proposal clarifies, for others, what is already being done.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction. Manufacturer's treating in accordance with the code requirement for pressure treatment or other means during manufacturer already mark each piece. The proposal clarifies, for others, what is already being done.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal provides a clarification of the labeling of fire-retardant-treated wood that aides verification in the field.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal provides a clarification of the labeling of fire-retardant-treated wood that aides verification in the field.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal provides a clarification of the labeling of fire-retardant-treated wood that aides verification in the field and Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not degrade the effectiveness of the code

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities and Does not degrade the effectiveness of the code.

Revise as follows:

2303.2.4 Labeling. ~~Fire-retardant-treated~~ In addition to the labels required in Section 2303.1.1 for sawn lumber and Section 2303.1.5 for wood structural panels each piece of fire-retardant-treated lumber and wood structural panels shall be labeled. The *label* shall contain the following items:

1. The identification *mark* of an *approved agency* in accordance with Section1703.5.
2. Identification of the treatingmanufacturer.
3. The name of the fire-retardanttreatment.
4. The species of wood treated.
5. Flame spread and smoke-developedindex.
6. Method of drying aftertreatment.
7. Conformance with appropriate standards in accordance with Sections 2303.2.5 through2303.2.8.
8. For*fire-retardant-treatedwood*exposedtoweather,damporwetlocations,includethewords"No increase in the *listed* classification when subjected to the Standard Rain Test" (ASTM D2898).

S7441

Date Submitted	11/26/2018	**Section**	2308.2.3	**Proponent**	Rick Hopkins
Chapter	23	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

2308.2.3

Summary of Modification

Live loads shall not exceed 40 psf (1916 N/m) for floors. Exception: Live loads for concrete slab -on-ground floors in Risk Category I and II occupancies are not limited.

Rationale

Reason:
Conventional light - frame construction is often desirable to use for small slab
- on - ground commercial structures. The restriction to a 40 pound per square foot
live load is currently interpreted to apply to all levels of the structure, even at a ground floor space located on a concrete slab - on - ground. This proposal clarifies that live loads of more than 40 pounds per square foot are permitted at ground floors of Risk Category I and II buildings having a concrete slab - on - ground. This clarification is consistent with
the very specific scope identified for the conventional light - frame construction in Section 2320.1 that go back to the 1997 UBC.
Concrete slabs -on-ground design will be governed by applicable portions of Chapter 18 and Section 1907.
This proposal is submitted by the ICC Building Code Action Committee (BCAC). BCAC was established by the ICC Board of Directors to pursue opportunities to improve and enhanc
e assigned International Codes or portions thereof. In 2014 and 2015 the BCAC has held 5 open meetings.
In addition, there were numerous Working Group meetings and conference calls for the current code development cycle, which included members of the committee as well as any interested party to discuss and debate the proposed changes. Related documentation and reports are posted on the BCAC website at: BCAC
Cost Impact:
Will not increase the cost of construction
This proposal will not increase the cost of construction as it simply allows a higher live load to be used where a concrete slab on grade is used at the ground floor level.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No

Does not degrade the effectiveness of the code

Does not

Exception: Live loads shall not exceed 40 psf (1916 N/m) for floors.
Exception: Live loads for concrete slab -on-ground floors in Risk Category I and II occupancies are not limited.

Date Submitted	11/26/2018	**Section**	2304.12.2.6	**Proponent**	Paul Coats
Chapter	23	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments	**No**	**Alternate Language**	**No**

Related Modifications

Summary of Modification

Introduces a new section which requires ventilation openings in enclosed wood floor framing when the floor supports an exterior balcony or walking surface that is exposed to the weather.

Rationale

This proposed modification was approved for the 2018 IBC by the ICC membership and appears in the 2018 edition of the IBC. Similar to the requirement for ventilation of unvented rafter assemblies in Section 1203.3, unvented floor assemblies that serve as exterior balconies or walking surfaces should have ventilation so the assembly can dry out if water gets into the assembly. The ventilation is important regardless of whether the wood is preservative treated or not, and the requirement is necessary especially for when wood structural members support moisture-permeable floors or roofs as permitted in Section 2304.12.2.5, the section which precedes this new proposed section.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Confirming during plan check or final inspection that ventilation is provided could be part of the same process that is currently used for required underfloor ventilation and ventilation of enclosed rafter and attic spaces, and therefore would not have a significant additional impact.

Impact to building and property owners relative to cost of compliance with code

Similar to providing required ventilation openings in underfloor spaces and enclosed rafter and attic spaces, the impact is minimal. Leaving the floor structure unenclosed from the bottom is an alternative.

Impact to industry relative to the cost of compliance with code

Similar to providing required ventilation openings in underfloor spaces and enclosed rafter and attic spaces, the impact is minimal. Leaving the floor structure unenclosed from the bottom is an alternative.

Impact to small business relative to the cost of compliance with code

Similar to providing required ventilation openings in underfloor spaces and enclosed rafter and attic spaces, the impact is minimal. Leaving the floor structure unenclosed from the bottom is an alternative.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The ventilation of enclosed floor spaces beneath balconies exposed to the weather is an important safeguard in case impervious moisture barriers or flashings fail due to damage or incorrect installation. The deterioration of wood in floors due to trapped moisture can be a life safety issue.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Although the code currently contains provisions for the protection of wood from water in this location, the additional safeguard of ventilation will improved the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This does not discriminate against any materials, products, methods, or systems of construction. The code already requires the protection of wood in this circumstance.

Does not degrade the effectiveness of the code

This does not degrade the effectiveness of current code requirements for the protection of wood.

2304.12.2.6 Ventilation required beneath balcony or elevated walking surfaces. Enclosed framing in exterior balconies and elevated walking surfaces that are exposed to rain, snow, or drainage from irrigation shall be provided with openings that provide a net free cross ventilation area not less than 1/150 of the area of each separate space.

S7460

Date Submitted	11/27/2018	**Section**	2308.2.3	**Proponent**	Rick Hopkins
Chapter	23	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Same as change between 2015 IBC-B and 2018 IBC-B

Summary of Modification

This proposal makes it clear that a concrete slab on grade can be used in conjunction with conventional light-frame construction and that the 40 psf live load limit for floors would not apply. The modification places a practical limit of 125 psf for the slab on grade live load.

Rationale

FBC section 2308.2.3 will now show the exception to the requirement in Risk Category I and II

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners

Impact to industry relative to the cost of compliance with code

No impact to industry

Impact to small business relative to the cost of compliance with code

No impact

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

strengthens and clarifies

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials, product, methods, or systems of construction

Does not degrade the effectiveness of the code

Clarifies and increases the effectiveness of the code

2308.2.3 Allowable Loads

Exception: live loads for concrete slab-on ground floors in Risk Category I and II occupancies are not limited.

S7626

Date Submitted	12/2/2018	**Section**	2304.8	**Proponent**	Ann Russo8
Chapter	23	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

S271-16

Summary of Modification

The purpose of this code change is to remove the redundant language contained within the footnotes.

Rationale

The purpose of this code change is to remove the redundant language contained within the footnotes. Section 2304.8.1 for roof sheathing and Section 2304.8.2 for floor sheathing state that sheathing conforming to the provisions of the Tables "shall be deemed to meet the requirements of this section." Repeating the language in the footnotes is unnecessary and should be deleted for simplicity. Also, in table 2304.8 (1) footnote a is removed because there are no installation details in either Sections 2304.8.1 or 2304.8.2.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal is intended to clarify the code and does not effect enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This proposal is intended to clarify the code and does not contain any new requirements nor is it removing any requirements for construction. No cost impact

Impact to industry relative to the cost of compliance with code

This proposal is intended to clarify the code and does not contain any new requirements nor is it removing any requirements for construction. No cost impact

Impact to small business relative to the cost of compliance with code

This proposal is intended to clarify the code and does not contain any new requirements nor is it removing any requirements for construction. No cost impact

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Code cleanup by removing the redundant language only.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Code cleanup by removing the redundant language only.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Code cleanup by removing the redundant language only. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

Code cleanup by removing the redundant language only. Does not degrade the effectiveness of the code.

Revise as follows:

TABLE 2304.8 (5)

ALLOWABLE LOAD (PSF) FOR WOOD STRUCTURAL PANEL ROOF SHEATHING CONTINUOUS OVER TWO OR MORE SPANS AND STRENGTH AXIS PARALLEL TO SUPPORTS (Plywood Structural Panels Are Five-Ply, Five-Layer Unless Otherwise Noted)[a, b]

PANEL GRADE	THICKNESS (inch)	MAXIMUM SPAN (inches)	LOAD AT MAXIMUM SPAN (psf)	
			Live	Total
Structural I sheathing	7/16	24	20	30
	15/32	24	35[cb]	45[cb]
	1/2	24	40[cb]	50[cb]
	19/32 , 5/8	24	70	80
	23/32 , 3/4	24	90	100
Sheathing, other grades	7/16	16	40	50

PANEL GRADE	THICKNESS (inch)	MAXIMUM SPAN (inches)	LOAD AT MAXIMUM SPAN (psf)	
			Live	Total
covered in DOC PS 1 or DOC PS 2	15/32	24	20	25
	1/2	24	25	30
	19/32	24	40cb	50cb
	5/8	24	45cb	55cb
	23/32 , 3/4	24	60cb	65cb

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m 2 .

~~a. Roof sheathing complying with this table shall be deemed to meet the design criteria of Section2304.8.~~

~~b~~a. Uniform load deflection limitations 1 / 180 of span under live load plus dead load, 1 / 240 under live load only. Edges shall be blocked with lumber or other approved type of edge supports.

~~c~~b. For composite and four-ply plywood structural panel, load shall be reduced by 15 pounds per square foot.

TABLE 2304.8 (4)

ALLOWABLE SPAN FOR WOOD STRUCTURAL PANEL COMBINATION SUBFLOOR-UNDERLAYMENT

(SINGLE FLOOR)a, b (Panels Continuous Over Two or More Spans and Strength Axis Perpendicular to Supports)

IDENTIFICATION	MAXIMUM SPACING OF JOISTS (inches)				
	16	20	24	32	48
Species group[cb]	Thickness (inches)				
1	1/2	5/8	3/4	—	—
2, 3	5/8	3/4	7/8	—	—
4	3/4	7/8	1	—	—
Single floor span rating[dc]	16 o.c.	20 o.c.	24 o.c.	32 o.c.	48 o.c.

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m 2 .

a. Spans limited to value shown because of possible effects of concentrated loads. Allowable uniform loads based on deflection of 1 / 360 of span is 100 pounds per square foot except allowable total uniform load for 1 1 / 8 -inch wood structural panels over joists spaced 48 inches on center is 65 pounds per square foot. Panel edges shall have approved tongue-and-groove joints or shall be supported with blocking, unless 1 / 4 -inch minimum thickness underlayment or 1 1 / 2 inches of approved cellular or lightweight concrete is placed over the subfloor, or finish floor is 3 / 4 -inch woodstrip.

b. ~~Floor panels complying with this table shall be deemed to meet the design criteria of Section 2304.8.~~ cb. Applicable to all grades of sanded exterior-type plywood. See DOC PS 1 for plywood speciesgroups.

~~d~~c. Applicable to Underlayment grade, C-C (Plugged) plywood, and Single Floor grade wood structural panels.

TABLE 2304.8 (3)

ALLOWABLE SPANS AND LOADS FOR WOOD STRUCTURAL PANEL SHEATHING AND SINGLE-FLOOR GRADES CONTINUOUS OVER TWO OR MORE SPANS WITH STRENGTH AXIS PERPENDICULAR TO SUPPORTS.a, b

SHEATHING GRADES		ROOF[cb]				FLOOR[dc]
		Maximum span (inches)		Load[ed] (psf)		
Panel span rating roof/ floor span	Panel thickness (inches)	With edge support[fe]	Without edge support	Total load	Live load	Maximum span (inches)
16/0	3/8	16	16	40	30	0
20/0	3/8	20	20	40	30	0

24/0	3/8 ,7/16 ,1/2	24	20[gf]	40	30	0
24/16	7/16 , 1/2	24	24	50	40	16
32/16	15/32 ,1/2 ,5/8	32	28	40	30	16[hg]
40/20	19/32 ,5/8 ,3/4 ,7/8	40	32	40	30	20[g, h,i]
48/24	23/32 ,3/4 ,7/8	48	36	45	35	24
54/32	7/8 , 1	54	40	45	35	32
60/32	7/8 , 11/8	60	48	45	35	32
SINGLE FLOOR GRADES		**ROOF[cb]**				**FLOOR[dc]**
Panel span	**Panel thickness**	**Maximum span (inches)**		**Load[ed] (psf)**		**Maximum**

rating	(inches)	With edge support[fe]	Without edge support	Total load	Live load	span (inches)
16 o.c.	1 /2 ,19 /32 ,5 /8	24	24	50	40	16hg
20 o.c.	19 /32 ,5 /8 ,3 /4	32	32	40	30	20g, h,i
24 o.c.	23 /32 ,3 /4	48	36	35	25	24
32 o.c.	7 /8 , 1	48	40	50	40	32
48 o.c.	13 /32 , 11 /8	60	48	50	40	48

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m 2 .

a. Applies to panels 24 inches orwider.

b. Floorandroofsheathingcomplyingwiththistableshallbedeemedtomeetthedesigncriteriaof Section2304.8. cb. Uniform load deflection limitations 1 / 180 of span under live load plus dead load, 1 / 240 under live loadonly.

dc. Panel edges shall have approved tongue-and-groove joints or shall be supported with blocking unless 1 / 4 -inch minimum thickness underlayment or 1 1 / 2 inches of approved cellular or lightweight concrete is placed over the subfloor, or finish floor is 3 / 4 -inch wood strip. Allowable uniform load based on deflection of 1 / 360 of span is 100 pounds per square foot except the span rating of 48 inches on center is based on a total load of 65 pounds per squarefoot.

ed. Allowable load at maximum span.

fe. Tongue-and-groove edges, panel edge clips (one midway between each support, except two equally spaced between supports 48 inches on center), lumber blocking or other. Only lumber blocking shall satisfy blocked diaphragm requirements.

gf. For 1 / 2 -inch panel, maximum span shall be 24 inches.

hg. Span is permitted to be 24 inches on center where 3 / 4 -inch wood strip flooring is installed at right angles to joist.

ih. Span is permitted to be 24 inches on center for floors where 1 1 / 2 inches of cellular or lightweight concrete is applied over the panels.

TABLE 2304.8 (1)

ALLOWABLE SPANS FOR LUMBER FLOOR AND ROOF SHEATHING[a, b]

SPAN (inches)	MINIMUM NET THICKNESS (inches) OF LUMBER PLACED			
	Perpendicular to supports		Diagonally to supports	
	Surfaced dry[ca]	Surfaced unseasoned	Surfaced dry[ca]	Surfaced unseasoned
Floors				
24	3/4	25/32	3/4	25/32
16	5/8	11/16	5/8	11/16
Roofs				
24	5/8	11/16	3/4	25/32

For SI: 1 inch = 25.4 mm.

~~a. Installation details shall conform to Sections 2304.8.1 and 2304.8.2 for floor and roof sheathing, respectively. b. Floor or roof sheathing complying with this table shall be deemed to meet the design criteria of Section 2304.8.~~ ca. Maximum 19-percent moisturecontent.

S7630

Date Submitted	12/2/2018	**Section**	2304.8	**Proponent**	Ann Russo8
Chapter	23	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

S280-16

Summary of Modification

This proposal is two-fold with the attempt to clarify and harmonize the code.

Rationale

This proposal is two-fold with the attempt to clarify and harmonize the code.

1. To clean-up the code and remove redundant language, the wording "and the special provisions in this section" is being removed from Section 2304.8.1 for structural floor sheathing. There are currently no provisions contained in this section, so the wording is meaningless. Leaving this phrase in this section only creates confusion and thus the wording should be removed.
2. In section 2304.8.2 the reference to exterior glue is changed to reflect the wording contained in section 2304.6.1 for exterior sheathing. As it stands the reference to "bonded by exterior glue" is ambiguous, and can be mistaken to mean the bond classification of the wood structural panel as defined in DOC PS1 or PS2. Identical wording contained in 2304.6.1 is used here to better reflect the intention of the code.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal is intended to clarify the code and does not contain any new requirements nor is it removing any requirements for construction. Will not effect the enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This proposal is intended to clarify the code and does not contain any new requirements nor is it removing any requirements for construction. Will not increase the cost of construction

Impact to industry relative to the cost of compliance with code

This proposal is intended to clarify the code and does not contain any new requirements nor is it removing any requirements for construction. Will not increase the cost of construction

Impact to small business relative to the cost of compliance with code

This proposal is intended to clarify the code and does not contain any new requirements nor is it removing any requirements for construction. Will not increase the cost of construction

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal is intended to clarify the code and does not contain any new requirements nor is it removing any requirements for construction. Will not effect the health, safety, and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal is intended to clarify the code and should improve the interpretation and implementation of the code by making it more clear.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal is intended to clarify the code and does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal is intended to clarify the code and does not degrade the effectiveness of the code.

Mod 7630

Revise as follows:

2304.8.1 Structural floor sheathing. Structural floor sheathing shall be designed in accordance with the general provisions of this code~~ and the special provisions in this section~~.

Floor sheathing conforming to the provisions of Table 2304.8(1), 2304.8(2), 2304.8(3) or 2304.8(4) shall be deemed to meet the requirements of this section.

2304.8.2 Structural roof sheathing. Structural roof sheathing shall be designed in accordance with the general provisions of this code and the special provisions in this section.

Roof sheathing conforming to the provisions of Table 2304.8(1), 2304.8(2), 2304.8 (3) or 2304.8 (5) shall be deemed to meet the requirements of this section. Wood structural panel roof sheathing shall be ~~bonded by~~ of a type manufactured with exterior glue (Exposure 1 or Exterior).

S7818

Date Submitted	12/10/2018	**Section**	2314.1	**Proponent**	Eduardo Fernandez
Chapter	23	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Ensure correlation with ASCE7-16

Rationale

This modification is intended to ensure the requirements contained in this section clarify the relevant standard for wood member design and wood member attachment design to ensure correlation with ASCE 7-16 as adopted. Additionally, this modification establishes consistency with other HVHZ structural sections.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities to enforcement of the code

Impact to building and property owners relative to cost of compliance with code

There is no impact to building and property owners. This code change merely establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Impact to industry relative to the cost of compliance with code

There is no impact to industry. This code change merely establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Impact to small business relative to the cost of compliance with code

There is no impact to small business impact. This code change merely establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposed code change provides uniformity with the HVHZ Sections of the code also establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposed code change provides uniformity with the HVHZ Sections of the code also establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This code change does not discriminate against materials, products, methods or systems of construction of demonstrated capabilities. Consequently, establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections

Does not degrade the effectiveness of the code

This code change makes the understanding and the applicability of this section reliable, precise and it will not degrade the effectiveness of the code. Consequently, establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

2314.1 Design. Wood members and their fastenings shall be designed to comply with ~~this code~~ ASCE 7 by methods based on rational analysis or approved laboratory testing procedures, both performed in accordance with fundamental principles of theoretical and applied mechanics.

S7820

Date Submitted	12/10/2018	**Section**	2319.13	**Proponent**	Eduardo Fernandez
Chapter	23	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Ensure correlation with ASCE7-16

Rationale

This modification is intended to ensure the requirements contained in this section clarify the relevant standard for wood member design and wood member attachment design to ensure correlation with ASCE 7-16 as adopted. Additionally, this modification establishes consistency with other HVHZ structural sections.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

There is no impact to building and property owners. This code change merely establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Impact to industry relative to the cost of compliance with code

There is no impact to industry. This code change merely establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Impact to small business relative to the cost of compliance with code

There is no impact to small business impact. This code change merely establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposed code change provides uniformity with the HVHZ Sections of the code also establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposed code change provides uniformity with the HVHZ Sections of the code also establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This code change does not discriminate against materials, products, methods or systems of construction of demonstrated capabilities. Consequently, establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Does not degrade the effectiveness of the code

This code change makes the understanding and the applicability of this section reliable, precise and it will not degrade the effectiveness of the code. Consequently, establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

2319.13 Heavy timber construction. Heavy timber construction of floors or roofs shall comply with the standards in Section 2314.4. All heavy timber construction shall be designed <u>by methods based on rational analysis performed in accordance with ASCE 7</u> ~~a registered professional engineer or registered architect proficient in structural design~~ to withstand the loads required in Chapter 16 (High-Velocity Hurricane Zones).

S7822

Date Submitted	12/10/2018	**Section**	2322.2.3	**Proponent**	Eduardo Fernandez
Chapter	23	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No **Alternate Language** No

Related Modifications

Summary of Modification

Ensure correlation with ASCE7-16.

Rationale

This modification is intended to ensure the requirements contained in this section clarify the relevant standard for wood member design and wood member attachment design to ensure correlation with ASCE 7-16 as adopted. Additionally, this modification establishes consistency with other HVHZ structural sections.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

There is no impact to building and property owners. This code change merely establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Impact to industry relative to the cost of compliance with code

There is no impact to industry. This code change merely establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Impact to small business relative to the cost of compliance with code

There is no impact to small business impact. This code change merely establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposed code change provides uniformity with the HVHZ Sections of the code also establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposed code change provides uniformity with the HVHZ Sections of the code also establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This code change does not discriminate against materials, products, methods or systems of construction of demonstrated capabilities. Consequently, establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Does not degrade the effectiveness of the code

This code change makes the understanding and the applicability of this section reliable, precise and it will not degrade the effectiveness of the code. Consequently, establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

2322.2.3 Plywood roof sheathing shall be rated for Exposure 1 and shall be designed in accordance with ASCE 7, to have a minimum nominal thickness of no less than 19/32 inch (15 mm) and shall be continuous over two or more spans with face grain perpendicular to supports. Roof sheathing panels shall be provided with a minimum of 2-inch by 4-inch (51 mm by 102 mm) edgewise blocking at all horizontal panel joints with edge spacing in accordance with manufacturer's specifications, for a distance at least 4 feet (1219 mm) from each gable end. The allowable spans shall not exceed those set forth in Table 2322.2.3.

S7824

Date Submitted	12/10/2018	**Section**	2322.2.5	**Proponent**	Eduardo Fernandez
Chapter	23	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** | **Alternate Language** **No**

Related Modifications

Summary of Modification

Correlates with ASCE 7-16

Rationale

This modification is intended to ensure the requirements contained in this section clarify the relevant standard for wood member design and wood member attachment design to ensure correlation with ASCE 7-16 as adopted. Additionally, this modification establishes consistency with other HVHZ structural sections.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

There is no impact to building and property owners. This code change merely establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Impact to industry relative to the cost of compliance with code

There is no impact to industry. This code change merely establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Impact to small business relative to the cost of compliance with code

There is no impact to small business impact. This code change merely establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposed code change provides uniformity with the HVHZ Sections of the code also establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposed code change provides uniformity with the HVHZ Sections of the code also establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This code change does not discriminate against materials, products, methods or systems of construction of demonstrated capabilities. Consequently, establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

Does not degrade the effectiveness of the code

This code change makes the understanding and the applicability of this section reliable, precise and it will not degrade the effectiveness of the code. Consequently, establishes correlation with ASCE 7 as adopted and creates consistency with other HVHZ sections.

2322.2.5 Nails and nail spacing shall be designed in accordance with ASCE 7 and shall be spaced no more than ~~be~~ 6-inches (152 mm) on center at panel edges and at intermediate supports. ~~Nail spacing shall be 4-inches (102 mm) on center at gable ends with either 8d ring shank nails or 10d common nails~~. Nails shall be minimum hand driven 8d ring shank or power driven 8d ring shank nails of the following minimum dimensions: (a) 0.113-inch (2.9 mm) nominal shank diameter, (b) ring diameter of 0.012 inch (0.3 mm) over shank diameter, (c) 16 to 20 rings per inch, (d) 0.280-inch (7.1 mm) full round head diameter, (e) 2-inch (60.3 mm) nail length.

~~2322.2.5.1 Nails shall be hand driven 8d ring shank or power driven 8d ring shank nails of the following minimum dimensions: (a) 0.113-inch (2.9 mm) nominal shank diameter, (b) ring diameter of 0.012 inch (0.3 mm) over shank diameter, (c) 16 to 20 rings per inch, (d) 0.280-inch (7.1 mm) full round head diameter, (e) 2-inch (60.3 mm) nail length. Nails of a smaller diameter or length may be used only when approved by an architect or professional engineer and only when the spacing is reduced accordingly~~

~~2322.2.5.2 Nails at gable ends shall be hand driven 8d ring shank or power driven 8d ring shank nails of the following minimum dimensions: (a) 0.113-inch (2.9 mm) nominal shank diameter, (b) ring diameter of 0.012 inch (0.3 mm) over shank diameter, (c) 16 to 20 rings per inch, (d) 0.280-inch (7.1 mm) full round head diameter, (e) 23/8-inch (60.3 mm) nail length or as an alternative hand driven 10d common nails [0.148-inch (4 mm) diameter by 3-inches (76 mm) long with 0.312 inch (7.9 mm) diameter full round head] or power driven 10d nails of the same dimensions [0.148 inch (4 mm) diameter by 3-inches (76 mm) long with 0.312-inch-diameter (8 mm) full round head]. Nails of a smaller diameter or length may be used only when approved by an architect or professional engineer and only when the spacing is reduced accordingly. Other products with unique fastening methods may be substituted for these nailing requirements as approved by the building official and verified by testing.~~

S7832

Date Submitted	12/10/2018	**Section**	2304.12.2.5	**Proponent**	Paul Coats
Chapter	23	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Requires positive drainage for impervious moisture barrier systems protecting wood structural members that support floors exposed to the weather, such as exterior balconies.

Rationale

A key functional requirement of impervious moisture barrier systems installed under a permeable floor system exposed to water are elements that provide for drainage of any water making it's way through the permeable floor system. Without a properly functioning method to transport this water out, the floor assembly can stay saturated for very long periods of time possibly contributing to premature failure. This code proposal creates a requirement for impervious moisture barrier systems protecting the structure, supporting a floor, to provide a mechanism for the water to drain out.

When such assemblies are a roof, and there is a leak in the impervious barrier, the occupants typically know about it and repairs are made. When the assembly supports a walking surface such as a balcony, there may be no early warning of a leak or decay because any leak may be located over unoccupied areas outside of the structure building envelope so the leak remains undetected. Balcony structure performance is critical because they may see substantial loading when the balcony is occupied by several persons and balconies can be located several stories above grade. Structural failure of a balcony is a life safety concern.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will require the application of new provisions for the drainage elements of an impervious barrier protecting wood structural elements in exterior walking surfaces such as balconies.

Impact to building and property owners relative to cost of compliance with code

May increase the cost of construction. Good design would provide drainage for moisture that may penetrate an impervious moisture barrier, but the code does not specifically call for it currently.

Impact to industry relative to the cost of compliance with code

May increase the cost of construction. Good design would provide drainage for moisture that may penetrate an impervious moisture barrier, but the code does not specifically call for it currently.

Impact to small business relative to the cost of compliance with code

May increase the cost of construction. Good design would provide drainage for moisture that may penetrate an impervious moisture barrier, but the code does not specifically call for it currently.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This has a direct connection with public safety by addressing a potential cause of structural failure.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by requirement a better system of construction.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

2304.12.2.5Supporting members for permeable floors and roofs.

Wood structural members that support moisture-permeable floors or roofs that are exposed to the weather, such as concrete or masonry slabs, shall be of naturally durable or *preservative-treated wood* unless separated from such floors or roofs by an impervious moisture barrier. The impervious moisture barrier system protecting the structure supporting floors shall provide positive drainage of water that infiltrates the moisture-permeable floor topping.

S279-16
IBC: 2304.12.2.5.

Proposed Change as Submitted

Proponent : Dennis Richardson, American Wood Council, representing American Wood Council (drichardson@awc.org)

2015 International Building Code

Revise as follows:

2304.12.2.5 Supporting members for permeable floors and roofs. Wood structural members that support moisture-permeable floors or roofs that are exposed to the weather, such as concrete or masonry slabs, shall be of naturally durable or *preservative-treated wood* unless separated from such floors or roofs by an impervious moisture barrier. The impervious moisture barrier system protecting the structure supporting floors shall include elements providing positive drainage of water that infiltrates the moisture-permeable floor topping.

Reason: A key functional requirement of impervious moisture barrier systems installed under a permeable floor system exposed to water are elements that provide for drainage of any water making it's way through the permeable floor system. Without a properly functioning method to transport this water out, the floor assembly can stay saturated for very long periods of time possibly contributing to premature failure. This code proposal creates a requirement for impervious moisture barrier systems protecting the structure, supporting a floor, to provide a mechanism for the water to drain out.

Cost Impact: Will increase the cost of construction
Drainage elements between the permeable floor slab and impervious barrier are commonly called for and installed by many practitioners and will not change the cost of construction in those cases. However in cases where no method to provide positive drainage is currently provided, this proposal will increase the cost of construction.

S279-16 : 2304.12.2.5-RICHARDSON12652

Public Hearing Results

Committee Action: **Disapproved**

Committee Reason: The proposed language on impervious moisture barriers is not clear enough for the building offical to enforce. The requirement for "elements providing positive drainage" should be clarified. The committee recognizes that this proposal would address a serious issue that needs to be dealt with and a public comment is encouraged to address the committee's concerns.

Assembly Motion: **As Submitted**
Online Vote Results: **Failed**
Support: 40.07% (107) Oppose: 59.93% (160)
Assembly Action: **None**

Individual Consideration Agenda

Public Comment 1:

Proponent : Dennis Richardson, representing American Wood Council (drichardson@awc.org) requests Approve as Modified by this Public Comment.

Modify as Follows:

2015 International Building Code

2304.12.2.5 Supporting members for permeable floors and roofs. Wood structural members that support moisture-permeable floors or roofs that are exposed to the weather, such as concrete or masonry slabs, shall be of naturally durable or *preservative-treated wood* unless separated from such floors or roofs by an impervious moisture barrier. The impervious moisture barrier system protecting the structure supporting floors shall ~~include elements providing~~ provide positive drainage of water that infiltrates the moisture-permeable floor topping.

Commenter's Reason: This existing code section applies when wood (that is not preservative-treated or naturally durable) supports moisture-permeable floors or roofs exposed to weather such as concrete or masonry slabs.

When such assemblies are a roof, and there is a leak in the impervious barrier, the occupants typically know about it and repairs are made. When the assembly supports a walking surface such as a balcony, there may be no early warning of a leak or decay because any leak may be located over unoccupied areas outside of the structure building envelope so the leak remains undetected.

Balcony structure performance is critical because they may see substantial loading when the balcony is occupied by several persons and balconies can be located several stories above grade. Structural failure of a balcony can result in multiple serious injuries or deaths.

In this code section, the existing requirement calls for separation by an impervious moisture barrier when the supporting wood is not preservative-treated or naturally durable. The term "impervious moisture barrier" is not defined in the code but really describes the required performance of the barrier. One bit of testimony during the Committee Action Hearing was existing language in 2304.12.2.5 may be unclear as it currently exists.

Other code changes affecting balconies were approved at the Committee Action Hearing:

ADM77-16 requires detailing on plans of all elements of the impervious moisture barrier system (including manufacturer's instructions when applicable) if the impervious moisture barrier option is used.

ADM87-16 requires inspection of all elements of the impervious moisture barrier system or special inspection can be utilized at the option of the code official.

S85-16 increased the live load for balconies to be consistent with live load requirements in ASCE-7.

S289-16 was disapproved on a close vote decided by the Chair. In their reason statement the Committee acknowledged this proposal would address a serious issue that needs to be dealt with and a public comment is encouraged to address the committee's concerns.

Early initial approaches to this code change as well as ADM77-16 and ADM87-16 were to include a comprehensive list of the various elements that might make up an impervious moisture barrier system. The proponent of these code changes received substantial feedback not to include a laundry list of possible elements that commonly make up these systems as the elements are not always the same for different systems and configurations. That logic was supported by the committee with the approval of ADM 77-16 and ADM 87-16.

Since the initial Group B code change deadline, an article by Joeseph Lstiburek has been published in the ASHRAE Journal. The unedited version can be found on the author's website at the following link:

http://buildingscience.com/documents/building-science-insights/bsi-093-all-decked-out (http://buildingscience.com/documents/building-science-insights/bsi-093-all-decked-out)

Two key concepts covered in this document is the need to provide slope, and when the traffic surface is permeable (like a concrete or masonry surface), then "it is critical that a drainage layer or space is provided immediately above the waterproofing layer." The article gives additional emphasis to the word "critical".

Without slope and a way for the water to get out, the impervious moisture barrier can be subject to constant attack by water that infiltrates the moisture permeable topping slab in a wet environment.

This concept is similar to a weep screed that provides a path for water to get out of the wood wall covered with plaster. Without an effective functioning weep screed there can be substantial water damage leading to the decay of the structural elements.

Because the overall code section is performance based, it is not possible to write a cookbook method to address this from a design standpoint. Articles such as the one linked to this reason statement do help the designer with some guidance as do manufacturer's instructions and recommendations. The key point though is just as with a weep screed, there needs to be positive drainage for moisture to get out.

There may be time to fully to address concerns of the existing language found in Section 2304.12.2.5 for the 2021 IBC code cycle. That is outside of the scope of the public comment process. Since existing language will be in place for at least three more years, this public comment at least makes it clear to designers of the need to consider and provide positive drainage of water that infiltrates the moisture permeable floor topping.

As the committee said this is a serious issue in the code that needs to be dealt with.

Information on this and other code change proposals by American Wood Council may be found at the following web address: www.woodcode.org (http://www.woodcode.org) .

Final action: Approved as Modified by PC-1

S279-16

S7849

Date Submitted	12/10/2018	**Section**	2303.1.7	**Proponent**	Paul Coats
Chapter	23	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

7846

Summary of Modification

Corrects the title and referencing language for ANSI A135.6 related to hardboard.

Rationale

The modifications correct the title of the references to the standard's title for accuracy with the current title, and also clarifies that hardboard siding must conform to the requirements of A135.6 with language that is consistent with other references in Chapter 14.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact, editorial correction.

Impact to building and property owners relative to cost of compliance with code

No cost impact.

Impact to industry relative to the cost of compliance with code

No cost impact.

Impact to small business relative to the cost of compliance with code

No cost impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Editorial correction of standard's title and referencing language.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Editorial correction improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Improves effectiveness of the code.

2303.1.7 Hardboard.

Hardboard siding shall conform to the requirements of ANSI A135.6 and, where used structurally shall be identified by the label of an *approved agency* ~~conforming to CPA/ANSI A135.6~~. Hardboard underlayment shall meet the strength requirements of 7/32-inch (5.6 mm) or 1/4-inch (6.4 mm) service class hardboard planed or sanded on one side to a uniform thickness of not less than 0.200 inch (5.1 mm). Prefinished hardboard paneling shall meet the requirements of ~~CPA/~~ANSI A135.5. Other basic hardboard products shall meet the requirements of ~~CPA/~~ANSI A135.4. Hardboard products shall be installed in accordance with manufacturer's recommendations.

S258-16

IBC: 2303.1.7, [BS] 1404.3, [BS] 1404.3.1, [BS] 1404.3.2.

Proponent : David Tyree, representing American Wood Council (dtyree@awc.org)

2015 International Building Code

Revise as follows:

[BS] 1404.3 Wood. *Exterior walls* of wood construction shall be designed and constructed in accordance with Chapter 23.

[BS] 1404.3.1 Basic hardboard. Basic hardboard shall conform to the requirements of ~~AHA~~ ANSI A135.4.

[BS] 1404.3.2 Hardboard siding. Hardboard siding shall conform to the requirements of ~~AHA~~ ANSI A135.6 and, where used structurally, shall be so identified by the *label* of an *approved* agency.

2303.1.7 Hardboard. Hardboard siding shall conform to the requirements of ANSI A135.6 and, where used structurally shall be identified by the label of an *approved agency*. ~~conforming to CPA/ANSI A135.6.~~ Hardboard underlayment shall meet the strength requirements of $^{7}/_{32}$-inch (5.6 mm) or $^{1}/_{4}$-inch (6.4 mm) service class hardboard planed or sanded on one side to a uniform thickness of not less than 0.200 inch (5.1 mm). Prefinished hardboard paneling shall meet the requirements of ~~CPA/~~ANSI A135.5. Other basic hardboard products shall meet the requirements of ~~CPA/~~ANSI A135.4. Hardboard products shall be installed in accordance with manufacturer's recommendations.

Reason: This proposal references various CPA stadnards in a consistent manner and also clarifies that hardboard siding must conform to the requirements of A135.6 in 2303.1.7 in a consistent manner with reference to hardboard siding in 1404.3.2.

Cost Impact: Will not increase the cost of construction
This proposal clarifies the code and does not place any additional costs on the user.

S258-16 : 2303.1.7-TYREE11261

Final action: AS (Approved as Submitted)

S7854

Date Submitted	12/10/2018	**Section**	2304.10.1	**Proponent**	Paul Coats
Chapter	23	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Corrects certain nail size options in the fastener schedule Table 2304.10.1 for consistency with the Residential code and also references a new standardized ring shank nail.

Rationale

This modification was approved by the ICC membership and appears in the 2018 edition of the International Building Code. This change brings consistency with the residential code for minimum nail size for roof sheathing attachment which is an 8d common nail (2-1/2" x 0.131"). The deformed nail option (2-1/2" x 0.131") is based on the assumption that the deformed nail, which has non standard deformations, has at least the same w ithdrawal capacity and head pull through performance as the 8d common smooth shank nail. This change also adds a new standardized Roof Sheathing Ring Shank (RSRS) nail for roof sheathing applications.

The RSRS nail has been standardized in ASTM F1667 and added in this proposal as equivalent to the 8d common nail to resist uplift of roof sheathing. This standard ring shank nail provides improved withdrawal resistance relative to the 8d common smooth shank nail. A head size of 0.281" diameter is specified for the RSRS-01 nail in ASTM F1667 which is equivalent to the head diameter of the 8d common nail. The slightly larger net area under the head (i.e. area of head minus area of shank) is considered to provide slightly improved head pull through performance.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will aid enforcement by adding options.

Impact to building and property owners relative to cost of compliance with code

May reduce costs by adding options

Impact to industry relative to the cost of compliance with code

May reduce costs by adding options

Impact to small business relative to the cost of compliance with code

May reduce costs by adding options

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, increased options for important nailing

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves code with increased options for important nailing

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate

Does not degrade the effectiveness of the code

Improves the code.

Mod 7854

Revise as follows:

TABLE2304.10.1
FASTENING SCHEDULE

(Rows not shown remain unchanged)

DESCRIPTION OFBUILDING ELEMENTS	NUMBERANDTYPEOF FASTENER	SPACINGANDLOCATION	
Wood structural panels(WSP), subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing[a]			
		Edges (inches)	**Intermediate supports (inches)**
	6d common or deformed (2"× 0.113") (subfloor and wall)	6	12
	8d ~~box~~ common or deformed (2 1/2" × ~~0.113~~0.131") (roof), or RSRS-01 (2-3/8"x 0.113") nail (roof)d	6	12
	2 3/8" × 0.113" nail (subfloor and wall)	6	12
	1 3/4" 16 gage staple, 7/16" crown (subfloor and wall)	4	8
	23/8" × 0.113" nail (roof)	4	8
	1 3/4" 16 gage staple, 7/16" crown (roof)	3	6

31. 3/8"–1/2"			
32. 19/32"–3/4"	8d common (21/2" × 0.131"); or 6d deformed (2" × 0.113") (subfloor and wall)	6	12
	8d common or deformed (2-1/2" x 0.131") (roof), or RSRS-01 (2-3/8" x 0.113") nail (roof)d	6	12
	2 3/8" × 0.113" nail; or 2" 16 gage staple, 7/16"crown	4	8
33. 7/8"–11/4"	10d common (3" × 0.148"); or 8d deformed (21/2" × 0.131")	6	12

For SI: 1inch=25.4 mm.

a. Nails spaced at 6 inches at intermediate supports where spans are 48 inches or more. For nailingof wood structural panel and particleboard diaphragms and shear walls, refer to Section 2305. Nails for wall sheathing are permitted to be common, box or casing.

b. Spacing shall be 6inches on center on the edges and 12 inches on center at intermediate supports for nonstructural applications. Panel supports at 16 inches (20 inches if strength axis in the long direction of the panel, unless otherwise marked).

c. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule and the ceiling joist is fastened to the top plate in accordance with this schedule, the number of toenails in the rafters hall be permitted to be reduced by one nail.

d.RSRS-01 is a Roof Sheathing Ring Shank nail meeting the specifications in ASTMF1667.

S272-16

IBC: 2304.10.1.

Proponent : Paul Coats, PE CBO, American Wood Council, representing American Wood Council (pcoats@awc.org)

2015 International Building Code

Revise as follows:

TABLE 2304.10.1
FASTENING SCHEDULE

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER	SPACING AND LOCATION
Roof		
1. Blocking between ceiling joists, rafters or trusses to top plate or other framing below	3-8d common ($2^1/_2$ " × 0.131"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails; or 3-3"14 gage staples, $^7/_{16}$ " crown	Each end, toenail
Blocking between rafters or truss not at the wall top plate, to rafter or truss	2-8d common (21 $/_2$ " × 0.131") 2-3" × 0.131" nails 2-3" 14 gage staples	Each end, toenail
	2-16 d common (31 $/_2$ " × 0.162") 3-3" × 0.131" nails 3-3" 14 gage staples	End nail
Flat blocking to truss and web filler	16d common ($3^1/_2$ " × 0.162") @ 6" o.c. 3" × 0.131" nails @ 6" o.c. 3" × 14 gage staples @ 6" o.c	Face nail
2. Ceiling joists to top plate	3-8d common ($2^1/_2$ " × 0.131"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails; or 3-3" 14 gage staples, $^7/_{16}$ " crown	Each joist, toenail
3. Ceiling joist not attached to parallel rafter, laps over partitions (no thrust) (see Section 2308.7.3.1, Table 2308.7.3.1)	3-16d common ($3^1/_2$ " × 0.162"); or 4-10d box (3" × 0.128"); or 4-3" × 0.131" nails; or 4-3" 14 gage staples, $^7/_{16}$ " crown	Face nail

4. Ceiling joist attached to parallel rafter (heel joint) (see Section 2308.7.3.1, Table 2308.7.3.1)	Per Table 2308.7.3.1	Face nail
5. Collar tie to rafter	3-10d common (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails; or 4-3″ 14 gage staples, 7 /16 ″ crown	Face nail
6. Rafter or roof truss to top plate (See Section 2308.7.5, Table 2308.7.5)	3-10 common (3″ × 0.148″); or 3-16d box (31 /2 ″ × 0.135″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131 nails; or 4-3″ 14 gage staples, 7 /16 ″ crown	Toenail[c]
7. Roof rafters to ridge valley or hip rafters; or roof rafter to 2-inch ridge beam	2-16d common (31 /2 ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, 7 /16 ″ crown; or	End nail
	3-10d common (31 /2 ″ × 0.148″); or 3-16d box (31 /2 ″ × 0.135″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails; or 4-3″ 14 gage staples, 7 /16 ″ crown	Toenail

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER	SPACING AND LOCATION
Wall		
8. Stud to stud (not at braced wall panels)	16d common (31 /2 ″ × 0.162″);	24″ o.c. face nail
	10d box (3″ × 0.128″); or 3″ × 0.131″ nails; or 3-3″ 14 gage staples, 7 /16 ″ crown	16″ o.c. face nail
9. Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d common (31 /2 ″ × 0.162″); or	16″ o.c. face nail
	16d box (31 /2 ″ × 0.135″); or	12″ o.c. face nail
	3″ × 0.131″ nails; or 3-3″ 14 gage staples,	

	7/16" crown	12" o.c. face nail
10. Built-up header (2" to 2" header)	16d common (3 1/2" × 0.162"); or	16" o.c. each edge, face nail
	16d box (3 1/2" × 0.135")	12" o.c. each edge, face nail
11. Continuous header to stud	4-8d common (2 1/2" × 0.131"); or 4-10d box (3" × 0.128")	Toenail
12. Top plate to top plate	16d common (3 1/2" × 0.162"); or	16" o.c. face nail
	10d box (3" × 0.128"); or 3" × 0.131" nails; or 3" 14 gage staples, 7/16" crown	12" o.c. face nail
13. Top plate to top plate, at end joints	8-16d common (3 1/2" × 0.162"); or 12-10d box (3" × 0.128"); or 12-3" × 0.131" nails; or 12-3" 14 gage staples, 7/16" crown	Each side of end joint, face nail (minimum 24" lap splice length each side of end joint)
14. Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common (3 1/2" × 0.162"); or	16" o.c. face nail
	16d box (3 1/2" × 0.135"); or 3" × 0.131" nails; or 3" 14 gage staples, 7/16" crown	12" o.c. face nail
15. Bottom plate to joist, rim joist, band joist or blocking at braced wall panels	2-16d common (3 1/2" × 0.162"); or 3-16d box (3 1/2" × 0.135"); or 4-3" × 0.131" nails; or 4-3" 14 gage staples, 7/16" crown	16" o.c. face nail
16. Stud to top or bottom plate	4-8d common (2 1/2" × 0.131"); or 4-10d box (3" × 0.128"); or 4-3" × 0.131" nails; or 4-3" 14 gage staples, 7/16" crown; or	Toenail
	2-16d common (3 1/2" × 0.162"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails; or	End nail

	3-3″ 14 gage staples, $^7/_{16}$ ″ crown	
17. Top or bottom plate to stud	2-16d common ($3^1/_2$ ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^7/_{16}$ ″ crown	End nail
18. Top plates, laps at corners and intersections	2-16d common ($3^1/_2$ ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^7/_{16}$ ″ crown	Face nail

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER	SPACING AND LOCATION
Wall		
19. 1″ brace to each stud and plate	2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2-3″ × 0.131″ nails; or 2-3″ 14 gage staples, $^7/_{16}$ ″ crown	Face nail
20. 1″ × 6″ sheathing to each bearing	2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″)	Face nail
21. 1″ × 8″ and wider sheathing to each bearing	3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″)	Face nail
Floor		
22. Joist to sill, top plate, or girder	3-8d common ($2^1/_2$ ″ × 0.131″); or floor 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^7/_{16}$ ″ crown	Toenail
23. Rim joist, band joist, or blocking to top plate, sill or other framing below	8d common ($2^1/_2$ ″ × 0.131″); or 10d box (3″ × 0.128″); or 3″ × 0.131″ nails; or 3″ 14 gage staples, $^7/_{16}$ ″ crown	6″ o.c., toenail

24. 1″ × 6″ subfloor or less to each joist	2-8d common ($2^1/_2$″ × 0.131″); or 2-10d box (3″ × 0.128″)	Face nail
25. 2″ subfloor to joist or girder	2-16d common ($3^1/_2$″ × 0.162″)	Face nail
26. 2″ planks (plank & beam – floor & roof)	2-16d common ($3^1/_2$″ × 0.162″)	Each bearing, face nail
27. Built-up girders and beams, 2″ lumber layers	20d common (4″ × 0.192″)	32″ o.c., face nail at top and bottom staggered on opposite sides
	10d box (3″ × 0.128″); or 3″ × 0.131″ nails; or 3″ 14 gage staples, $^7/_{16}$″ crown	24″ o.c. face nail at top and bottom staggered on opposite sides
	And: 2-20d common (4″ × 0.192″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^7/_{16}$″ crown	Ends and at each splice, face nail
28. Ledger strip supporting joists or rafters	3-16d common ($3^1/_2$″ × 0.162″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails; or 4-3″ 14 gage staples, $^7/_{16}$″ crown	Each joist or rafter, face nail
29. Joist to band joist or rim joist	3-16d common ($3^1/_2$″ × 0.162″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails; or 4-3″ 14 gage staples, $^7/_{16}$″ crown	End nail
30. Bridging or blocking to joist, rafter or truss	2-8d common ($2^1/_2$″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2-3″ × 0.131″ nails; or 2-3″ 14 gage staples, $^7/_{16}$″ crown	Each end, toenail

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER	SPACING AND LOCATION
Wood structural panels (WSP), subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framinga		

		Edges (inches)	Intermediate supports (inches)
31. $^{3}/_{8}$″ – $^{1}/_{2}$″	6d common or deformed (2″ × 0.113″) (subfloor and wall)	6	12
	8d ~~box~~common or deformed ($2^{1}/_{2}$″ × ~~0.113~~0.131″) (roof), or RSRS-01 (2-3/8″ x 0.113″) nail (roof)[d]	6	12
	$2^{3}/_{8}$″ × 0.113″ nail (subfloor and wall)	6	12
	$1^{3}/_{4}$″ 16 gage staple, $^{7}/_{16}$″ crown (subfloor and wall)	4	8
	$2^{3}/_{8}$″ × 0.113″ nail (roof)	4	8
	$1^{3}/_{4}$″ 16 gage staple, $^{7}/_{16}$″ crown (roof)	3	6
32. $^{19}/_{32}$″ – $^{3}/_{4}$″	8d common ($2^{1}/_{2}$″ × 0.131″); or 6d deformed (2″ × 0.113″) (subfloor and wall)	6	12
	8d common or deformed (2-1/2″ x 0.131″) (roof), or RSRS-01 (2-3/8″ x 0.113″) nail (roof)[d]	6	12
	$2^{3}/_{8}$″ × 0.113″ nail; or 2″ 16 gage staple, $^{7}/_{16}$″ crown	4	8
33. $^{7}/_{8}$″ – $1^{1}/_{4}$″	10d common (3″ × 0.148″); or 8d deformed ($2^{1}/_{2}$″ × 0.131″)	6	12

Other exterior wall sheathing			
34. 1 /2 ″ fiberboard sheathing[b]	1 1 /2 ″ galvanized roofing nail (7 /16 ″ head diameter); or 1 1 /4 ″ 16 gage staple with 7 /16 ″ or 1″ crown	3	6
35. 25 /32 ″ fiberboard sheathing[b]	1 3 /4 ″ galvanized roofing nail (7 /16 ″ diameter head); or 1 1 /2 ″ 16 gage staple with 7 /16 ″ or 1″ crown	3	6
Wood structural panels, combination subfloor underlayment to framing			
36. 3 /4 ″ and less	8d common (2 1 /2 ″ × 0.131″); or 6d deformed (2″ × 0.113″)	6	12
37. 7 /8 ″ – 1″	8d common (2 1 /2 ″ × 0.131″); or 8d deformed (2 1 /2 ″ × 0.131″)	6	12
38. 1 1 /8 ″ – 1 1 /4 ″	10d common (3″ × 0.148″); or 8d deformed (2 1 /2 ″ × 0.131″)	6	12
Panel siding to framing			
39. 1 /2 ″ or less	6d corrosion-resistant siding (1 7 /8 ″ × 0.106″); or 6d corrosion-resistant casing (2″ × 0.099″)	6	12
40. 5 /8 ″	8d corrosion-resistant siding (2 3 /8 ″ × 0.128″); or 8d corrosion-resistant casing (2 1 /2 ″ × 0.113″)	6	12

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF	SPACING AND LOCATION

	FASTENER		
Wood structural panels (WSP), subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framinga			
		Edges (inches)	Intermediate supports (inches)
Interior paneling			
41. 1/4 "	4d casing (1 1/2 " × 0.080"); or 4d finish (1 1/2 " × 0.072")	6	12
42. 3/8 "	6d casing (2" × 0.099"); or 6d finish (Panel supports at 24 inches)	6	12

For SI: 1 inch = 25.4 mm.

a. Nails spaced at 6 inches at intermediate supports where spans are 48 inches or more. For nailing of wood structural panel and particleboard diaphragms and shear walls, refer to Section 2305. Nails for wall sheathing are permitted to be common, box or casing.

b. Spacing shall be 6 inches on center on the edges and 12 inches on center at intermediate supports for nonstructural applications. Panel supports at 16 inches (20 inches if strength axis in the long direction of the panel, unless otherwise marked).

c. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule and the ceiling joist is fastened to the top plate in accordance with this schedule, the number of toenails in the rafter shall be permitted to be reduced by one nail.

d. RSRS-01 is a Roof Sheathing Ring Shank nail meeting the specifications in ASTM F1667.

Reason: This change brings consistency with the IRC for minimum nail size for roof sheathing attachment which is an 8d common nail (2-1/2" x 0.131"). The deformed nail option (2-1/2" x 0.131") is based on the assumption that the deformed nail, which has non-standard deformations, has at least the same withdrawal capacity and head pull through performance as the 8d common smooth shank nail.

This change also adds a new standardized Roof Sheathing Ring Shank (RSRS) nail for roof sheathing applications. The RSRS nail has been standardized in ASTM F1667 and added in this proposal as equivalent to the 8d common nail to resist uplift of roof sheathing. This standard ring shank nail provides improved withdrawal resistance relative to the 8d common smooth shank nail. A head size of 0.281" diameter is specified for the RSRS-01 nail in ASTM F1667 which is equivalent to the head diameter of the 8d common nail. The slightly larger net area under the head (i.e. area of head minus area of shank) is considered to provide slightly improved head pull through performance.

Cost Impact: Will not increase the cost of construction

Although there are technical changes, existing alternatives for attachment remain unchanged and a new ring shank nail option is added; therefore, there is no cost increase.

S272-16 : TABLE 2304.10.1-COATS11400

Final Action: AS (Approved as Submitted)

S272-16

Committee Action: **Approved as Submitted**

Committee Reason: Agreement with the proponent's reason which indicates that this code change provides consistecy with the the roof sheating attachments in the IRC. The deformed nail and the roof sheathing ring shank nail provide option that have an equivalent capacity.

Assembly Action: **None**

S273-16

S7860

Date Submitted	12/11/2018	**Section**	2304.10.1	**Proponent**	Paul Coats
Chapter	23	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Editorial corrections to Table 2304.10.1 Fastener Schedule to remove redundancy and make nail designations consistent with the Residential code.

Rationale

This change was approved by the ICC membership and appears in the 2018 edition of the International Building Code.
Item (Row) 7: The correct length of the 10d common nail is 3" not 3-1/2". 10d common is correctly shown as 3" long elsewhere in the table. The equivalent number of 16d box nails to the common nail reference is 4. This change makes the specified nailing consistent with the Residential Code Table R602.3(1).

Item 17: Top or bottom plate to stud nailing is redundant with nailing in Item 16. Item 16 includes both toenail and end nail option. Item 16 end nail option is identical to the end nail option described in item 17.

Item 31: This change brings consistency with the the Residential code for minimum nail size for roof sheathing attachment which is an 8d common nail (2-1/2" x 0.131"). The 8d common is a smooth shank nail.

Item 32: The deformed nail option (2-1/2" x 0.131") is based on the assumption that the deformed nail has at least the same withdrawal capacity and head pull through performance of the equivalent diameter 8d common smooth shank nail.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code
No impact on enforcement, editorial corrections for fasteners.

Impact to building and property owners relative to cost of compliance with code
No cost-related impact.

Impact to industry relative to the cost of compliance with code
No cost-related impact.

Impact to small business relative to the cost of compliance with code
No cost-related impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public
Provides correct nail designations only--yes.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction
Improves the code with correct nail designations.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities
Does not discriminate.

Does not degrade the effectiveness of the code
Improves effectiveness.

Reviseasfollows(changes to rows 7, 17, 31, and 32 only, and highlighted):

TABLE2304.10.1
FASTENINGSCHEDULE

DESCRIPTION OFBUILDINGELEMENTS	NUMBERANDTYPEOFFASTENER	SPACINGANDLOCATION
Roof		
1.Blockingbetweenceilingjoists, raftersor trussestotopplateorotherframingbelow	3-8d common(21/2?×0.131?); or3-10d box (3?×0.128?); or3-3?×0.131? nails; or 3-3?14 gagestaples, 7/16?crown	Eachend,toenail
Blockingbetweenraftersortrussnot atthe walltopplate, torafterortruss	2-8d common(21/2?×0.131?) 2-3?× 0.131? nails 2-3?14gagestaples	Eachend,toenail
	2-16 dcommon(31/2?×0.162?) 3-3?× 0.131? nails 3-3?14gagestaples	End nail
Flat blockingtotrussandwebfiller	16d common(31/2?×0.162?) @6?o.c. 3?×0.131? nails @6?o.c. 3?×14gage staples @6?o.c	Facenail
	3-8d common(21/2?×0.131?); or3-10d box (3?×0.128?); or3-3?×0.131? nails; or 3-3?14gagestaples, 7/16?crown	

2.Ceilingjoists totopplate		Eachjoist, toenail
3.Ceilingjoist not attachedtoparallel rafter,laps overpartitions (nothrust) (seeSection2308.7.3.1,Table2308.7.3.1)	3-16d common(31/2?×0.162?); or 4-10d box (3?×0.128?); or 4-3?×0.131? nails; or 4-3?14gagestaples, 7/16?crown	Facenail
4.Ceilingjoist attachedtoparallelrafter		

(heeljoint)(seeSection2308.7.3.1,Table 2308.7.3.1)	PerTable2308.7.3.1	Facenail
5.Collartietorafter	3-10d common(3?×0.148?); or4-10d box (3?×0.128?); or4-3?×0.131? nails; or4-3? 14gagestaples, 7/16?crown	Facenail
6.Rafterorroof trusstotopplate(See Section2308.7.5,Table2308.7.5)	3-10 common(3?×0.148?); or3-16d box (31/2?×0.135?); or4-10d box (3?× 0.128?); or4-3?×0.131 nails; or4-3?14 gagestaples, 7/16?crown	Toenailc
	2-16d common(31/2?×0.162?); or3-10d box (3?×0.128?); or3-3?×0.131? nails; or 3-3?14gagestaples, 7/16?crown; or	End nail
7.Roof rafterstoridgevalley orhip rafters;orroof rafterto2-inchridgebeam	3-10d common(3 ~~1/2~~?×0.148?); or 4-16dbox (3 1/2?×0.135?); or4-10d box (3?× 0.128?); or4-3?×0.131? nails; or4-3?14 gagestaples, 7/ 1 6 ?crown	Toenail

DESCRIPTION OFBUILDINGELEMENTS	NUMBERANDTYPEOFFASTENER	SPACINGANDLOCATION
Wall		
	16d common(31/2?×0.162?);	24?o.c. facenail

8.Stud tostud(not atbracedwallpanels)	10d box (3?×0.128?); or3?×0.131? nails; or3-3?14gagestaples, 7/16?crown	16?o.c. facenail
9.Stud tostudandabuttingstudsat intersectingwallcorners(atbracedwall panels)	16d common(31/2?×0.162?); or	16?o.c. facenail
	16d box (31/2?×0.135?); or	12?o.c. facenail
	3?×0.131? nails; or3-3?14gagestaples,	12?o.c. facenail

	7/16?crown	
10. Built-upheader(2?to2?header)	16d common(31/2?×0.162?); or	16?o.c. eachedge,facenail
	16d box (31/2?×0.135?)	12?o.c. eachedge,facenail
11. Continuous headertostud	4-8d common(21/2?×0.131?); or4-10d box (3?×0.128?)	Toenail
12. Topplatetotopplate	16d common(31/2?×0.162?); or	16?o.c. facenail
	10d box (3?×0.128?); or3?×0.131? nails; or3?14gagestaples, 7/16?crown	12?o.c. facenail
13. Topplatetotopplate, atendjoints	8-16d common(31/2?×0.162?); or12-10d box (3?×0.128?); or12-3?×0.131? nails; or12-3?14gagestaples, 7/16? crown	Eachsideof endjoint, facenail (minimum 24"lapsplicelength eachsideof endjoint)
14. Bottom platetojoist, rim joist, band joist orblocking(not atbracedwallpanels)	16d common(31/2?×0.162?); or	16"o.c. facenail
	16d box (31/2?×0.135?); or3?×0.131? nails; or3?14gagestaples, 7/16?crown	12"o.c. facenail
15. Bottom platetojoist, rim joist, band joist orblockingatbracedwallpanels	2-16d common(31/2?×0.162?); or3-16d box (31/2?×0.135?); or4-3?×0.131? nails; or4-3?14gagestaples, 7/16? crown	16"o.c. facenail

	4-8d common(21/2?×0.131?); or4-10d box (3?×0.128?); or4-3?×0.131? nails; or 4-3?14gagestaples, 7/16?crown; or	Toenail
16. Stud totoporbottom plate	2-16d common(31/2?×0.162?); or3-10d box (3?×0.128?); or3-3?×0.131? nails; or	End nail

	3-3?14gagestaples, 7/16?crown	
~~17.Toporbottomplatetostud~~	~~2-16dcommon(31 /2 ?×0.162?);or3-10d box(3?×0.128?);or3-3?×0.131?nails;or 3-3?14gagestaples, 7 /16 ?crown~~	~~Endnail~~
18. Topplates, laps atcornersand intersections	2-16d common(31/2?×0.162?); or3-10d box (3?×0.128?); or3-3?×0.131? nails; or 3-3?14gagestaples, 7/16?crown	Facenail

DESCRIPTION OFBUILDINGELEMENTS	NUMBERANDTYPEOFFASTENER	SPACINGANDLOCATION
Wall		
19. 1?bracetoeachstudandplate	2-8d common(21/2?×0.131?); or2-10d box (3?×0.128?); or2-3?×0.131? nails; or 2-3?14gagestaples, 7/16?crown	Facenail
20. 1?×6?sheathingtoeachbearing	2-8d common(21/2?×0.131?); or2-10d box (3?×0.128?)	Facenail
21. 1?×8?andwidersheathingtoeach bearing	3-8d common(21/2?×0.131?); or3-10d box (3?×0.128?)	Facenail
Floor		
	3-8d common(21/2?×0.131?); orfloor3-10d box (3?×0.128?); or3-3?×0.131? nails; or3-3?14gagestaples, 7/16? crown	

22. Joist tosill, topplate, orgirder		Toenail
23. Rim joist, bandjoist, orblockingtotop plate, sillorotherframingbelow	8dcommon(21/2?×0.131?); or10d box (3?×0.128?); or3?×0.131? nails; or3?14 gagestaples, 7/16?crown	6"o.c., toenail

2-8d common(2

/2?×0.131?); or2-10d

24. 1?×6?subfloororless toeachjoist	1 box (3?×0.128?)	Facenail
25. 2?subfloortojoist orgirder	2-16d common(31/2?×0.162?)	Facenail
26. 2?planks (plank &beam–floor&roof)	2-16d common(31/2?×0.162?)	Eachbearing, facenail
27. Built-upgirders andbeams,2?lumber layers	20d common(4?×0.192?)	32"o.c., facenailattopand bottom staggeredonoppositesides
	10d box (3?×0.128?); or3?×0.131? nails; or3?14gagestaples, 7/16?crown	24"o.c. facenailattopandbottom staggeredonoppositesides
	And:2-20d common(4?×0.192?); or3-10d box (3?×0.128?); or3-3?×0.131? nails; or 3-3?14gagestaples, 7/16?crown	Endsandateachsplice, facenail
28. Ledgerstripsupportingjoists orrafters	3-16d common(31/2?×0.162?); or4-10d box (3?×0.128?); or4-3?×0.131? nails; or 4-3?14gagestaples, 7/16?crown	Eachjoist orrafter,facenail
29. Joist tobandjoist orrim joist	3-16d common(31/2?×0.162?); or4-10d box (3?×0.128?); or4-3?×0.131? nails; or 4-3?14gagestaples, 7/16?crown	End nail

30. Bridgingorblockingtojoist, rafteror truss	2-8d common(21/2?×0.131?); or2-10d box (3?×0.128?); or2-3?×0.131? nails; or 2-3?14gagestaples, 7/16?crown	Eachend,toenail

DESCRIPTION OFBUILDING ELEMENTS	NUMBERANDTYPEOF FASTENER	SPACINGANDLOCATION
Wood structural panels(WSP), subfloor, roof and interiorwall sheathing to framing and particleboard wall sheathing to framinga		

		Edges (inches)	Intermediate supports (inches)
31. 3/8?–1/2?	6dcommonordeformed(2?× 0.113?) (subfloorandwall)	6	12
	8d~~box~~ commonordeformed(2 1/2?×0.~~113~~ 0.131?) (roof)	6	12
	23/8?×0.113? nail(subfloorand wall)	6	12
	13/4? 16gagestaple, 7/16? crown (subfloorandwall)	4	8
	23/8?×0.113? nail(roof)	4	8
	13/4? 16gagestaple, 7/16? crown (roof)	3	6
32. 19/32?–3/4?	8dcommon(21/2?×0.131?)~~;~~ or 6ddeformed(2?×0.113?) (subfloor and wall)	6	12
	8dcommonor deformed (2 1/2"× 0.131")(roof)	6	12
	23/8?×0.113? nail; or2?16 gagestaple, 7/16?crown	4	8

33. 7/8?–11/4?	10d common(3?×0.148?); or8d deformed(21/2?×0.131?)	6	12
Otherexterior wall sheathing			
	11/2? galvanizedroofingnail(7		

34. 1/2?fiberboardsheathingb	/16? headdiameter);or11/4? 16 gagestaplewith7/16? or1? crown	3	6
35. 25/32?fiberboardsheathingb	13/4? galvanizedroofingnail(7 /16? diameterhead);or11/2? 16 gagestaplewith7/16? or1? crown	3	6
Wood structural panels, combinationsubfloor underlaymentto framing			
36. 3/4? andless	8dcommon(21/2?×0.131?); or 6ddeformed(2?×0.113?)	6	12
37. 7/8?–1?	8dcommon(21/2?×0.131?); or 8ddeformed(21/2?×0.131?)	6	12
38. 11/8?–11/4?	10d common(3?×0.148?); or8d deformed(21/2?×0.131?)	6	12
Panelsiding to framing			
39. 1/2? orless	6dcorrosion-resistant siding(17 /8?×0.106?); or6dcorrosion-resistant casing(2?×0.099?)	6	12
40. 5/8?	8dcorrosion-resistant siding(23 /8?×0.128?); or8dcorrosion-resistant casing(21/2?×0.113?)	6	12

DESCRIPTION OFBUILDINGELEMENTS	NUMBERANDTYPEOF FASTENER	SPACINGANDLOCATION	
Wood structural panels(WSP), subfloor, roof and interiorwall sheathing to framing and particleboard wall sheathing to framinga			

		Edges (inches)	Intermediatesupports (inches)
Interior paneling			
41. 1/4?	4dcasing(11/2?×0.080?); or4d finish(11/2?×0.072?)	6	12
42. 3/8?	6dcasing(2?×0.099?); or6dfinish (Panelsupportsat24inches)	6	12

ForSI:1inch=25.4 mm.

a. Nails spacedat6inches atintermediatesupportswherespansare48inches ormore.Fornailingof wood structuralpaneland particleboarddiaphragmsandshearwalls, refertoSection2305. Nails forwallsheathingarepermittedtobecommon, box orcasing.

b. Spacingshallbe6inches oncenterontheedgesand12inches oncenteratintermediatesupportsfornonstructural applications. Panelsupportsat16inches (20inches if strengthaxis inthelongdirectionof thepanel, unless otherwisemarked).

c. Wherearafteris fastenedtoanadjacent parallelceilingjoist inaccordancewiththis scheduleandtheceilingjoist is fastenedto thetopplateinaccordancewiththis schedule, thenumberof toenails intheraftershallbepermittedtobereduced by onenail.

Revise as follows:

TABLE 2304.10.1
FASTENING SCHEDULE

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER	SPACING AND LOCATION
Roof		
1. Blocking between ceiling joists, rafters or trusses to top plate or other framing below	3-8d common ($2^1/_2$ " × 0.131"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails; or 3-3"14 gage staples, $^7/_{16}$ " crown	Each end, toenail
Blocking between rafters or truss not at the wall top plate, to rafter or truss	2-8d common (21 $/_2$ " × 0.131") 2-3" × 0.131" nails 2-3" 14 gage staples	Each end, toenail
	2-16 d common (31 $/_2$ " × 0.162") 3-3" × 0.131" nails 3-3" 14 gage staples	End nail
Flat blocking to truss and web filler	16d common ($3^1/_2$ " × 0.162") @ 6" o.c. 3" × 0.131" nails @ 6" o.c. 3" × 14 gage staples @ 6" o.c	Face nail
2. Ceiling joists to top plate	3-8d common ($2^1/_2$ " × 0.131"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails; or 3-3" 14 gage staples, $^7/_{16}$ " crown	Each joist, toenail
3. Ceiling joist not attached to parallel rafter, laps over partitions (no thrust) (see Section 2308.7.3.1, Table 2308.7.3.1)	3-16d common ($3^1/_2$ " × 0.162"); or 4-10d box (3" × 0.128"); or 4-3" × 0.131" nails; or 4-3" 14 gage staples, $^7/_{16}$ " crown	Face nail
4. Ceiling joist attached to parallel rafter		

(heel joint) (see Section 2308.7.3.1, Table 2308.7.3.1)	Per Table 2308.7.3.1	Face nail
5. Collar tie to rafter	3-10d common (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails; or 4-3″ 14 gage staples, 7/16″ crown	Face nail
6. Rafter or roof truss to top plate (See Section 2308.7.5, Table 2308.7.5)	3-10 common (3″ × 0.148″); or 3-16d box (3 1/2″ × 0.135″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131 nails; or 4-3″ 14 gage staples, 7/16″ crown	Toenail[c]
7. Roof rafters to ridge valley or hip rafters; or roof rafter to 2-inch ridge beam	2-16d common (3 1/2″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, 7/16″ crown; or	End nail
	3-10d common (3~~1/2~~″ × 0.148″); or 4-16d box (3 1/2″ × 0.135″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails; or 4-3″ 14 gage staples, 7/16″ crown	Toenail

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER	SPACING AND LOCATION
Wall		
8. Stud to stud (not at braced wall panels)	16d common (3 1/2″ × 0.162″);	24″ o.c. face nail
	10d box (3″ × 0.128″); or 3″ × 0.131″ nails; or 3-3″ 14 gage staples, 7/16″ crown	16″ o.c. face nail
9. Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d common (3 1/2″ × 0.162″); or	16″ o.c. face nail
	16d box (3 1/2″ × 0.135″); or	12″ o.c. face nail
	3″ × 0.131″ nails; or 3-3″ 14 gage staples,	12″ o.c. face nail

	7/16″ crown	
10. Built-up header (2″ to 2″ header)	16d common (3 1/2″ × 0.162″); or	16″ o.c. each edge, face nail
	16d box (3 1/2″ × 0.135″)	12″ o.c. each edge, face nail
11. Continuous header to stud	4-8d common (2 1/2″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toenail
12. Top plate to top plate	16d common (3 1/2″ × 0.162″); or	16″ o.c. face nail
	10d box (3″ × 0.128″); or 3″ × 0.131″ nails; or 3″ 14 gage staples, 7/16″ crown	12″ o.c. face nail
13. Top plate to top plate, at end joints	8-16d common (3 1/2″ × 0.162″); or 12-10d box (3″ × 0.128″); or 12-3″ × 0.131″ nails; or 12-3″ 14 gage staples, 7/16″ crown	Each side of end joint, face nail (minimum 24″ lap splice length each side of end joint)
14. Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common (3 1/2″ × 0.162″); or	16″ o.c. face nail
	16d box (3 1/2″ × 0.135″); or 3″ × 0.131″ nails; or 3″ 14 gage staples, 7/16″ crown	12″ o.c. face nail
15. Bottom plate to joist, rim joist, band joist or blocking at braced wall panels	2-16d common (3 1/2″ × 0.162″); or 3-16d box (3 1/2″ × 0.135″); or 4-3″ × 0.131″ nails; or 4-3″ 14 gage staples, 7/16″ crown	16″ o.c. face nail
16. Stud to top or bottom plate	4-8d common (2 1/2″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails; or 4-3″ 14 gage staples, 7/16″ crown; or	Toenail
	2-16d common (3 1/2″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or	End nail

	3-3″ 14 gage staples, $^{7}/_{16}$″ crown	
~~17. Top or bottom plate to stud~~	~~2-16d common (3$^{1}/_{2}$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^{7}/_{16}$″ crown~~	~~End nail~~
18. Top plates, laps at corners and intersections	2-16d common (3$^{1}/_{2}$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^{7}/_{16}$″ crown	Face nail

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER	SPACING AND LOCATION
Wall		
19. 1″ brace to each stud and plate	2-8d common (2$^{1}/_{2}$″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2-3″ × 0.131″ nails; or 2-3″ 14 gage staples, $^{7}/_{16}$″ crown	Face nail
20. 1″ × 6″ sheathing to each bearing	2-8d common (2$^{1}/_{2}$″ × 0.131″); or 2-10d box (3″ × 0.128″)	Face nail
21. 1″ × 8″ and wider sheathing to each bearing	3-8d common (2$^{1}/_{2}$″ × 0.131″); or 3-10d box (3″ × 0.128″)	Face nail
Floor		
22. Joist to sill, top plate, or girder	3-8d common (2$^{1}/_{2}$″ × 0.131″); or floor 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^{7}/_{16}$″ crown	Toenail
23. Rim joist, band joist, or blocking to top plate, sill or other framing below	8d common (2$^{1}/_{2}$″ × 0.131″); or 10d box (3″ × 0.128″); or 3″ × 0.131″ nails; or 3″ 14 gage staples, $^{7}/_{16}$″ crown	6″ o.c., toenail

24. 1″ × 6″ subfloor or less to each joist	2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″)	Face nail
25. 2″ subfloor to joist or girder	2-16d common ($3^1/_2$ ″ × 0.162″)	Face nail
26. 2″ planks (plank & beam – floor & roof)	2-16d common ($3^1/_2$ ″ × 0.162″)	Each bearing, face nail
27. Built-up girders and beams, 2″ lumber layers	20d common (4″ × 0.192″)	32″ o.c., face nail at top and bottom staggered on opposite sides
	10d box (3″ × 0.128″); or 3″ × 0.131″ nails; or 3″ 14 gage staples, $^7/_{16}$ ″ crown	24″ o.c. face nail at top and bottom staggered on opposite sides
	And: 2-20d common (4″ × 0.192″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^7/_{16}$ ″ crown	Ends and at each splice, face nail
28. Ledger strip supporting joists or rafters	3-16d common ($3^1/_2$ ″ × 0.162″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails; or 4-3″ 14 gage staples, $^7/_{16}$ ″ crown	Each joist or rafter, face nail
29. Joist to band joist or rim joist	3-16d common ($3^1/_2$ ″ × 0.162″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails; or 4-3″ 14 gage staples, $^7/_{16}$ ″ crown	End nail
30. Bridging or blocking to joist, rafter or truss	2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2-3″ × 0.131″ nails; or 2-3″ 14 gage staples, $^7/_{16}$ ″ crown	Each end, toenail

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER	SPACING AND LOCATION
Wood structural panels (WSP), subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framinga		

		Edges (inches)	Intermediate supports (inches)
31. $^3/_8$ " – $^1/_2$ "	6d common or deformed (2" × 0.113") (subfloor and wall)	6	12
	8d ~~box~~common or deformed (2$^1/_2$ " × 0.~~113~~ 0.131") (roof)	6	12
	2$^3/_8$ " × 0.113" nail (subfloor and wall)	6	12
	1$^3/_4$ " 16 gage staple, $^7/_{16}$ " crown (subfloor and wall)	4	8
	2$^3/_8$ " × 0.113" nail (roof)	4	8
	1$^3/_4$ " 16 gage staple, $^7/_{16}$ " crown (roof)	3	6
32. $^{19}/_{32}$ " – $^3/_4$ "	8d common (2$^1/_2$ " × 0.131")~~;~~ or 6d deformed (2" × 0.113") (subfloor and wall)	6	12
	8d common or deformed (2 1/2" × 0.131") (roof)	6	12
	2$^3/_8$ " × 0.113" nail; or 2" 16 gage staple, $^7/_{16}$ " crown	4	8
33. $^7/_8$ " – 1$^1/_4$ "	10d common (3" × 0.148"); or 8d deformed (2$^1/_2$ " × 0.131")	6	12
Other exterior wall sheathing			
	1$^1/_2$ " galvanized roofing nail (^{7}		

34. 1 /2 ″ fiberboard sheathing[b]	/16 ″ head diameter); or 1 1 /4 ″ 16 gage staple with 7 /16 ″ or 1″ crown	3	6
35. 25 /32 ″ fiberboard sheathing[b]	1 3 /4 ″ galvanized roofing nail (7 /16 ″ diameter head); or 1 1 /2 ″ 16 gage staple with 7 /16 ″ or 1″ crown	3	6
Wood structural panels, combination subfloor underlayment to framing			
36. 3 /4 ″ and less	8d common (2 1 /2 ″ × 0.131″); or 6d deformed (2″ × 0.113″)	6	12
37. 7 /8 ″ – 1″	8d common (2 1 /2 ″ × 0.131″); or 8d deformed (2 1 /2 ″ × 0.131″)	6	12
38. 1 1 /8 ″ – 1 1 /4 ″	10d common (3″ × 0.148″); or 8d deformed (2 1 /2 ″ × 0.131″)	6	12
Panel siding to framing			
39. 1 /2 ″ or less	6d corrosion-resistant siding (1 7 /8 ″ × 0.106″); or 6d corrosion-resistant casing (2″ × 0.099″)	6	12
40. 5 /8 ″	8d corrosion-resistant siding (2 3 /8 ″ × 0.128″); or 8d corrosion-resistant casing (2 1 /2 ″ × 0.113″)	6	12

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER	SPACING AND LOCATION
Wood structural panels (WSP), subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framinga		

		Edges (inches)	Intermediate supports (inches)
Interior paneling			
41. $^{1}/_{4}$ "	4d casing ($1^{1}/_{2}$ " × 0.080"); or 4d finish ($1^{1}/_{2}$ " × 0.072")	6	12
42. $^{3}/_{8}$ "	6d casing (2" × 0.099"); or 6d finish (Panel supports at 24 inches)	6	12

For SI: 1 inch = 25.4 mm.

a. Nails spaced at 6 inches at intermediate supports where spans are 48 inches or more. For nailing of wood structural panel and particleboard diaphragms and shear walls, refer to Section 2305. Nails for wall sheathing are permitted to be common, box or casing.

b. Spacing shall be 6 inches on center on the edges and 12 inches on center at intermediate supports for nonstructural applications. Panel supports at 16 inches (20 inches if strength axis in the long direction of the panel, unless otherwise marked).

c. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule and the ceiling joist is fastened to the top plate in accordance with this schedule, the number of toenails in the rafter shall be permitted to be reduced by one nail.

Final Action: AS (Approved as Submitted)

S273-16

IBC: 2304.10.1.

Proponent : Matthew Hunter, representing American Wood Council (mhunter@awc.org)

2015 International Building Code

Revise as follows:

TABLE 2304.10.1
FASTENING SCHEDULE

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER	SPACING AND LOCATION
	Roof	
1. Blocking between ceiling joists, rafters or trusses to top plate or other framing below	3-8d common (2$^1/_2$ " × 0.131"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails; or 3-3"14 gage staples, $^7/_{16}$ " crown	Each end, toenail
Blocking between rafters or truss not at the wall top plate, to rafter or truss	2-8d common (21 /$_2$ " × 0.131") 2-3" × 0.131" nails 2-3" 14 gage staples	Each end, toenail
	2-16 d common (31 /$_2$ " × 0.162") 3-3" × 0.131" nails 3-3" 14 gage staples	End nail
Flat blocking to truss and web filler	16d common (3$^1/_2$ " × 0.162") @ 6" o.c. 3" × 0.131" nails @ 6" o.c. 3" × 14 gage staples @ 6" o.c	Face nail
2. Ceiling joists to top plate	3-8d common (2$^1/_2$ " × 0.131"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails; or 3-3" 14 gage staples, $^7/_{16}$ " crown	Each joist, toenail
3. Ceiling joist not attached to parallel rafter, laps over partitions (no thrust) (see Section 2308.7.3.1, Table 2308.7.3.1)	3-16d common (3$^1/_2$ " × 0.162"); or 4-10d box (3" × 0.128"); or 4-3" × 0.131" nails; or 4-3" 14 gage staples, $^7/_{16}$ " crown	Face nail
4. Ceiling joist attached to parallel rafter		

(heel joint) (see Section 2308.7.3.1, Table 2308.7.3.1)	Per Table 2308.7.3.1	Face nail
5. Collar tie to rafter	3-10d common (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails; or 4-3″ 14 gage staples, $^7/_{16}$ ″ crown	Face nail
6. Rafter or roof truss to top plate (See Section 2308.7.5, Table 2308.7.5)	3-10 common (3″ × 0.148″); or 3-16d box (3$^1/_2$ ″ × 0.135″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131 nails; or 4-3″ 14 gage staples, $^7/_{16}$ ″ crown	Toenail[c]
7. Roof rafters to ridge valley or hip rafters; or roof rafter to 2-inch ridge beam	2-16d common (31 /$_2$ ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, 7 /$_{16}$ ″ crown; or	End nail
	3-10d common (3~~1 /2~~ ″ × 0.148″); or <u>4</u>-16d box (31 /$_2$ ″ × 0.135″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails; or 4-3″ 14 gage staples, 7 /$_{16}$ ″ crown	Toenail

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER	SPACING AND LOCATION
Wall		
8. Stud to stud (not at braced wall panels)	16d common (3$^1/_2$ ″ × 0.162″);	24″ o.c. face nail
	10d box (3″ × 0.128″); or 3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^7/_{16}$ ″ crown	16″ o.c. face nail
9. Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d common (3$^1/_2$ ″ × 0.162″); or	16″ o.c. face nail
	16d box (3$^1/_2$ ″ × 0.135″); or	12″ o.c. face nail
	3″ × 0.131″ nails; or 3-3″ 14 gage staples,	12″ o.c. face nail

	7/16" crown	
10. Built-up header (2" to 2" header)	16d common (3 1/2" × 0.162"); or	16" o.c. each edge, face nail
	16d box (3 1/2" × 0.135")	12" o.c. each edge, face nail
11. Continuous header to stud	4-8d common (2 1/2" × 0.131"); or 4-10d box (3" × 0.128")	Toenail
12. Top plate to top plate	16d common (3 1/2" × 0.162"); or	16" o.c. face nail
	10d box (3" × 0.128"); or 3" × 0.131" nails; or 3" 14 gage staples, 7/16" crown	12" o.c. face nail
13. Top plate to top plate, at end joints	8-16d common (3 1/2" × 0.162"); or 12-10d box (3" × 0.128"); or 12-3" × 0.131" nails; or 12-3" 14 gage staples, 7/16" crown	Each side of end joint, face nail (minimum 24" lap splice length each side of end joint)
14. Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common (3 1/2" × 0.162"); or	16" o.c. face nail
	16d box (3 1/2" × 0.135"); or 3" × 0.131" nails; or 3" 14 gage staples, 7/16" crown	12" o.c. face nail
15. Bottom plate to joist, rim joist, band joist or blocking at braced wall panels	2-16d common (3 1/2" × 0.162"); or 3-16d box (3 1/2" × 0.135"); or 4-3" × 0.131" nails; or 4-3" 14 gage staples, 7/16" crown	16" o.c. face nail
16. Stud to top or bottom plate	4-8d common (2 1/2" × 0.131"); or 4-10d box (3" × 0.128"); or 4-3" × 0.131" nails; or 4-3" 14 gage staples, 7/16" crown; or	Toenail
	2-16d common (3 1/2" × 0.162"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails; or	End nail

	3-3″ 14 gage staples, $^7/_{16}$ ″ crown	
~~17. Top or bottom plate to stud~~	~~2-16d common ($3^1/_2$ ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^7/_{16}$ ″ crown~~	~~End nail~~
18. Top plates, laps at corners and intersections	2-16d common ($3^1/_2$ ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^7/_{16}$ ″ crown	Face nail

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER	SPACING AND LOCATION
Wall		
19. 1″ brace to each stud and plate	2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2-3″ × 0.131″ nails; or 2-3″ 14 gage staples, $^7/_{16}$ ″ crown	Face nail
20. 1″ × 6″ sheathing to each bearing	2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″)	Face nail
21. 1″ × 8″ and wider sheathing to each bearing	3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″)	Face nail
Floor		
22. Joist to sill, top plate, or girder	3-8d common ($2^1/_2$ ″ × 0.131″); or floor 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^7/_{16}$ ″ crown	Toenail
23. Rim joist, band joist, or blocking to top plate, sill or other framing below	8d common ($2^1/_2$ ″ × 0.131″); or 10d box (3″ × 0.128″); or 3″ × 0.131″ nails; or 3″ 14 gage staples, $^7/_{16}$ ″ crown	6″ o.c., toenail

24. 1″ × 6″ subfloor or less to each joist	2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″)	Face nail
25. 2″ subfloor to joist or girder	2-16d common ($3^1/_2$ ″ × 0.162″)	Face nail
26. 2″ planks (plank & beam – floor & roof)	2-16d common ($3^1/_2$ ″ × 0.162″)	Each bearing, face nail
27. Built-up girders and beams, 2″ lumber layers	20d common (4″ × 0.192″)	32″ o.c., face nail at top and bottom staggered on opposite sides
	10d box (3″ × 0.128″); or 3″ × 0.131″ nails; or 3″ 14 gage staples, $^7/_{16}$ ″ crown	24″ o.c. face nail at top and bottom staggered on opposite sides
	And: 2-20d common (4″ × 0.192″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails; or 3-3″ 14 gage staples, $^7/_{16}$ ″ crown	Ends and at each splice, face nail
28. Ledger strip supporting joists or rafters	3-16d common ($3^1/_2$ ″ × 0.162″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails; or 4-3″ 14 gage staples, $^7/_{16}$ ″ crown	Each joist or rafter, face nail
29. Joist to band joist or rim joist	3-16d common ($3^1/_2$ ″ × 0.162″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails; or 4-3″ 14 gage staples, $^7/_{16}$ ″ crown	End nail
30. Bridging or blocking to joist, rafter or truss	2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2-3″ × 0.131″ nails; or 2-3″ 14 gage staples, $^7/_{16}$ ″ crown	Each end, toenail

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER	SPACING AND LOCATION
Wood structural panels (WSP), subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framinga		

		Edges (inches)	Intermediate supports (inches)
31. 3/8″ – 1/2″	6d common or deformed (2″ × 0.113″) (subfloor and wall)	6	12
	8d ~~box~~common or deformed (2 1/2″ × 0.~~113~~ 0.131″) (roof)	6	12
	2 3/8″ × 0.113″ nail (subfloor and wall)	6	12
	1 3/4″ 16 gage staple, 7/16″ crown (subfloor and wall)	4	8
	2 3/8″ × 0.113″ nail (roof)	4	8
	1 3/4″ 16 gage staple, 7/16″ crown (roof)	3	6
32. 19/32″ – 3/4″	8d common (2 1/2″ × 0.131″)~~;~~ or 6d deformed (2″ × 0.113″) (subfloor and wall)	6	12
	8d common or deformed (2 1/2″ × 0.131″) (roof)	6	12
	2 3/8″ × 0.113″ nail; or 2″ 16 gage staple, 7/16″ crown	4	8
33. 7/8″ – 1 1/4″	10d common (3″ × 0.148″); or 8d deformed (2 1/2″ × 0.131″)	6	12
Other exterior wall sheathing			
	1 1/2″ galvanized roofing nail (7		

34. 1/2" fiberboard sheathing[b]	/16" head diameter); or 1 1/4" 16 gage staple with 7/16" or 1" crown	3	6
35. 25/32" fiberboard sheathing[b]	1 3/4" galvanized roofing nail (7/16" diameter head); or 1 1/2" 16 gage staple with 7/16" or 1" crown	3	6
Wood structural panels, combination subfloor underlayment to framing			
36. 3/4" and less	8d common (2 1/2" × 0.131"); or 6d deformed (2" × 0.113")	6	12
37. 7/8" – 1"	8d common (2 1/2" × 0.131"); or 8d deformed (2 1/2" × 0.131")	6	12
38. 1 1/8" – 1 1/4"	10d common (3" × 0.148"); or 8d deformed (2 1/2" × 0.131")	6	12
Panel siding to framing			
39. 1/2" or less	6d corrosion-resistant siding (1 7/8" × 0.106"); or 6d corrosion-resistant casing (2" × 0.099")	6	12
40. 5/8"	8d corrosion-resistant siding (2 3/8" × 0.128"); or 8d corrosion-resistant casing (2 1/2" × 0.113")	6	12

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER	SPACING AND LOCATION
Wood structural panels (WSP), subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framinga		

		Edges (inches)	Intermediate supports (inches)
Interior paneling			
41. $^{1}/_{4}$ "	4d casing ($1^{1}/_{2}$ " × 0.080"); or 4d finish ($1^{1}/_{2}$ " × 0.072")	6	12
42. $^{3}/_{8}$ "	6d casing (2" × 0.099"); or 6d finish (Panel supports at 24 inches)	6	12

For SI: 1 inch = 25.4 mm.

a. Nails spaced at 6 inches at intermediate supports where spans are 48 inches or more. For nailing of wood structural panel and particleboard diaphragms and shear walls, refer to Section 2305. Nails for wall sheathing are permitted to be common, box or casing.

b. Spacing shall be 6 inches on center on the edges and 12 inches on center at intermediate supports for nonstructural applications. Panel supports at 16 inches (20 inches if strength axis in the long direction of the panel, unless otherwise marked).

c. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule and the ceiling joist is fastened to the top plate in accordance with this schedule, the number of toenails in the rafter shall be permitted to be reduced by one nail.

Reason: Item 7. The correct length of the 10d common nail is 3" not 3-1/2". 10d common is correctly shown as 3" long elsewhere in the table. The equivalent number of 16d box nails to the common nail reference is 4. This change makes the specified nailing consistent with IRC Table R602.3(1).
Item 17. Top or bottom plate to stud nailing is redundant with nailing in Item 16. Item 16 includes both toenail and end nail option. Item 16 end nail option is identical to the end nail option described in item 17.

Item 31. This change brings consistency with the IRC for minimum nail size for roof sheathing attachment which is an 8d common nail (2-1/2" x 0.131"). The 8d common is a smooth shank nail.

Item 32. The deformed nail option (2-1/2" x 0.131") is based on the assumption that the deformed nail has at least the same withdrawal capacity and head pull through performance of the equivalent diameter 8d common smooth shank nail.

Cost Impact: Will not increase the cost of construction
Nail sizes are editorially fixed, redundancy removed, and with size consistent with recognized sizes in IRC, therefore increased costs are not anticipated.

S273-16 : TABLE 2304.10.1-HUNTER11289

Final Action: AS (Approved as Submitted)

S7874

Date Submitted	12/11/2018	**Section**	2304.11	**Proponent**	Paul Coats
Chapter	23	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

Summary of Modification

An editorial addition that adds a helpful reference to the section on lumber decking in the section on heavy timber, necessary since lumber decking can be heavy timber.

Rationale

This modification was approved by the ICC membership and appears in the 2018 edition of the International Building Code. Section 2304.11 is becoming the focus of requirements for heavy timber construction. Heavy timber and "mass timber" construction will become more prevalent with the increased use of new products such as cross-laminated timber. Traditional lumber decking utilizing nail-laminated dimension lumber, or nail-laminated timber (NLT) is being used increasingly in heavy timber construction, but the requirements for NLT are not found in the heavy timber section, but in 2304.9. This editorial pointer will be helpful to the code user who is trying to find the requirements for NLT. It makes no technical changes to the code. If Section 2304.11 is modified further by other modifications, it is the intent that this proposed sentence appear at the end of the section regardless of new content.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will help code officials find the requirements for lumber decking and nail laminated timber more easily; editorial.

Impact to building and property owners relative to cost of compliance with code

No cost-related impact.

Impact to industry relative to the cost of compliance with code

No cost-related impact.

Impact to small business relative to the cost of compliance with code

No cost-related impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Editorial correction to improve application of the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code with editorial direction.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code, but improves it.

2304.11Heavy timber construction.

Where a structure or portion thereof is required to be of Type IV construction by other provisions of this code, the building elements therein shall comply with the applicable provisions of Sections 2304.11.1 through 2304.11.5. Lumber decking shall also be in accordance with Section 2304.9.

S276-16

IBC: 2304.11.

Proponent : Dennis Richardson, American Wood Council, representing American Wood Council (drichardson@awc.org)

2015 International Building Code

Revise as follows:

2304.11 Heavy timber construction. Where a structure or portion thereof is required to be of Type IV construction by other provisions of this code, the building elements therein shall comply with the applicable provisions of Sections 2304.11.1 through 2304.11.5. Lumber decking shall also be in accordance with Section 2304.9.

Reason: The intent of this change is to help the user be aware of Section 2304.9 applicable to heavy timber for the detailing and fastening of lumber decking. this section was revised in G 179 of the Group A cycle. There is no intent to modify changes already made to this section in G 179. The intent of this section is to add the words "Lumber decking shall also be in accordance with Section 2304.9." at the end of the final language approved in to 2304.11 in G 179 as a pointer to Section 2304.9.

Cost Impact: Will not increase the cost of construction
This code change correlates existing section to assist users of the code.

S276-16 : 2304.11-
RICHARDSON13296

Final Action: AS (Approved as Submitted)

S7877

Date Submitted	12/11/2018	**Section**	2304.9.3.2	**Proponent**	Paul Coats
Chapter	23	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Provides an alternative fastener schedule for construction of mechanically laminated decking.

Rationale

This modification was approved by the ICC membership and appears in the 2018 International Building Code. This proposal adds alternative fastener schedules for construction of mechanically laminated decking, providing specific guidance for use of mechanically-driven nails which are typically used in construction. The alternative fastening schedules are based on equivalency to the reference 20d common nail currently required in 2304.9.3.2 for laminations with a 2-inch nominal thickness, and provide equivalent lateral strength, shear stiffness and withdrawal capacity, as calculated in accordance with the AWC NDS.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Provides alternatives which make make it easier to enforce the code.

Impact to building and property owners relative to cost of compliance with code

No cost implication, it is an additional alternative and could save costs.

Impact to industry relative to the cost of compliance with code

This additional alternative could save costs.

Impact to small business relative to the cost of compliance with code

This additional alternative could save costs.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, as an alternative for structural design.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by providing another alternative.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code but improves it.

2304.9.3.2 Nailing.

The length of nails connecting laminations shall be not less than two and one-half times the net thickness of each lamination. Where decking supports are 48 inches (1219 mm) on center or less, side nails shall be installed not more than 30 inches (762 mm) on center alternating between top and bottom edges, and staggered one-third of the spacing in adjacent laminations. Where supports are spaced more than 48 inches (1219 mm) on center, side nails shall be installed not more than 18 inches (457 mm) on center alternating between top and bottom edges and staggered one-third of the spacing in adjacent laminations. For mechanicallylaminated decking constructed with laminationsof 2-inch (51mm) nominal thickness,nailing inaccordance with Table 2304.9.3.2 shall be permitted.

Two side nails shall be installed at each end of butt-jointed pieces.

Laminations shall be toenailed to supports with 20d or larger common nails. Where the supports are 48 inches (1219 mm) on center or less, alternate laminations shall be toenailed to alternate supports; where supports are spaced more than 48 inches (1219 mm) on center, alternate laminations shall be toenailed to every support. For mechanically laminated decking constructed with laminations of 2-inch (51 mm) nominal thickness, toenailing at supports in accordance with Table 2304.9.3.2 shall be permitted.

TABLE 2304.9.3.2 FASTENING SCHEDULE FOR MECHANICALLY LAMINATED DECKING USING LAMINATIONS OF 2-INCH NOMINAL THICKNESS

MINIMUMNAILSIZE (LengthxDiameter)	MAXIMUMSPACINGBETWEEN a,b		NUMBEROFTOENAILS INTO SUPPORTSc
	DeckingSupports =48incheso.c.	DeckingSupports >48incheso.c.	
4"x 0.192"	30	18	1
4"x 0.162"	24	14	2
4"x 0.148"	22	13	2
31/2"x 0.162"	20	12	2
31/2"x 0.148"	19	11	2

31/2"x 0.135"	17	10	2
3"x 0.148"	11	7	2
3"x 0.128"	9	5	2
23/4"x 0.148"	10	6	2
23/4"x 0.131"	9	6	3
23/4"x 0.120"	8	5	3

For SI:1inch = 25.4mm

a.Nailsshall bedriven perpendicular to thelamination face,alternating between top andbottomedges.

b.Wherenails penetratethrough two laminations andinto thethird, they shall bestaggered one-third ofthespacing in adjacent laminations. Otherwise,nailsshall bestaggered one-half of thespacing in adjacentlaminations.

c.Wheresupports are48 inches (1219mm) on center or less, alternate laminations shall be toenailedtoalternate supports; wheresupports arespaced morethan48 inches (1219mm) on center, alternatelaminat ions shall be toenailed to everysupport.

S281-16

IBC: 2304.9.3.2, 2304.9.3.2 (New).

Proponent : David Tyree, representing American Wood Council (dtyree@awc.org)

2015 International Building Code

Revise as follows:

2304.9.3.2 Nailing. The length of nails connecting laminations shall be not less than two and one-half times the net thickness of each lamination. Where decking supports are 48 inches (1219 mm) on center or less, side nails shall be installed not more than 30 inches (762 mm) on center alternating between top and bottom edges, and staggered one-third of the spacing in adjacent laminations. Where supports are spaced more than 48 inches (1219 mm) on center, side nails shall be installed not more than 18 inches (457 mm) on center alternating between top and bottom edges and staggered one-third of the spacing in adjacent laminations. For mechanically laminated decking constructed with laminations of 2-inch (51 mm) nominal thickness, nailing in accordance with Table 2304.9.3.2 shall be permitted. Two side nails shall be installed at each end of butt-jointed pieces.

Laminations shall be toenailed to supports with 20d or larger common nails. Where the supports are 48 inches (1219 mm) on center or less, alternate laminations shall be toenailed to alternate supports; where supports are spaced more than 48 inches (1219 mm) on center, alternate laminations shall be toenailed to every support. For mechanically laminated decking constructed with laminations of 2-inch (51 mm) nominal thickness, toenailing at supports in accordance with Table 2304.9.3.2 shall be permitted.

Add new text as follows:

TABLE 2304.9.3.2
FASTENING SCHEDULE FOR MECHANICALLY LAMINATED DECKING USING LAMINATIONS OF 2-INCH NOMINAL THICKNESS

MINIMUM NAIL SIZE (Length x Diameter)	MAXIMUM SPACING BETWEEN FACE NAILS [a,b] (inches)		NUMBER OF TOENAILS INTO SUPPORTS [c]
	Decking Supports ≤ 48 inches o.c.	Decking Supports > 48 inches o.c.	
4" x 0.192"	30	18	1
4" x 0.162"	24	14	2
4" x 0.148"	22	13	2
$3\frac{1}{2}$" x 0.162"	20	12	2

3 1/2" x 0.148"	19	11	2
3 1/2" x 0.135"	17	10	2
3" x 0.148"	11	7	2
3" x 0.128"	9	5	2
2 3/4" x 0.148"	10	6	2
2 3/4" x 0.131"	9	6	3
2 3/4" x 0.120"	8	5	3

For SI: 1 inch = 25.4 mm

a. Nails shall be driven perpendicular to the lamination face, alternating between top and bottom edges.

b. Where nails penetrate through two laminations and into the third, they shall be staggered one-third of the spacing in adjacent laminations. Otherwise, nails shall be staggered one-half of the spacing in adjacent laminations.

c. Where supports are 48 inches (1219 mm) on center or less, alternate laminations shall be toenailed to alternate supports; where supports are spaced more than 48 inches (1219 mm) on center, alternate laminations shall be toenailed to every support.

Reason: This proposal adds alternative fastener schedules for construction of mechanically laminated decking, providing specific guidance for use of mechanically-driven nails which are typically used in construction. The alternative fastening schedules are based on equivalency to the reference 20d common nail currently required in 2304.9.3.2 for laminations with a 2-inch nominal thickness, and provide equivalent lateral strength, shear stiffness and withdrawal capacity, as calculated in accordance with the AWC NDS.

Cost Impact: Will not increase the cost of construction
This change does not add additional requirements. It provides equivalent alternative options for construction of mechanically laminated decking.

S281-16 : 2304.9.3.2-TYREE12558

Final Action: AS (Approved as Submitted)

S281-16

Committee Action: **Approved as Submitted**

Committee Reason: This code change clarifies circumstances surrounding power-driven fasteners when used in lieu of the code-specified nailing and provides an additional option for laminated decking.

Assembly Action: **None**

S281-16

IBC: 2304.9.3.2, 2304.9.3.2 (New).

Proponent : David Tyree, representing American Wood Council (dtyree@awc.org)

2015 International Building Code

Revise as follows:

2304.9.3.2 Nailing. The length of nails connecting laminations shall be not less than two and one-half times the net thickness of each lamination. Where decking supports are 48 inches (1219 mm) on center or less, side nails shall be installed not more than 30 inches (762 mm) on center alternating between top and bottom edges, and staggered one-third of the spacing in adjacent laminations. Where supports are spaced more than 48 inches (1219 mm) on center, side nails shall be installed not more than 18 inches (457 mm) on center alternating between top and bottom edges and staggered one-third of the spacing in adjacent laminations. For mechanically laminated decking constructed with laminations of 2-inch (51 mm) nominal thickness, nailing in accordance with Table 2304.9.3.2 shall be permitted. Two side nails shall be installed at each end of butt-jointed pieces.

Laminations shall be toenailed to supports with 20d or larger common nails. Where the supports are 48 inches (1219 mm) on center or less, alternate laminations shall be toenailed to alternate supports; where supports are spaced more than 48 inches (1219 mm) on center, alternate laminations shall be toenailed to every support. For mechanically laminated decking constructed with laminations of 2-inch (51 mm) nominal thickness, toenailing at supports in accordance with Table 2304.9.3.2 shall be permitted.

Add new text as follows:

TABLE 2304.9.3.2
FASTENING SCHEDULE FOR MECHANICALLY LAMINATED DECKING USING LAMINATIONS OF 2-INCH NOMINAL THICKNESS

MINIMUM NAIL SIZE (Length x Diameter)	MAXIMUM SPACING BETWEEN FACE NAILS [a,b] (inches)		NUMBER OF TOENAILS INTO SUPPORTS [c]
	Decking Supports ≤ 48 inches o.c.	Decking Supports > 48 inches o.c.	
4" x 0.192"	30	18	1
4" x 0.162"	24	14	2
4" x 0.148"	22	13	2
3 1/2" x 0.162"	20	12	2

3-1/2" x 0.148"	19	11	2
3-1/2" x 0.135"	17	10	2
3" x 0.148"	11	7	2
3" x 0.128"	9	5	2
2-3/4" x 0.148"	10	6	2
2-3/4" x 0.131"	9	6	3
2-3/4" x 0.120"	8	5	3

For SI: 1 inch = 25.4 mm

a. Nails shall be driven perpendicular to the lamination face, alternating between top and bottom edges.

b. Where nails penetrate through two laminations and into the third, they shall be staggered one-third of the spacing in adjacent laminations. Otherwise, nails shall be staggered one-half of the spacing in adjacent laminations.

c. Where supports are 48 inches (1219 mm) on center or less, alternate laminations shall be toenailed to alternate supports; where supports are spaced more than 48 inches (1219 mm) on center, alternate laminations shall be toenailed to every support.

Reason: This proposal adds alternative fastener schedules for construction of mechanically laminated decking, providing specific guidance for use of mechanically-driven nails which are typically used in construction. The alternative fastening schedules are based on equivalency to the reference 20d common nail currently required in 2304.9.3.2 for laminations with a 2-inch nominal thickness, and provide equivalent lateral strength, shear stiffness and withdrawal capacity, as calculated in accordance with the AWC NDS.

Cost Impact: Will not increase the cost of construction
This change does not add additional requirements. It provides equivalent alternative options for construction of mechanically laminated decking.

S281-16 : 2304.9.3.2-TYREE12558

Final Action: AS (Approved as Submitted)

S281-16

Committee Action: **Approved as Submitted**

Committee Reason: This code change clarifies circumstances surrounding power-driven fasteners when used in lieu of the code-specified nailing and provides an additional option for laminated decking.

Assembly Action: **None**

S7879

Date Submitted	12/11/2018	**Section**	2306.3	**Proponent**	Paul Coats
Chapter	23	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Corrects a mistaken staple size in Table 2306.3(2)

Rationale

This modification was approved by the ICC membership and appears in the 2018 edition of the International Building Code. A review of the test report referenced at the time staples w ere added to this table shows that 16 gage staples were used in testing and also that staple length for both sheathing thicknesses w as 1-3/4". The 1-3/4" staple length is incorporated directly into the table in lieu of reference to footnote f.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Corrects a mistaken staple size listing, no impact

Impact to building and property owners relative to cost of compliance with code

No cost-related impact.

Impact to industry relative to the cost of compliance with code

No cost-related impact.

Impact to small business relative to the cost of compliance with code

No cost-related impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Corrects a staple size in a table

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by making a correction to a staple size

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

Reviseasfollows:

TABLE2306.3 (2)

_ALLOWABLESHEARVALUES(plf)FORWINDORSEISMICLOADINGONSHEARWALLSOF FIBERBOARDSHEATHINGBOARDCONSTRUCTION UTILIZINGSTAPLESFORTYPEVCONSTRUCTION ONLYa,b,c,d,e

THICKNESS AND GRADE	FASTENERSIZE	ALLOWABLESHEARVALUE(poundsper linear foot) STAPLE SPACINGATPANELEDGES(inches)a		
		4	3	2
1/2? or25/32? Structural	~~No.~~16gagegalvanized staple, 7/16?crownf1-3/4 inchlong	150	200	225
	~~No.~~16gagegalvanized staple, 1?crownf 1-3/4inch long	220	290	325

ForSI:1inch=25.4 mm,1pound perfoot =14.5939N/m.

a. Fiberboardsheathingshallnot beusedtobraceconcreteormasonrywalls.

b.Paneledgesshallbebackedwith2-inchorwiderframingof Douglas Fir-larchorSouthernPine. Forframingof otherspecies: (1) Findspecific gravity forspecies of framinglumberinANSI/AWCNDS. (2)Forstaples, multiply theshearvaluefrom thetable aboveby 0.82 forspecies withspecific gravity of 0.42 orgreater,or0.65 forallotherspecies.

c. Values shownareforfiberboardsheathingononesideonly withlongpaneldimensioneitherparallelorperpendiculartostuds.

d. Fastenershallbespaced6inches oncenteralongintermediateframingmembers.

e. Values arenot permittedinSeismic DesignCategoryD,EorF.

~~_f. Staplelengthshallbenotlessthan1 1-/ 2 inchesfor 25 / 32 -inchsheathingor1 1 / 4 inchesfor 1 / 2 -inchsheathing.~~

Revise as follows:

TABLE 2306.3 (2)
ALLOWABLE SHEAR VALUES (plf) FOR WIND OR SEISMIC LOADING ON SHEAR WALLS OF FIBERBOARD SHEATHING BOARD CONSTRUCTION UTILIZING STAPLES FOR TYPE V CONSTRUCTION ONLY[a, b, c, d, e]

THICKNESS AND GRADE	FASTENER SIZE	ALLOWABLE SHEAR VALUE (pounds per linear foot) STAPLE SPACING AT PANEL EDGES (inches)[a]		
		4	3	2
1/2" or 25/32" Structural	~~No.~~ 16 gage galvanized staple, 7/16" crown~~f~~ 1-3/4 inch long	150	200	225
	~~No.~~ 16 gage galvanized staple, 1" crown~~f~~ 1-3/4 inch long	220	290	325

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

a. Fiberboard sheathing shall not be used to brace concrete or masonry walls.

b. Panel edges shall be backed with 2-inch or wider framing of Douglas Fir-larch or Southern Pine. For framing of other species: (1) Find specific gravity for species of framing lumber in ANSI/AWC NDS. (2) For staples, multiply the shear value from the table above by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species.

c. Values shown are for fiberboard sheathing on one side only with long panel dimension either parallel or perpendicular to studs.

d. Fastener shall be spaced 6 inches on center along intermediate framing members.

e. Values are not permitted in Seismic Design Category D, E or F.

~~f. Staple length shall be not less than 1 1/2 inches for 25/32 inch sheathing or 1 1/4 inches for 1/2 inch sheathing.~~

Final Action: AS (Approved as submitted)

S286-16

IBC: 2306.3.

Proponent : Dennis Richardson, American Wood Council, representing American Wood Council (drichardson@awc.org)

2015 International Building Code

Revise as follows:

TABLE 2306.3 (2)
ALLOWABLE SHEAR VALUES (plf) FOR WIND OR SEISMIC LOADING ON SHEAR WALLS OF FIBERBOARD SHEATHING BOARD CONSTRUCTION UTILIZING STAPLES FOR TYPE V CONSTRUCTION ONLY[a, b, c, d, e]

THICKNESS AND GRADE	FASTENER SIZE	ALLOWABLE SHEAR VALUE (pounds per linear foot) STAPLE SPACING AT PANEL EDGES (inches)[a]		
		4	3	2
1/2" or 25/32" Structural	~~No.~~ 16 gage galvanized staple, 7/16" crown~~[f]~~ 1-3/4 inch long	150	200	225
	~~No.~~ 16 gage galvanized staple, 1" crown~~[f]~~ 1-3/4 inch long	220	290	325

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

a. Fiberboard sheathing shall not be used to brace concrete or masonry walls.

b. Panel edges shall be backed with 2-inch or wider framing of Douglas Fir-larch or Southern Pine. For framing of other species: (1) Find specific gravity for species of framing lumber in ANSI/AWC NDS. (2) For staples, multiply the shear value from the table above by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species.

c. Values shown are for fiberboard sheathing on one side only with long panel dimension either parallel or perpendicular to studs.

d. Fastener shall be spaced 6 inches on center along intermediate framing members.

e. Values are not permitted in Seismic Design Category D, E or F.

~~f. Staple length shall be not less than 1 1/2 inches for 25/32 inch sheathing or 1 1/4 inches for 1/2 inch sheathing.~~

Reason: A review of the test report referenced at the time staples were added to this table shows that 16 gage staples were used in testing and also that staple length for both sheathing thicknesses was 1-3/4". The 1-3/4" staple length is incorporated directly into the table in lieu of reference to footnote f.

Cost Impact: Will not increase the cost of construction
This proposal does not increase the cost of construction as it merely correlates and clarifies various requirements from standards.

Final Action: AS (Approved as submitted)

S286-16

Committee Action: **Approved as Submitted**

Committee Reason: This code change simplifies the shear wall table by elimminating a note and incorporating the staple length into the appropriate table entries.

Assembly Action: **None**

Date Submitted 12/12/2018	**Section** 2306.1	**Proponent** Borjen Yeh
Chapter 23	**Affects HVHZ** No	**Attachments** No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No | **Alternate Language** No

Related Modifications

Summary of Modification

Update the referenced standards for glulam.

Rationale

This proposal updates the referenced standards for ANSI A190.1 for structural glued laminated timber (glulam). ANSI/AITC A190.1 is now designed as ANSI A190.1 and AITC 117 is now designed as ANSI 117. Both ANSI standards are now published by APA.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal updates the referenced standards for glulam.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

American Institute of Timber Construction.

AITC 104	Typical Construction Details
AITC 110	Standard Appearance Grades for StructuralGlued Laminated Timber
AITC 113	Standard for Dimensions of StructuralGlued Laminated Timber
~~AITC 117~~	~~Standard Specifications for StructuralGlued Laminated Timber of SoftwoodSpecies~~
AITC 119	Standard Specifications for StructuralGlued Laminated Timber of HardwoodSpecies
~~ANSI/AITC A190.1~~	~~Structural Glued Laminated Timber~~
AITC 200	Inspection Manual

American Society of Agricultural and BiologicalEngineers.

(No changes)

APA—The Engineered Wood Association.

ANSI 117 Glued Laminated Timber of Softwood Species

ANSI A190.1 Structural Glued Laminated Timber

(No changes to the reamining section.)

S8126

Date Submitted	12/14/2018	**Section**	2306	**Proponent**	Andy Williams
Chapter	23	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Chapter 35 addition of referenced standard

Summary of Modification

Addition of ASABE Standard S618 R2016 Post Frame Building System Nomenclature and updating standard references.

Rationale

ASABE S618 is a standard that was published by ASABE originally published in 2010 and revised in 2016. This standard provides definitions for the terms used in Post-Frame construction. Inclusion of this reference provides direction and clarification for the users and designers of Post Frame construction method.

EP 484 and EP 486 have ben updated to the latest version (.3)

Reference to EP for ASABE 559.1 has been inadvertently removed from the text. This should be an editorial fix to resolve that reference.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Addition of S618 and updating the other Standards should make enforcement easier using updated standards

Impact to building and property owners relative to cost of compliance with code

There should be no cost of compliance change to the property owners.

Impact to industry relative to the cost of compliance with code

There should be no cost of compliance change to the industry.

Impact to small business relative to the cost of compliance with code

There should be no cost of compliance change to small business.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Addition of definitions and the proposed updates should increase the safety of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Addition of definitions and the proposed updates should improve the code and systems of construction.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Addition of definitions and the proposed updates should not discriminate against materials or methods.

Does not degrade the effectiveness of the code

Addition of definitions and the proposed updates should not degrade the effectiveness of the code.

Add text as follows

SECTION2306
ALLOWABLE STRESS DESIGN

2306.1Allowable stress design.

The design and construction of wood elements in structures using allowable stress design shall be in accordance with the following applicable standards:

American Society of Agricultural and Biological Engineers.

ASABE EP 484.~~2~~3 Diaphragm Design of Metal-clad, Post-Frame Rectangular Buildings

ASABE EP 486.~~2~~3 Shallow Post Foundation Design

ASABE EP 559.1 Design Requirements and Bending Properties for Mechanically Laminated Columns

ASABE S 618 Post Frame Building System Nomenclature

CHAPTER 35
REFERENCED STANDARDS

ASABE

ASABE S 618 Post Frame Building System Nomenclature

ANSI/ASAE EP484.3 DEC2017
Diaphragm Design of Metal-Clad, Wood-Frame Rectangular Buildings

American Society of
Agricultural and Biological Engineers

STANDARD

ASABE is a professional and technical organization, of members worldwide, who are dedicated to advancement of engineering applicable to agricultural, food, and biological systems. ASABE Standards are consensus documents developed and adopted by the American Society of Agricultural and Biological Engineers to meet standardization needs within the scope of the Society; principally agricultural field equipment, farmstead equipment, structures, soil and water resource management, turf and landscape equipment, forest engineering, food and process engineering, electric power applications, plant and animal environment, and waste management.

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Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made toward their resolution.

CAUTION NOTICE: ASABE and ANSI standards may be revised or withdrawn at any time. Additionally, procedures of ASABE require that action be taken periodically to reaffirm, revise, or withdraw each standard.

ASABE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA, phone 269-429-0300, fax 269-429-3852, hq@asabe.org

ANSI/ASAE EP484.3 DEC2017
Revision approved December 2017 as an American National Standard

Diaphragm Design of Metal-Clad, Wood-Frame Rectangular Buildings

Developed by the ASAE Diaphragm Design of Metal-Clad, Post-Frame Rectangular Buildings Subcommittee of the Structures Group; approved by the Structures and Environment Division Standards Committee; adopted by ASAE September 1989; revised December 1990; reaffirmed December 1994, 1995, 1996, 1997; revised June 1998; approved as an American National Standard August 1998; revised editorially February 2000; reaffirmed February 2003; revised editorially August 2003; reaffirmed February 2008, February 2013; revised December 2017.

Keywords: Buildings, Structures, Terminology, Wood-frame

1 Purpose and Scope

1.1 This Engineering Practice is a consensus document for the analysis and design of metal-clad wood-frame buildings using roof and ceiling diaphragms, alone or in combination. The roof (and ceiling) diaphragms, endwalls, intermediate shearwalls, and building frames are the main structural elements of a structural system used to efficiently resist the design lateral (wind, seismic) loads. This Engineering Practice gives acceptable methods for analyzing and designing the elements of the diaphragm system.

1.2 The provisions of this Engineering Practice are limited to the analysis of single-story buildings of rectangular shape.

2 Normative References

The following referenced documents are integral components in the application of this document. For dated references, only the edition cited applies unless noted. For undated references, the latest approved edition of the referenced document (including any amendments) applies.

AWC (American Wood Council) National Design Specification® (NDS®) for Wood Construction. Washington, D.C.)

ASAE EP486, Shallow Post and Pier Foundation Design

ASAE EP558, Load Tests for Metal-Clad, Wood Frame Diaphragms

AISI S310, North American Standard for the Design of Profiled Steel Diaphragm Panels

3 Definitions (see Figures 1 and 2)

3.1 diaphragm: A structural assembly of metal cladding, including the wood or wood product framing, metal cladding, fasteners and fastening patterns, capable of transferring in-plane shear forces through the cladding and framing members.

3.2 diaphragm design: Design of roof (and ceiling) diaphragm(s), sidewall posts, endwalls, shearwalls, component connections, chord splices, and foundation anchorages, for the purpose of transferring lateral (e.g., wind) loads to the foundation structure.

3.3 diaphragm dimensions

3.3.1 diaphragm length, *d*: Length of a building diaphragm in the plane of the diaphragm.

3.3.2 diaphragm span, b_h: Horizontal span of a building diaphragm having length, *d*.

3.3.3 diaphragm width, *s*: Distance between individual building frames; see also 3.10.

3.3.4 model diaphragm length, *b*: Length of a model diaphragm as measured parallel to the direction of applied load.

3.3.5 model diaphragm width, *a*: Length of a model diaphragm as measured perpendicular to the direction of applied load.

3.4 diaphragm fasteners: The various fasteners and fastener patterns used to connect the several components of the endwalls, shearwalls, and diaphragms. These include fasteners between cladding and purlins, between cladding and endwall girts, between diaphragm framing members, and between individual sheets of cladding (stitch fasteners).

3.5 diaphragm shear stiffness

3.5.1 model diaphragm shear stiffness, *c*: The in-plane shear stiffness of a model diaphragm. Defined as the slope of the shear load-deflection curve between zero load and the load corresponding to the diaphragm allowable shear strength.

3.5.2 in-plane shear stiffness, c_p: The in-plane shear stiffness of an individual roof or ceiling diaphragm.

3.5.3 horizontal shear stiffness, c_h: The horizontal shear stiffness of an individual roof or ceiling diaphragm. It is obtained by adjusting diaphragm in-plane shear stiffness, c_p, for slope.

3.5.4 total horizontal diaphragm shear stiffness, C_h: The horizontal shear stiffness of the roof and ceiling assembly is calculated by summing the horizontal shear stiffness values of individual roof and ceiling diaphragms. Alternatively, this stiffness can be obtained from full-scale building tests.

3.6 diaphragm shear strength, V_a: The allowable design shear strength (see ASAE EP558) of a diaphragm in the plane of the cladding.

3.7 eave load, *R*: A concentrated (point) load, horizontally acting, that is located at the eave of each frame, and results in a horizontal eave displacement identical to that caused by application of the controlling combination of design loads. *R* is numerically equal to the horizontal force required to prevent horizontal translation of the eave when the controlling combination of design loads is applied to the frame.

3.8 endwall and shearwall stiffness, k_e: The ratio of a horizontal force applied at the eave to the corresponding deflection of an individual unattached wall. A wall is unattached when it is not connected to components that lie outside the plane of the wall.

3.9 frame stiffness, *k*: The ratio of a horizontal force applied at the eave to the corresponding deflection of the individual unclad post-frames.

3.10 frame spacing, *s*: The distance between frames. In the absence of stiff frames that resist lateral loads, the frame spacing is generally equated to the distance between adjacent trusses (or rafters) or to the model diaphragm width. Frame spacing defines the width (and therefore stiffness properties) of roof/ceiling diaphragm sections. Frame spacing may vary within a building.

3.11 metal cladding: The metal exterior and interior coverings, usually cold-formed aluminum or steel sheet, fastened to the wood framing.

3.12 model diaphragm: A laboratory tested diaphragm or a diaphragm analyzed using a validated structural model that is used to predict the behavior of a building diaphragm. Laboratory tested diaphragms should be sized, constructed, supported and tested in accordance with ASAE EP558. AISI S310 shall be considered to be a validated structural model to calculate the strength and stiffness of a profiled steel panel and its connectors, to a wood support.

3.13 post frame: A structural building frame consisting of a wood roof truss or rafters connected to vertical timber columns, or sidewall posts.

3.14 sidesway restraining force, *Q*: The total force applied to a frame by the roof/ceiling diaphragm.

3.15 shear transfer: The transfer of the resultant shear forces between individual sheets of cladding, between the ends of roof/ceiling diaphragms and frames and shear walls, or between the bottom of the shear walls and the base of the posts or foundation.

3.16 shearwall: An endwall or intermediate wall designed to transfer shear from the roof/ceiling diaphragm into the foundation structure.

3.17 wood frame: A structural building frame consisting of wood or wood-based materials. Wood trusses over studwalls and post and beam are examples of wood frames.

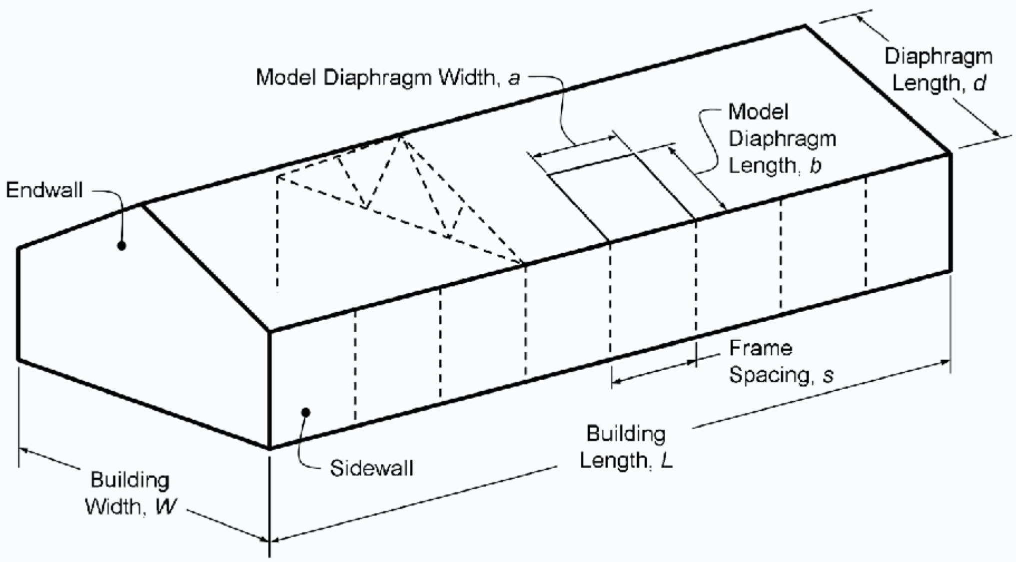

Figure 1 – Definition sketch for terminology

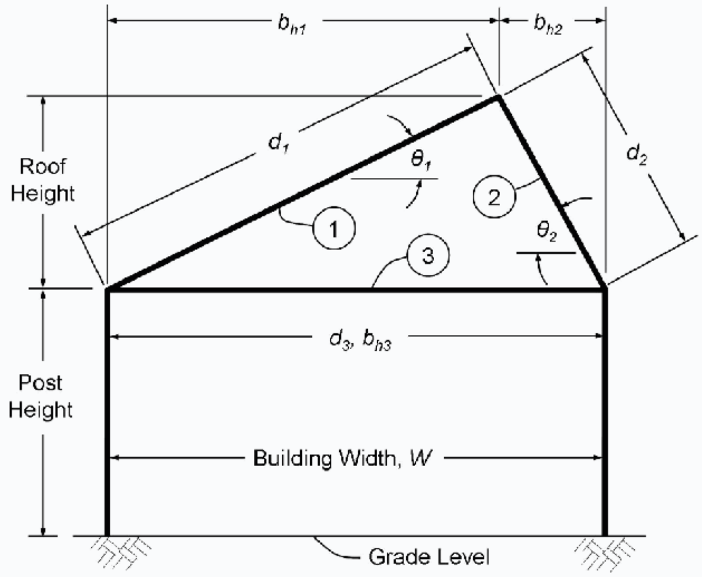

Figure 2 – Building cross section showing roof diaphragms 1 and 2, and ceiling diaphragm 3

4 Diaphragm Stiffness

4.1 General provisions. This section outlines procedures for determining the total horizontal shear stiffness, C_h, of a width, s, of the roof/ceiling assembly. This stiffness is defined as the horizontal load required to cause a horizontal displacement (in a direction parallel to the trusses/rafters) of the roof/ceiling assembly over a spacing, s (Figure 1). This stiffness can be obtained directly from full scale building tests (Gebremedhin *et al.*, 1992), validated structural models, or using procedures outlined in clause 4.2.

4.2 Total horizontal shear stiffness, C_h. The total horizontal diaphragm shear stiffness, C_h, for the frame spacing, s, of the roof / ceiling assembly is defined as:

$$C_h = \sum_{i=1}^{n} c_{h,i} \qquad (1)$$

where:

$c_{h,i}$ = horizontal shear stiffness of diaphragm i with a width, s, from clause 4.3, kN/mm (lbf/in.);

n = number of individual roof and ceiling diaphragms in the roof/ceiling assembly (Figure 2).

When the frame spacing, s, or roof/ceiling diaphragm construction varies along the length of a building, C_h may vary, and the building requires special analysis (see clause 7.3).

4.2.1 Excluding diaphragms. Diaphragm analyses may be simplified by excluding from an analysis any diaphragm that is considerably less stiff than others in the roof/ceiling system. For example, where a ceiling diaphragm is much stiffer than the roof diaphragm(s), the stiffness of the roof diaphragm(s) may be excluded from total stiffness calculations (i.e., Equation 1). For diaphragms that are sheathed with dissimilar materials, the combined allowable design unit shear capacity shall be either two times the smaller allowable design unit shear capacity or the larger allowable design unit shear capacity, whichever is greater.

4.3 Horizontal shear stiffness of an individual diaphragm, $c_{h,i}$. The horizontal shear stiffness of an individual diaphragm can be calculated from the diaphragm's in-plane shear stiffness (Equation 2) or from the in-plane stiffness of a model diaphragm (Equation 3) (Anderson and Bundy, 1989). Model diaphragms used to predict the horizontal stiffness of a building diaphragm shall be functionally equivalent to the building diaphragm. ASAE

EP558 gives laboratory test procedures for obtaining model diaphragm shear stiffness.

$$c_{h,i} = c_{p,i}(\cos^2 \theta_i) \quad (2)$$

$$c_{h,i} = G(\cos \theta_i)(b_{h,i}/s) \quad (3)$$

where:

$c_{h,i}$ = horizontal shear stiffness of diaphragm *i* with width, *s*, and horizontal span $b_{h,i}$, kN/mm (lbf/in.);

$c_{p,i}$ = in-plane shear stiffness of diaphragm *i* with width, *s*, and horizontal span $b_{h,i}$, kN/mm (lbf/in.);

θ_i = slope from the horizontal of diaphragm *i*;

$G = c\,(a/b)$, effective shear modulus, kN/mm (lbf/in.);

$b_{h,i}$ = horizontal span of diaphragm *i* as measured parallel to trusses/rafters, m (ft);

s = frame spacing, m (ft);

c = in-plane shear stiffness of the model diaphragm, kN/mm (lbf/in.);

a = length of the model diaphragm as measured perpendicular to the direction of applied load, m (ft);

b = depth of the model diaphragm as measured parallel to the direction of applied load, m (ft).

5 Frame, Endwall, and Shearwall Stiffness

5.1 General provisions. Frames, endwalls, and intermediate shearwalls transfer roof/ceiling loads to the foundation. The amount of load that a frame, endwall, or shearwall attracts is dependent upon its in-plane stiffness.

5.2 Frame stiffness, *k*. A horizontal force, *P*, applied at the eave of a building frame will result in a horizontal displacement of the eave, Δ. The ratio of the force *P* to the horizontal displacement Δ is defined as the horizontal frame stiffness, *k*. Frame stiffness is generally obtained with a plane-frame structural analysis program. Frame stiffness is equal to zero when all posts in the frame are pin connected to both the truss and the base/foundation.

5.2.1 Frame stiffness can be calculated using Equation 4 when: (1) trusses/rafters are assumed to be pin-connected to the posts, and (2) the base of each post is assumed fixed.

$$k = 3\sum_{i=1}^{n}(E_i I_i)/H_i^3 \quad (4)$$

where:

k = frame stiffness, kN/mm (lbf/in.);

n = number of posts in the post-frame (normally 2);

E_i = modulus of elasticity of post *i*, kN/mm^2 (lbf/in.^{2});

I_i = moment of inertia of post *i*, mm^4 (in.^{4});

H_i = distance from base to pin connection of post *i*, mm (in.).

5.3 Endwall and shearwall stiffness, k_e. Endwall and shearwall stiffness, like frame stiffness, is defined as the ratio of a horizontal force, *P*, applied at the eave of the wall, to the resulting horizontal displacement, Δ. Endwall and shearwall stiffness can be obtained directly from full scale building tests (Gebremedhin et al, 1992), validated structural models, or from tests of functionally equivalent assemblies (Gebremedhin and Jorgensen, 1993). ASAE EP558 gives laboratory test procedures that can be used to determine the stiffness of functionally equivalent walls.

6 Eave Loads

6.1 General provisions. In diaphragm analysis, building loads are replaced by an equivalent set of horizontally acting, concentrated (i.e., point) loads. These loads are located at the eave of each frame, endwall, and shearwall (i.e., they are spaced a distance, *s*, apart), and therefore are referred to as eave loads. Eave loads and applied building loads are equivalent when they horizontally displace the eave an equal amount.

6.2 Eave loads, *R*, by plane-frame structural analysis. A horizontal restraint (vertical roller) is placed at the eave line as shown in Figure 3 and the structural analog is analyzed with all external loads in place. The horizontal reaction at the vertical roller support is numerically equal to the eave load, *R*. Note that the vertical roller should always be placed at the same location that horizontal load *P* was placed when determining frame stiffness (clause 5.2).

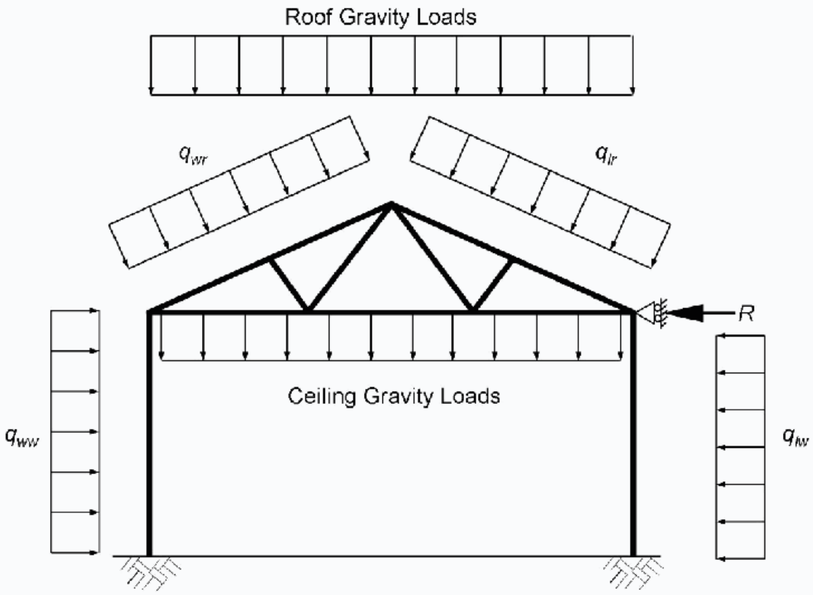

Figure 3 – Structural analog for obtaining eave load, *R*

6.3 Eave load calculation using frame base fixity factors. Eave loads resulting from wind loads can be estimated using Equation 5 (Bohnhoff, 1992b).

$$R = s\,(h_{wr}\,q_{wr} - h_{lr}\,q_{lr} + h_{ww}\,f_w\,q_{ww} - h_{lw}\,f_l\,q_{lw}) \quad (5)$$

where:

R = eave load, kN (lb);

s = frame spacing for interior frames and shearwalls, m (ft);

= one-half the frame spacing for endwalls, m (ft);

h_{wr} = windward roof height, m (ft);

h_{lr} = leeward roof height, m (ft);

h_{ww} = windward wall height, m (ft);

h_{lw} = leeward wall height, m (ft);

q_{wr} = design windward roof pressure, kN/m^2 (lbf/ft^2);

q_{lr} = design leeward roof pressure, kN/m^2 (lbf/ft^2);

q_{ww} = design windward wall pressure, kN/m^2 (lbf/ft^2);

q_{lw} = design leeward wall pressure, kN/m^2 (lbf/ft^2);

f_w = windward post fixity factor;

f_l = leeward post fixity factor.

Inward acting wind pressures have positive signs, outward acting pressures are negative (see Figure 3). Equation 5 shall be modified for cases where pressures are not uniform over a wall or roof surface. In buildings with variable frame spacings, set s equal to the average of the frame spacings on each side of the eave load.

The frame base fixity factor(s), f_w and f_l, will equal 3/8 for a fixed condition at the groundline. The frame base fixity factor(s) will equal 1/2 for all other cases (see ASAE EP486).

For symmetrical base restraint and frame geometry, Equation 5 reduces to:

$$R = s\,[h_r\,(q_{wr} - q_{lr}) + h_w\,f\,(q_{ww} - q_{lw})] \qquad (6)$$

where:

h_r = roof height, m (ft);

h_w = wall height, m (ft);

f = leeward and windward post base fixity factor.

6.4 Maximum total diaphragm shear, V_h. A conservative value of maximum total diaphragm shear, V_h, due to wind load may be calculated by multiplying the equations in clause 6.3 by one-half the building length instead of the frame spacing, s.

$$V_h = R\,L\,/\,(2s) \qquad (7)$$

where:

V_h = maximum total diaphragm shear, kN (lbf);

R = eave load given by either Equation 5 or 6, kN (lbf);

L = building length, m (ft).

For symmetrical base restraint and frame geometry, the maximum diaphragm shear is conservatively estimated by Equation 7 where the eave load, R, is determined with Equation 6.

7 Load Distribution

7.1 General provisions. The distribution of horizontal loads to the various frames, walls, and diaphragms can be determined after diaphragm, frame, shearwall, and endwall stiffness values have been calculated and eave loads have been established. Use the procedure outlined in clause 7.2 to determine load distribution in a building without intermediate shearwalls and with constant values of: diaphragm stiffness, C_h; frame stiffness, k; endwall stiffness, k_e; and eave load, R. When one or more of these variables is not fixed, use methods referenced in clause 7.3. If the number of individual roof and ceiling diaphragms in the roof/ceiling assembly exceeds one, use the equation in clause 7.4 to determine the distribution of roof shear, V_h, to the individual diaphragms, and use the equation in clause 7.5 to determine the horizontal restraining force associated with each diaphragm.

7.2 Load distribution using tables. Tables 1 and 2 are used to determine the maximum total diaphragm shear V_h, and the maximum sidesway restraining force, Q, respectively, in buildings without intermediate shearwalls and with constant values of: diaphragm stiffness, C_h; frame stiffness, k; endwall stiffness, k_e; and eave load, R for interior frames. Input parameters for Tables 1 and 2 include: number of building frames (endwalls are counted as frames); ratio of diaphragm to frame stiffness, C_h/k; and ratio of endwall to frame stiffness, k_e/k. Tables 1 and 2 were developed by Dr. David R. Bohnhoff using a special version of the DAFI Program (Bohnhoff, 1992a). When establishing the values in Tables 1 and 2, it was assumed that the eave load, R, for the endwalls was one-half the load applied to each interior frame.

Table 1 – Shear force modifier (*mS*)

k_e / k	C_h / k	Number of Frames (endwalls are counted as frames)													
		3	4	5	6	7	8	9	10	11	12	13	14	15	16
5	5	0.88	1.14	1.33	1.45	1.53	1.59	1.62	1.65	1.66	1.67	1.68	1.68	1.68	1.68
5	10	0.89	1.19	1.42	1.59	1.72	1.82	1.89	1.94	1.98	2.00	2.02	2.04	2.05	2.06
5	20	0.90	1.22	1.48	1.68	1.85	1.98	2.08	2.16	2.23	2.29	2.33	2.36	2.39	2.41
5	50	0.91	1.24	1.51	1.74	1.93	2.10	2.23	2.35	2.45	2.53	2.60	2.67	2.72	2.77
5	100	0.91	1.24	1.53	1.76	1.97	2.14	2.29	2.42	2.53	2.63	2.72	2.80	2.87	2.93
5	200	0.91	1.25	1.53	1.77	1.98	2.16	2.32	2.46	2.58	2.69	2.79	2.87	2.95	3.02
5	500	0.91	1.25	1.54	1.78	1.99	2.18	2.34	2.48	2.61	2.73	2.83	2.92	3.01	3.08
5	1000	0.91	1.25	1.54	1.78	2.00	2.18	2.35	2.49	2.62	2.74	2.84	2.94	3.02	3.10
5	10000	0.91	1.25	1.54	1.79	2.00	2.19	2.35	2.50	2.63	2.75	2.86	2.95	3.04	3.12
10	5	0.91	1.23	1.46	1.62	1.73	1.81	1.86	1.89	1.91	1.92	1.93	1.93	1.94	1.94
10	10	0.93	1.29	1.58	1.81	1.99	2.13	2.23	2.31	2.36	2.40	2.44	2.46	2.48	2.49
10	20	0.94	1.33	1.66	1.94	2.17	2.36	2.52	2.66	2.76	2.85	2.92	2.98	3.03	3.06
10	50	0.95	1.35	1.70	2.02	2.30	2.55	2.76	2.96	3.12	3.27	3.40	3.51	3.61	3.70
10	100	0.95	1.36	1.72	2.05	2.35	2.62	2.86	3.08	3.27	3.45	3.61	3.76	3.89	4.01
10	200	0.95	1.36	1.73	2.07	2.37	2.65	2.91	3.14	3.36	3.56	3.74	3.90	4.06	4.20
10	500	0.95	1.36	1.74	2.08	2.39	2.68	2.94	3.19	3.41	3.62	3.82	4.00	4.17	4.32
10	1000	0.95	1.36	1.74	2.08	2.40	2.68	2.95	3.20	3.43	3.64	3.84	4.03	4.20	4.37
10	10000	0.95	1.36	1.74	2.08	2.40	2.69	2.96	3.21	3.45	3.66	3.87	4.06	4.24	4.41
20	5	0.93	1.28	1.54	1.73	1.85	1.94	2.00	2.03	2.06	2.07	2.09	2.09	2.10	2.10
20	10	0.95	1.35	1.68	1.95	2.16	2.33	2.45	2.55	2.62	2.67	2.71	2.74	2.76	2.78
20	20	0.96	1.39	1.76	2.09	2.38	2.62	2.83	3.00	3.14	3.25	3.35	3.43	3.49	3.54
20	50	0.97	1.41	1.82	2.20	2.54	2.85	3.14	3.39	3.62	3.83	4.01	4.17	4.32	4.44
20	100	0.97	1.42	1.84	2.23	2.60	2.95	3.26	3.56	3.83	4.09	4.32	4.54	4.74	4.92
20	200	0.97	1.42	1.85	2.25	2.63	2.99	3.33	3.65	3.95	4.24	4.50	4.75	4.99	5.21
20	500	0.98	1.43	1.86	2.27	2.65	3.02	3.38	3.71	4.03	4.33	4.62	4.90	5.16	5.41
20	1000	0.98	1.43	1.86	2.27	2.66	3.03	3.39	3.73	4.06	4.37	4.66	4.95	5.22	5.48
20	10000	0.98	1.43	1.86	2.27	2.67	3.04	3.40	3.75	4.08	4.40	4.70	5.00	5.28	5.55
50	5	0.95	1.31	1.59	1.79	1.93	2.03	2.09	2.14	2.16	2.18	2.19	2.20	2.20	2.21
50	10	0.97	1.38	1.74	2.04	2.28	2.46	2.61	2.72	2.80	2.86	2.91	2.94	2.97	2.99
50	20	0.98	1.43	1.83	2.20	2.52	2.80	3.04	3.25	3.41	3.55	3.67	3.77	3.84	3.91
50	50	0.99	1.45	1.90	2.32	2.71	3.08	3.42	3.73	4.01	4.26	4.50	4.70	4.89	5.06
50	100	0.99	1.46	1.92	2.36	2.78	3.18	3.57	3.93	4.27	4.60	4.90	5.18	5.45	5.69
50	200	0.99	1.47	1.93	2.38	2.82	3.24	3.65	4.04	4.42	4.79	5.14	5.47	5.79	6.09
50	500	0.99	1.47	1.94	2.40	2.84	3.28	3.70	4.12	4.52	4.91	5.29	5.66	6.02	6.37
50	1000	0.99	1.47	1.94	2.40	2.85	3.29	3.72	4.14	4.55	4.96	5.35	5.73	6.11	6.47
50	10000	0.99	1.47	1.94	2.40	2.86	3.30	3.74	4.16	4.58	5.00	5.40	5.80	6.19	6.57
100	5	0.95	1.32	1.61	1.82	1.96	2.06	2.13	2.17	2.20	2.22	2.23	2.24	2.24	2.25
100	10	0.97	1.40	1.76	2.07	2.32	2.51	2.67	2.78	2.87	2.93	2.98	3.02	3.05	3.06
100	20	0.98	1.44	1.86	2.24	2.58	2.87	3.12	3.34	3.52	3.67	3.79	3.89	3.98	4.05
100	50	0.99	1.47	1.92	2.36	2.77	3.16	3.52	3.85	4.16	4.43	4.69	4.91	5.12	5.30
100	100	0.99	1.48	1.95	2.40	2.85	3.27	3.68	4.07	4.44	4.79	5.13	5.44	5.73	6.01
100	200	0.99	1.48	1.96	2.43	2.89	3.33	3.77	4.19	4.61	5.00	5.39	5.76	6.12	6.46
100	500	1.00	1.48	1.97	2.44	2.91	3.37	3.83	4.27	4.71	5.14	5.56	5.98	6.38	6.78
100	1000	1.00	1.48	1.97	2.45	2.92	3.39	3.85	4.30	4.75	5.19	5.62	6.05	6.48	6.89
100	10000	1.00	1.49	1.97	2.45	2.93	3.40	3.86	4.32	4.78	5.23	5.68	6.12	6.56	7.00
1000	5	0.95	1.33	1.63	1.84	1.99	2.09	2.16	2.20	2.23	2.25	2.27	2.27	2.28	2.28
1000	10	0.98	1.41	1.78	2.10	2.36	2.56	2.72	2.84	2.93	3.00	3.05	3.09	3.12	3.14
1000	20	0.99	1.45	1.88	2.28	2.63	2.93	3.20	3.43	3.62	3.78	3.91	4.02	4.11	4.18
1000	50	1.00	1.48	1.95	2.40	2.83	3.24	3.62	3.97	4.30	4.60	4.87	5.12	5.34	5.54
1000	100	1.00	1.49	1.97	2.45	2.91	3.36	3.79	4.21	4.61	4.99	5.35	5.69	6.02	6.32
1000	200	1.00	1.49	1.99	2.47	2.95	3.42	3.89	4.34	4.78	5.22	5.64	6.05	6.44	6.83
1000	500	1.00	1.50	1.99	2.49	2.98	3.46	3.95	4.42	4.90	5.37	5.83	6.29	6.74	7.18
1000	1000	1.00	1.50	2.00	2.49	2.98	3.48	3.97	4.45	4.94	5.42	5.90	6.37	6.85	7.31
1000	10000	1.00	1.50	2.00	2.50	2.99	3.49	3.98	4.48	4.97	5.47	5.96	6.45	6.94	7.43
10000	5	0.96	1.33	1.63	1.84	1.99	2.09	2.16	2.21	2.24	2.26	2.27	2.28	2.28	2.29
10000	10	0.98	1.41	1.79	2.10	2.36	2.57	2.72	2.85	2.94	3.01	3.06	3.10	3.12	3.14
10000	20	0.99	1.45	1.89	2.28	2.63	2.94	3.21	3.43	3.63	3.79	3.92	4.03	4.12	4.19
10000	50	1.00	1.48	1.95	2.40	2.84	3.25	3.63	3.98	4.31	4.61	4.89	5.14	5.36	5.57
10000	100	1.00	1.49	1.98	2.45	2.92	3.37	3.80	4.22	4.62	5.01	5.37	5.72	6.05	6.35
10000	200	1.00	1.50	1.99	2.48	2.96	3.43	3.90	4.35	4.80	5.24	5.66	6.08	6.48	6.87
10000	500	1.00	1.50	2.00	2.49	2.98	3.47	3.96	4.44	4.92	5.39	5.86	6.32	6.78	7.23
10000	1000	1.00	1.50	2.00	2.50	2.99	3.49	3.98	4.47	4.96	5.44	5.93	6.41	6.88	7.36
10000	10000	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	4.99	5.49	5.99	6.49	6.98	7.48

Table 1 *(continued)* – Shear force modifier (*mS*)

k_e/k	C_h/k	Number of Frames (endwalls are counted as frames)													
		17	18	19	20	21	22	23	24	25	26	27	28	29	30
5	5	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69
5	10	2.06	2.07	2.07	2.07	2.07	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08
5	20	2.43	2.44	2.46	2.46	2.47	2.48	2.48	2.49	2.49	2.49	2.49	2.49	2.50	2.50
5	50	2.81	2.84	2.87	2.89	2.92	2.94	2.95	2.97	2.98	2.99	3.00	3.01	3.01	3.02
5	100	2.98	3.03	3.07	3.11	3.14	3.18	3.20	3.23	3.25	3.27	3.29	3.30	3.32	3.33
5	200	3.09	3.14	3.19	3.24	3.28	3.32	3.36	3.39	3.42	3.45	3.48	3.50	3.52	3.54
5	500	3.15	3.22	3.28	3.33	3.38	3.43	3.47	3.51	3.55	3.58	3.61	3.64	3.67	3.70
5	1000	3.18	3.24	3.30	3.36	3.41	3.46	3.51	3.55	3.59	3.63	3.66	3.70	3.73	3.75
5	10000	3.20	3.27	3.33	3.39	3.45	3.50	3.54	3.59	3.63	3.67	3.71	3.74	3.78	3.81
10	5	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94
10	10	2.50	2.50	2.51	2.51	2.51	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52
10	20	3.09	3.12	3.14	3.15	3.16	3.17	3.18	3.19	3.19	3.20	3.20	3.20	3.21	3.21
10	50	3.77	3.84	3.89	3.94	3.99	4.02	4.06	4.09	4.11	4.13	4.15	4.17	4.18	4.19
10	100	4.12	4.21	4.30	4.38	4.45	4.52	4.58	4.63	4.68	4.72	4.76	4.80	4.83	4.86
10	200	4.33	4.45	4.56	4.66	4.76	4.84	4.92	5.00	5.07	5.13	5.19	5.25	5.30	5.35
10	500	4.47	4.61	4.74	4.86	4.97	5.08	5.18	5.27	5.36	5.44	5.52	5.60	5.67	5.73
10	1000	4.52	4.66	4.80	4.93	5.05	5.16	5.27	5.37	5.47	5.56	5.65	5.73	5.81	5.88
10	10000	4.57	4.72	4.86	4.99	5.12	5.24	5.36	5.47	5.57	5.67	5.76	5.86	5.94	6.03
20	5	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10
20	10	2.79	2.80	2.80	2.81	2.81	2.81	2.82	2.82	2.82	2.82	2.82	2.82	2.82	2.82
20	20	3.58	3.62	3.64	3.66	3.68	3.69	3.71	3.71	3.72	3.73	3.73	3.74	3.74	3.74
20	50	4.56	4.65	4.74	4.82	4.88	4.94	4.99	5.03	5.07	5.11	5.14	5.16	5.18	5.20
20	100	5.08	5.24	5.38	5.51	5.62	5.73	5.83	5.91	5.99	6.07	6.13	6.20	6.25	6.30
20	200	5.42	5.61	5.80	5.97	6.13	6.28	6.42	6.55	6.67	6.79	6.90	7.00	7.09	7.18
20	500	5.65	5.88	6.09	6.30	6.50	6.69	6.87	7.04	7.20	7.36	7.51	7.65	7.78	7.91
20	1000	5.73	5.97	6.20	6.42	6.64	6.84	7.03	7.22	7.40	7.58	7.74	7.90	8.06	8.21
20	10000	5.81	6.06	6.30	6.54	6.77	6.98	7.20	7.40	7.60	7.79	7.97	8.15	8.33	8.50
50	5	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21
50	10	3.00	3.01	3.02	3.02	3.03	3.03	3.03	3.03	3.03	3.04	3.04	3.04	3.04	3.04
50	20	3.96	4.00	4.03	4.06	4.08	4.10	4.11	4.12	4.13	4.14	4.14	4.15	4.15	4.16
50	50	5.20	5.33	5.45	5.55	5.64	5.72	5.79	5.85	5.90	5.95	5.99	6.03	6.06	6.08
50	100	5.92	6.13	6.33	6.51	6.67	6.83	6.97	7.10	7.21	7.32	7.42	7.51	7.59	7.67
50	200	6.39	6.66	6.93	7.18	7.41	7.64	7.85	8.05	8.24	8.42	8.59	8.75	8.90	9.04
50	500	6.71	7.04	7.36	7.67	7.97	8.26	8.54	8.81	9.07	9.32	9.57	9.80	10.03	10.25
50	1000	6.83	7.18	7.52	7.85	8.18	8.50	8.80	9.10	9.40	9.68	9.96	10.23	10.50	10.75
50	10000	6.94	7.31	7.68	8.03	8.38	8.72	9.06	9.39	9.72	10.04	10.35	10.66	10.97	11.27
100	5	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25
100	10	3.08	3.09	3.10	3.10	3.11	3.11	3.11	3.11	3.11	3.12	3.12	3.12	3.12	3.12
100	20	4.10	4.14	4.18	4.21	4.23	4.25	4.27	4.28	4.29	4.30	4.30	4.31	4.31	4.31
100	50	5.46	5.61	5.74	5.85	5.95	6.04	6.12	6.19	6.24	6.30	6.34	6.38	6.42	6.45
100	100	6.26	6.50	6.72	6.93	7.12	7.29	7.45	7.60	7.74	7.86	7.98	8.08	8.18	8.27
100	200	6.79	7.10	7.41	7.69	7.97	8.23	8.48	8.72	8.94	9.15	9.35	9.54	9.72	9.89
100	500	7.16	7.54	7.91	8.27	8.62	8.96	9.29	9.62	9.93	10.24	10.53	10.82	11.10	11.37
100	1000	7.30	7.70	8.10	8.49	8.87	9.24	9.61	9.97	10.33	10.67	11.01	11.35	11.68	12.00
100	10000	7.43	7.85	8.28	8.69	9.11	9.51	9.92	10.32	10.72	11.11	11.50	11.88	12.27	12.64
1000	5	2.28	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29
1000	10	3.15	3.16	3.17	3.18	3.18	3.18	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19
1000	20	4.24	4.29	4.32	4.36	4.38	4.40	4.42	4.43	4.44	4.45	4.46	4.46	4.47	4.47
1000	50	5.72	5.88	6.02	6.15	6.26	6.36	6.44	6.52	6.59	6.65	6.70	6.74	6.78	6.81
1000	100	6.61	6.87	7.12	7.35	7.57	7.77	7.95	8.12	8.28	8.43	8.56	8.68	8.79	8.89
1000	200	7.20	7.56	7.90	8.23	8.55	8.85	9.14	9.41	9.68	9.93	10.17	10.39	10.61	10.81
1000	500	7.62	8.05	8.48	8.89	9.30	9.70	10.10	10.48	10.86	11.22	11.58	11.93	12.27	12.61
1000	1000	7.78	8.24	8.69	9.15	9.59	10.04	10.47	10.91	11.33	11.75	12.17	12.58	12.99	13.39
1000	10000	7.92	8.41	8.90	9.39	9.87	10.36	10.84	11.33	11.81	12.29	12.77	13.25	13.73	14.20
10000	5	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29
10000	10	3.16	3.17	3.18	3.19	3.19	3.19	3.19	3.20	3.20	3.20	3.20	3.20	3.20	3.20
10000	20	4.25	4.30	4.34	4.37	4.40	4.42	4.43	4.45	4.46	4.46	4.47	4.48	4.48	4.48
10000	50	5.75	5.91	6.05	6.18	6.29	6.39	6.48	6.56	6.62	6.68	6.73	6.78	6.82	6.85
10000	100	6.64	6.91	7.17	7.40	7.62	7.82	8.01	8.18	8.34	8.49	8.62	8.74	8.86	8.96
10000	200	7.24	7.60	7.95	8.29	8.61	8.92	9.21	9.49	9.76	10.01	10.26	10.49	10.71	10.91
10000	500	7.67	8.11	8.54	8.96	9.38	9.78	10.18	10.57	10.96	11.33	11.70	12.06	12.41	12.75
10000	1000	7.83	8.30	8.76	9.22	9.67	10.12	10.57	11.01	11.44	11.88	12.30	12.72	13.14	13.55
10000	10000	7.98	8.47	8.97	9.46	9.96	10.45	10.94	11.44	11.93	12.42	12.91	13.40	13.89	14.38

Table 2 – Sidesway restraining force modifier (*mD*)

k_e / k	C_h / k	Number of Frames (endwalls counted as frames)													
		3	4	5	6	7	8	9	10	11	12	13	14	15	16
5	5	0.75	0.64	0.52	0.43	0.34	0.28	0.22	0.18	0.14	0.12	0.09	0.08	0.06	0.05
5	10	0.78	0.69	0.59	0.52	0.44	0.39	0.33	0.28	0.24	0.21	0.18	0.15	0.13	0.11
5	20	0.80	0.72	0.64	0.58	0.51	0.46	0.41	0.37	0.33	0.30	0.26	0.24	0.21	0.19
5	50	0.81	0.74	0.67	0.62	0.56	0.52	0.48	0.44	0.41	0.38	0.35	0.32	0.30	0.28
5	100	0.81	0.74	0.68	0.63	0.58	0.54	0.50	0.47	0.44	0.41	0.38	0.36	0.34	0.32
5	200	0.82	0.75	0.69	0.64	0.59	0.55	0.52	0.48	0.46	0.43	0.41	0.38	0.36	0.35
5	500	0.82	0.75	0.69	0.64	0.60	0.56	0.52	0.49	0.47	0.44	0.42	0.40	0.38	0.36
5	1000	0.82	0.75	0.69	0.64	0.60	0.56	0.53	0.50	0.47	0.45	0.42	0.40	0.39	0.37
5	10000	0.82	0.75	0.69	0.64	0.60	0.56	0.53	0.50	0.47	0.45	0.43	0.41	0.39	0.37
10	5	0.83	0.73	0.60	0.51	0.41	0.34	0.27	0.22	0.17	0.14	0.11	0.09	0.07	0.06
10	10	0.86	0.79	0.70	0.63	0.54	0.48	0.41	0.36	0.30	0.26	0.22	0.19	0.16	0.14
10	20	0.88	0.83	0.76	0.70	0.64	0.58	0.52	0.48	0.43	0.39	0.35	0.31	0.28	0.25
10	50	0.90	0.85	0.80	0.75	0.71	0.66	0.62	0.58	0.55	0.51	0.48	0.45	0.42	0.39
10	100	0.90	0.86	0.81	0.77	0.73	0.70	0.66	0.63	0.60	0.57	0.54	0.51	0.49	0.46
10	200	0.90	0.86	0.82	0.78	0.75	0.71	0.68	0.65	0.63	0.60	0.57	0.55	0.53	0.51
10	500	0.90	0.86	0.82	0.79	0.75	0.72	0.70	0.67	0.64	0.62	0.60	0.58	0.56	0.54
10	1000	0.90	0.86	0.83	0.79	0.76	0.73	0.70	0.67	0.65	0.63	0.61	0.59	0.57	0.55
10	10000	0.91	0.86	0.83	0.79	0.76	0.73	0.70	0.68	0.66	0.63	0.61	0.59	0.58	0.56
20	5	0.87	0.78	0.65	0.56	0.45	0.38	0.30	0.25	0.19	0.16	0.13	0.10	0.08	0.07
20	10	0.91	0.85	0.76	0.69	0.60	0.54	0.46	0.41	0.35	0.30	0.26	0.22	0.19	0.16
20	20	0.93	0.89	0.83	0.78	0.72	0.66	0.60	0.55	0.50	0.46	0.41	0.37	0.33	0.30
20	50	0.94	0.91	0.87	0.84	0.80	0.76	0.72	0.69	0.65	0.62	0.58	0.55	0.51	0.48
20	100	0.95	0.92	0.89	0.86	0.83	0.80	0.77	0.75	0.72	0.69	0.66	0.64	0.61	0.58
20	200	0.95	0.92	0.90	0.87	0.85	0.83	0.80	0.78	0.76	0.73	0.71	0.69	0.67	0.65
20	500	0.95	0.93	0.90	0.88	0.86	0.84	0.82	0.80	0.78	0.76	0.74	0.72	0.71	0.69
20	1000	0.95	0.93	0.91	0.88	0.86	0.84	0.82	0.81	0.79	0.77	0.75	0.74	0.72	0.71
20	10000	0.95	0.93	0.91	0.89	0.87	0.85	0.83	0.81	0.80	0.78	0.76	0.75	0.73	0.72
50	5	0.89	0.81	0.68	0.59	0.48	0.40	0.32	0.26	0.21	0.17	0.13	0.11	0.09	0.07
50	10	0.93	0.88	0.80	0.73	0.65	0.58	0.50	0.44	0.38	0.33	0.28	0.24	0.21	0.18
50	20	0.96	0.93	0.88	0.83	0.77	0.72	0.66	0.61	0.55	0.51	0.46	0.41	0.37	0.34
50	50	0.97	0.95	0.93	0.90	0.87	0.84	0.80	0.77	0.73	0.70	0.66	0.63	0.59	0.56
50	100	0.98	0.96	0.94	0.93	0.90	0.88	0.86	0.84	0.81	0.79	0.76	0.74	0.71	0.69
50	200	0.98	0.97	0.95	0.94	0.92	0.91	0.89	0.88	0.86	0.84	0.82	0.81	0.79	0.77
50	500	0.98	0.97	0.96	0.95	0.94	0.92	0.91	0.90	0.89	0.88	0.86	0.85	0.84	0.83
50	1000	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.88	0.87	0.86	0.85
50	10000	0.98	0.97	0.96	0.95	0.94	0.93	0.93	0.92	0.91	0.90	0.89	0.88	0.87	0.87
100	5	0.90	0.82	0.69	0.60	0.48	0.41	0.32	0.27	0.21	0.17	0.14	0.11	0.09	0.07
100	10	0.94	0.90	0.82	0.75	0.66	0.59	0.51	0.45	0.39	0.34	0.29	0.25	0.21	0.18
100	20	0.97	0.94	0.89	0.85	0.79	0.74	0.68	0.63	0.57	0.52	0.47	0.43	0.39	0.35
100	50	0.98	0.97	0.94	0.92	0.89	0.86	0.83	0.80	0.76	0.73	0.69	0.66	0.62	0.59
100	100	0.99	0.98	0.96	0.95	0.93	0.91	0.89	0.87	0.85	0.83	0.80	0.78	0.75	0.73
100	200	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.91	0.90	0.88	0.87	0.85	0.84	0.82
100	500	0.99	0.98	0.98	0.97	0.96	0.96	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.88
100	1000	0.99	0.98	0.98	0.97	0.97	0.96	0.95	0.95	0.94	0.93	0.93	0.92	0.91	0.91
100	10000	0.99	0.99	0.98	0.98	0.97	0.97	0.96	0.96	0.95	0.95	0.94	0.94	0.93	0.93
1000	5	0.91	0.83	0.70	0.61	0.49	0.41	0.33	0.27	0.22	0.18	0.14	0.11	0.09	0.07
1000	10	0.95	0.91	0.83	0.76	0.67	0.60	0.52	0.46	0.40	0.35	0.30	0.26	0.22	0.19
1000	20	0.98	0.95	0.91	0.87	0.81	0.76	0.70	0.65	0.59	0.54	0.49	0.45	0.40	0.36
1000	50	0.99	0.98	0.96	0.94	0.91	0.89	0.86	0.83	0.79	0.76	0.72	0.69	0.65	0.62
1000	100	0.99	0.99	0.98	0.97	0.95	0.94	0.92	0.90	0.88	0.86	0.84	0.82	0.79	0.77
1000	200	1.00	0.99	0.99	0.98	0.98	0.97	0.96	0.95	0.94	0.93	0.91	0.90	0.88	0.87
1000	500	1.00	1.00	0.99	0.99	0.99	0.99	0.98	0.98	0.97	0.97	0.96	0.95	0.95	0.94
1000	1000	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.97	0.97	0.97
1000	10000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99
10000	5	0.91	0.83	0.70	0.61	0.49	0.42	0.33	0.27	0.22	0.18	0.14	0.11	0.09	0.07
10000	10	0.95	0.91	0.83	0.76	0.68	0.61	0.53	0.46	0.40	0.35	0.30	0.26	0.22	0.19
10000	20	0.98	0.95	0.91	0.87	0.81	0.76	0.70	0.65	0.59	0.54	0.49	0.45	0.40	0.37
10000	50	0.99	0.98	0.96	0.94	0.92	0.89	0.86	0.83	0.79	0.76	0.72	0.69	0.65	0.62
10000	100	1.00	0.99	0.98	0.97	0.96	0.94	0.93	0.91	0.89	0.87	0.84	0.82	0.80	0.77
10000	200	1.00	1.00	0.99	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.90	0.89	0.87
10000	500	1.00	1.00	1.00	0.99	0.99	0.99	0.98	0.98	0.98	0.97	0.96	0.96	0.95	0.95
10000	1000	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.97
10000	10000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 2 *(continued)* – Sidesway restraining force modifier (*mD*)

k_e/k	C_h/k	Number of Frames (endwalls counted as frames)													
		17	18	19	20	21	22	23	24	25	26	27	28	29	30
5	5	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
5	10	0.09	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01
5	20	0.17	0.15	0.13	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.06	0.05	0.04	0.04
5	50	0.26	0.24	0.22	0.21	0.19	0.18	0.17	0.16	0.14	0.13	0.12	0.12	0.11	0.10
5	100	0.30	0.29	0.27	0.26	0.24	0.23	0.22	0.20	0.19	0.18	0.17	0.17	0.16	0.15
5	200	0.33	0.31	0.30	0.29	0.27	0.26	0.25	0.24	0.23	0.22	0.21	0.20	0.19	0.19
5	500	0.35	0.33	0.32	0.31	0.29	0.28	0.27	0.26	0.25	0.25	0.24	0.23	0.22	0.21
5	1000	0.35	0.34	0.33	0.31	0.30	0.29	0.28	0.27	0.26	0.25	0.25	0.24	0.23	0.23
5	10000	0.36	0.35	0.33	0.32	0.31	0.30	0.29	0.28	0.27	0.26	0.26	0.25	0.24	0.24
10	5	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
10	10	0.12	0.10	0.09	0.08	0.06	0.06	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.02
10	20	0.23	0.20	0.18	0.16	0.15	0.13	0.12	0.11	0.09	0.08	0.08	0.07	0.06	0.05
10	50	0.36	0.34	0.32	0.30	0.28	0.26	0.24	0.23	0.21	0.20	0.18	0.17	0.16	0.15
10	100	0.44	0.42	0.40	0.38	0.36	0.34	0.33	0.31	0.29	0.28	0.27	0.25	0.24	0.23
10	200	0.49	0.47	0.45	0.43	0.42	0.40	0.39	0.37	0.36	0.34	0.33	0.32	0.31	0.30
10	500	0.52	0.50	0.49	0.47	0.46	0.44	0.43	0.42	0.40	0.39	0.38	0.37	0.36	0.35
10	1000	0.53	0.52	0.50	0.49	0.47	0.46	0.45	0.43	0.42	0.41	0.40	0.39	0.38	0.37
10	10000	0.54	0.53	0.51	0.50	0.49	0.47	0.46	0.45	0.44	0.43	0.42	0.41	0.40	0.39
20	5	0.05	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00
20	10	0.14	0.12	0.10	0.09	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.03	0.02	0.02
20	20	0.27	0.24	0.22	0.20	0.17	0.16	0.14	0.13	0.11	0.10	0.09	0.08	0.07	0.06
20	50	0.45	0.42	0.40	0.37	0.35	0.33	0.30	0.28	0.27	0.25	0.23	0.22	0.20	0.19
20	100	0.56	0.53	0.51	0.49	0.47	0.45	0.43	0.41	0.39	0.37	0.35	0.34	0.32	0.31
20	200	0.63	0.61	0.59	0.57	0.55	0.53	0.52	0.50	0.48	0.47	0.45	0.44	0.42	0.41
20	500	0.67	0.66	0.64	0.63	0.61	0.60	0.59	0.57	0.56	0.55	0.53	0.52	0.51	0.50
20	1000	0.69	0.68	0.66	0.65	0.64	0.62	0.61	0.60	0.59	0.58	0.57	0.55	0.54	0.53
20	10000	0.71	0.69	0.68	0.67	0.66	0.65	0.64	0.63	0.62	0.61	0.60	0.59	0.58	0.57
50	5	0.06	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00
50	10	0.15	0.13	0.11	0.10	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02
50	20	0.30	0.27	0.24	0.22	0.20	0.18	0.16	0.14	0.13	0.11	0.10	0.09	0.08	0.07
50	50	0.52	0.49	0.46	0.44	0.41	0.38	0.36	0.34	0.31	0.29	0.27	0.26	0.24	0.22
50	100	0.66	0.64	0.61	0.59	0.56	0.54	0.52	0.50	0.47	0.45	0.43	0.41	0.40	0.38
50	200	0.75	0.73	0.71	0.69	0.68	0.66	0.64	0.62	0.60	0.59	0.57	0.55	0.54	0.52
50	500	0.81	0.80	0.79	0.78	0.76	0.75	0.74	0.73	0.71	0.70	0.69	0.68	0.67	0.65
50	1000	0.84	0.83	0.82	0.81	0.80	0.79	0.78	0.77	0.76	0.75	0.74	0.73	0.72	0.71
50	10000	0.86	0.85	0.84	0.84	0.83	0.82	0.81	0.81	0.80	0.79	0.79	0.78	0.77	0.77
100	5	0.06	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00
100	10	0.16	0.13	0.11	0.10	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02
100	20	0.31	0.28	0.25	0.23	0.20	0.18	0.16	0.15	0.13	0.12	0.11	0.09	0.08	0.08
100	50	0.55	0.52	0.49	0.46	0.43	0.41	0.38	0.36	0.33	0.31	0.29	0.27	0.25	0.24
100	100	0.70	0.68	0.65	0.63	0.60	0.58	0.56	0.53	0.51	0.49	0.47	0.45	0.43	0.41
100	200	0.80	0.78	0.77	0.75	0.73	0.71	0.69	0.68	0.66	0.64	0.62	0.61	0.59	0.57
100	500	0.87	0.86	0.85	0.84	0.83	0.82	0.81	0.80	0.79	0.77	0.76	0.75	0.74	0.73
100	1000	0.90	0.89	0.88	0.88	0.87	0.86	0.85	0.84	0.84	0.83	0.82	0.81	0.80	0.80
100	10000	0.92	0.92	0.91	0.91	0.90	0.90	0.90	0.89	0.89	0.88	0.88	0.87	0.87	0.86
1000	5	0.06	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00
1000	10	0.16	0.14	0.12	0.10	0.09	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.02	0.02
1000	20	0.33	0.29	0.26	0.24	0.21	0.19	0.17	0.15	0.14	0.12	0.11	0.10	0.09	0.08
1000	50	0.58	0.55	0.52	0.49	0.46	0.43	0.40	0.38	0.35	0.33	0.31	0.29	0.27	0.25
1000	100	0.74	0.72	0.69	0.67	0.64	0.62	0.60	0.57	0.55	0.53	0.50	0.48	0.46	0.44
1000	200	0.85	0.84	0.82	0.80	0.79	0.77	0.75	0.74	0.72	0.70	0.68	0.66	0.65	0.63
1000	500	0.93	0.93	0.92	0.91	0.90	0.89	0.88	0.87	0.86	0.85	0.84	0.83	0.82	0.81
1000	1000	0.96	0.96	0.95	0.95	0.94	0.94	0.93	0.93	0.92	0.92	0.91	0.90	0.90	0.89
1000	10000	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
10000	5	0.06	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00
10000	10	0.16	0.14	0.12	0.10	0.09	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.02	0.02
10000	20	0.33	0.30	0.26	0.24	0.21	0.19	0.17	0.15	0.14	0.12	0.11	0.10	0.09	0.08
10000	50	0.58	0.55	0.52	0.49	0.46	0.43	0.40	0.38	0.36	0.33	0.31	0.29	0.27	0.25
10000	100	0.75	0.72	0.70	0.67	0.65	0.62	0.60	0.58	0.55	0.53	0.51	0.49	0.47	0.45
10000	200	0.86	0.84	0.83	0.81	0.79	0.78	0.76	0.74	0.72	0.71	0.69	0.67	0.65	0.64
10000	500	0.94	0.93	0.92	0.92	0.91	0.90	0.89	0.88	0.87	0.86	0.85	0.84	0.83	0.82
10000	1000	0.97	0.96	0.96	0.96	0.95	0.95	0.94	0.94	0.93	0.93	0.92	0.91	0.91	0.90
10000	10000	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99

7.2.1 Maximum total diaphragm shear, V_h. Table 1 contains shear force modifiers or *mS* values. Multiply the appropriate *mS* value by eave load *R* from clause 6.2 or 6.3 to obtain maximum total diaphragm shear. This value is the total shear, V_h, in the endwalls and in the diaphragm sections adjacent to the endwalls. This value will be less than the conservative estimate calculated using the equations in clause 6.4.

7.2.2 Sidesway restraining force, *Q*. Table 2 contains sidesway restraining force factors or *mD* values. Multiply the appropriate *mD* value by eave load *R* from clause 6.2 or 6.3 to obtain the sidesway restraining force, *Q*. The sidesway restraining force is the total force applied to the critical frame by the roof/ceiling assembly. The critical frame in a symmetric building without interior shearwalls is always the one closest to the building midlength.

7.3 Load distribution — detailed analyses. The force distribution method (Anderson et al, 1989) and computer program DAFI (Bohnhoff, 1992) are two methods that can be used to determine load distribution in a building in which the stiffness of individual frames differ, endwalls differ in stiffness, intermediate shearwalls are present, and eave loads and diaphragm stiffness values vary from frame to frame. The force distribution method is an iterative method for hand-calculating load distribution that is procedurally identical to the classical method of moment distribution. The computer program DAFI automatically formulates and solves a set of equations to obtain eave deflections. Both methods output individual frame, shearwall, endwall, and diaphragm forces. Another specialized structural analysis software package to account for diaphragm action is METCLAD (Gebremedhin, 1987).

7.4 In-plane shear force in individual diaphragms, $V_{p,i}$. The maximum in-plane shear force in an individual diaphragm, $V_{p,i}$, is given as

$$V_{p,i} = (c_{h,i} / C_h)\ V_h / (\cos \theta_i) \qquad (8)$$

where:

$V_{p,i}$ = maximum in-plane shear force in diaphragm *i*, kN (lbf);

$c_{h,i}$ = horizontal shear stiffness of diaphragm *i* with spacing s from clause 4.3, kN/mm (lbf/in.);

C_h = total horizontal diaphragm shear stiffness, C_h, for a spacing *s* of the roof/ceiling assembly, kN/mm (lbf/in.);

V_h = maximum total diaphragm shear from clause 6.4, 7.2.1, or 7.3, kN (lbf);

θ_i = slope from the horizontal of diaphragm *i*.

7.5 Sidesway restraining force — individual diaphragms, Q_i. The total sidesway force applied to the critical frame by an individual diaphragm is given as

$$Q_i = (c_{h,i} / C_h)\ Q \qquad (9)$$

where:

Q_i = sidesway restraining force for diaphragm *i*, kN (lbf);

c_{hi} = horizontal shear stiffness of diaphragm *i* with spacing *s* from clause 4.3, kN/mm (lbf/in.);

C_h = total horizontal diaphragm shear stiffness, C_h, for a spacing *s* of the roof/ceiling assembly, kN/mm (lbf/in.);

Q = sidesway restraining force for the roof/ceiling assembly from clause 7.2.2 or 7.3, kN/mm (lbf/in.).

8 Building Diaphragm and Shearwall Design

8.1 General. All building components shall be checked to ensure that actual loads do not exceed allowable design values for all applicable load combinations.

8.2 Diaphragms. The maximum in-plane shear in a diaphragm, $V_{p,i}$, cannot exceed the allowable shear strength, $V_{a,i}$, multiplied by the diaphragm length:

$$V_{p,i} \leq V_{a,i}\ d_i \qquad (10)$$

where:

$V_{p,i}$ = maximum in-plane shear force in diaphragm *i* from clause 7.4, kN (lbf);

$V_{a,i}$ =allowable in-plane shear strength of diaphragm *i*, kN/m (lbf/ft);

d_i = length of diaphragm *i* as measured parallel to trusses/ rafters (see Figure 2), m (ft);

= $b_{h,i}$ /cos θ_i;

$b_{h,i}$ = horizontal span of diaphragm *i* as measured parallel to trusses/rafters, m (ft).

The allowable in-plane shear strength, $V_{a,i}$, is obtained from tests (ASAE EP558) or from validated structural models as given in Section 9.

8.3 Diaphragm chords. The diaphragm chords shall be designed to resist axial forces caused by bending moments induced in the diaphragm by the applied loads. A conservative estimate of chord force is

$$P_{c,i} = (R/s)(c_{h,i}/C_h)\, L^2/(8\, b_{h,i}) \qquad (11)$$

where:

$P_{c,i}$ = maximum chord force in diaphragm *i*, kN (lbf);

R = eave load from clause 6.2 or 6.3, kN (lbf);

s = frame spacing, m (ft);

$c_{h,i}$ = horizontal shear stiffness of diaphragm *i* with width *s* from clause 4.3, kN/mm (lbf/in.);

C_h = total horizontal diaphragm shear stiffness, C_h, for a width *s* of the roof/ceiling assembly, kN/mm (lbf/in.);

L = building length, m (ft);

$b_{h,i}$ = horizontal span of diaphragm *i* as measured parallel to trusses/rafters, m (ft).

More accurate chord forces may be used when estimated by full-scale tests or structural engineering analysis.

8.4 Diaphragm-to-wall connections. Provisions shall be made for the transfer of shear from roof and ceiling diaphragms to endwalls and intermediate shearwalls. The design strength of these connections may be proven by tests of a typical connection detail. Where applicable, the building designer may use the National Design Specifications (NDS) for Wood Construction to design this connection.

8.5 Shearwalls. Endwalls and intermediate shearwalls shall have sufficient shear strength to transmit the induced loads from roof and ceiling diaphragms to the foundation system. The allowable shear capacity of endwalls and intermediate shearwalls, V_e, is obtained from Section 9 of this standard, or from tests (ASAE EP558) or from validated structural models. For buildings without intermediate shearwalls, the allowable shear strength of the endwalls shall be greater than the maximum total diaphragm shear force, V_h, or

$$V_h \leq V_e W \qquad (12)$$

where:

V_h = maximum total diaphragm shear force, kN (lbf);

V_e = allowable unit shear capacity of the endwall, kN/m (lbf/ft);

W = building width, m (ft).

8.5.1 Doors and openings reduce the total shear capacity of walls. When doors or openings are present in an endwall, the following equation applies for the segmented shear wall approach:

$$V_h \leq V_e(W - D_T) \qquad (13)$$

where:

D_T = total width of doors and openings in the endwall, m (ft).

Note that this approach requires hold-downs at the ends of each shear wall segment.

8.5.2 The structural framing over doors or openings in walls acts as a drag strut transferring shear force across the opening. The header over the opening shall be designed to carry the force in tension and/or compression across the opening.

8.6 Shearwall-to-foundation connections. The connection system between endwalls and intermediate shearwalls and the foundation system shall be designed to resist the shear carried by the walls. The design of these connections may be proved by tests of a typical connection detail or by a calculation method appropriate for the foundation system.

8.7 Shearwall overturning. Diaphragm loading produces overturning moments in intermediate shearwalls and endwalls. These forces may be calculated using structural analyses that include the resisting action of sidewalls when they are present. ASAE EP486 is recommended for designing uplift resistance of embedded post foundations. For wall framing members attached to a slab, the connection between the members and slab should be designed by the provisions of the NDS.

8.8 Sidewall posts. Sidewall members (and frames) resist the lateral loads not transmitted to the foundation by endwalls and shearwalls. The post shall be designed for combined axial and bending moment according to the NDS. The moment and axial force are calculated by any method of frame analysis, using the design loads applied to a post-frame and the sidesway resisting forces from clause 7.5. Figure 4 gives a structural analog for a post-frame with the sidesway resisting forces distributed to the truss top and bottom chords as uniform loads, q_i.

8.9 Endwall members. Endwall members shall be designed to meet wind pressure loads normal to the endwall surface as well as other design loads.

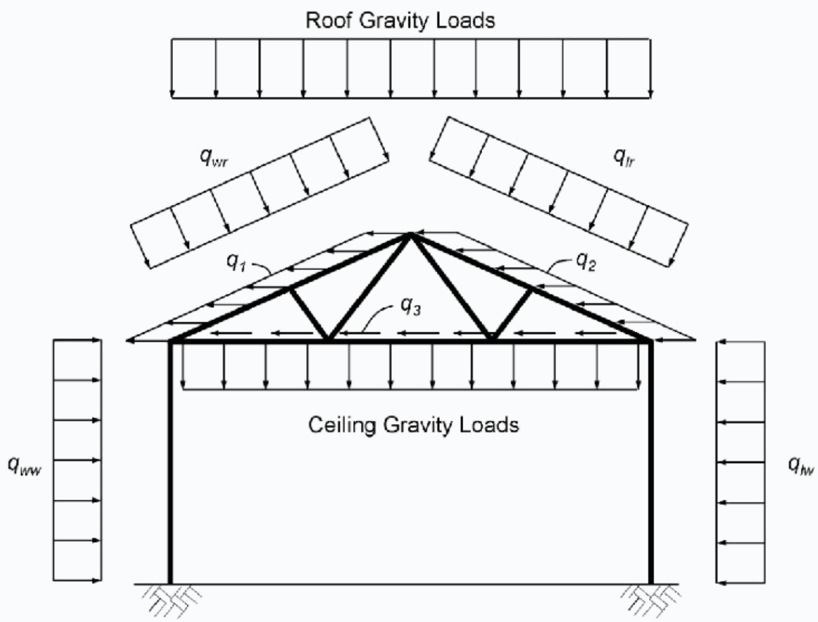

Figure 4 – Structural analog for a building with roof and ceiling diaphragms; sidesway restraining forces, Q_{is}, converted to distributed loads, q_{is}

9 Diaphragm Unit Shear Strength and Stiffness

9.1 General provisions. This section contains a procedure for determining the unit shear strength (clause 9.3), and the effective shear modulus (clause 9.4) of steel-clad, wood-framed diaphragms. The basis for the design values is the MCA procedure as originally developed by Luttrell (1992) and modified by Leflar (2008) and Aguilera (2014).

9.2 Construction specifications. Use of the values in Tables 3, 4, and 5 is restricted to diaphragms that meet the following specifications.

9.2.1. Purlins. Purlins shall be spaced 0.61 m (24 in.), be no less than three in number, have a specific gravity of at least 0.42, be oriented on-edge, and nailed to the top of rafters with 60d post-frame nails. A 60d post-frame nail is a hardened ring-shank nail with a diameter of 5.3 mm (0.207 in.) and a length 152 mm (6.0 in.).

9.2.2. Cladding major ribs. Major ribs shall have an on-center spacing of either 0.23 m (9 in.) or 0.30 (12 in.). Major rib height shall be between 19 and 25 mm (0.75 and 1.0 in.). Major rib bottom width shall be between 35 and 64 mm (1.4 and 2.5 in.), and major rib top width shall be between 13 and 19 mm (0.5 and 0.75 in.).

9.2.3. Field screw location. Screws located in the field of the cladding shall be placed in the flats at locations adjacent to the major rib as shown in Figure 5. Diaphragms *with* stitch screws into the cladding overlaps shall have field screws placed adjacent to, and on only *one* side of each major rib at purlin locations. Diaphragms *without* stitch screws into the cladding overlaps shall have field screws placed adjacent to, and on *both* sides of the major rib *at the cladding overlaps* at purlin locations. At end purlins, screws shall be placed adjacent to and on both sides of each major rib.

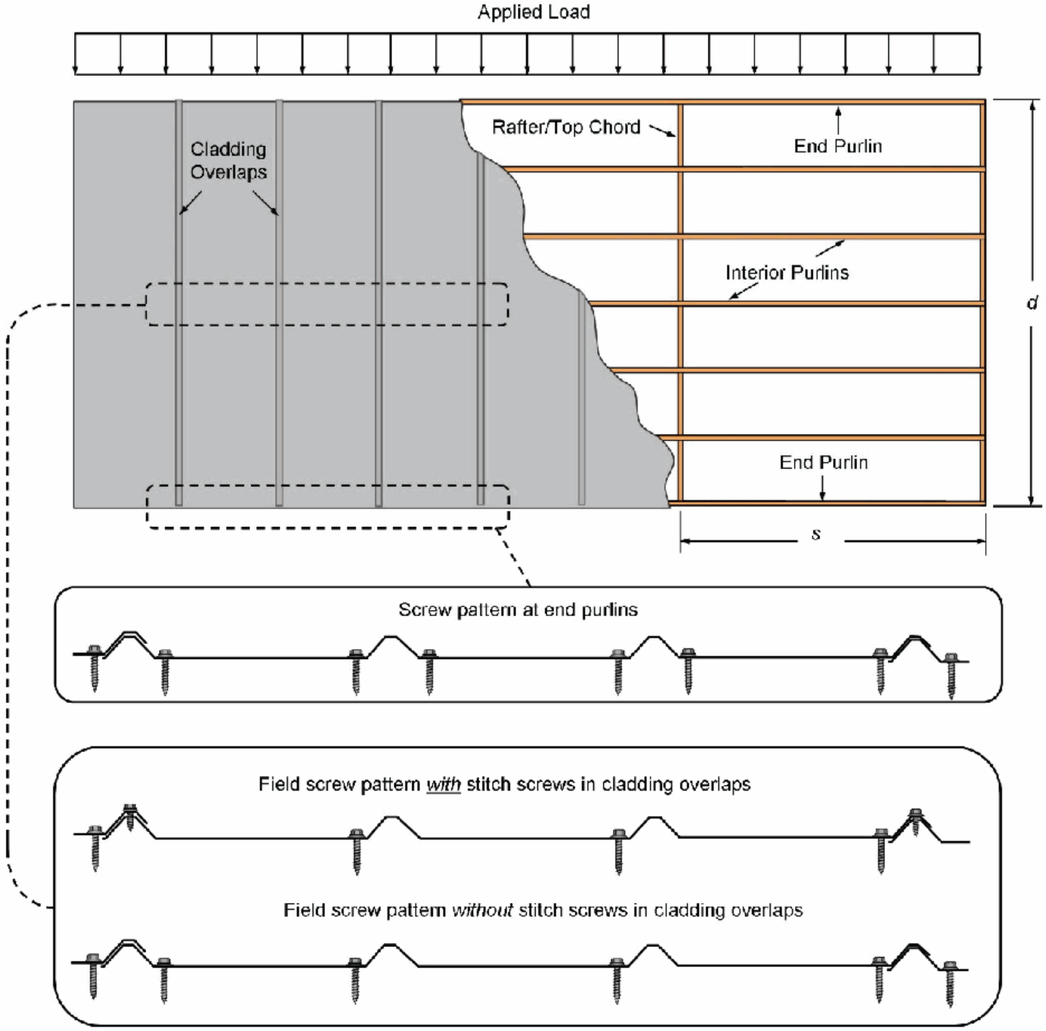

Figure 5 – Required field fastener locations for application of values in Tables 3, 4, 5 and 6. See clause 9.2.3.

Table 3 – ASD allowable diaphragm unit shear strength as governed by cladding fastener failure [a]

Field Screws (in Flats) Size and Length [c]	Stitch Screw Size [c]	Stitch Screw Spacing	0.23 m (9.0 in.) Major Rib Spacing			0.30 m (12.0 in.) Major Rib Spacing		
			V_{10} [b]	V_{50} [b]	G'	V_{10} [b]	V_{50} [b]	G'
mm (in.)		m (in.)	kN/m (lbf/ft)	kN/m (lbf/ft)	kN/mm (lbf/in)	kN/m (lbf/ft)	kN/m (lbf/ft)	kN/mm (lbf/in)
26 Gage Steel, 0.475 mm (0.0187 in.) thick, 345 MPa (50000 lbf/in²) minimum yield strength, 359 MPa (52000 lbf/in²) minimum ultimate strength								
No. 9 25 mm (1.0 in.)	No. 10	0.20 (8)	3.27 (224)	2.99 (205)	7.0 (4.0E4)	2.84 (194)	2.65 (181)	6.8 (3.9E4)
		0.30 (12)	2.73 (187)	2.38 (163)	5.7 (3.2E4)	2.40 (164)	2.14 (147)	5.6 (3.2E4)
		0.61 (24)	2.07 (142)	1.66 (114)	3.7 (2.1E4)	1.81 (124)	1.48 (101)	3.7 (2.1E4)
	No. 12	0.20 (8)	3.46 (237)	3.19 (219)	7.0 (4.0E4)	2.98 (204)	2.81 (192)	6.8 (3.9E4)
		0.30 (12)	2.89 (198)	2.55 (175)	5.7 (3.2E4)	2.53 (174)	2.29 (157)	5.6 (3.2E4)
		0.61 (24)	2.18 (149)	1.76 (121)	3.7 (2.1E4)	1.91 (131)	1.58 (108)	3.7 (2.1E4)
	None	NA	1.46 (100)	1.21 (83)	0.5 (2.8E3)	1.22 (84)	1.04 (71)	0.4 (2.4E3)
No. 10 25 mm (1.0 in.)	No. 10	0.20 (8)	3.37 (231)	3.06 (210)	7.0 (4.0E4)	2.93 (201)	2.72 (186)	6.8 (3.9E4)
		0.30 (12)	2.81 (192)	2.44 (167)	5.7 (32.E4)	2.47 (169)	2.20 (150)	5.6 (3.2E4)
		0.61 (24)	2.14 (147)	1.71 (117)	3.7 (2.1E4)	1.87 (128)	1.52 (104)	3.7 (2.1E4)
	No. 12	0.20 (8)	3.56 (244)	3.27 (224)	7.0 (4.0E4)	3.08 (211)	2.89 (198)	6.8 (3.9E4)
		0.30 (12)	2.98 (204)	2.61 (179)	5.7 (3.2E4)	2.61 (179)	2.35 (161)	5.6 (3.2E4)
		0.61 (24)	2.25 (154)	1.81 (124)	3.7 (2.1E4)	1.97 (135)	1.62 (111)	3.7 (2.1E4)
	None	NA	1.54 (106)	1.28 (88)	0.5 (2.8E3)	1.29 (89)	1.10 (75)	0.4 (2.4E3)
No. 10 38 mm (1.5 in.)	No. 10	0.20 (8)	3.37 (231)	3.06 (210)	7.0 (4.0E4)	2.93 (201)	2.72 (186)	6.8 (3.9E4)
		0.30 (12)	2.81 (192)	2.44 (167)	5.7 (3.2E4)	2.47 (169)	2.20 (150)	5.6 (3.2E4)
		0.61 (24)	2.14 (147)	1.71 (117)	3.7 (2.1E4)	1.87 (128)	1.52 (104)	3.7 (2.1E4)
	No. 12	0.20 (8)	3.56 (244)	3.27 (224)	7.0 (4.0E4)	3.08 (211)	2.89 (198)	6.8 (3.9E4)
		0.30 (12)	2.98 (204)	2.61 (179)	5.7 (3.2E4)	2.61 (179)	2.35 (161)	5.6 (3.2E4)
		0.61 (24)	2.25 (154)	1.81 (124)	3.7 (2.1E4)	1.97 (135)	1.62 (111)	3.7 (2.1E4)
	None	NA	1.54 (106)	1.28 (88)	0.5 (2.8E3)	1.29 (89)	1.10 (75)	0.4 (2.4E3)
No. 12 38 mm (1.5 in.)	No. 10	0.20 (8)	4.23 (290)	3.71 (254)	7.0 (4.0E4)	3.71 (254)	3.33 (228)	6.8 (3.9E4)
		0.30 (12)	3.57 (244)	2.98 (204)	5.7 (3.2E4)	3.12 (213)	2.67 (183)	5.6 (3.2E4)
		0.61 (24)	2.83 (194)	2.19 (150)	3.7 (2.1E4)	2.42 (166)	1.91 (131)	3.7 (2.1E4)
	No. 12	0.20 (8)	4.49 (307)	3.97 (272)	7.0 (4.0E4)	3.93 (269)	3.56 (244)	6.8 (3.9E4)
		0.30 (12)	3.76 (258)	3.18 (218)	5.7 (3.2E4)	3.29 (226)	2.85 (195)	5.6 (3.2E4)
		0.61 (24)	2.95 (202)	2.30 (158)	3.7 (2.1E4)	2.53 (174)	2.02 (138)	3.7 (2.1E4)
	None	NA	2.40 (165)	1.99 (136)	0.5 (2.8E3)	2.00 (137)	1.70 (117)	0.4 (2.4E3)
28 Gage Steel, 0.399 mm (0.0157 in.) thick, 552 MPa (80000 lbf/in²) minimum yield strength, 565 MPa (82000 lbf/in²) minimum ultimate strength								
No. 9 25 mm (1.0 in.)	No. 10	0.20 (8)	2.91 (199)	2.59 (178)	5.6 (3.2E4)	2.53 (173)	2.31 (158)	5.7 (3.3E4)
		0.30 (12)	2.43 (167)	2.07 (142)	4.8 (2.7E4)	2.12 (146)	1.85 (127)	4.8 (2.8E4)
		0.61 (24)	1.89 (130)	1.49 (102)	3.3 (1.9E4)	1.63 (111)	1.30 (89)	3.3 (1.9E4)
	No. 12	0.20 (8)	3.08 (211)	2.78 (190)	5.6 (3.2E4)	2.68 (183)	2.46 (169)	5.7 (3.3E4)
		0.30 (12)	2.57 (176)	2.21 (152)	4.8 (2.7E4)	2.25 (154)	1.98 (136)	4.8 (2.8E4)
		0.61 (24)	1.98 (136)	1.57 (107)	3.3 (1.9E4)	1.71 (117)	1.38 (95)	3.3 (1.9E4)
	None	NA	1.49 (102)	1.24 (85)	0.5 (2.8E3)	1.24 (85)	1.06 (73)	0.4 (2.4E3)
No. 10 25 mm (1.0 in.)	No. 10	0.20 (8)	2.99 (205)	2.66 (182)	5.6 (3.2E4)	2.61 (179)	2.37 (162)	4.8 (2.8E4)
		0.30 (12)	2.51 (172)	2.12 (146)	4.8 (2.7E4)	2.19 (150)	1.90 (130)	3.3 (1.9E4)
		0.61 (24)	1.96 (134)	1.53 (105)	3.3 (1.9E4)	1.68 (115)	1.34 (92)	5.7 (3.3E4)
	No. 12	0.20 (8)	3.17 (217)	2.84 (195)	5.6 (3.2E4)	2.76 (189)	2.53 (173)	4.8 (2.8E4)
		0.30 (12)	2.65 (182)	2.27 (156)	4.8 (2.7E4)	2.31 (159)	2.03 (139)	3.3 (1.9E4)
		0.61 (24)	2.05 (140)	1.61 (111)	3.3 (1.9E4)	1.76 (121)	1.42 (97)	0.4 (2.4E3)
	None	NA	1.58 (108)	1.31 (89)	0.5 (2.8E3)	1.31 (90)	1.12 (77)	4.8 (2.8E4)
No. 10 38 mm (1.5 in.)	No. 10	0.20 (8)	3.29 (225)	2.87 (197)	5.6 (3.2E4)	2.87 (197)	2.56 (176)	4.8 (2.8E4)
		0.30 (12)	2.77 (190)	2.31 (158)	4.8 (2.7E4)	2.41 (165)	2.06 (141)	3.3 (1.9E4)
		0.61 (24)	2.20 (151)	1.71 (117)	3.3 (1.9E4)	1.88 (129)	1.48 (101)	5.7 (3.3E4)
	No. 12	0.20 (8)	3.48 (238)	3.07 (211)	5.6 (3.2E4)	3.04 (208)	2.74 (188)	4.8 (2.8E4)
		0.30 (12)	2.92 (200)	2.46 (169)	4.8 (2.7E4)	2.55 (174)	2.20 (151)	3.3 (1.9E4)
		0.61 (24)	2.30 (157)	1.79 (123)	3.3 (1.0E4)	1.97 (135)	1.56 (107)	0.4 (2.4E3)
	None	NA	1.89 (129)	1.56 (107)	0.5 (2.8E3)	1.57 (108)	1.34 (92)	4.8 (2.8E4)
No. 12 38 mm (1.5 in.)	No. 10	0.20 (8)	3.74 (256)	3.20 (219)	5.6 (3.2E4)	3.26 (223)	2.85 (196)	4.8 (2.8E4)
		0.30 (12)	3.20 (219)	2.61 (179)	4.8 (2.7E4)	2.76 (189)	2.31 (158)	3.3 (1.9E4)
		0.61 (24)	2.61 (179)	1.99 (137)	3.3 (1.9E4)	2.20 (151)	1.71 (117)	5.7 (3.3E4)
	No. 12	0.20 (8)	3.95 (271)	3.42 (234)	5.6 (3.2E4)	3.45 (236)	3.05 (209)	4.8 (2.8E4)
		0.30 (12)	3.35 (230)	2.77 (190)	4.8 (2.7E4)	2.91 (199)	2.46 (168)	3.3 (1.9E4)
		0.61 (24)	2.70 (185)	2.08 (142)	3.3 (1.9E4)	2.29 (157)	1.79 (123)	0.4 (2.4E3)
	None	NA	2.40 (165)	1.99 (136)	0.5 (2.8E3)	2.00 (137)	1.70 (117)	4.8 (2.8E4)

a Diaphragms must be constructed in accordance with clause 9.2.
b An ASD safety factor of 2.5 has been applied to V_{10} and V_{50} values.
c Screw sizes correspond to the following crest diameters: No. 9 = 4.50 mm (0.177 in.), No. 10 = 4.75 mm (0.187 in.), and No. 12 = 5.40 mm (0.211 in.)

Table 3 *(continued)* – ASD allowable diaphragm unit shear strength as governed by cladding fastener failure [a]

Field Screws (in Flats) Size and Length [c]	Stitch Screw Size [c]	Stitch Screw Spacing	0.23 m (9.0 in.) Major Rib Spacing			0.30 m (12.0 in.) Major Rib Spacing		
			V_{10} [b]	V_{50} [b]	G'	V_{10} [b]	V_{50} [b]	G'
mm (in.)		m (in.)	kN/m (lbf/ft)	kN/m (lbf/ft)	kN/mm (lbf/in)	kN/m (lbf/ft)	kN/m (lbf/ft)	kN/mm (lbf/in)
29 Gage Steel, 0.361 mm (0.0142 in.) thick, 552 MPa (80000 lbf/in²) minimum yield strength, 565 MPa (82000 lbf/in²) minimum ultimate strength								
No. 9 25 mm (1.0 in.)	No. 10	0.20 (8)	2.71 (186)	2.38 (163)	5.1 (2.9E4)	2.36 (162)	2.13 (146)	5.2 (3.0E4)
		0.30 (12)	2.28 (156)	1.91 (131)	4.4 (2.5E4)	1.98 (136)	1.71 (117)	4.4 (2.5E4)
		0.61 (24)	1.79 (123)	1.40 (96)	3.1 (1.8E4)	1.53 (105)	1.22 (83)	3.1 (1.8E4)
	No. 12	0.20 (8)	2.87 (197)	2.55 (175)	5.1 (2.9E4)	2.50 (171)	2.28 (156)	5.2 (3.0E4)
		0.30 (12)	2.40 (165)	2.04 (140)	4.4 (2.5E4)	2.10 (144)	1.82 (125)	4.4 (2.5E4)
		0.61 (24)	1.87 (128)	1.47 (101)	3.1 (1.8E4)	1.61 (110)	1.28 (88)	3.1 (1.8E4)
	None	NA	1.49 (102)	1.24 (85)	0.5 (2.8E3)	1.24 (85)	1.06 (73)	0.4 (2.4E3)
No. 10 25 mm (1.0 in.)	No. 10	0.20 (8)	2.79 (191)	2.44 (167)	5.1 (2.9E4)	2.43 (167)	2.18 (149)	5.2 (3.0E4)
		0.30 (12)	2.35 (161)	1.96 (135)	4.4 (2.5E4)	2.04 (140)	1.75 (120)	4.4 (2.5E4)
		0.61 (24)	1.86 (128)	1.44 (99)	3.1 (1.8E4)	1.59 (109)	1.25 (86)	3.1 (1.8E4)
	No. 12	0.20 (8)	2.95 (202)	2.61 (179)	5.1 (2.9E4)	2.57 (176)	2.33 (160)	5.2 (3.0E4)
		0.30 (12)	2.48 (170)	2.09 (143)	4.4 (2.5E4)	2.16 (148)	1.87 (128)	4.4 (2.5E4)
		0.61 (24)	1.94 (133)	1.52 (104)	3.1 (1.8E4)	1.66 (114)	1.32 (91)	3.1 (1.8E4)
	None	NA	1.58 (108)	1.31 (89)	0.5 (2.8E3)	1.31 (90)	1.12 (77)	0.4 (2.4E3)
No. 10 38 mm (1.5 in.)	No. 10	0.20 (8)	3.03 (208)	2.62 (179)	5.1 (2.9E4)	2.64 (181)	2.34 (160)	5.2 (3.0E4)
		0.30 (12)	2.57 (176)	2.12 (145)	4.4 (2.5E4)	2.23 (153)	1.88 (129)	4.4 (2.5E4)
		0.61 (24)	2.07 (142)	1.59 (109)	3.1 (1.8E4)	1.76 (120)	1.37 (94)	3.1 (1.8E4)
	No. 12	0.20 (8)	3.21 (220)	2.80 (192)	5.1 (2.9E4)	2.80 (192)	2.50 (171)	5.2 (3.0E4)
		0.30 (12)	2.70 (185)	2.26 (155)	4.4 (2.5E4)	2.35 (161)	2.01 (137)	4.4 (2.5E4)
		0.61 (24)	2.15 (148)	1.67 (114)	3.1 (1.8E4)	1.83 (126)	1.44 (99)	3.1 (1.8E4)
	None	NA	1.85 (127)	1.53 (105)	0.5 (2.8E3)	1.54 (105)	1.31 (90)	0.4 (2.4E3)
No. 12 38 mm (1.5 in.)	No. 10	0.20 (8)	3.38 (232)	2.87 (197)	5.1 (2.9E4)	2.95 (202)	2.56 (175)	5.2 (3.0E4)
		0.30 (12)	2.91 (199)	2.36 (162)	4.4 (2.5E4)	2.50 (172)	2.08 (142)	4.4 (2.5E4)
		0.61 (24)	2.40 (164)	1.82 (125)	3.1 (1.8E4)	2.02 (138)	1.56 (107)	3.1 (1.8E4)
	No. 12	0.20 (8)	3.57 (245)	3.06 (210)	5.1 (2.9E4)	3.11 (213)	2.73 (187)	5.2 (3.0E4)
		0.30 (12)	3.05 (209)	2.50 (171)	4.4 (2.5E4)	2.63 (180)	2.21 (151)	4.4 (2.5E4)
		0.61 (24)	2.48 (170)	1.90 (130)	3.1 (1.8E4)	2.09 (144)	1.63 (112)	3.1 (1.8E4)
	None	NA	2.26 (155)	1.87 (128)	0.5 (2.8E3)	1.88 (129)	1.60 (110)	0.4 (2.4E3)
30 Gage Steel, 0.323 mm (0.0127 in.) thick, 552 MPa (80000 lbf/in²) minimum yield strength, 565 MPa (82000 lbf/in²) minimum ultimate strength								
No. 9 25 mm (1.0 in.)	No. 10	0.20 (8)	2.49 (171)	2.16 (148)	4.5 (2.6E4)	2.17 (149)	1.93 (132)	4.6 (2.6E4)
		0.30 (12)	2.11 (145)	1.75 (120)	3.9 (2.2E4)	1.83 (125)	1.55 (106)	3.9 (2.2E4)
		0.61 (24)	1.70 (116)	1.31 (89)	2.9 (1.6E4)	1.44 (99)	1.13 (77)	2.9 (1.6E4)
	No. 12	0.20 (8)	2.64 (181)	2.31 (158)	4.5 (2.6E4)	2.30 (158)	2.06 (141)	4.6 (2.6E4)
		0.30 (12)	2.22 (152)	1.86 (127)	3.9 (2.2E4)	1.93 (132)	1.65 (113)	3.9 (2.2E4)
		0.61 (24)	1.76 (121)	1.37 (94)	2.9 (1.6E4)	1.50 (103)	1.19 (81)	2.9 (1.6E4)
	None	NA	1.49 (102)	1.24 (85)	0.5 (2.8E3)	1.24 (85)	1.06 (73)	0.4 (2.4E3)
No. 10 25 mm (1.0 in.)	No. 10	0.20 (8)	2.57 (176)	2.21 (152)	4.5 (2.6E4)	2.24 (153)	1.98 (135)	4.6 (2.6E4)
		0.30 (12)	2.18 (149)	1.80 (123)	3.9 (2.2E4)	1.89 (129)	1.59 (109)	3.9 (2.2E4)
		0.61 (24)	1.76 (121)	1.35 (93)	2.9 (1.6E4)	1.49 (102)	1.16 (80)	2.9 (1.6E4)
	No. 12	0.20 (8)	2.71 (186)	2.37 (162)	4.5 (2.6E4)	2.37 (162)	2.11 (145)	4.6 (2.6E4)
		0.30 (12)	2.29 (157)	1.91 (131)	3.9 (2.2E4)	1.99 (136)	1.70 (116)	3.9 (2.2E4)
		0.61 (24)	1.83 (125)	1.41 (97)	2.9 (1.6E4)	1.56 (107)	1.22 (84)	2.9 (1.6E4)
	None	NA	1.58 (108)	1.31 (89)	0.5 (2.8E3)	1.31 (90)	1.12 (77)	0.4 (2.4E3)
No. 10 38 mm (1.5 in.)	No. 10	0.20 (8)	2.62 (180)	2.25 (154)	4.5 (2.6E4)	2.29 (157)	2.01 (138)	4.6 (2.6E4)
		0.30 (12)	2.23 (153)	1.83 (126)	3.9 (2.2E4)	1.93 (132)	1.62 (111)	3.9 (2.2E4)
		0.61 (24)	1.81 (124)	1.39 (95)	2.9 (1.6E4)	1.53 (105)	1.19 (82)	2.9 (1.6E4)
	No. 12	0.20 (8)	2.77 (190)	2.41 (165)	4.5 (2.6E4)	2.42 (166)	2.15 (147)	4.6 (2.6E4)
		0.30 (12)	2.34 (161)	1.95 (133)	3.9 (2.2E4)	2.04 (139)	1.73 (118)	3.9 (2.2E4)
		0.61 (24)	1.88 (129)	1.45 (99)	2.9 (1.6E4)	1.60 (109)	1.25 (86)	2.9 (1.6E4)
	None	NA	1.64 (112)	1.36 (93)	0.5 (2.8E3)	1.37 (94)	1.16 (80)	0.4 (2.4E3)
No. 12 38 mm (1.5 in.)	No. 10	0.20 (8)	2.84 (194)	2.41 (165)	4.5 (2.6E4)	2.47 (169)	2.14 (147)	4.6 (2.6E4)
		0.30 (12)	2.44 (167)	1.98 (136)	3.9 (2.2 E4)	2.10 (144)	1.74 (119)	3.9 (2.2E4)
		0.61 (24)	2.01 (138)	1.53 (105)	2.9 (1.6E4)	1.69 (116)	1.30 (89)	2.9 (1.6E4)
	No. 12	0.20 (8)	2.99 (205)	2.57 (176)	4.5 (2.6E4)	2.61 (179)	2.29 (157)	4.6 (2.6E4)
		0.30 (12)	2.55 (175)	2.09 (143)	3.9 (2.2E4)	2.21 (151)	1.85 (127)	3.9 (2.2E4)
		0.61 (24)	2.08 (142)	1.59 (109)	2.9 (1.6E4)	1.76 (120)	1.36 (93)	2.9 (1.6E4)
	None	NA	1.89 (130)	1.57 (107	0.5 (2.8E3)	1.58 (108)	1.34 (92)	0.4 (2.4E3)

a Diaphragms must be constructed in accordance with clause 9.2.
b An ASD safety factor of 2.5 has been applied to V_{10} and V_{50} values.
c Screw sizes correspond to the following crest diameters: No. 9 = 4.50 mm (0.177 in.), No. 10 = 4.75 mm (0.187 in.), and No. 12 = 5.40 mm (0.211 in.)

Table 4 – Adjustment factor for diaphragm length, F_L*

Length m (ft)	F_L*	Length m (ft)	F_L*	Length m (ft)	F_L*	Length m (ft)	F_L*
3.0 (10)	1.00	6.1 (20)	0.38	9.1 (30)	0.17	12.2 (40)	0.06
3.3 (11)	0.89	6.4 (21)	0.35	9.4 (31)	0.15	12.5 (41)	0.05
3.7 (12)	0.79	6.7 (22)	0.32	9.7 (32)	0.14	12.8 (42)	0.05
4.0 (13)	0.71	7.0 (23)	0.29	10.1 (33)	0.13	13.1 (43)	0.04
4.3 (14)	0.64	7.3 (24)	0.27	10.4 (34)	0.12	13.4 (44)	0.03
4.6 (15)	0.58	7.6 (25)	0.25	10.7 (35)	0.11	13.7 (45)	0.03
4.9 (16)	0.53	7.9 (26)	0.23	11.0 (36)	0.10	14.0 (46)	0.02
5.2 (17)	0.49	8.2 (27)	0.21	11.3 (37)	0.09	14.3 (47)	0.02
5.5 (18)	0.44	8.5 (28)	0.20	11.6 (38)	0.08	14.6 (48)	0.01
5.8 (19)	0.41	8.8 (29)	0.18	11.9 (39)	0.07	14.9 (49)	0.01
						15.2 (50)	0.00

* Adjustment factor equation: F_L = (3.81 m) /d_i – 0.25 = (12.5 ft) /d_i – 0.25

9.2.4. Blocking. Blocking shall be placed between purlins at locations where diaphragm loads transfer to shear walls. Diaphragms with stitch screws spaced 0.20, 0.30 and 0.61 m (8, 12 and 24 in.) on center require structural screws into the blocking at a spacing of 0.20, 0.30 and 0.30 m (8, 12 and 12 in.) on center, respectively, at locations where diaphragm loads transfer to shear walls.

9.3 Allowable diaphragm unit shear strength. Allowable diaphragm unit shear strength, $V_{a,i}$, is governed by either cladding fastener failure (clause 9.3.1) or cladding buckling (clause 9.3.2). The lowest of the unit shear strengths calculated using clauses 9.3.1 and 9.3.2 governs. Calculated values are for allowable stress design (ASD).

9.3.1 Allowable diaphragm unit shear strength as governed by cladding fastener failure. Table 3 provides ASD unit shear strength values as governed by cladding fastener failure. Values V_{10} and V_{50} in Table 3 are applicable to 3.0 m (10 ft) and 15.2 m (50 ft) length diaphragms, respectively. For diaphragms with lengths between 3.0 and 15.2 m, use Equation 14 to calculate unit shear strength. An ASD safety factor of 2.5 is included in all unit shear strength values in Table 3.

$$V_{a,i} = F_L\ (V_{10} - V_{50}) + V_{50} \quad (14)$$

where:

$V_{a,i}$ = allowable in-plane shear strength of diaphragm i, kN/m (lbf/ft);

F_L = adjustment factor for diaphragm length from Table 4, dimensionless;

= 3.81 m / d_i – 0.25

= 12.5 ft /d_i – 0.25

d_i = length of the building diaphragm in the plane of the diaphragm, m (ft);

V_{10} = allowable design unit shear strength for 3.0 m (10 ft) long diaphragm, kN/m (lbf/ft);

V_{50} = allowable design unit shear strength for 15.2 m (50 ft) long diaphragm, kN/m (lbf/ft).

9.3.2 Allowable diaphragm unit shear strength as governed by cladding buckling. Table 5 provides diaphragm unit shear strength values as governed by cladding buckling. The buckling unit shear strength is dependent on the dimensions of the major rib (height, top width, and bottom width of the major rib). Linear interpolation may be used for intermediate major rib dimensions. An ASD safety factor of 2.5 is included in all Table 5 values.

9.4 Effective shear modulus, *G*. The effective shear modulus, G, used in Equation 3 is the in-plane stiffness of a building diaphragm with a width s and an in-plane length d_i. G is a function of the stiffness modulus G' of the cladding and cladding fasteners (see clause 9.4.1) and the stiffness K_R of the rafter-purlin and rafter-shear block connections (see clause 9.4.2) and is calculated as:

$$G = s\ /[(s/G') + (2d_i/K_R)] \quad (15)$$

where:

G = effective shear modulus of the steel-clad, wood-framed diaphragm, kN/mm (lbf/in.);

G' = stiffness modulus of cladding and cladding fasteners from Table 3 kN/mm (lbf/in.);

s = frame spacing (width between rafters) m (ft);

d_i = length of diaphragm *i* as measured parallel to trusses/rafters (see Figure 2), m (ft);

K_R = total stiffness of all rafter-purlin and rafter-shear block connections on a single rafter, kN/mm (lbf/in.)

Table 5 – ASD allowable diaphragm unit shear strength as governed by cladding buckling [a]

Major Rib Spacing	Major Rib Height [c]	Top Width of Major Rib[c] mm (in.)	Bottom Width of Major Rib [c]					
			36 mm (1.4 in.)	38 mm (1.5 in.)	44 mm (1.75 in.)	51 mm (2.0 in.)	57 mm (2.25 in.)	63.5 mm (2.5 in.)
			ASD Shear Strength, $V_{a,i}$,[b] kN/m (lbf/ft)					
26 Gage Steel, 0.475 mm (0.0187 in.) thick								
0.23 m (9.0 in.)	19 mm (0.75 in.)	13 (0.50)	4.97 (341)	5.02 (344)	5.13 (352)	5.26 (360)	5.39 (369)	5.52 (379)
		19 (0.75)	5.43 (372)	5.47 (375)	5.56 (381)	5.67 (389)	5.79 (397)	5.92 (406)
	22 mm (0.87 in.)	13 (0.50)	6.42 (440)	6.47 (443)	6.60 (452)	6.75 (462)	6.90 (473)	7.06 (484)
		19 (0.75)	6.99 (479)	7.03 (482)	7.15 (490)	7.27 (498)	7.41 (508)	7.56 (518)
	25 mm (1.0 in.)	13 (0.50)	8.03 (551)	8.09 (554)	8.24 (564)	8.40 (576)	8.58 (588)	8.77 (601)
		19 (0.75)	8.73 (598)	8.77 (601)	8.90 (610)	9.04 (620)	9.20 (631)	9.37 (642)
0.30 m (12.0 in.)	19 mm (0.75 in.)	13 (0.50)	4.08 (280)	4.11 (282)	4.21 (288)	4.31 (295)	4.41 (302)	4.52 (310)
		19 (0.75)	4.46 (306)	4.49 (308)	4.57(313)	4.65 (319)	4.75 (325)	4.85 (332)
	22 mm (0.87 in.)	13 (0.50)	5.27 (361)	5.31 (364)	5.42(371)	5.53 (379)	5.66 (388)	5.79 (397)
		19 (0.75)	5.75 (394)	5.78 (396)	5.87 (402)	5.97 (409)	6.08 (417)	6.20 (425)
	25 mm (1.0 in.)	13 (0.50)	6.61 (453)	6.65 (456)	6.77 (464)	6.90 (473)	7.04 (482)	7.19 (493)
		19 (0.75)	7.18 (492)	7.22 (495)	7.32 (501)	7.43 (509)	7.56 (518)	7.69 (527)
28 Gage Steel, 0.399 mm (0.0157 in.) thick								
0.23 m (9.0 in.)	19 mm (0.75 in.)	13 (0.50)	3.44 (236)	3.47 (238)	3.56 (244)	3.65 (250)	3.75 (257)	3.86 (265)
		19 (0.75)	3.73 (256)	3.76 (258)	3.84 (263)	3.92 (269)	4.02 (275)	4.12 (282)
	22 mm (0.87 in.)	13 (0.50)	4.45 (305)	4.49 (308)	4.59 (315)	4.70 (322)	4.82 (330)	4.95 (339)
		19 (0.75)	4.83 (331)	4.86 (333)	4.95 (339)	5.05 (346)	5.16 (353)	5.28 (362)
	25 mm (1.0 in.)	13 (0.50)	5.59 (383)	5.63 (386)	5.74 (394)	5.87 (402)	6.01 (412)	6.15 (422)
		19 (0.75)	6.05 (415)	6.09 (417)	6.18 (424)	6.30 (432)	6.42 (440)	6.56 (449)
0.30 m (12.0 in.)	19 mm (0.75 in.)	13 (0.50)	2.79 (191)	2.82 (193)	2.89 (198)	2.96 (203)	3.04 (209)	3.13 (214)
		19 (0.75)	3.03 (208)	3.05 (209)	3.11 (213)	3.18 (218)	3.26 (223)	3.34 (229)
	22 mm (0.87 in.)	13 (0.50)	3.62 (248)	3.65 (250)	3.73 (255)	3.82 (262)	3.91 (268)	4.01 (275)
		19 (0.75)	3.93 (269)	3.95 (271)	4.02 (276)	4.10 (281)	4.19 (287)	4.28 (293)
	25 mm (1.0 in.)	13 (0.50)	4.55 (312)	4.58 (314)	4.67 (320)	4.77 (327)	4.88 (334)	4.99 (342)
		19 (0.75)	4.93 (338)	4.95 (340)	5.03 (345)	5.12 (351)	5.22 (358)	5.33 (365)
29 Gage Steel, 0.361 mm (0.0142 in.) thick								
0.23 m (9.0 in.)	19 mm (0.75 in.)	13 (0.50)	2.90 (198)	2.92 (200)	3.00 (206)	3.08 (211)	3.17 (217)	3.26 (224)
		19 (0.75)	3.14 (215)	3.17 (217)	3.23 (222)	3.31 (227)	3.39 (232)	3.48 (238)
	22 mm (0.87 in.)	13 (0.50)	3.76 (257)	3.79 (260)	3.88 (266)	3.97 (272)	4.08 (279)	4.18 (287)
		19 (0.75)	4.07 (279)	4.10 (281)	4.17 (286)	4.26 (292)	4.36 (299)	4.46 (306)
	25 mm (1.0 in.)	13 (0.50)	4.72 (323)	4.76 (326)	4.85 (333)	4.96 (340)	5.08 (348)	5.21 (357)
		19 (0.75)	5.10 (350)	5.14 (352)	5.22 (358)	5.32 (364)	5.43 (372)	5.55 (380)
0.30 m (12.0 in.)	19 mm (0.75 in.)	13 (0.50)	2.35 (161)	2.37 (163)	2.43 (167)	2.50 (171)	2.57 (176)	2.64 (181)
		19 (0.75)	2.55 (175)	2.57 (176)	2.62 (180)	2.68 (184)	2.75 (188)	2.82 (193)
	22 mm (0.87 in.)	13 (0.50)	3.07 (210)	3.10 (212)	3.17 (217)	3.25 (223)	3.34 (229)	3.43 (235)
		19 (0.75)	3.31 (227)	3.33 (228)	3.39 (232)	3.46 (237)	3.54 (242)	3.62 (248)
	25 mm (1.0 in.)	13 (0.50)	3.86 (265)	3.89 (267)	3.97 (272)	4.07 (279)	4.17 (285)	4.27 (293)
		19 (0.75)	4.16 (285)	4.18 (286)	4.25 (291)	4.32 (296)	4.41 (302)	4.50 (309)
30 Gage Steel, 0.323 mm (0.0127 in.) thick								
0.23 m (9.0 in.)	19 mm (0.75 in.)	13 (0.50)	2.36 (162)	2.39 (164)	2.45 (168)	2.52 (173)	2.60 (178)	2.67 (183)
		19 (0.75)	2.56 (175)	2.58 (177)	2.64 (181)	2.70 (185)	2.77 (190)	2.85 (195)
	22 mm (0.87 in.)	13 (0.50)	3.07 (210)	3.10 (212)	3.17 (217)	3.25 (223)	3.34 (229)	3.43 (235)
		19 (0.75)	3.32 (228)	3.34 (229)	3.41 (234)	3.48 (239)	3.56 (244)	3.65 (250)
	25 mm (1.0 in.)	13 (0.50)	3.86 (265)	3.89 (267)	3.97 (272)	4.07 (279)	4.17 (285)	4.27 (293)
		19 (0.75)	4.17 (286)	4.20 (288)	4.27 (293)	4.35 (298)	4.45 (305)	4.55 (311)
0.30 m (12.0 in.)	19 mm (0.75 in.)	13 (0.50)	1.92 (131)	1.94 (133)	1.99 (136)	2.04 (140)	2.10 (144)	2.17 (148)
		19 (0.75)	2.08 (142)	2.09 (144)	2.14 (147)	2.19 (150)	2.25 (154)	2.31 (158)
	22 mm (0.87 in.)	13 (0.50)	2.49 (171)	2.51 (172)	2.57 (176)	2.64 (181)	2.71 (186)	2.78 (191)
		19 (0.75)	2.70 (185)	2.72 (186)	2.77 (190)	2.83 (194)	2.89 (198)	2.96 (203)
	25 mm (1.0 in.)	13 (0.50)	3.14 (215)	3.16 (217)	3.23 (221)	3.30 (226)	3.38 (232)	3.47 (237)
		19 (0.75)	3.40 (233)	3.42 (234)	3.47 (238)	3.54 (242)	3.61 (247)	3.69 (253)

a Diaphragms must be constructed in accordance with clause 9.2.
b An ASD safety factor of 2.5 has been applied to $V_{a,i}$ values.
c Linear interpolation may be used for intermediate major rib dimensions.

9.4.1 Stiffness modulus of cladding and cladding fasteners, *G'*. Table 3 provides stiffness modulus values attributable to the cladding and cladding fasteners for diaphragms that meet the construction specification in clause 9.2. Stiffness modulus *G'* accounts for deformations from shear strain of the steel, panel warping, and cladding-to-framing fastener slip.

9.4.2 Stiffness of rafter-purlin and rafter-shear blocking connections, K_R. Diaphragm stiffness associated with rafter-purlin connector slip and rafter-shear blocking connector slip is calculated as:

$$K_R = N_P K_P + N_{sb} K_{sb} \quad (16)$$

where:

K_R = total stiffness of purlin and shear block connectors for a single rafter, kN/mm (lbf/in.)

N_p = number of purlins attached to a single rafter

K_p = stiffness of one rafter-purlin connection, kN/mm (lbf/in.)

N_{sb} = number of shear blocks attached to a single rafter

K_{sb} = stiffness of one shear block connection, kN/mm (lbf/in.)

Table 6 provides stiffness values for rafter-purlin and rafter-shear block connections. If purlins or blocking of different size, connection type, or significantly different specific gravity are used, the connection stiffness can be determined through testing using methods similar to those established by Leflar (2008).

Table 6 – Stiffness of rafter-purlin and rafter-shear block connections

Member	Connection	Size	Orientation	Location	Specific Gravity	Stiffness kN/m (lbf/in.)
Purlin	1-60d post-frame ring shank nail (ASTM F1667 NL PF - 19B	38 × 89 mm	on-edge	on top of rafter	0.42	0.175 (1.0E3)
Shear block	2-60d post-frame ring shank nails (ASTM F1667 NL PF – 19B	38 × 89 mm	on-edge	on top of rafter	0.42	1.75 (1.0E4)

Annex A
(informative)
Bibliography

The following documents are cited as reference sources used in the development of this Engineering Practice:

Aguilera, D. 2014. Development of strength and stiffness design values for steel-clad, wood-framed diaphragms. M.S. thesis, Department of Civil and Environmental Engineering, Washington State University, Pullman, WA.

Anderson, G. A., D. S. Bundy, and N. F. Meador. 1989. The force distribution method: Procedure and application to the analysis of buildings with diaphragm action. *Transactions of the ASAE* 32(5):1791-1796.

Anderson, G. A. and D. S. Bundy. 1989b. Characterizing diaphragm shear stiffness and diaphragm-frame interaction analysis. *Transactions of the ASAE* 32(5): 1785-1790.

Bohnhoff, D. R. 1992. Expanding diaphragm analysis for post-frame buildings. *Applied Engineering in Agriculture* 35(4):509-517.

Bohnhoff, D. R. 1992b. Estimating frame stiffness and eave loads for diaphragm analysis of post-frame buildings. *Transactions of the ASAE* 35(3): 1043-1054.

Gebremedhin, K.G., E.L. Bahler and S.R. Humphreys. 1986. A modified approach to post-frame design using diaphragm theory. *Transactions of the ASAE* 29(5):1364-1372.

Gebremedhin, K. G. 1987b. *Diaphragm design of metal-clad post-frame buildings using microcomputers*. Ithaca, NY: Northeast Regional Agricultural Engineering Service, Cornell University.

Gebremedhin, K. G., J. A. Bartscwh, and M. C. Jorgensen. 1992. Full-scale test of post-frame buildings. In *Post-Frame Building Design*. ASAE Monograph No. 11. ASAE, St. Joseph, MI 49085.

Gebremedhin, K. G., and M. C. Jorgensen. 1993. Stiffness of post-frame building endwalls. *Transactions of the ASAE* 36(3):905-913.

Gebremedhin, K. G., H. B. Manbeck, and E. L. Bahler. 1992. Diaphragm analysis and design of post-frame buildings. In *Post-Frame Building Design*. ASAE Monograph No. 11. ASAE, St. Joseph, MI 49085.

Leflar, J.A. 2008. A Mathematical Model of Steel-Clad Wood-Frame Shear Diaphragms. Unpublished M.S. thesis, Department of Civil and Environmental Engineering, Colorado State University, Fort Collins, CO.

Luttrell, L. D. 1992. *Diaphragm Design Manual*. Steel Deck Institute, Second Edition, Fox River Grove, IL.

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Shallow Post and Pier Foundation Design

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Keywords: Foundation, Post, Shallow, Structures

1 Purpose and scope

1.1 Purpose. The purpose of this Engineering Practice is to present a procedure for determining the adequacy of shallow, isolated post and pier foundations in resisting applied structural loads. This Engineering Practice will help ensure that soil and backfill are not overloaded, foundation elements have adequate strength, frost heave is minimized, and lateral movements are not excessive.

1.2 Scope. This engineering practice contains safety factors and other provisions for allowable stress design (ASD) which is also known as working stress design, and for load and resistance factor design (LRFD) which is also known as strength design. It also contains properties and procedures for modeling soil deformation for use in structural building frame analyses.

1.2.1 Limitations. Application of this Engineering Practice is limited to post and pier foundations with the following characteristics:

- vertically installed in relatively level terrain;
- concentrically-loaded footings;
- minimum post or pier foundation spacing equal to the greater of 4.5 times the maximum dimension of the post/pier cross-section, or three times the maximum dimension of a footing or attached collar.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies unless noted. For undated references, the latest approved edition of the referenced document (including any amendments) applies.

2.1 Structural design specifications

ACI 318, Building Code Requirements for Structural Concrete and Commentary

ANSI/AWC NDS, National Design Specification (NDS) for Wood Construction with Commentary

ANSI/ASAE EP484, Diaphragm Design of Metal-Clad, Wood-Frame Rectangular Buildings

ANSI/ASAE EP559, Design Requirements and Bending Properties for Mechanically Laminated-Wood Assemblies

ASCE/SEI 7-10, Minimum Design Loads for Buildings and Other Structures

SEI/ASCE 32, Design and Construction of Frost-Protected Shallow Foundations

2.2 Laboratory soil testing standards

ASTM D422, Standard Test Method for Particle-Size Analysis of Soils

ASTM D854, Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer

ASTM D2166, Standard Test Method for Unconfined Compressive Strength of Cohesive Soil

ASTM D2435, Standard Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading

ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D2850, Standard Test Method for Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D3080, Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions

ASTM D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D4643, Test Method for Determination of Water (Moisture) Content of Soil by Microwave Oven Heating

ASTM D4767, Standard Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils

ASTM D7181, Standard Test Method for Consolidated Drained Triaxial Compression Test for Soils

2.3. In-situ soil testing standards

ASTM D1586, Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

ASTM D2573, Standard Test Method for Field Vane Shear Test in Cohesive Soil

ASTM D3441, Standard Test Method for Mechanical Cone Penetration Tests of Soil

ASTM D4719, Standard Test Method for Prebored Pressuremeter Testing in Soils

ASTM D1194, Standard Test Method for Bearing Capacity of Soil for Static Load and Spread Footings (withdrawn 2003)

ASTM D4750, Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)

ASTM D5778, Standard Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils

2.4 Preservative-treated wood standard

AWPA U1, Use Category System: User Specification for Treated Wood

2.5 Nomenclature standard

ANSI/ASABE S618, Post-Frame Building System Nomenclature

3 Definitions

3.1 Foundation types and components

3.1.1 backfill: Material filling the excavation around a post or pier foundation. See Figure 5.

3.1.2 collar: Foundation component attached to a post or pier, and that moves with it to resist lateral and vertical loads. See Figure 5.

3.1.3 driven pier or post: A pier or post that is pounded or turned into the ground. A pier or post foundation not requiring prior soil excavation. Also referred to as a displacement pier or post. See Figure 2.

3.1.4 footing: Foundation component at the base of a post or pier that provides resistance to vertical downward forces. When properly attached to the post/pier, a footing aids in the resistance of lateral and vertical uplift forces, and embedment depth is measured to the base of the footing instead of to the top of the footing. See Figures 1 through 5.

3.1.5 helical pier: A pier comprised of a steel pipe or tubing with an attached helix or helices. See Figure 2. Helices are also known as auger flighting. A helical pier is a type of driven pier that is turned into the soil in a manner that minimizes soil movement/displacement.

3.1.6 pedestal: A relatively short column that can support vertical forces, but is not designed to transmit horizontal shear, and bending moments. This engineering practice is not applicable to the design of pedestals.

3.1.7 pier: A relatively short column partly embedded in the soil to provide lateral and vertical support for a building or other structure. Piers include members of any material with assigned structural properties such as solid or laminated wood, steel, or concrete. Piers differ from embedded posts in that they seldom extend above the lowest horizontal framing element in a structure, and when they do, it is often only a few centimeters. See Figures 2 through 4.

3.1.8 pier foundation: An assembly consisting of a pier and all below-grade elements, which may include a footing, uplift resistance system, and collar. See Figure 3.

3.1.9 pile: A relatively long and slender column driven, screwed, jacked, vibrated, drilled or otherwise installed into soil to provide lateral and vertical support for a structure. Generally used to carry loads through weak layers of soil to those capable of supporting such loads. This engineering practice is not applicable to the design of piles.

3.1.10 pole: A round post.

3.1.11 post: A structural column that functions as a major foundation element by providing lateral and vertical support for a structure when it is embedded in the soil. Posts include members of any material with assigned structural properties such as solid or laminated wood, steel, or concrete. See Figures 1 and 5.

3.1.12 post foundation: An assembly consisting of an embedded post and all below-grade elements, which may include a footing, uplift resistance system, and collar. See Figure 1.

3.1.13 screw anchor: A helical pier primarily designed to handle uplift or tension forces.

3.1.14 shallow foundation: A foundation for which deformation under load is small, so foundation movement approximates rigid body motion. Foundation deformation is kept small by selection of foundation depth, d, and post/pier bending stiffness, $E_p I_p$.

3.1.15 uplift resistance system: Elements attached to an embedded post or pier, generally near the base, to increase the uplift resistance of a foundation system. See Figures 1 through 5.

3.2 Foundation geometry and constraints

3.2.1 constrained post (or pier): A post or pier foundation that is restrained from significant horizontal movement at the ground surface, typically by a concrete slab.

3.2.2 foundation depth, d_F: Vertical distance from the ground surface to the bottom of a post or pier foundation. Typically the vertical distance from the ground surface to the base of the footing.

3.2.3 non-constrained post (or pier): A post or pier foundation that is not restrained from moving horizontally at or above the ground surface.

3.2.4 post (or pier) embedment depth, *d*: Vertical distance from the ground surface to the bottom of the embedded post or pier. Includes the thickness of the footing when the footing is rigidly attached to the post/pier or is cast integrally with the post/pier.

3.2.5 post (or pier) width, *B*: The cross-sectional dimension that is perpendicular to the direction of lateral post/pier movement. This width defines the area of contact between the foundation and soil that resists lateral post/pier movement. The width of a round post or pier is its diameter.

3.3 Material properties and characteristics

3.3.1 cohesion of soil, *c*: Component of soil shear strength due to cementation or bonding at particle contacts resulting from ionic bonds, hydrogen bonds, and gravitational attraction.

3.3.2 controlled low-strength material (CLSM): A self-leveling and self-compacting, cementitious material with an unconfined compressive strength of 8 MPa (1200 psi) or less. Other terms used to describe controlled low-strength material (CLSM) include flowable fill, unshrinkable fill, controlled density fill, flowable mortar, flowable fly ash, fly ash slurry, plastic soil-cement and soil-cement slurry.

3.3.3 constant of horizontal subgrade reaction, n_h: Soil property used in the calculation of horizontal soil stiffness. When divided by post/pier width *b*, the constant of horizontal subgrade reaction establishes the rate at which the modulus of horizontal subgrade reaction increases with depth.

3.3.4 dry bulk density of soil, ρ_D: Oven-dried mass of a soil divided by its in-situ volume. Also known as dry unit weight.

3.3.5 effective stress: Net stress across points of contact of soil particles, generally considered as equivalent to the total stress minus the pore water pressure.

3.3.6 frost heave: Surface distortion caused by volume expansion within the soil when water freezes and ice lenses form.

3.3.7 moist bulk density of soil, ρ: Mass of a soil divided by its in-situ volume. Also known as wet unit weight.

3.3.8 Poisson's ratio, *v*: Transverse (lateral) strain divided by the corresponding axial (longitudinal) strain that occurs when a uniformly distributed axial load is applied to a soil sample whose transverse expansion is not restricted during load application.

3.3.9 soil friction angle, ϕ: Slope angle of Mohr-Coulomb shear strength criterion for soils, where shear strength = $\sigma \tan \phi + c$.

3.3.10 swelling soil: A soil material, particularly clays, that exhibit expansion with increasing moisture content, and shrinkage with decreasing moisture content. Also referred to as an expansive soil.

3.3.11 total stress: Total pressure exerted in any direction by both soil and water.

3.3.12 undrained shear strength, S_U: Shear strength of soil sheared such that pore water pressure is not allowed to dissipate (i.e., undrained condition). Shear strength criterion typically used for short-term loading of soil with significant clay content.

3.3.13 Young's modulus for soil, E_S: Uniaxial compressive stress divided by the corresponding uniaxial strain of a soil sample whose transverse (lateral) expansion is not restricted during load application.

3.4 Structural loads and analysis

3.4.1 allowable stress design: A method of proportioning structural members such that elastically computed stresses produced in the members by nominal loads do not exceed specified allowable stresses. Also called "working stress design".

3.4.2 bearing pressure, *q*: Pressure applied normal to the base of the foundation by the soil in response to all downward forces acting on the foundation.

3.4.3 modulus of horizontal subgrade reaction, *k*: Ratio of the load per unit area on a vertical soil surface to the corresponding lateral displacement of the surface. Also known as the coefficient of horizontal subgrade reaction. It is a function of soil properties, surface area over which the pressure is applied, depth below grade at which the pressure is applied, and the magnitude of the lateral displacement.

3.4.4 modulus of vertical subgrade reaction, k_v: Ratio of the load per unit area on a horizontal soil surface to the corresponding vertical displacement of the surface. Also known as the coefficient of subgrade reaction or subgrade modulus.

3.4.5 lateral loading: Any horizontally-directed forces applied to the foundation.

3.4.6 lateral soil pressure, *p*: Net soil pressure acting normal to the sides of the foundation in response to horizontal displacements of the foundation.

3.4.7 load combination: A combination of nominal loads that can reasonably be expected to act on a structure. Loads in a particular combination will be reduced by load factors where there is a low probability of them simultaneously acting at their full value. Load factors in load combinations for strength design also account for uncertainties in structural analyses, and uncertainties surrounding nominal load calculations.

3.4.8 load factor: A factor that accounts for deviations of the actual load from the nominal loads, for uncertainties in the analysis that transforms the load into a load effect, and for the probability that more than one extreme load will simultaneously occur.

3.4.9 nominal loads: The magnitudes of loads specified in ASCE 7 for dead, live, wind, snow, rain, earthquake, etc.

3.4.10 required soil strength: Equal to the product of the nominal load and a load factor.

3.4.11 resistance factor: A factor that accounts for deviations of the actual strength from the nominal strength and the manner and consequences of failure. Also called “strength reduction factor”.

3.4.12 spring constant, K_H: A value assigned to the stiffness of a spring used to model the resistance provided by a soil layer with thickness, *t*, to the lateral movement of a foundation element with thickness, *b*. Numerically equal to the product of *t*, *b* and the modulus of horizontal subgrade reaction *k*.

3.4.13 strength design: A method of proportioning structural members such that the computed forces produced in the members by the factored loads do not exceed the member design strength. Also called “load and resistance factor design”.

3.4.14 structural analysis: Any analysis used to determine the distribution of applied structural loads to various structural elements.

3.4.15 vertical loading: Any upward or downward force applied to the foundation.

3.4.16 uplift resistance: Resistance provided by the soil to the vertical force acting to withdraw the foundation.

4 Nomenclature (Symbols)

4.1 Abbreviations

ASD allowable stress design

CPT Cone Penetration Test

LRFD load and resistance factor design

SPT Standard Penetration Test

4.2 Variables and Constants. The units shown after the description of each term are suggested units. Other units that are consistent with expressions being evaluated may be used.

A footing bearing area, m^2 (in^2)

A_E linear increase in Young's modulus with depth z below grade, kPa/m (lbf/in^2/in). When A_E is multiplied by depth z, Young's modulus E_S at depth z (or $E_{S,Z}$) is obtained

A_P cross-sectional area of post/pier, m^2 (in^2). For helical piers, A_P is the cross-sectional area of the shaft (it does not include the area of the attached helix)

b width of the face of the post/pier, footing, or collar that applies load to the soil when the foundation moves laterally, m (in)

b_G post/pier face width at the ground surface, m (in)

B diameter of a round footing or side length of a square footing, m (in)

B_U diameter of a circular uplift resisting system or the smaller of the two dimensions characterizing a rectangular uplift resisting system, m (in)

c cohesion of soil, kPa (lbf/in^2)

C_{CPT} constant relating CPT blow counts to bearing resistance, kPa (lbf/in^2)

C_{PB} empirical bearing capacity coefficient for adjustment of pressuremeter readings, dimensionless

C_{SPT} constant relating SPT blow counts to bearing resistance, kPa (lbf/in^2)

C_{w1} correction factor for effect of ground water location on the ultimate bearing strength of cohesionless soils, dimensionless

C_{w2} correction factor for effect of ground water location on the ultimate bearing strength of cohesionless soils, dimensionless

d post/pier embedment depth, m (in)

d_c depth factor for ultimate bearing strength of a cohesive soil based on the general bearing capacity equation, dimensionless

d_q depth factor for ultimate bearing strength of a cohesionless soil based on the general bearing capacity equation, dimensionless

d_R depth from ground surface to point of post/pier rotation, m (in)

d_{RU} depth from ground surface to point of post/pier rotation at ultimate load, m (in)

d_F foundation or footing depth, m (ft)

d_U distance between soil surface and top of the foundation uplift resisting system, m (in)

d_W distance between soil surface and top of the water table, m (in)

E_P Young's modulus for the post/pier material, kPa (lbf/in^2)

E_S Young's modulus for soil which may or may not vary with depth z, kPa (lbf/in^2)

$E_{S,B}$ Young's modulus for backfill soil which may or may not vary with depth z, kPa (lbf/in^2)

$E_{S,U}$ Young's modulus for unexcavated soil which may or may not vary with depth z, kPa (lbf/in^2)

$E_{S,Z}$ Young's modulus for unexcavated soil that is assumed equal to zero at grade and increases linearly with increasing depth z below grade, kPa (lbf/in^2)

f_B ASD factor of safety for bearing strength assessment, dimensionless

f_L ASD factor of safety for lateral strength assessment, dimensionless

f_U ASD factor of safety for uplift strength assessment, dimensionless

F_C breakout factor for soil uplift, dimensionless

F_S force in a horizontal spring used to model lateral soil resistance, kN (lbf)

F_{ASD} — F_S induced by an ASD load combination, kN (lbf)

F_{LRFD} — F_S induced by an LRFD load combination, kN (lbf)

F_{ult} — soil spring ultimate strength, kN (lbf)

g — gravitation acceleration constant, 9.81x10^{-3} kN/kg (1.0 lbf/lbm)

h — vertical extent of the uplift soil failure surface, m (in)

I_P — moment of inertia of post/pier around axis of rotation, m^4 (in^4). Equal to $w^3b/12$ for a solid rectangular post/pier

I_S — strain influence factor, dimensionless

k — modulus of horizontal subgrade reaction which may or may not vary with depth z, kN/m^3 (lbf/in^3)

k_c — modulus of horizontal subgrade reaction that is constant with depth z, kN/m^3 (lbf/in^3)

k_B — modulus of horizontal subgrade for backfill soil which may or may not vary with depth z, kN/m^3 (lbf/in^3)

k_U — modulus of horizontal subgrade reaction for unexcavated soil which may or may not vary with depth z, kN/m^3 (lbf/in^3)

k_V — modulus of vertical subgrade reaction, kN/m^3 (lbf/in^3)

K_H — stiffness of a horizontal spring used to model the resistance to lateral post/pier movement provided by a soil layer with thickness t in contact with a foundation element of width b, kN/m (lbf/in)

K_P — coefficient of passive earth pressure, dimensionless

K_U — nominal uplift coefficient of earth pressure on a vertical plane, dimensionless

L_U — length of a rectangular uplift resisting system with a width B_U, m (in)

M — bending moment in post/pier, kN-m (lbf- in)

M_F — foundation mass, kg (lbm)

M_G — bending moment in post/pier at the ground surface (at grade), kN-m (lbf- in)

M_{ASD} — M_G due to a ASD load combination, kN-m (lbf-in)

M_{LRFD} — M_G due to a LRFD load combination, kN-m (lbf-in)

M_U — ultimate groundline bending moment capacity of the foundation as limited by soil strength, kN-m (lbf-in)

n_h — constant of horizontal subgrade reaction, kN/m^3 (lbf/in^3)

N_C — bearing capacity factor that accounts for cohesion in the general bearing capacity equation, dimensionless

N_γ — bearing capacity factor that accounts for soil unit weight in the general bearing capacity equation, dimensionless

N_q — bearing capacity factor that accounts for surcharge pressures in the general bearing capacity equation, dimensionless

N_{SPT} — SPT blow count as recorded during test, Blows per 300 mm (Blows per 12 in.)

N_{60} — N_{SPT} blow count corrected for field procedures and equipment, Blows per 300 mm (Blows per 12 in.)

$(N_1)_{60}$ — N_{60} blow count normalized with respect to vertical effective stress, Blows per 300 mm (Blows per 12 in.)

p — lateral soil resistance, kPa (lbf/in^2)

p_A — atmospheric pressure, 100 kPa (2090 lbf/in^2)

p_L limit pressure from a prebored pressuremeter, kPa (lbf/in²)

p_U ultimate lateral soil resistance, kPa (lbf/in²)

$p_{U,z}$ ultimate lateral soil resistance at depth z, kPa (lbf/in²)

p_z lateral soil resistance at a depth z, kPa (lbf/in²)

P axial load in post/pier, kN (lbf)

P_{LRFD} P due to a load and resistance factor load combination, kN (lbf)

P_{ASD} P due to an allowable stress design load combination, kN (lbf)

q_B ultimate soil bearing capacity, kPa (lbf/ in²)

q_{cr} average cone penetration resistance measured over a specified depth during a CPT test. Cone penetration resistance is equal to the vertical force applied to the cone divided by its horizontally projected area, kPa (lbf/in²)

q_0 total overburden pressure at footing depth d_F, kPa (lbf/in²)

r radius of uplift resisting system (e.g. concrete collar), m (in)

R_B LRFD resistance factor for bearing strength assessment, dimensionless

R_L LRFD resistance factor for lateral strength assessment, dimensionless

R_U LRFD resistance factor for uplift strength assessment, dimensionless

s_c shape factor for ultimate bearing strength of a cohesive soil based on the general bearing capacity equation, dimensionless

s_q shape factor for ultimate bearing strength of a cohesionless soil based on the general bearing capacity equation, dimensionless

s_γ shape factor for ultimate bearing strength of a cohesionless soil based on the general bearing capacity equation, dimensionless

s_F shape factor for uplift resistance in cohesionless soils, dimensionless

S_{LU} increase per unit depth in the ultimate lateral force per unit depth that is applied to a foundation by a cohesionless soil, kPa (lbf/in²)

S_u undrained shear strength, kPa (lbf/in²). Numerically equal to cohesion, c, for a saturated clay soil

t thickness of a soil layer that is represented with a soil spring with stiffness K_S, m (in)

u_z pore water pressure at depth z, kPa (lbf/in²)

U ultimate uplift resistance due to soil mass, kN (lbf)

V shear force in post/pier, kN (lbf)

V_G V at the ground surface (at grade), kN (lbf)

V_{ASD} V_G due to a ASD load combination, kN (lbf)

V_{LRFD} V_G due to a LRFD load combination, kN (lbf)

V_U ultimate groundline shear capacity of the foundation as limited by soil strength, kN (lbf)

y lateral deflection of post/pier, m (in)

w dimension of a post/pier measured parallel to the direction of applied lateral load. Equal to width b for a round pier/pole; m (in)

z depth below the ground surface, m, (in)

γ moist unit weight of soil = $\rho\ g$, kN/m³ (lbf/ in³)

γ_D dry unit weight of soil = $\rho_D\ g$, kN/m³ (lbf/ in³)

Δ lateral deflection of post/pier at ground surface, m (in)

ε	strain, mm/mm (in /in)
θ	below grade rotation of post/pier with infinite flexural rigidity, radians
v	Poisson's ratio, dimensionless
ρ	moist bulk density of soil, kg/m^3 (lbm/in^3)
ρ_D	dry bulk density of soil, kg/m^3 (lbm/in^3)
σ	stress, kPa (lbf/in^2)
σ_v	total vertical stress, kPa (lbf/in^2)
σ'_v	effective vertical stress, kPa (lbf/in^2)
σ_{0h}	total horizontal stress at rest, kPa (lbf/in^2)
σ'_{0h}	effective horizontal stress at rest, kPa (lbf/in^2)
ϕ	effective friction angle of soil, degrees

5 Soil and backfill properties

5.1 General. This clause addresses soils that should be avoided during post/pier construction (clause 5.2) and appropriate backfill materials (clause 5.3). It also contains provisions for establishing Young's modulus (clause 5.5), undrained shear strength (clause 5.6), and friction angle (clause 5.7) of soils from applicable soil tests. Clause 5.8 addresses presumptive soil properties.

5.1.1 Drained versus undrained. When establishing soil properties, assume that all cohesive soils will be loaded undrained, even under long-term static loadings, and that all cohesionless soils will be loaded drained, even under rapid loadings such as those resulting from earthquakes and wind forces.

5.2 Poor soils. Building in organic silts, soft clays and peat soils is never recommended as these soils are either weak or inherently unstable. Extra caution should be taken when evaluating strength properties of soils with variable characteristics, composition, and moisture content.

5.2.1 Expansive soils. A soil with an expansion index greater than 20, as determined in accordance with ASTM D482, is considered expansive and should be avoided. A soil is also considered expansive if it meets both of the following criteria:

1. Plasticity index (PI) of 15 or greater, determined in accordance with ASTM D4318;
2. More than 10% of the soil particles are less than 5 micrometers in size, determined in accordance with ASTM D422.

5.3 Backfill materials. Backfill properties can have a significant impact on post/pier foundation behavior. Appropriate backfill materials include:

5.3.1 Excavated soil. Except as excluded in clause 5.2, excavated soil can generally be used for backfill. In the special case where holes are drilled in clay, it may be preferable to backfill with the excavated clay instead of a coarse-grained material (clause 5.3.2) for reasons explained in clause 13.2.3. In all cases, excavated material used as backfill should be compacted to at least its pre-excavation density and should be free of organic material and construction debris.

5.3.2 Coarse-grained soils. Replacing excavated material with a gravel or well-graded sand may be necessary where greater soil strength and stiffness are needed. Compact all backfill by tamping layers that do not exceed a thickness of 0.2 m (8 in.).

5.3.3 Concrete and CLSM. Cast-in-place concrete and controlled low-strength material (CLSM) can significantly enhance the lateral strength and stiffness of a post/pier foundation. This is because the width, *b*, of the pier/post foundation for lateral strength analysis is equated to the diameter of the concrete or CLSM backfill. Concrete and CLSM placed against soil may affect frost heaving; see clause 13 on frost heaving.

5.4 Soil tests. Obtaining soil properties by laboratory or in-situ testing reduces uncertainty and enables the application of lower factors of safety relative to those associated with ultimate strength values based on presumptive soil properties.

5.4.1 Sampling locations. For uplift and lateral strength assessments, soil sampling and in-situ soil tests should cover the distance between one-third and 100% of the anticipated foundation depth. For bearing strength assessment, in-situ soil tests should be taken at a location between the anticipated footing base and a distance B below the anticipated footing depth.

5.5 Young's modulus for soil, E_S. Young's modulus is used to calculate modulus of horizontal subgrade reaction (clause 8.2) for backfill and the surrounding soil. In order to use the Simplified Method *for determination of foundation and soil forces* (clause 8.4), E_S must increase linearly with depth or be constant with depth.

5.5.1 E_S from laboratory tests. Young's modulus can be determined for any soil using a triaxial compression test in accordance with ASTM D2850. E_s for most cohesive soils can also be determined using an unconfined compression test in accordance with ASTM D2166. E_s can also be determined from a one-dimensional consolidation test in accordance with ASTM D2435. Where horizontally applied loads are primarily due to forces that fluctuate with time (e.g., wind, stored materials), define E_S as the secant modulus associated with a major principle stress of approximately one-fourth of the soil's ultimate strength at the location being modeled.

5.5.2 E_S from prebored pressuremeter test (PMT) results. For all soils:

$$E_S = (E_O + E_R) / 2$$

where E_O is the pressuremeter first load modulus and E_R is the pressuremeter reload modulus calculated in accordance ASTM D4719.

5.5.3 E_S from cone penetration test (CPT) results. For sandy soils:

$E_S = 1.5\ q_{cr}$ for silts, sands and silty sands;

$E_S = 2\ q_{cr}$ for young, normally consolidated sands;

$E_S = 3\ q_{cr}$ for aged, normally consolidated sands;

$E_S = 4\ q_{cr}$ for sand and gravel.

where q_{cr} is average cone resistance in kPa (lbf/in.^{2}) determined in accordance with ASTM D3441.

5.5.4 E_S from standard penetration test (SPT) results.

For silts, sandy silts, slightly cohesive soils:

$$E_S \text{ (kPa)} = 380\ (N_1)_{60}$$

$$E_S \text{ (lbf/in}^2\text{)} = 56\ (N_1)_{60}$$

For clean fine to medium sands and slightly silty sands:

$$E_S \text{ (kPa)} = 670\ (N_1)_{60}$$

$$E_S \text{ (lbf/in}^2\text{)} = 97\ (N_1)_{60}$$

For coarse sands and sands with little gravel:

$$E_S \text{ (kPa)} = 960\ (N_1)_{60}$$

$$E_S \text{ (lbf/in}^2\text{)} = 140\ (N_1)_{60}$$

For sandy gravel and gravels:

$$E_S \text{ (kPa)} = 1150\ (N_1)_{60}$$

$$E_S \text{ (lbf/in}^2\text{)} = 170\ (N_1)_{60}$$

and $(N_1)_{60} = N_{60}\ (p_A / \sigma'_v)^{0.5}$

where:

$(N_1)_{60}$ is the N_{60} blow count normalized with respect to vertical effective stress;

N_{60} is the N_{SPT} blow count corrected for field procedures and equipment;

p_A is atmospheric pressure (100 kPa or 2090 lbf/ft^2 or 14.5 lbf/in^2); and

σ'_V is vertical effective stress.

5.5.5 E_S from undrained shear strength, S_U

For soft sensitive clay: E_S ranges from 400 S_U to 1000 S_U

For medium stiff to stiff clay: E_S ranges from 1500 S_U to 2400 S_U

For very stiff clay: E_S ranges from 3000 S_U to 4000 S_U

where S_U is undrained shear strength, kPa (lbf/in^2).

5.6 Constant of horizontal subgrade reaction, n_h

$$n_h = 2.0\ E_{S,Z} / z = 2.0\ A_E$$

and

$$E_{S,Z} = A_E\ z$$

where:

n_h is the modulus of horizontal subgrade reaction, kN/m^3 (lbf/in^3);

z is depth below grade, m (in);

$E_{S,Z}$ is a Young's modulus for soil that is assumed equal to zero at grade and to increase linearly with increasing depth z below grade (e.g., a cohesionless soil), kN/m^2 (lbf/in^2); and

A_E is the increase in Young's modulus per unit increase in depth z below grade, kN/m^3 (lbf/in^3).

5.7 Undrained shear strength, S_U. Is used to calculate bearing capacity, uplift resistance and lateral strength in cohesive soils.

5.7.1 S_U from laboratory tests. Determine S_U for a cohesive soil using an unconfined compressive strength test in accordance with ASTM D2166 or an unconsolidated-undrained triaxial compression test in accordance with ASTM D2850.

5.7.2 S_U from prebored pressuremeter (PBPMT) test results

$$S_U = 0.67\ p_L^{0.75} \quad \text{for } S_U \text{ and } p_L \text{ in kPa}$$

$$S_U = 0.41\ p_L^{0.75} \quad \text{for } S_U \text{ and } p_L \text{ in lbf/in}^2$$

where p_L is limit pressure determined in accordance with ASTM D4719.

5.7.3 S_U from cone penetration test (CPT) results

$$S_U = 0.037\ q_{cr}$$

where q_{cr} is average cone resistance determined in accordance with ASTM D3441.

5.7.4 S_U from field vane tests. Determine S_U of cohesive soils directly from the torque applied to a four-bladed vane shear device in accordance with ASTM D2573.

5.8 Soil friction angle, ϕ. Is required in clause 12.5.1 to calculate the uplift resistance, U, provided by a cohesionless soil. When ultimate bearing capacity, q_B, is not determined via in-situ tests, ϕ is used in the general bearing capacity equation (clause 10.4.1) to determine q_B of cohesionless soils. Likewise, ϕ is used to calculate the ultimate lateral resistance pressure, p_U, where p_U has not been determined by in-situ testing.

5.8.1 Friction angle ϕ from laboratory tests. For cohesionless soils determine the friction angle ϕ using a direct shear test in accordance with ASTM D3080 or a consolidated-drained (CD) triaxial compression test in accordance with ASTM D7181.

5.8.2 Friction angle ϕ from standard penetration test (SPT) results. For sandy soils:

$$\phi = [20\ (N_1)_{60}]^{0.5} + 20$$

and

$$(N_1)_{60} = N_{60}\ (p_A / \sigma'_v)^{0.5}$$

where:

$(N_1)_{60}$ is the N_{60} blow count normalized with respect to vertical effective stress;

N_{60} is the N_{SPT} blow count corrected for field procedures and equipment;

p_A is atmospheric pressure (100 kPa or 2090 lbf/ft^2 or 14.5 lbf/in^2); and

σ'_v is vertical effective stress.

5.8.3 Friction angle ϕ from cone penetration test (CPT) results. For sandy soils:

$$\phi = 17.6 + 11.0 \log [q_{cr} / (p_A\ \sigma'_v)^{0.5}]$$

where:

q_{cr} is average cone resistance;

p_A is atmospheric pressure (100 kPa or 2090 lbf/ft^2 or 14.5 lbf/in^2); and

σ'_v is vertical effective stress.

5.9 Presumptive values. In the absence of satisfactory soil test data or specific building code requirements, presumptive soil characteristics in Table 1 may be used.

6 Foundation material properties

6.1 General. This clause contains material requirements for post and pier foundation elements. Elements not specifically addressed by the following requirements shall be designed in accordance with applicable normative references, building codes, standards, and good engineering judgment.

6.2 Minimum concrete compressive strength. All concrete used in footings, posts and piers must have a minimum 28-day compressive strength of 3000 lbf/in^2.

6.3 Cast-in-place concrete footings

6.3.1 Minimum nominal thickness. The minimum nominal thickness of an unreinforced (plain) footing that is cast-in-place on a compacted base shall be 20 cm (8 in). The minimum thickness of a reinforced cast-in-place footing shall be such that the concrete provides a minimum cover of 7.5 cm (3 in) above and below the reinforcement. Load-induced forces may dictate a thicker footing.

6.3.2 Reinforcement. Cast-in-place concrete footings do not require steel reinforcement when the actual maximum distance from a footing edge to the nearest post/pier edge is less than the nominal thickness of the footing. Where this requirement is not met, the need for reinforcement shall be determined in accordance with ACI 318 Chapter 15.

6.4 Precast concrete footings

6.4.1 Minimum actual thickness. The minimum actual thickness of unreinforced (plain) precast footing that is placed on a flat, compacted base shall be 10 cm (4 in). The minimum thickness of a reinforced precast footing shall be such that the concrete provides a minimum cover of 4 cm (1.5 in) above and below the reinforcement. Load-induced forces may dictate a thicker footing.

6.4.2 Reinforcement. Precast concrete footings do not require steel reinforcement when the actual maximum distance from a precast footing edge to the nearest post/pier edge is less than 1.25 times the actual thickness of the footing. Where this requirement is not met, the need for reinforcement shall be determined in accordance with ACI 318 Chapter 15.

6.5 Concrete piers

6.5.1 Longitudinal reinforcement. The location and size of longitudinal reinforcement shall be determined in accordance with ACI 318 Chapter 10. The cross-sectional area of longitudinal reinforcement shall not be less than 1.0% of the gross cross-sectional area of the concrete. The minimum number of longitudinal bars shall be 4 for bars within rectangular or circular ties, 3 for bars with triangular ties and 6 for bars enclosed with spirals.

6.5.2 Shear reinforcement. The location and size of shear reinforcement shall be determined in accordance with ACI 318 Chapter 11. Shear reinforcement is not required where tests show that the required bending strength and shear strengths can be developed when shear reinforcement is omitted.

6.5.3 Cover on reinforcement. When a concrete pier is formed by casting concrete directly against earth, a minimum concrete cover of 7.5 cm (3 in) shall be provided on all steel reinforcement. When concrete is cast on site but not directly against the earth (e.g., the concrete is cast into cardboard forming tubes), the minimum concrete cover on steel reinforcement can be reduced to 5 cm (2 in) for bars 19 mm or greater in diameter (No. 6 or larger bars) and 3.8 cm (1.5 in) for bars 13 mm or smaller in diameter (No. 5 or smaller bars). Minimum concrete cover on reinforcement in precast concrete piers (i.e., piers manufactured under plant control conditions) shall be 3.8 cm (1.5 in) for bars 19 mm or greater in diameter (No. 6 or larger bars) and 3.2 cm (1.25 in) for bars 13 mm or smaller in diameter (No. 5 or smaller bars).

6.6 Embedded wood posts and piers

6.6.1 Preservative treatment. Wood used for embedded posts and piers shall be preservative treated in accordance with AWPA U1 Use Category UC4B.

6.6.2 Size. Mechanically-laminated wood posts and piers shall be sized in accordance with ASAE EP 559. All other wood posts and piers shall be sized in accordance with ANSI/AWC NDS.

6.6.3 Mechanical Fasteners. Fasteners used below grade in mechanically-laminated wood posts and piers shall meet the requirements of ASAE EP 559.

6.7 Anchor attachments. Fasteners used below grade to attach collars, footings and other devices to resist uplift forces shall have a durability equal to the service life of the structure.

6.8 CLSM base for precast concrete and wood footings. A controlled low-strength material (CLSM) placed between the bottom of a precast concrete or wood footing and the underlying soil can be used to increase the effective bearing area of the footing when its unconfined compressive strength exceeds the ultimate bearing capacity of the underlying soil.

7 Structural load combinations

7.1 General. Loads applied to the above-grade portion of a structure, shall be considered to act in the combinations specified in clause 7.2 for allowable stress design, and in clause 7.3 for strength design. More than one combination may control the design of the same structural element. Consideration shall be given to one or more loads in the same combination not acting.

7.1.1 Nominal loads. The following nominal loads shall be calculated in accordance with ASCE 7.

D nominal dead load

E nominal earthquake load

F nominal load due to fluids with well-defined pressures and maximum heights

H nominal pressure of bulk materials

L	nominal live load
L_r	nominal roof live load
R	nominal rain load
S	nominal snow load
T	self-straining force
W	nominal wind load

7.1.2 Combinations including wind and earthquake loads. The most unfavorable effects from both wind and earthquake loads shall be considered, where appropriate, but need not be assumed to act simultaneously.

7.1.3 Ice, wind-on-ice, flood, and self-straining loads. Ice, wind-on-ice, flood and self-straining loads shall be calculated in accordance with ASCE 7, and shall be used in load combinations as specified in ASCE 7.

7.1.4 Snow loads. In load combinations in which the full force of companion load S is not assumed to be acting (i.e., combinations 4 and 6 in clause 7.2 and combinations 2, 4 and 5 in clause 7.3), S shall be taken as either the flat roof snow load (p_f) or the sloped roof snow load (p_s). In combinations in which the full force of companion load S is assumed to be acting (i.e., combination 3 in clause 7.2 and combination 3 in clause 7.3), S shall account for adverse effects of partial, unbalanced, drift and sliding loads where applicable.

7.1.5 Loads due to lateral earth pressure, ground water pressure, or pressure of bulk materials. Load H shall be included with an ASD load factor of 1.0 (clause 7.2 combinations) and an LRFD load factor of 1.6 (clause 7.3 combinations) when the effect of H adds to the primary variable load effect. Where H is a permanent load and its effect resists the primary variable load effect, include H with an ASD load factor of 0.6 in clause 7.2 combinations and with a LRFD load factor of 0.9 in clause 7.3 combinations. Use a load factor of 0 when H resists the primary load variable but is not a permanent load.

7.1.6 Fluid loads. Where fluid loads F are present, they shall be included in ASD (clause 7.2) combinations 1 through 6 and 8 and in LRFD (clause 7.3) combinations 1 through 5 and 7. Assign fluid loads the same factors as used in the combination for dead load.

7.2 Load combinations for allowable stress design (a.k.a. working stress design)

1. D
2. $D + L$
3. $D + (L_r \text{ or } S \text{ or } R)$
4. $D + 0.75L + 0.75(L_r \text{ or } S \text{ or } R)$
5. $D + (0.6W \text{ or } 0.7E)$

6a. $D + 0.75L + 0.75(0.6W) + 0.75(L_r \text{ or } S \text{ or } R)$

6b. $D + 0.75L + 0.75(0.7E) + 0.75S$

7. $0.6D + 0.6W$
8. $0.6D + 0.7E$

7.3 Load combinations for load and resistance factor design (a.k.a. strength design)

1. $1.4D$
2. $1.2D + 1.6L + 0.5(L_r \text{ or } S \text{ or } R)$
3. $1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (L \text{ or } 0.5W)$
4. $1.2D + W + L + 0.5(L_r \text{ or } S \text{ or } R)$
5. $1.2D + E + L + 0.2S$
6. $0.9D + W$
7. $0.9D + E$

7.3.1 The load factor on L in LRFD load combinations 3, 4, and 5 is permitted to equal 0.5 for all occupants in which the uniformly distributed live load is less than or equal to 100 psf, which the exception of garages or areas occupied as places of public assembly.

8 Structural analysis

8.1 General. Structural analysis is the determination of the forces induced in a post/pier foundation by applied structural loads. Two methods are outlined in this clause. The Universal Method (clause 8.3) can be used to analyze any post/pier foundation. Application of the Simplified Method (clause 8.4) is limited by assumptions inherent in its development which are outlined in clause 8.4. In order to complete the calculations in clauses 8.3 and 8.4, the modulus of horizontal subgrade reaction must be established in accordance with clause 8.2.

8.1.1 Alternative analyses. Structural analyses of post and pier foundations are not restricted to the procedures outlined here. Other analytical procedures along with laboratory and field testing are available that can provide more accurate analyses. In all cases, sound engineering judgment should guide selection and application of the design procedure.

8.2 Modulus of horizontal subgrade reaction, *k*. The modulus of horizontal subgrade reaction k is the ratio of average contact pressure (between the foundation and soil) to horizontal foundation movement, and is equated to twice the effective Young's modulus for the soil divided by foundation face width. In equation form:

$$k = p_Z / \Delta_Z = 2.0\ E_{SE} / b$$

where:

k is modulus of horizontal subgrade reaction at depth z;

p_z is average contact pressure between the foundation and soil at depth z;

Δ_Z is horizontal movement of the foundation at depth z;

E_{SE} is effective Young's modulus for the soil at depth z from clause 8.2.1 or 8.2.2; and

b is face width of foundation at depth z.

8.2.1 Effective Young's modulus of soil, E_{SE}, for portions of the foundation backfilled with soil.

$$E_{SE} = \frac{1}{I_S / E_{S,B} + (1 - I_S) / E_{S,U}} \quad \text{for } 0 < J < 3b$$

$$E_{SE} = E_{S,B} \quad \text{for } J \geq 3b$$

$$E_{SE} = E_{S,U} \quad \text{for } J = 0$$

where $\quad I_S = [\ln(1 + J/b)] / 1.386 \quad$ for $0 < J < 3b$

and:

$E_{S,B}$ is E_S for backfill at depth z;

$E_{S,U}$ is E_S for the unexcavated soil surrounding the backfill at depth z;

I_S is strain influence factor, dimensionless;

b is width of the face of the foundation component (post/pier, footing, or collar) at depth z; and

J is distance (measured in the direction of lateral foundation movement) between the edge of the backfill and the face of the foundation component at depth z (see Figure 9).

The condition of J = 0 would apply to a driven pier/post for which the foundation is entirely surrounded by unexcavated soil.

8.2.2 Effective Young's modulus of soil, E_{SE}, for portions of the foundation backfilled with concrete or CLSM

At any depth below grade where concrete or CLSM backfill is present, face width *b* is equal to the width of the concrete backfill or CLSM backfill, respectively, and effective Young's modulus of the soil at that depth is equal to E_S for the unexcavated soil surrounding the concrete or CLSM backfill.

8.3 Universal Method for determination of foundation and soil forces. The Universal Method refers to any structural analysis utilizing a 2-dimensional structural analog that uses conventional frame elements to model the below grade portions of a post/pier foundation, and horizontal spring elements to model the resistance to lateral movement provided by backfill and soil (Figures 6, 7 and 8). Soil spring stiffness values are calculated in accordance with clause 8.3.1. Recommendations for soil spring and support placements are given in clauses 8.3.2 and 8.3.3, respectively. Soil spring forces provided by the subsequent structural analysis are converted to soil pressures in accordance with clause 8.3.4.

8.3.1 Soil spring stiffness. The stiffness of a horizontal soil spring, K_H, located at depth, *z*, is given as:

$$K_H = t\,k\,b = 2.0\,t\,E_{SE}$$

where:

t is thickness of the soil layer represented by the spring;

b is width of the post/pier, footing, or collar upon which soil represented by the spring is acting; and

k is modulus of horizontal subgrade reaction at depth *z* from clause 8.2.

E_{SE} is effective Young's modulus for soil at depth *z* from clause 8.2.1 or 8.2.2

8.3.2 Soil spring placement. A closer spring spacing enables more accurate estimation of post/pier forces and soil pressures and is most important where such forces and pressures change rapidly. In general, soil spring spacing, *t*, should not exceed 2*w* where *w* is the face width of a rectangular post/pier and diameter of a round post/pier.

8.3.3 Support placement. Where a post is constrained from moving laterally by a concrete slab or other rigid structure, place a vertical roller support at the point of likely contact between the post and constraining component (Figure 8a). Do not constrain post/pier movement with a roller support if the post/pier is not directly connected to the structure and will move away from it when loaded (Figure 8b). Model the interface between the base of the foundation and the soil with a horizontal roller support (Figure 8).

8.3.4 Lateral soil pressures. Lateral soil pressure at a depth *z* below the ground surface, p_z, is given as:

$$p_z = F_S \,/\, (t\,b)$$

where F_S is the force in a horizontal spring located at depth *z* that represents a soil layer with thickness *t* and width *b*. In this case, *b* is the width of the post/pier, footing, or collar upon which the soil represented by the spring is acting.

8.4 Simplified method for determination of foundation and soil forces. The Simplified Method assumes the following:

1. At-grade pier/post forces are not dependent on below-grade deformations.
2. The below-grade portion of the foundation has an infinite flexural rigidity ($E_P I_P$).
3. Unexcavated soil and backfill are each homogeneous for the entire embedment depth.
4. Young's modulus for soil is either constant for all depths below grade or is zero at grade and then linearly increases with depth below grade.
5. Width *b* of the below-grade portion of the foundation is constant. This generally means that there are no attached collars or footings that are effective in resisting lateral soil forces.

The Simplified Method can be used if the condition in clause 8.4.1 is met. The procedure uses a fixed-based structural analog described in clause 8.4.2 to determine the bending moment, axial, and shear forces induced in the post/pier near the ground surface. These forces are then substituted in the appropriate equations in clause 8.4.3 to determine lateral soil pressures as well as the ground surface displacement and rotation of the post/pier.

Equations in clause 8.4.3 utilize the sign convention shown in Figure 10. Note: V_G and M_G have the same sign if they independently rotate the foundation in the same direction.

8.4.1 Depth requirements. For soils whose modulus of horizontal subgrade reaction k increases linearly with depth, the Simplified Method can be used if:

$$d \leq 2(E_P I_P / n_h)^{0.20} = 2[E_P I_P / (2A_E)]^{0.20}$$

For soils whose modulus of horizontal subgrade reaction k is constant with depth, the Simplified Method can be used if:

$$d \leq 2[E_P I_P / (k_c b)]^{0.25} = 2[E_P I_P / (2E_{SE})]^{0.25}$$

8.4.2 Fixed base analog. The fixed base analog refers to any 2-dimensional structural analog that replaces an embedded post/pier foundation with fixed supports. For a constrained foundation (i.e., a post/pier constrained from moving laterally by a concrete slab or other rigid structure located at grade), place a vertical roller support at the point of likely contact between the post/pier and constraining component, and place a fixed support at the ground surface. For a non-constrained post/pier, place the fixed support a distance w below the ground surface, where w is the face width of a rectangular post/pier and diameter of a round post/pier (Figure 11a). The shear force, V, and bending moment, M, resisted by the fixed support shall be used in the equations of clause 8.4.3. for V_G and M_G, respectively. Note that:

$V_{LRFD} = V_G$ for LRFD

$M_{LRFD} = M_G$ for LRFD

$V_{ASD} = V_G$ for ASD

$M_{ASD} = M_G$ for ASD

8.4.3 Lateral soil pressures. For calculation of lateral soil pressures use clauses 8.4.3.1 and 8.4.3.3 for *non-constrained* posts/piers and clauses 8.4.3.2 and 8.4.3.4 for *constrained* posts/piers. The effective Young's modulus for soil E_{SE} is not required in this clause to calculate lateral soil pressures, which is one advantage of using the Simplified Method. However, the effective Young's modulus for soil is required in the following clauses for calculation of post/pier displacement parameters θ and Δ.

8.4.3.1 Non-constrained posts/piers with linearly increasing soil stiffness. The following equations for non-constrained post/pier foundations assume the effective Young's modulus for soil E_{SE} increases linearly with soil depth, and is numerically equal to $A_E z$ (Figure 12).

$$d_R = \frac{d(3\ V_G d + 4\ M_G)}{4\ V_G d + 6\ M_G} \quad \text{for } 0 \leq d_R \leq d$$

$$\theta = \frac{12\ V_G d + 18\ M_G)}{d^4 A_E}$$

$$\Delta = \frac{9\ V_G d + 12\ M_G)}{d^3 A_E}$$

$$p_z = 6z(6M_G z/d + 4V_G z - 3dV_G - 4M_G)/(d^3 b)$$

8.4.3.2 Constrained posts/piers with linearly increasing soil stiffness. The following equations for post/pier foundations constrained at grade assume the effective Young's modulus for soil E_{SE} increases linearly with soil depth, and is numerically equal to $A_E z$ (Figure 13).

$$\theta = \frac{2\ M_G}{d^4 A_E}$$

$$p_z = 4z^2 M_G / (d^4 b)$$

8.4.3.3 Non-constrained posts/piers with constant soil stiffness. The following equations for non-constrained post/pier foundations assume the effective Young's modulus for soil E_{SE} remains constant with depth (Figure 14).

$$d_R = \frac{d(2\ V_G d + 3\ M_G)}{3\ V_G d + 6\ M_G}$$

$$\theta = \frac{3\ V_G d + 6\ M_G}{d^3 E_{SE}}$$

$$\Delta = \frac{2\ V_G d + 3\ M_G}{d^2 E_{SE}}$$

$$p_z = (12 M_G z/d + 6 V_G z - 4 d V_G - 6 M_G)/(d^2 b)$$

8.4.3.4 Constrained posts/piers with constant soil stiffness. The following equations for post/pier foundations constrained at grade assume the effective Young's modulus for soil E_{SE} remains constant with depth (Figure 15).

$$\theta = \frac{1.5\ M_G}{d^3 E_{SE}}$$

$$p_z = 3 z M_G/(d^3 b)$$

9 Resistance and safety factors

9.1 Tabulated values. Tables 2, 3, 4 and 5 contain resistance factors for LRFD design and corresponding safety factors for ASD design. Table 2 values apply to bearing strength assessment, Table 3 values apply to lateral strength assessment involving the Universal Method of analysis, Table 4 values apply to lateral strength assessment involving the Simplified Method of analysis, and Table 5 values apply to uplift strength assessment.

9.2 Adjustments. For buildings and other structures that represent a low risk to human life in the event of a failure, Tables 2, 3, 4, and 5 resistance factors may be increased 25% (multiplied by 1.25), and Tables 2, 3, 4, and 5 safety factors may be reduced 20% (multiplied by 0.80). In all cases, the adjusted resistance factor is limited to a maximum value of 0.93 and the adjusted safety factor is limited to a minimum value of 1.50.

10 Bearing strength assessment

10.1 General. Clauses 10.2 and 10.3 contain equations for checking adequacy of the foundation's bearing capacity under ASD and LRFD load combinations, respectively. Clause 10.4 contains equations for calculating ultimate soil bearing capacity, q_B, a variable in the equations of clauses 10.2 and 10.3. The quantity q_0 in clauses 10.2 and 10.3 is the pressure applied by the soil overburden at the foundation base (i.e., at a depth, d_F) and is equal to γd_F for soils with a uniform unit weight γ between the soil surface and depth d_F.

Assuming that the difference is negligible between the moist unit weight γ of the soil and the average unit weight of the foundation elements, the net ultimate bearing capacity can be approximated as the difference between q_B and q_0. When the net ultimate bearing capacity is calculated in this fashion, the values of P_{ASD} and P_{LRFD} should not include the weight of foundation elements located below grade.

10.2 Allowable stress design. Bearing area is sufficient if the following inequality is met.

$$(q_B - q_0)/f_B \geq P_{ASD}/A$$

or

$$A \geq f_B\ P_{ASD}/(q_B - q_0)$$

where f_B is the allowable stress design factor of safety for bearing strength assessment from Table 2.

10.3 Load and resistance factor design. Bearing area is sufficient if the following inequality is met.

$$(q_B - q_0)\, R_B \geq P_{LRFD} / A$$

or

$$A \geq P_{LRFD} / [R_B\, (q_B - q_0)]$$

where R_B is the LRFD resistance factor for bearing strength assessment from Table 2.

10.4 Ultimate soil bearing capacity, q_B. Different methods for calculating ultimate soil bearing capacity are given in clauses 10.4.1, 10.4.2, 10.4.3, and 10.4.4. Equations in these clauses assume that the ground surrounding the location of the installed footing is level. If it is not, adjustments to calculated values must be made in accordance with common engineering practice. Correction factors C_{W1} and C_{W2} are included in equations for cohesionless soils to account for water table depth, d_W relative to foundation depth, d_F. In equation form:

$$C_{W1} = 0.5 \quad \text{when } d_W \leq d_F$$

$$= 1.0 \quad \text{when } d_W \geq 1.5\, B + d_F$$

$$= 0.5 + (d_W - d_F) / (3B) \quad \text{when } d_F < d_W < 1.5\, B + d_F$$

$$C_{W2} = 0.5 + 0.5\, d_W / d_F \quad \text{when } d_W < d_F$$

$$= 1.0 \quad \text{when } d_W \geq d_F$$

10.4.1 q_B from the general bearing capacity equation. For saturated clay soils:

$$q_B = S_u\, N_C\, d_C\, s_C + \gamma d_F$$

$$q_B = S_u\, (6.19 + 1.23\, d_F / B) + \gamma d_F \quad \text{for } d_F / B < 2.5$$

$$q_B = S_u\, 9.25 + \gamma d_F \quad \text{for } d_F / B \geq 2.5$$

where:

$N_C = 5.14$ for $\phi = 0$

$s_C = 1.2$ for square and round footings

$d_C = 1 + 0.2\, d_F / B$ for $d_F / B < 2.5$

$d_C = 1.5$ for $d_F / B \geq 2.5$

For cohesionless soils:

$$q_B = \gamma(0.5\, B\, C_{w1}\, N_\gamma\, s_\gamma + d_F\, C_{w2}\, N_q\, d_q\, s_q)$$

where:

$N_\gamma = 2\, (N_q + 1) \tan \phi$

$N_q = \exp(\pi \tan\phi) \tan^2(45 + \phi/2)$

$s_\gamma = 0.6$ for square and round footings

$s_q = 1 + \tan \phi$ for square and round footings

$d_q = 1 + 2 \tan \phi\, (1 - \sin\phi)^2 \tan^{-1}(d_F / B)$

Obtain values for C_{W1} and C_{W2} from clause 10.4. Values of N_γ, N_q, s_q and d_q for different values of ϕ are given in Table 6.

10.4.2 q_B from standard penetration test (SPT) results. Bearing resistance for foundations in sands can be taken as:

$$q_B = N_1\, C_{SPT}\, B(C_{w1} + C_{w2}\, d_F / B)$$

where:

C_{SPT} is a constant equal to 31.4 kPa/m (200 lbf/ft^3 or 0.116 lbf/in^3);

C_{w1} and C_{w2} are given in clause 10.4; and

N_1 is the SPT blow count, N_{SPT}, normalized with respect to vertical effective stress as given in clause 5.5.4. For calculations of q_B, the SPT blow count, N_{SPT}, shall be obtained within the range of depth from footing base to 1.5 B below the footing.

10.4.3 q_B from cone penetration test (CPT) results. For saturated clay soils:

$$q_B = C_{CPT1} + q_{cr} / 3$$

For cohesionless soils:

$$q_B = q_{cr} B (C_{w1} + C_{w2} d_F / B) / C_{CPT2}$$

where:

q_{cr} is average cone resistance within a depth B below the bottom of the footing;

C_{CPT1} is a constant equal to 546 kPa (11,400 lbf/ft^2 or 79.2 lbf/in^2);

C_{CPT2} is a constant equal to 12 m (40 ft or 480 in); and

C_{w1} and C_{w2} are given in clause 10.4.

10.4.4 q_B from pressuremeter test (PMT) results

$$q_B = q_o + C_{PB} (p_L - \sigma_{0h})$$

where:

q_o is the initial total vertical pressure at the base of the footing;

p_L is the average value of limiting pressures obtained from pressuremeter tests within a zone of $\pm$1.5 B above and below the footing depth d_F;

σ_{0h} is the horizontal total stress at rest for the depth where the pressuremeter test is performed; and

C_{PB} is an empirical bearing capacity coefficient given as:

$C_{PB} = 0.80 + 0.642(d_F / B) - 0.0839(d_F / B)^2$ for sands

$C_{PB} = 0.80 + 0.384(d_F / B) - 0.0572(d_F / B)^2$ for silts

$C_{PB} = 0.80 + 0.223(d_F / B) - 0.0395(d_F / B)^2$ for clays

where d_F is footing depth; and B is diameter of a round footing or side length of a square footing.

11 Lateral strength assessment

11.1 General. Where the Universal Method has been used to determine foundation and soil forces, conduct lateral stress checks in accordance with clause 11.3. This will require that ultimate lateral soil resistance first be determined in accordance with clause 11.2

For foundations that meet the following two criteria, lateral strength can be assessed using equations in clause 11.4.

1. Soil is homogeneous for the entire embedment depth.
2. Width b of the below-grade portion of the foundation is constant. This generally means that there are no attached collars or footings that are effective in resisting lateral soil forces.

All checks in this section ignore resistance to lateral movement provided by friction between the base of the post/pier foundation and the soil.

11.2 Ultimate lateral soil resistance, p_U

11.2.1 p_U based on soil properties. At a given depth z the ultimate lateral soil resistance p_U can be calculated as:

$$p_{U,z} = 3\sigma'_{v,z} K_P + (2 + z / b)\, c\, K_P^{0.5} \quad \text{for } 0 \le z < 4b_G$$

$$p_{U,z} = 3\,(\sigma'_{v,z}\,K_P + 2\,c\,K_P^{0.5}) \quad \text{for } z \geq 4b_G$$

$$K_P = (1 + \sin\phi)\,/\,(1 - \sin\phi)$$

where:

$p_{U,z}$ is the ultimate lateral resistance at depth z;

$\sigma'_{v,z}$ is the effective vertical stress at depth z;

K_P is the coefficient of passive earth pressure;

b_G is foundation width at the ground surface;

c is soil cohesion at depth z; and

ϕ is soil friction angle.

For cohesionless soils the preceding equation reduces to:

$$p_{U,z} = 3\,\sigma'_{v,z}\,K_P$$

For cohesive soils the preceding equation reduces to:

$$p_{U,z} = 3\,S_U\,[1 + z\,/\,(2b)] \quad \text{for } 0 \leq z < 4b_G$$

$$p_{U,z} = 9\,S_U \quad \text{for } z \geq 4b_G$$

where S_U is undrained soil shear strength as depth z.

11.2.1.1 Effective vertical stress, $\sigma'_{v,z}$. The difference between the total vertical stress and pore water pressure at a given depth z is defined as the effective vertical stress at depth z, or:

$$\sigma'_{v,z} = \sigma_{v,z} - u_z$$

where:

$\sigma'_{v,z}$ is effective vertical stress at depth z;

$\sigma_{v,z}$ is total vertical stress at depth z; and

u_z is pore water pressure at depth, z.

11.2.2 p_U from in-situ soil tests

11.2.2.1 p_U for cohesionless soils from CPT tests. At a given depth z, ultimate lateral soil resistance p_u for cohesionless soils can be determined from CPT cone penetration resistance q_{cr} at depth z using the following correlation from Lee et al. (2010).

$$p_{U,z} = (1.959\,p_A^{-0.10}\,q_{cr}^{0.47})\,/\,(\sigma'_{m,z}{}^{-0.63})$$

where:

$p_{U,z}$ is ultimate lateral resistance at depth z;

p_A is atmospheric pressure; and

$\sigma'_{m,z}$ is mean effective stress at depth z and is given as:

$$\sigma'_{m,z} = (\sigma'_{v,z} + 2\,\sigma'_{0h,z})\,/\,3$$

where:

$\sigma'_{v,z}$ is effective vertical stress at depth z; and

$\sigma'_{0h,z}$ is at rest effective horizontal stress at depth z.

To maintain dimensional homogeneity, input p_A, q_{cr}, and $\sigma'_{m,z}$ in identical units. Pressure $p_{U,z}$ will then have the same units as these three input variables.

11.2.2.2 p_U from pressuremeter tests. p_U for a given depth can be determined from a pressuremeter reading in accordance with procedures outlined by Briaud (1992).

11.3 Lateral strength checks for Universal Method

When soil springs are used to model soil behavior, there are two different methods that can be used to check the adequacy of the soil in resisting applied lateral loads. The first method is presented in clause 11.3.2 and requires establishment of a $V_U - M_U$ envelope. The second method is presented in clause 11.3.3 and involves a check on the force induced in each soil spring when ASD (or LRFD) loads are applied to the structure. Both methods require calculation of soil spring ultimate strength, F_{ult} (clause 11.3.1).

11.3.1 Soil spring ultimate strength, F_{ult}. The maximum force that an individual soil spring can sustain is given as:

$$F_{ult} = p_{U,z}\ t\ b$$

where:

F_{ult} is soil spring ultimate strength

$p_{U,z}$ is ultimate lateral resistance p_U at soil spring location from clause 11.2

t is thickness of the soil layer represented by soil spring

b is width of foundation at soil spring location

11.3.2 Lateral strength check using $V_U - M_U$ envelope

A foundation is adequate if on a plot of groundline shear versus groundline bending moment, the point $V_{ASD}\ f_L$, $M_{ASD}\ f_L$ (for ASD load combinations) or the point V_{LRFD}/R_L, M_{LRFD}/R_L (for LRFD load combinations) is located within the $V_U - M_U$ envelope,

where:

V_{ASD} is the shear force in the foundation at the ground surface due to an ASD load combination

M_{ASD} is the bending moment in the foundation at the ground surface due to an ASD load combination

f_L is the ASD factor of safety for lateral strength assessment from Table 3

V_{LRFD} is the shear force in the foundation at the ground surface due to an LRFD load combination

M_{LRFD} is the bending moment in the foundation at the ground surface due to an LRFD load combination

R_L is the LRFD resistance factor for lateral strength assessment from Table 3

The $V_U - M_U$ envelope is established by using the following equations to calculate V_U and M_U for different ultimate pivot point locations.

$$V_U = -\sum_{i=1}^{n} F_{ult,i}$$

$$M_U = -\sum_{i}^{n} F_{ult,i}$$

where:

M_U is ultimate groundline bending moment capacity of the foundation (as limited by soil strength). Positive when acting clockwise.

V_U is ultimate groundline shear capacity (as limited by soil strength) of the foundation. Positive when acting to the right.

n is number of springs used to model the soil surrounding the foundation.

$F_{ult,i}$ is ultimate strength of soil spring i from clause 11.3.1. For clockwise foundation rotation, $F_{ult,i}$ is negative for any soil spring located above the selected ultimate pivot point and positive for any soil spring located below the selected ultimate pivot point. For counterclockwise foundation rotation, $F_{ult,i}$ is positive for any soil spring located above the selected ultimate pivot point and negative for any soil spring located below the selected ultimate pivot point.

z_i is absolute distance between groundline and spring i.

To establish a complete $V_U - M_U$ envelope, locate the ultimate pivot point at the ground surface and at the bottom of each of the n soil layers. Conduct two sets of calculations, one assuming the foundation rotates clockwise; the other assuming the foundation rotates counter clockwise.

Shown in Figure 16 is a foundation model utilizing five soil springs. To the right of the model is the free body diagram associated with each of the $n + 1$ ultimate pivot point locations. The direction of the spring forces in Figure 16 assumes clockwise foundation rotation. Reversing the direction of the spring forces from those shown in Figure 16 provides the six free body diagrams associated with counterclockwise foundation rotation. The resulting $V_U - M_U$ envelope is shown in Figure 17.

11.3.3 Lateral strength check of individual soil spring forces. The capacity of the soil to resist lateral forces is sufficient if the following inequality is met for all soil springs.

$$F_{ASD} \leq F_{ult} / f_L \quad \text{for ASD load combinations}$$

or

$$F_{LRFD} \leq F_{ult}\ R_L \quad \text{for LRFD load combinations}$$

where:

F_{ASD} is force induced in soil spring by ASD load combination

F_{LRFD} is force induced in soil spring by LRFD load combination

F_{ult} is soil spring ultimate strength from clause 11.3.1

f_L is the allowable stress design factor of safety for lateral strength assessment from Table 3

R_L is the LRFD resistance factor for lateral strength assessment from Table 3

If F_{ASD} exceeds F_{ult} / f_L for a soil spring, replace that spring with a horizontal force equal to F_{ult} / f_L and rerun the structural analysis. Repeat this process as often as needed and/or until only one soil spring remains that has not been converted to a horizontal force. If F_{ASD} for the last remaining soil spring exceeds F_{ult} / f_L then the soil can not adequately resist the forces applied to the foundation.

If F_{LRFD} exceeds $F_{ult}\ R_L$ for a soil spring, replace that spring with a horizontal force equal to $F_{ult}\ R_L$ and rerun the structural analysis. Repeat this process as often as needed and/or until only one soil spring remains that has not been converted to a horizontal force. If F_{LRFD} for the last remaining spring exceeds $F_{ult}\ R_L$ then the soil can not adequately resist the forces applied to the foundation.

11.4 Lateral strength checks for Simplified Method. For foundations meeting the two requirements in clause 11.1, the ultimate groundline bending moment capacity of the foundation, M_U, is obtained using clause 11.4.1, 11.4.2 or 11.4.3 when the foundation is non-constrained and clause 11.4.4, 11.4.5 or 11.4.6 when the foundation is constrained.

A constrained foundation is adequate if the following inequality is met.

$$M_U \geq M_{LRFD} / R_L \quad \text{for LRFD}$$

and

$$M_U \geq f_L\ M_{ASD} \quad \text{for ASD}$$

where:

f_L and R_L are obtained from clause 9; and

M_{LRFD} and M_{ASD} are determined in accordance with clause 8.4.2.

A non-constrained foundation is adequate if the previous inequality for M_U is met when V_U and M_U are both positive. If M_U and V_U have opposite signs, construct a $V_U - M_U$ envelope as described in clause C11.4 to determine the adequacy of the foundation.

11.4.1 Non-constrained pier/post in cohesionless soils. The ultimate moment M_U that can be applied at the groundline to a post/pier foundation that is not constrained at the groundline and is embedded in cohesionless soil (Figure 18) is given as:

$$M_U = S_{LU}\ (d^3 - 2\ d_{RU}^3) / 3 \text{ for } 0 \leq d_{RU} \leq d$$

where:

$d_{RU} = (V_U / S_{LU} + d^2 / 2)^{0.5}$

$S_{LU} = 3\ b\ K_P\ \gamma$

$K_P = (1 + \sin\phi) / (1 - \sin\phi)$

$V_U = V_{LRFD} / R_L$ for LRFD

$V_U = f_L\, V_{ASD}$ for ASD

11.4.2 Non-constrained pier/post in cohesive soils. The ultimate moment M_U that can be applied at the groundline to a post/pier foundation that is not constrained at the groundline and is embedded in cohesive soil is given as:

$$M_U = b\, S_U\, [4.5\, d^2 - 6\, d_{RU}^2 - d_{RU}^3 / (2b)] \text{ for } 0 \le d_{RU} \le d$$

where $$d_{RU} = [64\, b^2 + 4 V_U / (3 S_U) + 12\, b\, d]^{0.5} - 8\, b$$

The preceding equations apply when d_{RU} is less than $4b_G$ and the force distribution shown in Figure 19a applies. If d_{RU} from the preceding equation is greater or equal to $4b_G$ (in which case the force distribution shown in Figure 19b applies) then d_{RU} is calculated as:

$$d_{RU} = V_U / (18\, b\, S_U) + d / 2 + 2\, b / 3$$

and $$M_U = 9\, b\, S_U\, (d^2 / 2 - d_{RU}^2 + 16\, b^2 / 9) \text{ for } 0 \le d_{RU} \le d$$

In both cases: $$V_U = V_{LRFD} / R_L \text{ for LRFD}$$

$$V_U = f_L\, V_{ASD} \text{ for ASD}$$

11.4.3 Non-constrained pier/post in any soil. The ultimate moment M_U that can be applied at the groundline to a post/pier foundation that is not constrained at the groundline and for which d_{RU} is greater than $4b_G$ (Figure 20) is given as:

$$M_U = S_{LU}\, (d^3 - 2\, d_{RU}^3) / 3 + 6\, b\, c\, K_P^{0.5}\, (d^2 / 2 - d_{RU}^2 + b^2 / 4) \text{ for } 0 \le d_{RU} \le d$$

where:

$d_{RU} = [X^2 + V_U / S_{LU} + X d + d^2 / 2 + X b / 2]^{0.5} - X$

$X = 2c / (K_P^{0.5} \gamma)$

$S_{LU} = 3\, b\, K_P\, \gamma$

$K_P = (1 + \sin \phi) / (1 - \sin \phi)$

$V_U = V_{LRFD} / R_L$ for LRFD

$V_U = f_L\, V_{ASD}$ for ASD

11.4.4 Constrained pier/post in cohesionless soils. The ultimate moment M_U that can be applied at the groundline to a post/pier foundation that is constrained at the groundline (d_{RU} = 0) and is embedded in cohesionless soil (Figure 21) is given as:

$$M_U = d^3 b\, K_P\, \gamma$$

$$K_P = (1 + \sin \phi) / (1 - \sin \phi)$$

11.4.5 Constrained pier/post in cohesive soils. The ultimate moment M_U that can be applied at the groundline to a post/pier foundation that is constrained at the groundline (d_{RU} = 0) and is embedded in cohesive soil (Figure 22) is given as:

$$M_U = b\, S_U\, (4.5\, d^2 - 16\, b^2) \quad \text{for } d \ge 4b_G$$

and $$M_U = b\, d^2\, S_U\, [3 / 2 + d / (2b)] \quad \text{for } d \le 4b_G$$

11.4.6 Constrained pier/post in any soil. The ultimate moment M_U that can be applied at the groundline to a post/pier foundation that is constrained at the groundline (d_{RU} = 0) in any soil (Figure 23) is given as:

$$M_U = d^3 b\, K_P \gamma + b c K_P^{0.5}\, (3d^2 - 32 b^2 / 3) \quad \text{for } d \ge 4b_G$$

and $$M_U = d^3\, b\, K_P\, \gamma + b\, d^2 c\, K_P^{0.5}\, [1 + d / (3b)] \quad \text{for } d \le 4b_G$$

$$K_P = (1 + \sin \phi) / (1 - \sin \phi)$$

12 Uplift strength assessment

12.1 General. Foundation uplift strength is due to the combination of foundation mass M_F and resistance to uplift provided by soil mass *U*. Clauses 12.3 and 12.4 contain equations for checking adequacy of the foundation's uplift strength under ASD and LRFD load combinations. These equations are only applicable when the requirements in clause 12.2 are met.

12.2 Uplift design requirements and considerations

12.2.1 Anchorage system design. The anchorage system must be designed with capacity to adequately handle and transfer load between the soil mass and the pier/post. Use the applicable structural design specification(s) to make these determinations. For example, use the ANSI/AWC *National Design Specification (NDS) for Wood Construction* to determine the adequacy of mechanical fasteners used to connect wood uplift blocking to a wood post.

12.2.2 Backfill compaction. Backfill must be compacted to at least 85% of the density of the surrounding soil. Where this compaction requirement is not met, soil uplift resistance *U* shall not exceed the product of the gravitational constant *g* and the mass of backfill material located directly above the anchorage system.

12.2.3 Concrete paving. When adequately mechanically fastened to posts/piers, paving adds vertical resistance equal to the mass of concrete that remains connected to the post/pier. It also increases effective soil stress and thus increases shear strength along the soil failure plane. See clause 13 for frost heaving considerations to be included in the concrete pavement design.

12.3 Allowable stress design. Resistance to foundation uplift is sufficient if the following inequality is met.

$$g\ M_F + U / f_U \geq P_{ASD}$$

where:

M_F is the mass of the foundation;

U is resistance to uplift provided by the soil from clause 12.5;

f_U is the ASD factor of safety for uplift strength assessment from Table 5 in accordance with clause 9; and

P_{ASD} is the maximum axial uplift force due to the ASD load combinations.

12.4 Load and resistance factor design. Resistance to foundation uplift is sufficient if the following inequality is met.

$$gM_F + UR_U \geq P_{LRFD}$$

where:

M_F is the mass of the foundation;

U is resistance to uplift provided by the soil from clause 12.5;

R_U is the LRFD resistance factor for uplift strength assessment from Table 5 in accordance with clause 9; and

P_{LRFD} is the maximum axial uplift force due to the LRFD load combinations.

12.5 Uplift resistance provided by soil. This clause is used to determine the resistance to foundation uplift provided by soil acting on a pier/post anchorage system. An anchorage system may be an attached footing, collar, uplift blocking, or any other devices that enlarges the base of a foundation. Use equations in clause 12.5.1 for foundations in cohesionless soils and those in clause 12.5.2 for cohesive soils.

12.5.1 Foundation in cohesionless soils. Use the following equations to determine the vertical extent of the uplift soil failure surface, *h,* as shown in Figure 24.

For $\phi \leq 20$: $h = 2.5\ B_U$

For $\phi > 20$: $h = B_U (5.78 - 0.350\ \phi + 0.00947\ \phi^2)$

where ϕ is in degrees.

If $h \geq d_U$ the foundation is classified as a *shallow foundation under uplift* and ultimate uplift resistance is determined in accordance with clause 12.5.1.1.

If $h < d_U$ the foundation is a *deep foundation under uplift* and ultimate uplift resistance is determined in accordance with clause 12.5.1.2.

12.5.1.1 Shallow foundation in cohesionless soils. For circular anchorage systems when $h \geq d_U$:

$$U = \gamma d_U (\pi\ d_U\ s_F\ B_U\ K_U \tan\phi / 2 + B_U^2 \pi / 4 - A_p)$$

For rectangular anchorage systems when $h \geq d_U$:

$$U = \gamma d_U [d_U (2 s_F B_U + L_U - B_U)\ K_U \tan\phi + B_U L_U - A_p]$$

where:

$K_U = 0.95$

$s_F = 1 + 1.105(10^{-5})\ \phi^{2.815} d_U / B_U$

where ϕ is in degrees.

12.5.1.2 Deep foundation in cohesionless soils. For circular anchorage systems when $h < d_U$:

$$U = \gamma\ [\pi\ h\ (d_U - h / 2)\ s_F\ B_U\ K_U \tan\phi + d_U\ B_U^2 \pi / 4 - d_U\ A_p]$$

For rectangular anchorage systems when $h < d_U$:

$$U = \gamma\ [h\ (2d_U - h)\ (2s_F\ B_U + L_U - B_U)\ K_U \tan\phi + d_U\ B_U\ L_U - d_U\ A_p]$$

where:

$K_U = 0.95$

h = vertical extent of the uplift soil failure surface from clause 12.5.1

$s_F = 1 + 1.105\ (10^{-5})\ \phi^{2.815} h / B_U$

where ϕ is in degrees.

12.5.2 Uplift resistance for foundation in cohesive soils. For circular anchorage systems:

$$U = \gamma d_U (B_U^2 \pi / 4 - A_p) + F_C\ S_u\ B_U^2 \pi / 4$$

For rectangular anchorage systems:

$$U = \gamma d_U (B_U L_U - A_p) + F_C\ S_u\ B_U\ L_U$$

where $F_C = 1.2\ d_U / B_U \leq 9$

13 Frost heave considerations

13.1 General. Freezing temperatures in the soil result in the formation of ice lenses in the spaces between soil particles. Under the right conditions, these ice lenses will continue to attract water and increase in size. This expansion of ice lenses increases soil volume. If this expansion occurs under a footing, or alongside a foundation element with a rough surface, that portion of the foundation will be forced upward. This action is called frost heave, and can induce large differential movements in a structure. Differential movement can crack building finishes, and induce significant stress in structural connections and components. When ice lenses thaw, soil moisture content increases dramatically. The soil is generally in a saturated state with reduced strength. As soil water drains from the soil, effective soil stresses increase and the foundation will generally settle.

13.2 Minimizing frost heave. Frost heave can be minimized by building on soils with a low likelihood of freezing, providing good water drainage, and using fine-grained soils with caution.

13.2.1 Footing location. The best way to avoid foundation frost heave is to minimize the freezing potential of underlying soils. This is accomplished by extending footings below the local frost line or by using a foundation system designed and constructed in accordance with SEI/ASCE 32.

13.2.2 Water drainage. Proper surface and subsurface drainage can reduce frost heave. Drainage of surface waters from a structure is enhanced by installing rain gutters, adequately sloping the finish grade away from the structure, and raising the building elevation to a level above that of the surrounding area. Subsurface drainage is achieved with the placement of drain tile or coarse granular material below the maximum frost depth, with drainage to an outlet. Such drainage lowers the water table and interrupts the flow of water moving both vertically and horizontally through the soil.

13.2.3 Fine-grained soils. Fine-grained soils such as clays and silts are more susceptible to frost heave than sands and gravels because (1) water is drawn up further in the smaller capillaries of fine-grained soils, and (2) there is much more surface area in a unit volume of fine-grained soil, and therefore more surface area for water adsorption. One factor that limits frost heave in fine-grained soils is that water is less mobile (moves slower) as capillaries decrease in size, a factor which explains why frost heave is more of a problem in silts than it is in the more finer-grained clay soils. While it is often recommended to backfill with coarse granular backfill to reduce frost heave, this is not recommended when holes are dug in clay soils. Drilling holes in clay soils and backfilling with a coarse-grained soil turns every post-hole into a sump pit that traps and holds water. This leaves the backfill in a saturated, and thus prolonged low-strength state and very prone to significant frost heave when freezing conditions occur. Consequently, as a general rule, backfill holes in silts and clays with clay soils.

13.3 Concrete floors. If the ground beneath a concrete floor can freeze, the floor should be installed such that its vertical movement is not restricted by embedded posts or by structural elements attached to embedded posts. While concrete shrinkage may break bonds between a floor and surrounding components, more proactive measures will ensure independent vertical behavior. For example, roofing felt or plastic film can be placed against surrounding surfaces prior to placing the floor.

13.4 Concrete backfill. The use of cast-in-place concrete as a backfill material may actually increase the likelihood of frost heave. The rough soil-to-concrete backfill interface provides the potential for significant vertical uplift forces due to frost heave. Also, the placement of concrete in holes that decrease in diameter with depth provide additional risk for frost heave.

14 Installation requirements

14.1 General. This section covers two construction-related factors that can significantly affect structural performance: soil compaction and component placement.

14.2 Compaction under footings. Compact all disturbed soil at the base of a hole to a level consistent with the soil bearing capacity assumed in design. Soil upon which a precast concrete footing will be placed must be flat and level. A non-flat surface results in uneven soil-to-footing contact, and this increases bending moments and shear stresses within the footing. If the compacted base is not level, the top surface of any precast concrete footing will not be level, resulting in only line or point contact between the footing and post/pier it supports.

14.3 Backfill compaction. Compact all backfill by tamping all soil in layers (a.k.a. lifts) that do not exceed a thickness of 0.2 m (8 in.) so as to achieve lateral stiffness and strength properties consistent with those used in design.

14.4 Embedment depth. Installed depth of a post/pier foundation shall not be less than 90% of the specified depth. A post foundation can be installed deeper than specified without adversely affecting foundation behavior. However, installing a post or pier deeper than specified can leave the top too short to meet specified structural needs. In the case of spliced, laminated wood posts (i.e., posts with preservative-treated lumber spliced to non-treated lumber), deeper embedment will bring the non-treated portion of the post closer to grade, making it more difficult to meet the ANSI/ASAE EP559 requirement that preservative wood treatment extend a minimum of 16 in above the ground surface.

14.5 Footing placement. The lateral location and plumbness of drilled holes can be adversely affected by: stones and roots struck during drilling, rough/sloping terrain, drilling equipment characteristics, limited site access for drilling equipment, etc. This frequently requires that the base of a hole be manually enlarged to facilitate more accurate footing placement. Unless otherwise permitted by engineering design, a precast concrete footing shall be placed so that the center of the footing is within a distance *b*/2 of the center of the post/pier it supports, where *b* is the width of the post/pier. Cast-in-place concrete footings shall be placed so that distance from the center of the post/pier to the nearest edge of the footing is not less than half the specified diameter/width of the footing.

Commentary

C1.1 Purpose. Post and pier foundations are embedded structural columns that provide lateral and vertical support for buildings and or other structures. A “post foundation” is a phrase generally used to define the embedded portion of structural column that runs continuously from below the soil surface to roof/ceiling framing. A “pier foundation” typically refers to any embedded column that supports an above grade structural column or floor support (and thus does not extend to roof/ceiling framing). As defined in this Engineering Practice, there is no “below-grade” behavioral difference between a post foundation and a pier foundation when subjected to equal loads.

Post and pier foundations tend to be the most economical option for applications that don’t require a continuous foundation wall. This includes buildings without basements and foundations for towers and similar structures. Post and pier foundations are used to support structures located above water or above a strata of expansive, collapsible, or frost-heave susceptible soil. They are considered a more environmentally-friendly option to concrete frost walls because they use considerably less concrete, they can be quickly and easily removed, and many types (e.g. precast concrete, wood, steel) can be reused.

In many respects, this engineering practice is a blend of commonly published procedures for determining allowable vertical loads on shallow spread footings, and commonly published procedures for determining allowable lateral loads on short piles. It is for this reason that the term “shallow” is included in the title of this engineering practice. As is common with shallow foundation design, this EP ignores any foundation-soil friction that would help a pier/post foundation transfer gravity loads into the soil.

C1.2 Scope. One of the primary features of this engineering practice is the inclusion of comprehensive factors of safety for both ASD and LRFD. These factors are a function of (1) the method used to obtain soil properties, (2) load direction (uplift, bearing or lateral), and (3) importance of the structure.

Several areas of this engineering practice contain alternative testing and analysis procedures. Some of these procedures are more accurate, some easier-to-apply, some less restrictive in applicability. More accurate testing and analysis procedures are associated with reduced factors of safety, and thus their use will generally produce higher design values.

C1.2.1 Limitations. One of the primary objectives during the development of this engineering practice was to avoid placing numerous restrictions on its applicability. To this end, only three limitations are listed in clause 1.2.1. The first of these limits the EP to posts and piers that are vertically installed in relatively level terrain. This follows from the fact that equations for calculating soil bearing and lateral load capacities as well as pier/post uplift resistance assume a relatively level terrain. In general, these equations should be applicable when the ground around the post/pier within a distance of two times the depth of embedment does not drop more than 10% of the depth of embedment (i.e., ground slopes downward less than 5%). Where the terrain slopes away from the post/pier more than this, the depth of embedment should be increased accordingly. In the absence of a more detailed analysis, one approach may be to increase the depth of embedment *d* (calculated using the equations of this EP which assume a level terrain) by the amount that the soil elevation drops in excess of 0.1*d* at a distance 2*d* from the post/pier. For example, if a minimum depth of embedment *d* of 1.2 m is calculated using the equations of this EP and the ground slope away and in a downward direction from the pier/post is 15%, the soil elevation drop at a distance 2*d* (i.e. 2.4 m) from the post/pier will be 0.36 m. This exceeds the

0.1*d* (i.e., 0.12 m) by 0.24 m and thus the actual depth of embedment to account for ground slope should be increased from 1.2 m to 1.44 m.

The second limitation in clause 1.2.1 restricts use of the EP to concentrically loaded footings. This provision is generally only of concern where a footing is not attached to the pier/post and is thus much freer to rotate separately of the pier/post. Post/piers that are rigidly attached to a footing will help restrict footing rotation and thus help maintain a more uniform bearing pressures and settlements.

The third limitation in clause 1.2.1 restricts post or pier foundation spacing to a minimum value equal to the greater of 4.5 times the maximum dimension of the post/pier cross-section or three times the maximum dimension of a footing or attached collar. For a foundation consisting of a 12 cm x 20 cm post resting on a 50 cm diameter footing, this equates to a minimum spacing between individual posts of 150 cm (i.e. the greater of 4.5 x 20 cm and 3 x 50 cm). This limitation addresses the fact that the shorter the distance between isolated pier/post foundations, the greater the overlap between the "pressure bulbs" surrounding the foundations, and the less applicable will be the equations contained in this engineering practice for estimating maximum uplift, bearing and lateral capacities for isolated pier/post foundations.

This engineering practice can be used to establish the design capacities of post/pier foundations spaced closer than the minimum allowed in clause 1.2.1. In such cases, the design capacities for the isolated foundation shall be taken as the minimum of the design capacities calculated (1) using this engineering practice for isolated foundations and (2) using similar design procedures for a continuous wall and footing with a length equal to the spacing of the isolated foundation. This requirement recognizes that as a string of isolated foundations are moved closer and closer together, the distribution of soil stresses they induce more closely mirrors those of continuous wall and footing.

Although the EP does not limit foundation depth, the Simplified Method for calculating lateral soil forces in clause 8.4 assumes the post/pier is infinitely rigid, and sets a limit on post/pier depth that is a function of post/pier and soil stiffness. If this depth is exceeded, the Universal Method (clause 8.3) must be used to calculate lateral soil pressures and foundation forces.

This EP applies to piers and posts that are driven into soil, as well as those that are placed into pre-excavated holes and then backfilled. Driven (or displacement) piers consists primarily of steel helical piers (e.g. screw anchors) which are turned into the ground. Driven (or displacement) posts include the short, wood posts used to support highway guardrails. Interestingly, helical piers are primarily used to resist bearing and uplift forces, and driven wood posts are primarily used to resist lateral forces.

C5.3.3 Concrete and CLSM. Where CLSM is used to increase the effective width of a post/pier for lateral strength and stiffness of a post/pier foundation, a CLSM unconfined compressive strength between 1 and 2 MPa (150 and 300 lbf/in.^{2}) is recommended. CLSM with an unconfined compressive strength less than 1 MPa can generally be excavated (broken up) using hand tools (e.g. shovels, picks) and machinery (e.g. excavators, backhoes) fitted with conventional buckets. Percussive devices such as jackhammers, impact hammers and rotary drills are generally required to break up CLSM with unconfined compressive strengths greater than 1 MPa.

C5.4 Soil tests. Either laboratory or in-situ testing or a combination of laboratory and in-situ testing can be used to obtain all necessary information needed for post/pier foundation design.

Soil tests remove uncertainty associated with the use of presumptive soil properties, and thus lower factors of safety are associated with calculations where soil characteristics have been ascertained through test. Since certain soil tests are more accurate than others for obtaining a specific soil property, factors of safety are a function of soil test method. Test procedures deemed the most accurate for obtaining various soil properties can be determined by a comparison of factor of safety values in Table 2.

C5.4.1 Sampling locations. A minimum site investigation generally includes at least three borings, usually combined with standard penetration testing. For a rectangular structure, a boring at each corner and one in the center of the structure is recommended, with more required depending on soil complexity and variability, and the size and importance of the structure.

C5.5 Young's modulus for soil, E_S. In addition to soil particle shape and size, Young's modulus E_S for a soil depends on factors that change as the soil is loaded. This includes the relative spacing and organization of particles, cementation between particles, and water content. Additionally, the stress-strain relationship of a soil is highly dependent on stress history (e.g. degree of overconsolidation) which means it will behave differently as it is reloaded. Of the several factors controlling E_S, the ones having the largest influence on granular soils are prestress, which can increase E_S by more than a factor of six, and extreme differences in relative density, which can make a fivefold difference in E_S (Lambrechts and Leonards, 1978).

The variation of E_S with stress level means that it is important to first define the level and type of loading to which the soil in question will be subjected. In this case, E_S is only used to predict lateral foundation displacements. Such displacements are largely due to horizontally-applied structural loads (e.g., wind, equipment impact, stored materials) which are highly cyclical in nature. This means that the soil will be repeatedly loaded and unloaded by forces that will seldom approach, and likely never exceed, those induced by nominal (i.e., unfactored) loads (see clause 7.1.1). It is for this reason that clause 5.5.1 recommends that E_S be defined as the secant modulus associated with a major principle stress approximately one-fourth of the soil's ultimate strength at the location being modeled. As a rule of thumb, the secant modulus at one-fourth of the soils ultimate strength is approximately 75% of the initial tangent modulus (Pyke and Beikae, 1984).

When piers/posts are backfilled with soil (as opposed to concrete or CLSM), the modulus of horizontal subgrade reaction will be largely dictated by the elastic modulus of the backfill. Given that soil backfills are highly disturbed materials without a stress history, their in-situ elastic modulus can be accurately predicted with laboratory tests given that laboratory specimens are prepared to mirror field compaction procedures. It is important to note that because of mixing that occurs when handling, backfills tend to be more isotropic and homogeneous than the surrounding, undisturbed soils.

E_S for non-backfill materials is generally best estimated using field (in-situ) tests because of the significance of stress history on E_S and the difficultly of obtaining undisturbed soil samples for laboratory testing.

Although in-situ soil is assumed to be isotropic, it is not. Anisotropy of both stiffness and strength has been observed in many soils (particularly for undrained loadings) but it is usually ignored in practice. For normally consolidated soils, the stiffness in the horizontal direction will normally be less than that in the vertical direction, but the reverse may be true for overconsolidated soils.

C5.5.1 E_S from laboratory tests. Determination of Young's modulus from laboratory compression tests requires simultaneous measurement of applied load and deflection. When the confining stress in a triaxial compression stress is not zero (as with tests according to ASTM D2850), the stresses applied in both directions as well as the strains induced in both directions must be measured (lateral strains are typically calculated from axial strains and total volume changes). Poisson's ratio and Young's modulus are then calculated as:

$$\nu = \frac{\sigma_3\varepsilon_1 - \sigma_1\varepsilon_3}{\sigma_1\varepsilon_1 + \sigma_3\varepsilon_1 - 2\sigma_3\varepsilon_3}$$

$$E_S = \frac{\sigma_1 - 2\nu\sigma_3}{\varepsilon_1}$$

where:

σ_1 and σ_3 are major and minor principle stresses, respectively, and
ε_1 and ε_3 are the associated strains.

In tests in which the lateral confining stress σ_3 is zero (as with tests according to ASTM D2166):

$$\nu = -\varepsilon_3 / \varepsilon_1$$

$$E_S = \sigma_1 / \varepsilon_1$$

In tests in which the specimen is restrained from moving laterally (i.e., $\varepsilon_3 = 0$) (as with tests according to ASTM D2435)

$$\nu = \sigma_3 / (\sigma_1 + \sigma_3)$$

$$E_S = \frac{\sigma_1(1+\nu)(1-2\nu)}{\varepsilon_1(1-\nu)}$$

$$M_S = \frac{\sigma_1}{\varepsilon_1} = \frac{E_S(1-\nu)}{(1+\nu)(1-2\nu)}$$

where:

M_S is the constrained modulus (a.k.a. oedometer modulus).

C5.5.2 E_S from prebored pressuremeter test (PMT) results. Pressuremeters measure Young's modulus in the horizontal direction which is desirable for application of E_S to the prediction of lateral foundation displacements.

C5.5.3 E_S from cone penetration test (CPT) results. Equations in clause 5.5.3 are from Canadian Foundation Engineering Manual and based on work by Schmertmann (1970).

C5.5.4 E_S from standard penetration test (SPT) results. The SPT equations in clause 5.5.4 for Young's modulus were adopted from the AASHTO LRFD Bridge Design Specifications. The SPT blow count, N_{SPT} is determined for clayey soils in accordance with ASTM D1586 and for sandy soils in accordance with ASTM D6066. The SPT blow count value designated as N_{60} is obtained by multiplying N_{SPT} (i.e., the raw SPT blow count recorded in the field) by factors that adjust for hammer efficiency, sample barrel size, borehole diameter and rod length. The symbol $(N_1)_{60}$ is used to identify an N_{60}, value that has been further adjusted to account for overburden pressure. The overburden correction factor is from Liao and Whitman (1986). A detailed discussion of how to calculate $(N_1)_{60}$, including correction factor values was published by the NCEER (1997).

C5.5.5 E_S from undrained shear strength, S_U. Ranges for E_S listed in clause 5.5.5 are from the AASHTO LRFD Bridge Design Specifications.

C5.6 Constant of horizontal subgrade reaction, n_h.

The constant of horizontal subgrade reaction n_h is multiplied by depth z and divided by width b to obtain the modulus of horizontal subgrade reaction k for the special case where modulus k is assumed to increase linearly with depth when b is fixed ($k = n_h\ z/b$). Derivation of the 2.0 factor appearing in the modulus of horizontal subgrade reaction equation is overviewed in clause C8.2.

C5.7.1 S_U from laboratory tests. The primary result of ASTM D2166 is the unconfined compressive strength of the soil, q_u. The undrained shear strength, S_U, as determined using ASTM D2166 is equal to one-half the unconfined compressive strength q_u.

ASTM D2850 does not directly produce the value for undrained shear strength S_U. To determine S_U using ASTM D2850, several (typically three) tests are required at different confining pressures, and S_U is equal to the cohesion intercept of the failure envelope drawn tangent to the Mohr's circle for all individual tests.

C5.7.2 S_U from prebored pressuremeter (PBPMT) test results. Equations in clause 5.7.2 are from Baguelin et al. (1978) as published in Briaud (1992).

C5.7.3 S_U from cone penetration test (CPT) results. The equation in clause 5.7.3 is from Briaud (1992).

C5.8.1 Friction angle ϕ from laboratory tests. Soil loadings associated with bearing, uplift and lateral forces acting on a pier/post foundation are not plane strain in nature like those associated with continuous foundations. The three-dimensional soil strain and stress fields associated with pier/post foundations make the CD triaxial compression test the more appropriate laboratory test for determining the soil friction angle (Salgado, 2008 page 444). The ASTM CD triaxial compression test method is ASTM D7181 *Standard Test Method for Consolidated Drained Triaxial Compression Test for Soils.*

C5.8.2 Friction angle ϕ from standard penetration test (SPT) results. The relationship between soil friction angle and $(N_1)_{60}$ is from Hatanaka and Uchida (1996).

C5.8.3 Friction angle ϕ from cone penetration test (CPT) results. The equation in clause 5.8.3 is from Kulhawy and Mayne (1990).

C5.9 Presumptive values. Data tabulated in Table 1 are unfactored values for use with the resistance and safety factors in Tables 2 through 5. Because the values in Table 1 have not been pre-adjusted to account for a margin of safety in design, they will appear to be less conservative than data appearing in many presumptive soil property tables.

Since the range of possible void ratios in silts (types ML and MH soils) and gravels (types GW and GP soils) is relatively small, the unit weights for these soils do not largely change with variations in consistency, and thus have been assigned constant values in Table 1.

C6.2 Minimum concrete compressive strength. Requiring a minimum compressive concrete strength is consistent with ACI 318 and important for application of the prescriptive minimum plain concrete footings sizes allowed in this EP.

C6.3.1 Minimum nominal thickness. The minimum thickness of plain concrete cast-in-place footings is in accordance with ACI 318 clause 22.7.4.

Cover on reinforcement in cast-in-place footings is in accordance with ACI 318 clause 7.7.1 requirements for concrete cast against and permanently exposed to earth.

C6.3.2 Reinforcement. The requirement that reinforcement need not be provided when "the actual maximum distance from a footing edge to the nearest post/pier edge is less than the nominal thickness of the footing" is based on the assumption that in such footings, arch action provides concrete compression under all conditions of loading.

Under this requirement, if a post with actual dimensions of 12 cm by 14 cm is centered on a footing with a diameter of 36 cm, reinforcement would not be required as long as the footing had a nominal thickness of at least 18 cm – 12 cm / 2 = 12 cm (i.e., the footing radius minus half the narrow dimension of the post). In this case, the 12 cm is guaranteed by the required minimum nominal thickness of 20 cm (8 in.) for plain cast-in-place footings.

C6.4.1 Minimum actual thickness. The post-frame building industry has a long history of using precast concrete footings. Far and away the most commonly used precast concrete footing is 10 cm (4 in.) thick and 35.5 cm (14 in.) in diameter. Footings of this size have been successfully used for several years in agricultural applications with design service loads per footing approaching 33.3 kN (7500 lbf).

When precast footings are used, it is important that they be placed on a flat, well-compacted surface so that the footing is not required to bridge low-spots in the compacted base.

Cover on reinforcement in precast footings is in accordance with ACI 318 clause 7.7.3 for precast concrete exposed to earth with reinforcement less than 4 cm (1.5 in.) in diameter.

C6.4.2 Reinforcement. The requirement that reinforcement need not be provided when "the actual maximum distance from a precast footing edge to the nearest post/pier edge is less than the 1.25 times the actual thickness of the footing" is based on the assumption that in such footings, arch action provides concrete compression under all conditions of loading.

Under this requirement, if a post with actual dimensions of 12 cm by 14 cm is centered on a precast footing with a diameter of 36 cm, reinforcement would not be required as long as the footing had a nominal thickness greater than (18 cm – 12 cm / 2) / 1.25 = 9.6 cm. In this case, the 9.6 cm is guaranteed by the required minimum actual thickness of 10 cm (4 in.) established for precast footings.

The 1.25 factor is used to compensate for the fact that the *maximum* distance from a footing edge to the nearest post/pier edge is used in the calculation, and this maximum distance is generally measurably greater than the *average* distance between the edge of the footing and the nearest post/pier edge. The 1.25 factor is not allowed in the design of cast-in-place footings because of greater variation in the actual size of cast-in-place footings, and because once they have been cast, cast-in-place footings cannot be shifted to improve alignment with the posts/piers they support.

When sizing reinforcement for larger precast footings, consideration should be given to the fact that the larger the footing, the less likely is there to be full contact between the base of the placed footing and the underlying compacted base.

C6.5.1 Longitudinal reinforcement. Axial, shear and bending forces in most concrete piers are such that the assemblies must be treated as structural columns. ACI 318 clause 22.2.2 requires that all structural columns contain reinforcement and thus be designed in accordance with Chapters 10, 11 and 12 of the code. The minimum cross-sectional area requirement is from ACI 318 clause 10.9.1. The minimum number of longitudinal bars is from ACI 318 clause 10.9.2.

C6.5.2 Shear reinforcement. ACI 318 clause 11.5.6.2 allows shear reinforcement to be omitted where tests show that the required nominal bending strength and nominal shear strength can be developed without it.

C6.5.3 Cover on reinforcement. The outer dimensions of a concrete pier are largely dependent on minimum requirements for concrete cover on the reinforcement. The specified minimum concrete cover requirements for reinforcement are from ACI 318 clause 7.7.1 and 7.7.3. These values represent the minimum distance between the surface of the pier and the surface of any steel reinforcement.

C6.9 CLSM base for precast concrete and wood footings. In lieu of using a CLSM base for footings, some builders have compacted a non-hydrated (i.e., dry) concrete mix in the base of holes drilled for pier/post foundation placement. Tests conducted by Bohnhoff et al. (2003) have shown that non-hydrated concrete mixes that are compacted within a soil mass and allowed to self-hydrate, will obtain unconfined compressive strengths that more than double the 8 MPa limit for classification as a controlled low-strength material.

C7.1 General. Structural load combinations from ASCE-7 are included here primarily to ensure consistency between soil resistance factors introduced in this document and the ASCE 7 load factors.

C7.1.1 Nominal loads. All ASCE-7 nominal loads are included in this EP with the exception that loads due to lateral earth pressure or ground water pressure have not been included. In this particular engineering practice, soil is treated and modeled as a structural element and not as an applied load (i.e., it is on the resistance side of the equation). In addition, it is assumed that ground water pressure acts equally on all sides of an embedded post or pier foundation and thus has no net effect on the behavior of embedded elements.

C8.1 General. The application of a lateral load to a pier or post causes a lateral deflection of the pier or post. The reactions that are generated in the soil must be such that the equations of static equilibrium are satisfied, and the reactions must be consistent with the deflections. Also, because no post or pier is completely rigid, the amount of pier/post bending must be consistent with soil properties and pier stiffness. Thus the problem of a laterally loaded pier/post is a "soil-structure-interaction" problem. The solution of the problem requires that numerical relationships between pier/post deflection and soil reactions be known and that these relationships be considered in obtaining the deflection shape of the pier/post.

C8.2 Modulus of horizontal subgrade reaction, *k*. The modulus of horizontal subgrade reaction k is the ratio of average contact pressure (between foundation and soil) and the horizontal movement of the foundation. In this engineering practice, modulus of subgrade reaction is equated to 2 times Young's modulus divided by width b, where b is the face width of the foundation component (post/pier, footing, or collar) at the location where k is being determined. This general equation for k is based on elastic theory and recommended by Pyke and Beikae (1984). It is similar in form to the standard equation for the modulus of *vertical* subgrade reaction k_V, which from elastic theory is given as:

$$k_V = q / S_i = E_s / [C_S\, b\, (1 - v^2)]$$

where:

- q is the equivalent uniform load on the footing;
- S_i is the immediate settlement of a point on the footing surface;
- E_S is Young's modulus;
- C_S is a combined footing shape and rigidity factor;
- b is the characteristic width of the footing; and
- v is Poisson's ratio.

C_S is equated to 0.79 for rigid circular footings and to 0.82 for rigid square footings. For rigid rectangular footings with length/width ratios of 2, 5 and 10, C_S is equal to 1.12, 1.6 and 2.0, respectively (NFEC, 1986a, Table 1 page 7.1-212).

Although Pyke and Beikae (1984) found the modulus of horizontal subgrade reaction to be equal to 2.3, 2.0, and 1.8 times E_S / b for Poisson's ratios of zero, 0.33, and 0.5, respectively, they recommend equating k to 2.0 E_S / b for all Poisson ratio values for practical purposes. Pyke and Beikae point out that this equation neglects friction between the foundation and soil, and also neglects the decrease in pressure on the back side of the foundation as it undergoes lateral movement. They note that a value of the order of 2.0 E_S / b is not unreasonable as it is about twice the value obtained by considering a strip footing acting on the surface of a half space.

Overall it is important to note that elastic theory shows that a coefficient of subgrade reaction is directly related to Young's modulus and inversely related to the characteristic width, b of the surface in contact with the soil. Given that soil deformation-related equations in this engineering practice are based on this theory and have not been experimentally validated, it would be prudent to investigate factors influencing the coefficient of subgrade reaction by conducting extensive field and laboratory tests using foundations with widths and depths that fall under the scope of this engineering practice,

C8.2.1 Effective Young's modulus of soil, E_{SE}, for portions of the foundation backfilled with soil. Laboratory testing and finite element analyses by many researchers have shown that the vast majority of soil deformation resulting from applied foundation forces will occur within a very short distance of the foundation. For continuous (strip) footings (i.e., situations for which conditions of plane strain apply) there is little deformation below a vertical distance 4b of the footing where b is the footing width (Schmertmann et al., 1978). For square and circular footings, this distance reduces to 2b where b is the diameter/width of the footing. These differences between continuous and square footings are consistent with the differences in stress distributions under continuous and square footings as predicted via elastic theory (see Figure 22).

For this engineering practice, it is assumed that all soil deformation occurs within a horizontal distance 3b of the foundation. Terzaghi (1955) states that "the displacements beyond a distance of 3b have practically no influence on the local bending moments", and this distance is midway between the aforementioned vertical distances of 4b and 2b associated with continuous and square footings, respectively. It is important to recognize that the use of a fixed value of 3b ignores the reality that the actual horizontal distance of "strain influence" varies. More specifically, the horizontal distance of "strain influence" decreases as vertical soil movement is less restrained, this increasingly occurs as you move away from horizontal soil layers characterized by plane strain behavior. Regions of reduced vertical restraint include locations near the ground surface, at the base of the foundation, and at depths where an unrestrained post rotates below grade.

Developed by Bohnhoff (2015), the strain influence factor I_S is the fraction of total lateral displacement that is due to soil straining within a distance J of the face of the foundation. When J is equal to 3b, the strain influence factor is equal to 1.0, which is consistent with the assumption that all displacement is due to soil straining occuring within a distance 3b of the foundation. When J is equal to b and 2b, I_S is equal to 0.500 and 0.792, respectively. Although the natural log function used to calculate I_S has some theoretical basis, it was primarily selected for its simplicity. Realize that the actual percentage of total foundation movement that is due to soil straining within a distance J of the foundation is dependent on numerous factors including: foundation shape, foundation flexibility, soil elastic properties, friction between soil and the foundation, magnitude of lateral displacement, foundation restraint conditions, and location relative to both the ground surface and the foundation base.

The strain influence factor is not needed when there is no backfill soil (in which case E_{SE} is equal to $E_{S,U}$) or when the distance from the face of the foundation to the edge of the backfill J exceeds 3b (in which case E_{SE} is equal to $E_{S,B}$). Use of the strain influence factor is only required when the distance J is less than 3b in which case the modulus of horizontal subgrade reaction is dependent on elastic properties of the backfill soil as well as the unexcavated soil that surrounds it.

The equation used to calculate E_{SE} for values of J less than 3b assumes distribution of *stress* around the foundation is not influenced by the difference between elastic properties of the backfill and the unexcavated soil surrounding the backfill. This means that deformation of the backfill between the face of the foundation and a distance J from the foundation is the same regardless of the properties of the surrounding soil. Likewise, the deformation of unexcavated soil beyond a distance J from the face of the foundation is the same regardless of backfill properties. To calculate the deformation of the backfill (i.e., soil within a distance J of the foundation), one only need assume that everything within a distance 3b of the foundation has the properties of the backfill material, in which case the deformation of everything within a distance J is equal to $I_S \Delta$ where I_S is the strain influence factor and Δ is the total soil deformation assuming all soil within a distance 3b has the elastic properties of the backfill (in which case Δ is equal to p_z $b/(2.0\ E_{S,B})$). In a similar fashion, it can be shown that the deformation of the unexcavated soil beyond a distance J is equal to $(1 - I_S)$ p_z $b/(2.0\ E_{S,U})$. Adding the deformation of the backfill to that of the surrounding soil yields the total soil deformation $\Delta = I_S\ p_z\ b/(2.0\ E_{S,B}) + (1 - I_S)\ p_z\ b/(2.0\ E_{S,U})$. Substituting $p_z\ b/(2.0\ E_{SE})$ for Δ and solving for E_{SE} yields the first equation in clause 8.2.1.

C8.2.2 Effective Young's modulus of soil, E_{SE}, for portions of the foundation backfilled with concrete or CLSM. The equations in clause 8.2.1 are applicable for foundations that are backfilled with soil. They are not applicable to foundations that are backfilled with concrete or compacted low strength material (CLSM). This is because the measurable difference in elastic properties of soil and concrete/CLSM produces stress and strain distributions around the foundation that depart significantly from those assumed in the derivation of the equations in clause 8.2.1.

Where a foundation or portion of a foundation is backfilled with concrete or CLSM, it is appropriate to treat the concrete/CSLM backfill as part of the post/pier foundation. The effective Young's modulus of the soil E_{SE} is taken as the Young's modulus of the surrounding unexcavated soil, $E_{S,U}$, and the horizontal modulus of subgrade reaction is then equal to $2.0\ E_{S,U} / b$ where b is the width of the concrete/CSLM backfill.

C8.4 Simplified method for determination of foundation and soil forces. The Simplified Method is the method that has traditionally been used to size pier and post foundations. The procedure is made possible with four major assumptions which turn a highly indeterminate structural analysis problem into a determinate analysis. These assumptions are:

1. The axial load, shear and bending moment in the post or pier are not dependent on below-grade deformation.
2. The flexural rigidity ($E_P I_P$) of the below grade portion of the foundation is infinite.
3. The soil is homogeneous for the entire embedment depth.
4. Coefficient of horizontal subgrade reaction k increases linearly with depth for cohesionless soils, and is constant for cohesive soils.

The Simplified Method has the advantage that it does not require estimates of soil stiffness or post/pier bending stiffness to determine lateral soil pressure p_z.

The Simplified Method can be used to estimate post/pier embedment depth for use in the more detailed Universal Method.

C8.4.1 Depth requirements. Depth limitations placed on use of the simplified methods are based on work by Broms (1964a, 1964b).

C8.4.2 Fixed base analog. The fixed base analog is less accurate then the soil-spring analog and is really only used to approximate shear and bending forces induced in a post/pier at the ground surface.

For non-constrained posts/piers, fixed supports are placed at a distance w below the ground surface (Figure 11a). This is done for two reasons. First, this location is close to the location of maximum post/pier bending moment, a fact confirmed by more detailed computer-based analyses and by observation of actual post-frame building failures. Secondly, fixing the support at a location below the ground surface yields a higher, and thus more conservative estimate of the at-grade bending moment. Such a conservative estimate helps offset the many assumptions inherent in the development of the Simplified Method, assumptions that may artificially reduce at-grade bending moment estimates.

Traditionally, engineers have modeled structures with non-constrained embedded piers/posts using an analog that fixes the pier/post at grade (Figure 11b) or that uses two pin supports located as shown in Figure 11c. The analog that fixes piers/posts at grade is obviously too rigid as it does not account for any soil deformation. The analog in Figure 11c not only requires an estimate of depth d, but it also predicts greater ground surface movement as depth d is increased. In reality, the deeper a post/pier is placed in the soil, the less will be the ground surface movement of the post/pier (assuming the post/pier has a fixed cross-sectional area and all other variables remain unchanged), and at some point, a further increase in embedment depth will have no influence on ground surface movement.

C9.1 Tabulated values. Resistance and safety factors for bearing capacity assessment (Table 2) are based on work by Foye, et al., (2006a, 2006b) and on similar factors compiled in the AASHTO LRFD Bridge Design Specifications.

Table 3 and 4 factors for lateral strength assessment are approximately 10% less conservative than those for bearing strength assessment in Table 2. This adjustment recognizes slightly greater confidence in ultimate lateral strength predictions due to comparisons with laboratory and field test data.

Table 5 factors for uplift strength assessment in cohesionless soils were obtained by increasing the resistance factors for bearing strength in Table 2 by 50% (or reducing the safety factors for bearing strength by 33%). Even with this adjustment, design uplift capacities in cohesionless soils calculated in accordance with Version 1 of ASAE EP 486 are at least twice those calculated in accordance with clause 12 of this version of the EP. Table 5 factors for uplift strength assessment in cohesive soils were obtained by reducing the safety factors for bearing strength by 15%.

Bearing, lateral and uplift capacities in cohesionless soils increase exponentially with friction angle, and thus small variances in estimated friction angle have an amplified effect on these capacities as friction angle increases (Foye, et al., 2006a). For this reason, a smaller (more conservative) resistance factor is required for greater friction angles.

C9.2 Adjustments. Buildings and other structures that represent a low risk to human life in the event of a failure are those that identified under ASCE 7 Risk Category I. Common to this category are agricultural buildings and storage shelters.

C10.4.1 q_B from the general bearing capacity equation. General bearing capacity equations are for vertically-loaded, horizontally-orientated, square or circular footings placed under a level surface. This means that in addition to depth factors, the equations incorporate shape factors for round and square footings, but exclude load-inclination factors, base inclination factors and ground inclination factors. Load-inclination factors are excluded because the depth of post/pier foundations is based on calculations that assume all horizontally applied loads are resisted by lateral forces applied to the foundation. To this end, the ratio of horizontal to vertical load applied at the top of the footing is likely to be relatively low and yield an inclination factor near 1.0. The shape and depth factors used in this EP are the same as those adopted in the AASHTO LRFD Bridge Design Specifications manual, as are the C_{W1} and C_{W2} values used to adjust bearing capacity for water table location.

C10.4.3 q_B from cone penetration test (CPT) results. The equation for clays was regressed from data reported in the National Cooperative Highway Research Program Report 343: Manual for the Design of Bridge Foundations (1991) and is from Awkati (1970) but reported by Schmertmann (1978). The equation for cohesionless soils was adopted from the AASHTO LRFD Bridge Design Specifications. Introduction of the constant C_{CPT2} with dimensions of length provides dimensional homogeneity. Average cone resistance, q_{cr}, is determined in accordance with ASTM D3441.

C10.4.4 q_B from pressuremeter test (PMT) results. The equation in clause 10.4.4 is from Briaud (1992) and is applicable for vertical loadings only. See Briaud (1992) for adjustments to account for inclined loadings. Equations for C_{PB} were regressed from curves in Figure 66 of Briaud (1992).

C11.2 Ultimate lateral soil resistance, p_U. Ultimate lateral soil pressure p_U is assumed to act on the entire vertical profile of the foundation, and is assumed to be fully mobilized wherever there is lateral foundation movement.

C11.2.1 p_U based on soil properties. Ultimate lateral soil resisting pressure p_U based on soil properties is taken as three times the Rankine passive pressure. Although basing resisting pressure solely on passive pressure would appear to neglect the active earth-pressure acting on the back of the foundation and side friction, the factor of three by which the passive pressure is increased is based on observed ultimate loads – ultimate loads which were most likely influenced by forces acting on all sides of the foundation system.

Passive pressure due to soil cohesion is assumed to increase from one-third its full value at the ground surface to its full value at a depth of $4b_G$. This partially accounts for the reduced soil containment at the soil surface and less than full mobilization of the soil due to the likelihood of foundation-soil detachment near the surface.

The value of 9 S_U is approximately equal to three times $2S_UK_P^{0.5}$ when ϕ is equal to 32 degrees. The quantity $2cK_P^{0.5}$ is the Rankine passive pressure due to soil cohesion.

C11.2.1.1 Effective vertical stress, $\sigma'_{v,z}$. Total vertical stress at depth *z* is equal to the weight of all soil above a given area located at depth *z* divided by the given area. Pore water pressure at depth *z* is equal to the product of water density and the vertical distance between the water table and depth *z*.

C11.2.2.1 p_U for cohesionless soils from CPT tests. The equation appearing in clause 11.2.2.1 is a corrected version of the original equation published by Lee et al. (2010).

Mean effective stress is the average stress acting on the six faces of a soil cube located below the soil surface. At rest effective horizontal stress at depth *z*, $\sigma'_{0h,z}$, can be estimated by multiplying the effective vertical stress by the quantity 1 – sin ϕ.

C11.3.2 Lateral strength check using $V_U – M_U$ envelope. The concept of a $V_U – M_U$ envelope for post/pier foundations along with techniques for its development and use were established by Bohnhoff (2015) and are presented here to enhance understanding of clause 11.3.2.

Each soil spring is assumed to exhibit linear-elastic behavior until its ultimate strength capacity, F_{ult}, is reached, at which point the spring is assumed to undergo a plastic state of strain with the force in the soil spring remaining at F_{ult}. The lateral strength capacity of a foundation (as limited by soil strength) is reached when *all* springs acting on the foundation have reached their maximum ultimate strength capacity. In other words, the lateral strength of a foundation (as limited by soil strength) is reached when there is not a single remaining soil spring that can take additional load.

The groundline shear V_G and groundline bending moment M_G that will result in a plastic state of strain in all soil springs are defined respectively as the ultimate groundline shear capacity V_U and ultimate groundline moment capacity M_U for the foundation. A $V_U – M_U$ envelope is a plot of all combinations of V_U and M_U that will produce a plastic state of strain in ALL soil springs. In this respect, the $V_U – M_U$ envelope is a *failure* envelope.

The term "pivot point" is used to define any point below the surface associated with zero lateral foundation displacement. At loads less than a foundation's ultimate capacity (i.e., prior to the yielding of all soil springs) there can be multiple pivot points; that is, there can be more than one location below grade where the foundation does not move laterally as shear and bending forces are applied above grade to the foundation (see Figure 26). At applied forces less than V_U and M_U the location of a pivot point is a function of the bending stiffness of the foundation relative to the stiffness of the surrounding soil, and this location changes as the magnitude of the applied groundline shear and bending forces change.

Once all soil being pushed on by the foundation has yielded, the foundation will pivot about a single point defined as the *ultimate* pivot point (Figure 26). Note that:

1. The ultimate pivot point's location is not a function of the foundation's bending stiffness, nor is it a function of soil stiffness. Its location is only a function of foundation dimensions and ultimate soil strength.

2. At failure, soil in contact with the foundation is pushed in one direction above the ultimate pivot point and in the opposite direction below the ultimate pivot point.

3. For each combination of (1) foundation rotation (i.e., clockwise or counter clockwise) and (2) ultimate pivot point depth d_{RU}, there is a unique combination of V_U and M_U as calculated using the equations in clause 11.3.2. The equation for V_U is obtained by summing soil spring forces in the horizontal direction on a free body diagram of the below-grade portion of a foundation. The equation for M_U is obtained by summing moments about the groundline on the same free body diagram.

Each soil spring represents a soil layer. Application of the equations in clause 11.3.2 requires the ultimate pivot point to be located at the interface between soil layers, at the soil surface, or at the base of the foundation. Thus, for an 8 soil spring model, the equations in clause 11.3.2 can be used to calculate 18 $V_U – M_U$ combinations as shown in Figure 27 (data for this $V_U – M_U$ envelope is in Table 7). This includes 9 each for clockwise and for counter clockwise foundation rotation. Not all 18 combinations are different. As shown in

Figure 27, a clockwise rotation of the foundation about the ground surface produces the same V_U and M_U values as a counter clockwise rotation about the base of the foundation. Likewise, a clockwise rotation of the foundation about the base of the foundation produces the same V_U and M_U values as a counter clockwise rotation about the ground surface. “Boxed” values in Figure 27 identify ultimate pivot point locations as a function of total foundation depth d_F.

The requirement that the ultimate pivot point be located between soil layers ensures that each soil spring is representing soil being pushed in the same direction. If the ultimate pivot point is located within a soil layer, then the spring associated with that soil layer must represent soil pushed in one direction above the pivot point, and in the opposite direction below the pivot point. Any soil spring modeling a layer of soil in which the ultimate pivot point is located is called a *pivot spring* (Bohnhoff, 2015). Note that the points on the plot in Figure 27 separate the $V_U – M_U$ envelope into segments, and each of these segments is associated with a different pivot spring. Segments identified with pivot springs 6 and 7 are identified in Figure 27. Because a pivot spring represents soil that is pushed in opposite directions by the foundation, the force in a pivot spring will always be less than the F_{ult} value calculated using the equation in clause 11.3.1.

For design purposes, the entire $V_U – M_U$ envelope need not be constructed. Calculating M_U and V_U for three or so ultimate pivot points in the ½ d_F to $^7/_8$ d_F range, enables construction of a $V_U – M_U$ envelope line that would cover most loadings associated with a non-constrained foundation. The deeper value of $^7/_8$ d_F is associated with foundations that have an attached footing, bottom collar, and/or some other mechanism that results in the base of the foundation having a much greater effective width than the rest of the foundation. Typically, the only way to move the ultimate pivot point outside of the ½ d_F to $^7/_8$ d_F range is for groundline shear and groundline bending moment to have opposite signs as shown in Figure 10.

The first sentence in clause 11.3.2 states that a foundation is adequate if on a plot of groundline shear versus groundline bending moment, the point $V_{ASD}\ f_L$, $M_{ASD}\ f_L$ (for ASD load combinations) or the point V_{LRFD}/R_L, M_{LRFD}/R_L (for LRFD load combinations) is located within the $V_U – M_U$ envelope. A mathematical way to check this for an ASD loading is to ensure that:

$$(M_U^2 + V_U^2)^{0.5} \geq [(M_{ASD}\ f_L)^2 + (V_{ASD}\ f_L)^2]^{0.5} \qquad \text{when } M_U/V_U = M_{ASD}/V_{ASD}$$

or for an LRFD loading:

$$(M_U^2 + V_U^2)^{0.5} \geq [(M_{LRFD}/R_L)^2 + (V_{LRFD}/R_L)^2]^{0.5} \qquad \text{when } M_U/V_U = M_{LRFD}/V_{LRFD}$$

These inequalities simply check that the distance from the origin to point V_U, M_U is greater or equal to the distance from the origin to point $V_{ASD}\ f_L$, $M_{ASD}\ f_L$ (or V_{LRFD}/R_L, M_{LRFD}/R_L) when *both points lie on the same line drawn through the origin*. On a plot of groundline shear force V_G versus groundline bending moment M_G, points are on the same line when they have the same M_G/V_G ratio (hence the requirement that M_U/V_U equal M_{ASD}/V_{ASD} for an ASD loading or M_{LRFD}/V_{LRFD} for an LRFD loading). Figure 28 shows the results of two structural analyses involving two completely different loadings on the same foundation; one ASD and the other LRFD. A quick scan of this plot reveals that the foundation is adequate for the LRFD loading but not for the ASD loading.

As is evident from Figure 28, there is a unique combination of V_U and M_U for each M_G/V_G ratio. To find this combination, the pivot spring associated with the specified M_G/V_G ratio must first be identified. This is accomplished with the use of a plot like that in Figure 27 and/or the corresponding data as given in Table 7. For example, examination of Figure 27 and Table 7 show that a line with a slope of 30 in (i.e., an M_G/V_G ratio of 30 in) crosses the $V_U – M_U$ envelope in the segment associated with spring 7 as the pivot spring. Once the pivot spring is identified, and ultimate groundline bending moment is equated to the product of V_U and the specified M_G/V_G ratio, a summation of moment about the location of the pivot spring will yield an equation with V_U as the only unknown (see Figure 29b). Solving for V_U and multiplying by the specified M_G/V_G ratio yields M_U. Once V_U is established, the force in the pivot spring can also be obtained by summing forces in the horizontal direction (Figure 29c). If the absolute value of the pivot spring force exceeds F_{ult} for that spring, then the wrong spring was selected as the pivot spring or a calculation error was made.

C11.3.3 Spring replacement. Maximum movement of an unrestrained post/pier occurs at grade where ultimate lateral resistance is the lowest. Depending on spring placement/spacing, this can result in the top spring(s) being overloaded in accordance with clause 11.3.1. Replacement of the springs with a force of magnitude F_{ult} recognizes the fact that the soil offers a fixed amount of resistance once a state of plastic strain is reached. To this end, if one or more springs near the surface are overloaded, it does not necessarily mean that the foundation is inadequate. The foundation is only inadequate when the inequality in clause 11.3.3 is not met for any of the modeling springs.

When replacing a spring with a fixed force, the force must act toward (push on) the foundation when the spring is in compression, and must act away from (pull on) the foundation when the spring is in tension.

C11.4 Lateral strength checks for Simplified Method. Relative to the Universal Method described in clause 11.3, the equations in clause 11.4 provide more exact V_U and M_U values for pier/post foundations that have (1) a fixed width, and (2) are embedded in soil considered homogeneous for their entire depth.

Equations for non-constrained foundations in clauses 11.4.1, 11.4.2 and 11.4.3 were obtained using the free body diagrams in Figures 18, 19 and 20, respectively. For each case, forces were summed in the horizontal direction to obtain an equation that was arranged with d_{RU} (ultimate pivot point depth) as the dependent variable and V_U as one of the independent variables. Moments where summed about the surface to obtain an equation for M_U.

The unconstrained foundation equations in clauses 11.4.1, 11.4.2 and 11.4.3 can be used to construct V_U – M_U envelopes. This is accomplished by selecting V_U values (both positive and negative) that produce a range of d_{RU} values between the ground surface (d = 0) and the depth of the foundation (d = d_F), The unconstrained foundation equations provide the d_{RU} values and then the corresponding M_U values for each of the selected V_U values. Use of the equations in clauses 11.4.1, 11.4.2 and 11.4.3 will produce only half the points needed for a complete V_U – M_U envelope; this since the equations only apply when soil forces act in the direction shown in Figures 18, 19, and 20. The other half of the V_U – M_U envelope is associated with soil forces applied in the opposite direction. The combination of V_U and M_U values associated with this reverse in soil forces are simply obtained by changing the signs on each set of V_U and M_U values obtained with the equations in clauses 11.4,1, 11.4.2 and 11.4.3.

Once a V_U – M_U envelope has been established, it can be used as described in clause C11.3.2 to determine the adequacy of the soil to resist the groundline shear and bending moment applied to the foundation.

Construction of a V_U – M_U envelope is not needed when V_G and M_G are both positive. In such cases, the inequality for M_U in clause 11.4 is the only check needed. Figure 30 illustrates how the checking process for the Simplified Method of analysis works. In this case, groundline shear and bending moment are due to an ASD load combination. The first step in the checking process is to multiply the ASD load-induced groundline shear by safety factor f_L. This yields the minimum required ultimate groundline shear capacity, V_U. Second, d_{RU} is calculated from V_U using the appropriate unconstrained foundation equation. Third, M_U is calculated from the d_{RU} value using the appropriate unconstrained foundation equation. In this case, the resulting M_U is exceeded by the combination of M_{ASD} and f_L, so design requirements are not met.

M_U equations for surface constrained foundations in clauses 11.4.4, 11.4.5, and 11.4.6 can be obtained by setting d_{RU} equal to zero in the equations in clauses 11.4.1, 11.4.2, and 11.4.3, respectively.

C11.4.1 Non-constrained pier/post in cohesionless soils. If shear force V_U is zero and there is a nonzero bending moment acting on the foundation, the foundation will rotate at a point below the surface equal to 0.707 d when Rankine soil pressures for cohesionless soils are acting. As V_U is increased, the point of rotation will lower (i.e., the ratio of d_{RU} to d will increase).

If shear V_G and moment M_G rotate the top of the foundation in opposite directions, a negative value must be input for V_{LRFD} (or V_{ASD}). This will move the point of rotation closer to the surface and d_{RU} will be less than 0.707 d.

C11.4.2 Non-constrained pier/post in cohesive soils. For calculation of the ultimate bending moment that can be applied to a non-constrained pier/post in cohesive soil, the force applied by the soil to the foundation per unit depth is assumed to equal 9 S_U b below the point of post/pier rotation. Above the point of rotation, a force of 3 S_U b is applied at the soil surface. This force increases at a rate of 1.5 S_U z. If 4b is less than d_{RU} the maximum applied soil force 9 S_U b will be reached above the point of post/pier rotation as shown in Figure 16b. If 4b is greater than d_{RU} the soil force above the point of rotation reaches a maximum value at the point of rotation of S_U (3b + 1.5d_{RU}) as shown in Figure 19a.

C11.4.3 Non-constrained pier/post in any soil. Equations for calculating the ultimate lateral load capacity of a pier/post in mixed soils requires tests to obtain both soil cohesion and friction angle under identical conditions (e.g. both drained). It is important that these conditions accurately reflect field conditions and do not overestimate soil strength as soil moisture content changes.

C11.4.5 Constrained pier/post in cohesive soils. For calculation of the ultimate bending moment that can be applied to a constrained pier/post in cohesive soil, the force applied by the soil is assumed to equal 3 $S_U\, b$ at the soil surface and increase at a rate of 1.5 $S_U\, z$ until a maximum of 9 $S_U\, b$ is reached at which point the force applied by the soil per unit depth remains at 9 $S_U\, b$. Where 4b exceeds d, the force acting on the foundation per unit depth will not reach 9 $S_U\, b$; instead it will reach a maximum at depth d of $S_U(3b + 1.5d)$.

C11.4.6 Constrained pier/post in any soil. Equations for calculating the ultimate lateral load capacity of a pier/post in mixed soils requires tests to obtain both soil cohesion and friction angle under identical conditions (e.g. both drained). It is important that these conditions accurately reflect field conditions and do not overestimate soil strength as soil moisture content changes.

C12.2.1 Anchorage system design. By design, the uplift strength of a post/pier foundation may be limited by the strength of the anchorage system or the method used to attach the anchorage system to the post/pier.

C12.2.2 Backfill compaction. The requirement in clause 12.2.2 is based on work by Kulhawy et al., (1987), which showed that the degree of backfill compaction had a significant impact on the actual ultimate uplift capacity of a foundation.

C12.5 Uplift resistance provided by soil. The force required to withdraw a post/pier foundation is largely dependent on the presence and size of an anchorage system. Without an anchorage system the only resistance to uplift is that provided by friction between the soil and vertical surfaces of the post/pier foundation.

Attaching a footing, collar, uplift blocking or any other device that effectively enlarges the foundation's base can significantly increase resistance to upward foundation displacement. This resistance is provided by the weight of the soil mass located above the anchorage system plus the resistance to movement of this soil mass.

To move the soil mass located above the anchorage systems requires that a failure plane form in the soil. This failure plane extends upward and outward from the edges of the anchorage system. It may or may not reach the ground surface depending on soil properties and the depth d_U and width B_U of the anchorage system. A shallow foundation under uplift is a foundation associated with a failure plane that reaches the ground surface as shown in Figure 24. Conversely, a deep foundation under uplift is a foundation associated with a failure plane that does not reach the ground surface as shown in Figure 24.

C12.5.1 Foundations in cohesionless soils. Soil uplift resistance values for foundations in cohesionless soils are based on work by Meyerhof and Adams (1968). The first step in these calculations is determining the *vertical extent of the uplift soil failure surface* for deep foundations, h which is a function of the angle of internal soil friction ϕ, and the anchorage system width B_U. The latter is the diameter of a circular anchorage system, or the smallest dimension of a rectangular anchorage system. The equation used to determine h for soil friction values greater than 20 degrees was regressed from data tabulated by Meyerhof and Adams (1968).

C12.5.1.1 Shallow foundation in cohesionless soils. Equations for calculating uplift resistance of foundations in cohesionless soils account for the soil mass that must be displaced as the anchorage system moves upward, and the internal friction (but not cohesion) between the upward moving soil mass and surrounding soil. The volume of soil displaced by that portion of the pier/post located above the anchorage systems is not included in the weight calculations.

K_U, which is the nominal uplift coefficient of earth pressure on a vertical plane through the edges of the anchorage systems, has been fixed at 0.95 for all calculations as suggested by Meyerhof and Adams (1968).

Shape factor s_F accounts for the shape of the failure plane. The equation for s_F was regressed from data tabulated by Meyerhof and Adams (1968).

C12.5.2 Uplift resistance for foundations in cohesive soils. Equations in clause 12.5.2 are from Meyerhof (1973). The quantity 1.2 d_U / B_U is referred to as the breakout factor, F_C, and is limited to a maximum value of 9.

References

AASHTO. 2008. *AASHTO LRFD Bridge Design Specifications*. Washington, D.C.: American Association of State Highway and Transportation Officials.

ACI. 2002a. Guide for Design of Jointed Concrete Pavements for Streets and Local Roads. ACI 325.12R. Farmington Hills, Mich.: American Concrete Institute.

ACI. 2002b. Suggested Analysis and Design Procedures for Combined Footings and Mats. ACI 336.2R. Farmington Hills, Mich.: American Concrete Institute.

Awkati. 1970. Unpublished, reported by Schmertmann, 1978.

Baguelin F., J. F. Jezequel, and D. H. Shields. 1978. *The Pressuremeter and Foundation Engineering*. Clausthal-Zellerfield, W. Germany.: Trans Tech Publications.

Bohnhoff, D. R., Z. D. Hartjes, D. W. Kammel, and N. P. Ryan. 2003. In-Situ Hydration of a Dry Concrete Mix. ASAE Paper No. 034003. St. Joseph, Mich.: American Society of Agricultural Engineers.

Bohnhoff, D. R. 2015. Lateral Strength and Stiffness of Post and Pier Foundations. ASABE Paper No. 152190408. St. Joseph, Mich.: American Society of Agricultural Engineers.

Briaud, Jean-Louis. 1992. *The Pressuremeter*. Brookfield, Vt.: A. A. Balkema Publishers.

Briaud, Jean-Louis. 2001. Introduction to Soil Moduli. *Geotechnical News* June, 2001.

Broms, B. B. 1964a. Lateral Resistance of Piles in Cohesive Soils. *ASCE Journal of the Soil Mechanics and Foundation Division*. 96(SM3): 27-63.

Broms, B. B. 1964b. Lateral Resistance of Piles in Cohesionless Soils. *ASCE Journal of the Soil Mechanics and Foundation Division*. 96(SM3): 123-158.

Canadian Geotechnical Society. 1992. *Canadian Foundation Engineering Manual*. Richmond, B.C., Canada: BiTech Publishers.

Davisson, M. T. 1970. Lateral Load Capacity of Piles. Highway Research Record No. 333. Washington, D.C.

Fellenius, Bengt H. 2003. Foundations. In *The Civil Engineering Handbook*. Chapter 23. Edited by W. F. Chen and J. Y. Richard Liew. New York, N.Y.: CRC Press.

Foye, K. C., R. Salgado, and B. Scott. 2006a. Resistance Factors for Use in Shallow Foundation LRFD. *ASCE Journal of Geotechnical and Geoenvironmental Engineering*. 132(9): 1208-1218.

Foye, K. C., R. Salgado, and B. Scott. 2006b. Assessment of Variable Uncertainties for Reliability-Based Design of Foundations. *ASCE Journal of Geotechnical and Geoenvironmental Engineering*. 132(9): 1197-1207.

Hatanaka, M. and A. Uchida. 1996. Empirical Correlation between Penetration Resistance and Internal Friction Angle of Sandy Soils. *Soils and Foundation* 36(4): 1-10.

Humphrey, Dana N. 2003. Strength and Deformation. In *The Civil Engineering Handbook*. Chapter 17. Edited by W. F. Chen and J. Y. Richard Liew. New York, N.Y.: CRC Press.

Kulhawy, F. H., and P. H. Mayne. 1990. *Manual on Estimating Soil Properties for Foundation Design*. Report EL-6800. Electric Power Research Institute (EPRI).

Kulhawy, F. H., C. H. Trautman, and C. N. Nicolaides. 1987. Spread foundations in uplift: Experimental study. In *Foundations for Transmission Line Towers*, 96-109. Edited by J. L. Briaud. New York, N.Y.: American Society of Civil Engineers.

Lambrechts, J. R., and G. A. Leonards. 1978. Effects of stress history on deformations of sands. *Journal of the Geotechnical Engineering Division, ASCE* 104)GT11): 1371-1387.

Lee, J., M. Kim, and D. Kyung. 2010. Estimation of Lateral Load Capacity of Rigid Short Piles in Sands Using CPT Results. *Journal of Geotechnical and Geoenvironmental Engineering* 136(1): 48-56.

Liao, S. S. C. and R. V. Whitman. 1986. Overburden Correction Factor for SPT in Sand. *ASCE Journal of Geotechnical Engineering* 112(3): 373-377.

Meyerhof, G. G. 1973. Uplift resistance of inclined anchors and piles. *Proceedings, 8th International Conference on Soil Mechanics and Foundation Engineering, Moscow* 2:167-172.

Meyerhof, G. G., and J. I. Adams. 1968. The uplift capacity of foundations. *Canadian Geotechnical Journal* 5(4): 225-244.

NCEER. 1997. *Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils*. Edited by T. L. Youd and I. M. Idriss. Technical Report NCEER-97-0022. Buffalo, N.Y.: National Center for Earthquake Engineering Research.

NCHRP. 1991. *Manual for the Design of Bridge Foundations*. NCHRP Report 343. Washington, D.C.: National Cooperative Highway Research Program.

NFEC. 1986a. *Soil Mechanics*. NFEC Design Manual 7.01. Alexandria, Va.: Naval Facilities Engineering Command.

NFEC. 1986b. *Foundations & Earth Structures*. NFEC Design Manual 7.02. Alexandria, Va.: Naval Facilities Engineering Command.

Prakash, Shamsher, and Hari D. Sharma. 1990. *Pile Foundations in Engineering Practice*. New York, N.Y.: John Wiley & Sons.

Pyke, Robert, and Mohsen Beikae. 1984. A New Solution for the Resistance of Single Piles to Lateral Loading. In *Laterally Loaded Deep Foundations: Analysis and Performance*, 3-20. ASTM STP 835. Edited by J. A. Langer, E. T. Mosley, and C. D. Thompson. American Society for Testing and Materials.

Robertson, P. K. and J. M. Hughes. 1986. Determination of Properties of Sand from Self-Boring Pressuremeter Tests. In *The Pressuremeter and Its Marine Applications*, 283-302. ASTM Special Publication 950. American Society for Testing and Materials.

Salgado, Rodrigo. 2008. *The Engineering of Foundations*. New York, N.Y.: McGraw-Hill.

Schmertmann, John H. 1970. Static Cone To Compute Static Settlement Over Sand. *ASCE Journal of the Soil Mechanics & Foundations Division* 96(SM3): 1011-1043.

Schmertmann, John H. 1978. Guidelines for CPT: Performance and design. Report FHWA-TS-78-209, Federal Highway Administration, Washington D.C. 145 pp.

Schmertmann, John H., John Paul Hartman, and Philip R. Brown. 1978. Improved Strain Factor Diagrams. *ASCE Journal of the Geotechnical Engineering Division* 104(GT*): 1131-1135.

Terzaghi, Karl. 1955. Evaluation of Coefficients of Subgrade Reaction. *Geotechnique* 5(4): 297-326.

Terzaghi, K., and R. B. Peck. 1967. *Soil Mechanics in Engineering Practice*. New York, N.Y.: John Wiley and Sons.

Table 1 – Presumptive soil properties for post and pier foundation design

Soil Type	Unified Soil Classification	Consistency	Moist Unit Weight, γ		Drained Cohesion, c'		Drained Soil Friction Angle, ϕ [(a)]	Undrained Soil Shear Strength[(b)], S_U		Young's Modulus for Soil, E_S [(c)(d)]		Increase in Young's Modulus per Unit Depth below Grade[(c)(d)(e)], A_E		Poisson's Ratio[(f)], ν
			kN/m³	lbf/ft³	kPa	lbf/ in²	Deg	kPa	lbf/in²	MPa	lbf/in²	MPa/m	(lbf/in²)/in	
Homogeneous inorganic clay, sandy or silty clay	CL	soft	19.5	125	0		NA	25	3.5	28	3920	-	-	0.5
		medium to stiff	20.5	130				50	7	44	6160	-	-	
		very stiff to hard	21.5	135				100	14	60	8400	-	-	
Homogeneous inorganic clay of high plasticity	CH	soft	17.0	110	0		NA	25	3.5	12	1680	-	-	0.5
		medium to stiff	18.0	115				50	7	20	2800	-	-	
		very stiff to hard	19.0	120				100	14	32	4480	-	-	
Inorganic silt, sandy or clayey silt, varved silt-clay-fine sand of low plasticity	ML	soft	19.0	120	0		NA	25	3.5	28	3920	-	-	0.5
		medium to stiff						50	7	44	6160	-	-	
		very stiff to hard						100	14	60	8400	-	-	
Inorganic silt, sandy or clayey silt, varved silt-clay-fine sand of high plasticity	MH	soft	16.5	105	0		NA	25	3.5	12	1680	-	-	0.5
		medium to stiff						50	7	20	2800	-	-	
		very stiff to hard						100	14	32	4480	-	-	
Silty or clayey fine to coarse sand	SM, SC, SP-SM, SP-SC, SW-SM, SW-SC	loose	16.5	105	0		30	NA		-	-	10	37	0.3
		medium to dense	17.0	110			35			-	-	15	55	
		very dense	18.0	115			40			-	-	20	75	
Clean sand with little gravel	SW, SP	loose	18.0	115	0		30	NA		-	-	20	75	0.3
		medium to dense	19.0	120			35			-	-	30	110	
		very dense	19.5	125			40			-	-	40	150	
Gravel, gravel-sand mixture, boulder-gravel mixtures	GW, GP	loose	21.5	135	0		35	NA		-	-	60	220	0.3
		medium to dense					40			-	-	80	300	
		very dense					45			-	-	100	370	
Well-graded mixture of fine- and coarse-grained soil: glacial till, hardpan, boulder clay	GW-GC, GC, SC	loose	19.0	120	0		35	NA		-	-	30	110	0.3
		medium to dense	19.5	125			40			-	-	40	150	
		very dense	20.5	130			45			-	-	50	185	

(a) Rapid undrained loading will typically be the critical design scenario in predominately silt and/or clay soils. Laboratory testing is recommended to assess clay friction angle for drained loading analysis.
(b) Loading assumed slow enough that sandy soils behave in a drained manner.
(c) Estimate of stiffness at rotation of 1° for use in approximating structural load distribution. For evaluation of serviceability limit state use values that are $^1/_3$ of tabulated value.
(d) Constant values of stiffness used for calculation of clay response. Stiffness increasing with depth from a value of zero used for calculation of sand response.
(e) Assumes soil is located below the water table. Double the tabulated A_E value for soils located above the water table.
(f) Poisson ratio of 0.5 (no volume change) assumes rapid undrained loading conditions.

Table 2 – LRFD resistance factors and ASD safety factors for bearing strength assessment

Soil	Associated Clause[(a)]	Method Used to Determine Ultimate Bearing Capacity, q_B	LRFD Resistance Factor for Bearing Strength Assessment, R_B	ASD Safety Factor for Bearing Strength Assessment, f_B
Cohesionless (SP, SW, GP, GW, GW-GC, GC, SC, SM, SP-SM, SP-SC, SW-SM, SW-SC)	10.4.1	General bearing capacity equation with ϕ determined from laboratory direct shear or axial compression tests (see clause 5.8.1)	$0.80 - 0.01 \cdot \phi$	$1.4/(0.80 - 0.01 \cdot \phi)$
		General bearing capacity equation with ϕ determined from SPT data in accordance with clause 5.8.2	$0.62 - 0.01 \cdot \phi$	$1.4/(0.62 - 0.01 \cdot \phi)$
		General bearing capacity equation with ϕ determined from CPT data in accordance with clause 5.8.3	$0.71 - 0.01 \cdot \phi$	$1.4/(0.71 - 0.01 \cdot \phi)$
		General bearing capacity equation with presumptive soil properties from Table 1	$0.58 - 0.01 \cdot \phi$	$1.4/(0.58 - 0.01 \cdot \phi)$
		General bearing capacity equation with presumptive soil properties from Table 1 with soil type verified by construction testing	$0.77 - 0.01 \cdot \phi$	$1.4/(0.77 - 0.01 \cdot \phi)$
	10.4.2	Standard penetration test (SPT)	0.41	3.4
	10.4.3	Cone penetration test (CPT)	0.50	2.8
	10.4.4	Pressuremeter test (PMT)	0.50	2.8
Cohesive (CL, CH, ML, MH)	10.4.1	General bearing capacity equation with undrained shear strength determined from laboratory compression tests (see clause 5.7.1)	0.60	2.3
		General bearing capacity equation with undrained shear strength determined from PBPMT data in accordance with clause 5.7.2	0.60	2.3
		General bearing capacity equation with undrained shear strength determined from CPT data in accordance with clause 5.7.3	0.60	2.3
		General bearing capacity equation with undrained shear strength determined from in-situ vane tests in accordance with clause 5.7.4	0.60	2.3
		General bearing capacity equation with presumptive soil properties from Table 1	0.47	3.0
		General bearing capacity equation with presumptive soil properties from Table 1 with soil type verified by construction testing	0.60	2.3
	10.4.3	Cone penetration test (CPT)	0.60	2.3
	10.4.4	Pressuremeter test (PMT)	0.60	2.3

[(a)] Clause containing the q_B equation to which the resistance/safety factor applies.

Table 3 – LRFD resistance factors and ASD safety factors for lateral strength assessment using the Universal Method of analysis

Soil	Method Used to Determine Ultimate Lateral Soil Resistance, $p_{U,z}$	LRFD Resistance Factor for Lateral Strength Assessment, R_L	ASD Safety Factor for Lateral Strength Assessment, f_L
Cohesionless (SP, SW, GP, GW, GW-GC, GC, SC, SM, SP-SM, SP-SC, SW-SM, SW-SC)	Equation from clause 11.2.1 with soil friction angle ϕ determined from laboratory direct shear or axial compression tests (see clause 5.8.1)	$0.86 - 0.01 \cdot \phi$	$1.4/(0.86 - 0.01 \cdot \phi)$
	Equation from clause 11.2.1 with soil friction angle ϕ determined from SPT data in accordance with clause 5.8.2	$0.66 - 0.01 \cdot \phi$	$1.4/(0.66 - 0.01 \cdot \phi)$
	Equation from clause 11.2.1 with soil friction angle ϕ determined from CPT data in accordance with clause 5.8.3	$0.76 - 0.01 \cdot \phi$	$1.4/(0.76 - 0.01 \cdot \phi)$
	Equation from clause 11.2.1 with soil friction angle ϕ from Table 1	$0.61 - 0.01 \cdot \phi$	$1.4/(0.61 - 0.01 \cdot \phi)$
	Equation from clause 11.2.1 with soil friction angle ϕ from Table 1, with soil type verified by construction testing	$0.82 - 0.01 \cdot \phi$	$1.4/(0.82 - 0.01 \cdot \phi)$
	Pressuremeter test (PMT) in accordance with clause 11.2.2	0.56	2.5
Cohesive (CL, CH, ML, MH)	Equation from clause 11.2.1 with undrained shear strength S_U determined from laboratory compression tests (see clause 5.7.1)	0.68	2.1
	Equation from clause 11.2.1 with undrained shear strength S_U determined from PBPMT data in accordance with clause 5.7.2	0.68	2.1
	Equation from clause 11.2.1 with undrained shear strength S_U determined from CPT data in accordance with clause 5.7.3	0.68	2.1
	Equation from clause 11.2.1 with undrained shear strength S_U determined from in-situ vane tests in accordance with clause 5.7.4	0.68	2.1
	Equation from clause 11.2.1 with undrained shear strength S_U from Table 1	0.54	2.6
	Equation from clause 11.2.1 with undrained shear strength S_U from Table 1 with soil type verified by construction testing	0.68	2.1
	Pressuremeter test (PMT) in accordance with clause 11.2.2	0.68	2.1

Table 4 – LRFD resistance factors and ASD safety factors for lateral strength assessment using the Simplified Method of analysis

Soil	Required Property	Method Used to Determine Required Soil Property	LRFD Resistance Factor for Lateral Strength Assessment, R_L	ASD Safety Factor for Lateral Strength Assessment, f_L
Cohesionless (SP, SW, GP, GW, GW-GC, GC, SC, SM, SP-SM, SP-SC, SW-SM, SW-SC)	Soil friction angle ϕ for equations in clauses 11.4.1, 11.4.3, 11.4.4 and 11.4.6	Laboratory direct shear or axial compression tests (see clause 5.8.1)	$0.86 - 0.01 \cdot \phi$	$1.4/(0.86 - 0.01 \cdot \phi)$
		SPT data in accordance with clause 5.8.2	$0.66 - 0.01 \cdot \phi$	$1.4/(0.66 - 0.01 \cdot \phi)$
		CPT data in accordance with clause 5.8.3	$0.76 - 0.01 \cdot \phi$	$1.4/(0.76 - 0.01 \cdot \phi)$
	Soil friction angle ϕ for equations in clauses 11.4.1 and 11.4.4	Table 1	$0.61 - 0.01 \cdot \phi$	$1.4/(0.61 - 0.01 \cdot \phi)$
		Table 1 with soil type verified by construction testing	$0.82 - 0.01 \cdot \phi$	$1.4/(0.82 - 0.01 \cdot \phi)$
Cohesive (CL, CH, ML, MH)	Undrained shear strength S_U for equations in clauses11.4.2, 11.4.3, 11.4.5 and 11.4.6	Laboratory compression tests (see clause 5.7.1)	0.68	2.1
		PBPMT data in accordance with clause 5.7.2	0.68	2.1
		CPT data in accordance with clause 5.7.3	0.68	2.1
		In-situ vane tests in accordance with clause 5.7.4	0.68	2.1
	Undrained shear strength S_U for equations in clauses 11.4.2 and 11.4.5	Table 1	0.54	2.6
		Table 1 with soil type verified by construction testing	0.68	2.1

Table 5 – LRFD resistance factors and ASD safety factors for uplift strength assessment

Soil	Required Property	Method Used to Determine Required Soil Property	LRFD Resistance Factor for Uplift Strength Assessment, R_U [a]	ASD Safety Factor for Uplift Strength Assessment, f_U [a]
Cohesionless (SP, SW, GP, GW, GW-GC, GC, SC, SM, SP-SM, SP-SC, SW-SM, SW-SC)	Soil friction angle ϕ for use in the equations of clauses 12.5.1.1 and 12.5.1.2	Laboratory direct shear or axial compression tests (see clause 5.8.1)	$1.20 - 0.015 \cdot \phi$	$1.4/(1.20 - 0.015 \cdot \phi)$
		SPT data in accordance with clause 5.8.2	$0.93 - 0.015 \cdot \phi$	$1.4/(0.93 - 0.015 \cdot \phi)$
		CPT data in accordance with clause 5.8.3	$1.07 - 0.015 \cdot \phi$	$1.4/(1.07 - 0.015 \cdot \phi)$
		Table 1	$0.87 - 0.015 \cdot \phi$	$1.4/(0.87 - 0.015 \cdot \phi)$
		Table 1 with soil type verified by construction testing	$1.16 - 0.015 \cdot \phi$	$1.4/(1.16 - 0.015 \cdot \phi)$
Cohesive (CL, CH, ML, MH)	Undrained shear strength S_U for use in the equation of clause 12.5.2	Laboratory compression tests (see clause 5.7.1)	0.70	2.0
		PBPMT data in accordance with clause 5.7.2	0.70	2.0
		CPT data in accordance with clause 5.7.3	0.70	2.0
		In-situ vane tests in accordance with clause 5.7.4	0.70	2.0
		Table 1	0.56	2.5
		Table 1 with soil type verified by construction testing	0.70	2.0

[a] In all cases, R_U is limited to a maximum value of 0.93 and F_U is limited to a minimum value of 1.50.

Table 6 – Bearing capacity factors as a function of soil friction angle

Soil Friction Angle, ϕ	tan ϕ	$1 - \sin\phi$	N_γ	N_q	s_q	d_F / B: 2	3	4	5	6	7	8	10	12
					$\tan^{-1}(d_F / B)$	1.11	1.25	1.33	1.37	1.41	1.43	1.45	1.47	1.49
						d_q								
0	0.000	1.000	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	0.017	0.983	0.07	1.09	1.02	1.04	1.04	1.04	1.05	1.05	1.05	1.05	1.05	1.05
2	0.035	0.965	0.15	1.20	1.03	1.07	1.08	1.09	1.09	1.09	1.09	1.09	1.10	1.10
3	0.052	0.948	0.24	1.31	1.05	1.10	1.12	1.12	1.13	1.13	1.13	1.14	1.14	1.14
4	0.070	0.930	0.34	1.43	1.07	1.13	1.15	1.16	1.17	1.17	1.17	1.18	1.18	1.18
5	0.087	0.913	0.45	1.57	1.09	1.16	1.18	1.19	1.20	1.20	1.21	1.21	1.21	1.22
6	0.105	0.895	0.57	1.72	1.11	1.19	1.21	1.22	1.23	1.24	1.24	1.24	1.25	1.25
7	0.123	0.878	0.71	1.88	1.12	1.21	1.24	1.25	1.26	1.27	1.27	1.27	1.28	1.28
8	0.141	0.861	0.86	2.06	1.14	1.23	1.26	1.28	1.29	1.29	1.30	1.30	1.31	1.31
9	0.158	0.844	1.03	2.25	1.16	1.25	1.28	1.30	1.31	1.32	1.32	1.33	1.33	1.34
10	0.176	0.826	1.22	2.47	1.18	1.27	1.30	1.32	1.33	1.34	1.34	1.35	1.35	1.36
11	0.194	0.809	1.44	2.71	1.19	1.28	1.32	1.34	1.35	1.36	1.36	1.37	1.37	1.38
12	0.213	0.792	1.69	2.97	1.21	1.30	1.33	1.35	1.37	1.37	1.38	1.39	1.39	1.40
13	0.231	0.775	1.97	3.26	1.23	1.31	1.35	1.37	1.38	1.39	1.40	1.40	1.41	1.41
14	0.249	0.758	2.29	3.59	1.25	1.32	1.36	1.38	1.39	1.40	1.41	1.41	1.42	1.43
15	0.268	0.741	2.65	3.94	1.27	1.33	1.37	1.39	1.40	1.41	1.42	1.43	1.43	1.44
16	0.287	0.724	3.06	4.33	1.29	1.33	1.38	1.40	1.41	1.42	1.43	1.44	1.44	1.45
17	0.306	0.708	3.53	4.77	1.31	1.34	1.38	1.41	1.42	1.43	1.44	1.44	1.45	1.46
18	0.325	0.691	4.07	5.26	1.32	1.34	1.39	1.41	1.43	1.44	1.44	1.45	1.46	1.46
19	0.344	0.674	4.68	5.80	1.34	1.35	1.39	1.42	1.43	1.44	1.45	1.45	1.46	1.47
20	0.364	0.658	5.39	6.40	1.36	1.35	1.39	1.42	1.43	1.44	1.45	1.46	1.46	1.47
21	0.384	0.642	6.20	7.07	1.38	1.35	1.39	1.42	1.43	1.44	1.45	1.46	1.46	1.47
22	0.404	0.625	7.13	7.82	1.40	1.35	1.39	1.42	1.43	1.44	1.45	1.46	1.46	1.47
23	0.424	0.609	8.20	8.66	1.42	1.35	1.39	1.42	1.43	1.44	1.45	1.46	1.46	1.47
24	0.445	0.593	9.44	9.60	1.45	1.35	1.39	1.42	1.43	1.44	1.45	1.45	1.46	1.47

Table 6 (continued) – Bearing capacity factors as a function of soil friction angle

Soil Friction Angle, ϕ	$\tan\phi$	$1-\sin\phi$	N_γ	N_q	s_q	d_F/B								
						2	3	4	5	6	7	8	10	12
						$\tan^{-1}(d_F/B)$								
						1.11	**1.25**	**1.33**	**1.37**	**1.41**	**1.43**	**1.45**	**1.47**	**1.49**
						d_q								
25	0.466	0.577	10.87	10.66	1.47	1.34	1.39	1.41	1.43	1.44	1.44	1.45	1.46	1.46
26	0.488	0.562	12.54	11.85	1.49	1.34	1.38	1.41	1.42	1.43	1.44	1.45	1.45	1.46
27	0.510	0.546	14.47	13.20	1.51	1.34	1.38	1.40	1.42	1.43	1.43	1.44	1.45	1.45
28	0.532	0.531	16.71	14.72	1.53	1.33	1.37	1.40	1.41	1.42	1.43	1.43	1.44	1.45
29	0.554	0.515	19.33	16.44	1.55	1.33	1.37	1.39	1.40	1.41	1.42	1.43	1.43	1.44
30	0.577	0.500	22.40	18.40	1.58	1.32	1.36	1.38	1.40	1.41	1.41	1.42	1.42	1.43
31	0.601	0.485	25.99	20.63	1.60	1.31	1.35	1.37	1.39	1.40	1.40	1.41	1.42	1.42
32	0.625	0.470	30.21	23.17	1.62	1.31	1.34	1.37	1.38	1.39	1.39	1.40	1.41	1.41
33	0.649	0.455	35.18	26.09	1.65	1.30	1.34	1.36	1.37	1.38	1.38	1.39	1.40	1.40
34	0.675	0.441	41.06	29.43	1.67	1.29	1.33	1.35	1.36	1.37	1.37	1.38	1.39	1.39
35	0.700	0.426	48.02	33.29	1.70	1.28	1.32	1.34	1.35	1.36	1.36	1.37	1.37	1.38
36	0.727	0.412	56.30	37.74	1.73	1.27	1.31	1.33	1.34	1.35	1.35	1.36	1.36	1.37
37	0.754	0.398	66.18	42.91	1.75	1.26	1.30	1.32	1.33	1.34	1.34	1.35	1.35	1.36
38	0.781	0.384	78.01	48.92	1.78	1.26	1.29	1.31	1.32	1.32	1.33	1.33	1.34	1.34
39	0.810	0.371	92.23	55.94	1.81	1.25	1.28	1.30	1.31	1.31	1.32	1.32	1.33	1.33
40	0.839	0.357	109.39	64.18	1.84	1.24	1.27	1.28	1.29	1.30	1.31	1.31	1.32	1.32
41	0.869	0.344	130.18	73.88	1.87	1.23	1.26	1.27	1.28	1.29	1.29	1.30	1.30	1.31
42	0.900	0.331	155.51	85.35	1.90	1.22	1.25	1.26	1.27	1.28	1.28	1.29	1.29	1.29
43	0.933	0.318	186.48	98.99	1.93	1.21	1.24	1.25	1.26	1.27	1.27	1.27	1.28	1.28
44	0.966	0.305	224.58	115.28	1.97	1.20	1.22	1.24	1.25	1.25	1.26	1.26	1.26	1.27
45	1.000	0.293	271.68	134.84	2.00	1.19	1.21	1.23	1.24	1.24	1.25	1.25	1.25	1.26
46	1.036	0.281	330.25	158.46	2.04	1.18	1.20	1.22	1.22	1.23	1.23	1.24	1.24	1.24
47	1.072	0.269	403.54	187.15	2.07	1.17	1.19	1.21	1.21	1.22	1.22	1.22	1.23	1.23
48	1.111	0.257	495.86	222.24	2.11	1.16	1.18	1.19	1.20	1.21	1.21	1.21	1.22	1.22
49	1.150	0.245	612.97	265.42	2.15	1.15	1.17	1.18	1.19	1.19	1.20	1.20	1.20	1.21
50	1.192	0.234	762.64	318.96	2.19	1.14	1.16	1.17	1.18	1.18	1.19	1.19	1.19	1.19

Table 7– Data for example V_U – M_U envelope formulation

Foundation and soil parameters: foundation width *b* is 4.5 in, foundation depth d_F is 48 in, soil is cohesionless with angle of internal friction of 35 degrees and corresponding coefficient of passive earth pressure K_P of 3.69, soil density is 0.637 lbm/in^3, each soil spring is used to model a 6-in thick layer of soil.

Spring number	Distance from surface to spring, *z*	Effective vertical soil stress at spring location	Ultimate lateral soil resistance at spring location, $p_{U,z}$	Absolute maximum force allowed in spring F_{ult}
	in	lbf/in^2	lbf/in^2	lbf
1	3	0.19	2.1	57
2	9	0.57	6.3	171
3	15	0.95	10.6	285
4	21	1.34	14.8	400
5	27	1.72	19.0	514
6	33	2.10	23.3	628
7	39	2.48	27.5	742
8	45	2.86	31.7	856

Depth to ultimate pivot point, d_{RU}, in	Ultimate pivot point location as function of total foundation depth, d_{RU}/d_F	Ultimate groundline shear, V_U, lbf	Ultimate groundline moment capacity, M_U, lbf-in	M_U/V_U
0	0	-3653	1.16E+05	-31.9
6	0.125	-3539	1.16E+05	-32.8
12	0.250	-3197	1.13E+05	-35.4
18	0.375	-2626	1.04E+05	-39.8
24	0.500	-1827	8.77E+04	-48.0
30	0.625	-799	5.99E+04	-75.0
36	0.750	457	1.85E+04	40.5
42	0.875	1941	-3.94E+04	-20.3
48	1.000	3653	-1.16E+05	-31.9

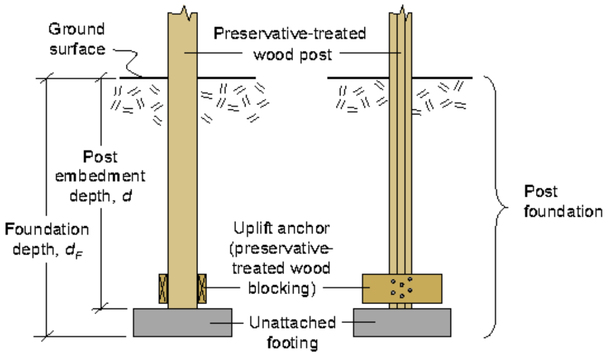

Figure 1 – Preservative-treated wood post foundation

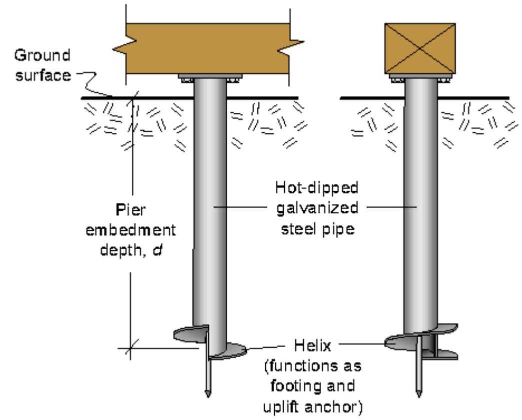

Figure 2 – Helical pier foundation

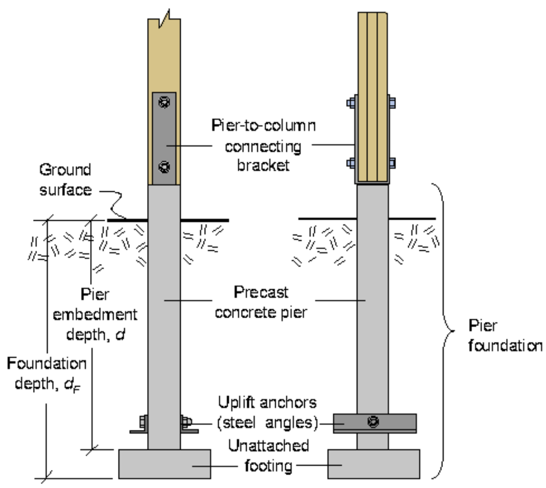

Figure 3 – Precast concrete pier foundation

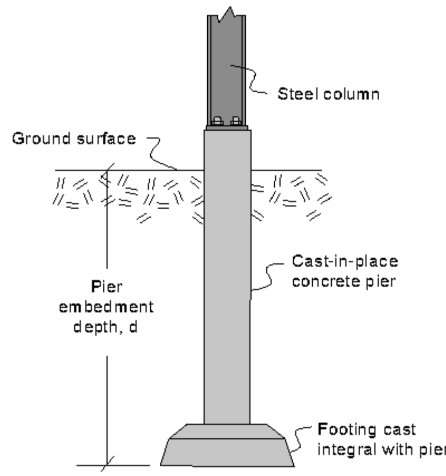

Figure 4 – Cast-in-place concrete pier foundation

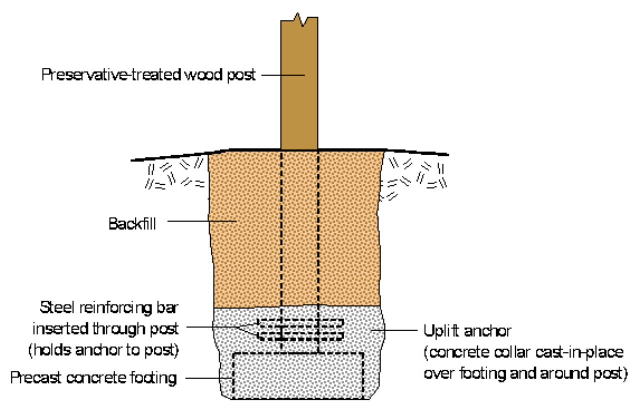

Figure 5 – Post foundation with cast-in-place concrete collar

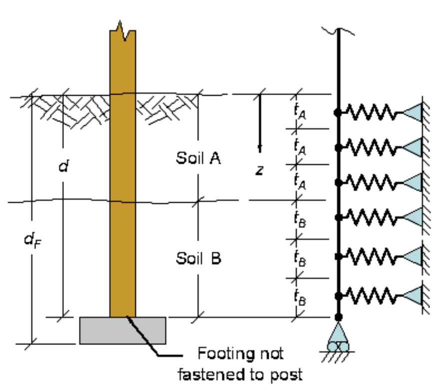

Figure 6 – Two-dimensional structural analog for a post/pier foundation. Spacing of soil springs dictated by thickness of each soil layer.

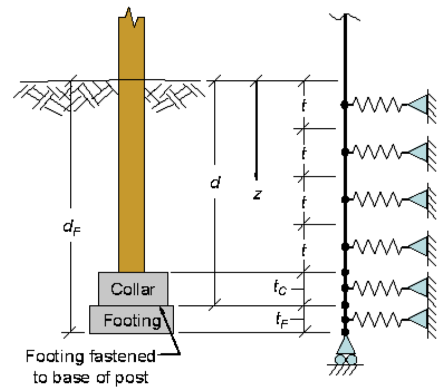

Figure 7 – Two-dimensional structural analog for a post/pier foundation. Different soil springs are used to model soil acting on the collar, attached footing, and pier/post because of the difference in width of the three foundation elements.

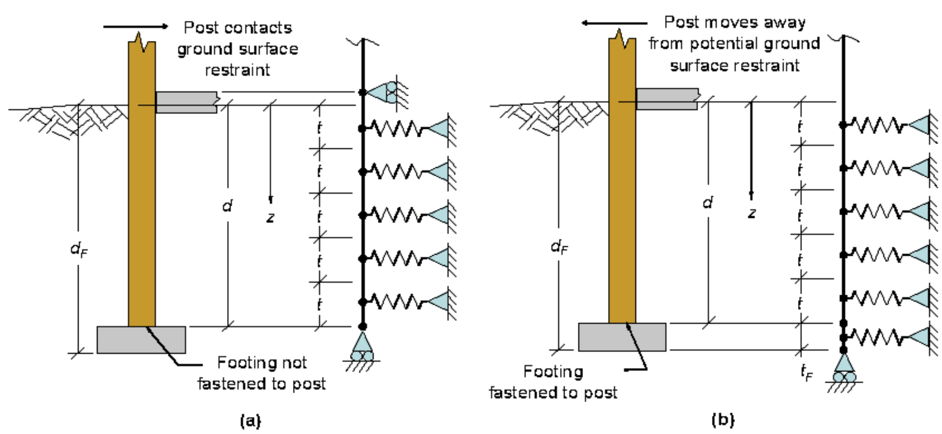

Figure 8 – Two-dimensional structural analogs for a post/pier foundation. If pier/post foundation is moving away from a surface restraint, do not model the surface restraint with a support.

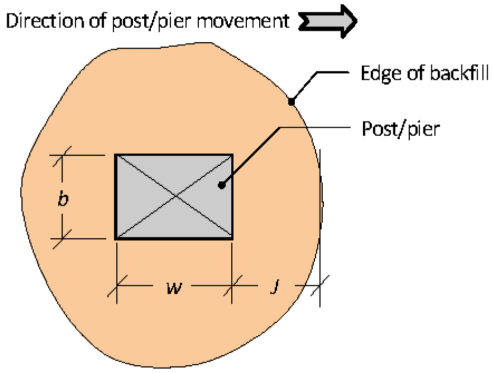

Figure 9 – Top view of foundation showing distance *J* between the post/pier and edge of backfill

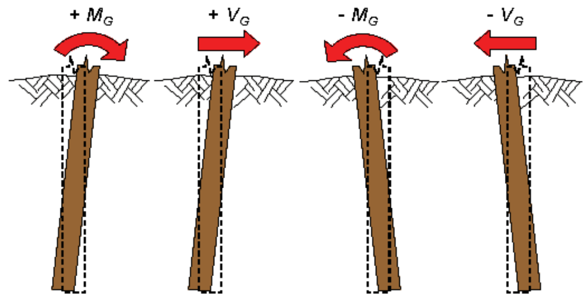

Figure 10 – Sign convention for groundline shear and groundline bending moment forces

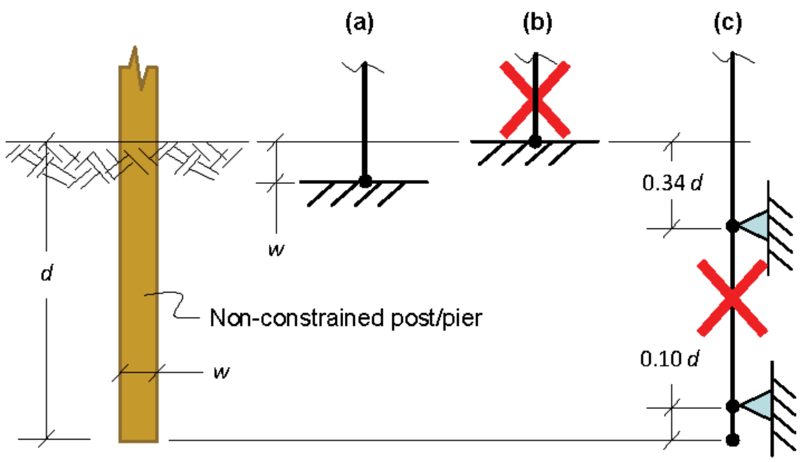

Figure 11 – Modeling analogs: (a) fixed base analog that is recommended when modeling a non-constrained pier/post to obtain M_G and V_G, (b) fixed base analog that is not recommended as it is too rigid, and (c) old two support analog that is too flexible for deeper foundations and too difficult to use.

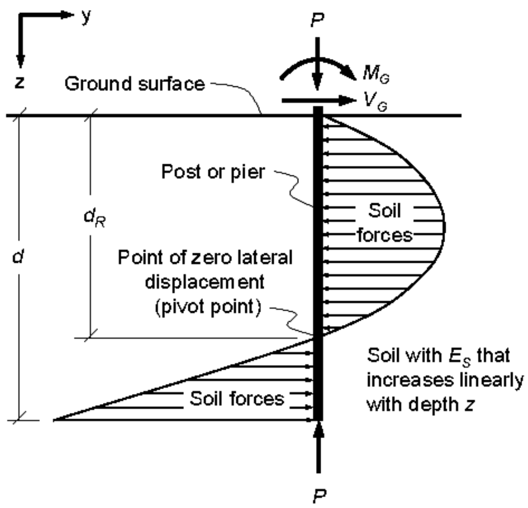

Figure 12 – Forces acting on a non-constrained post/pier of fixed width *b* when soil stiffness increases linearly with depth

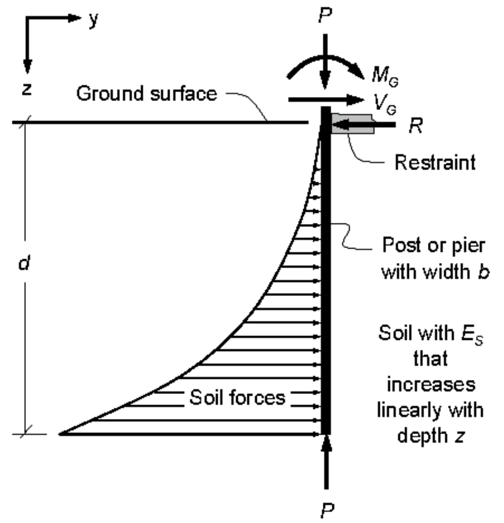

Figure 13 – Forces acting on a ground surface-constrained post/pier of fixed width *b* when soil stiffness increases linearly with depth

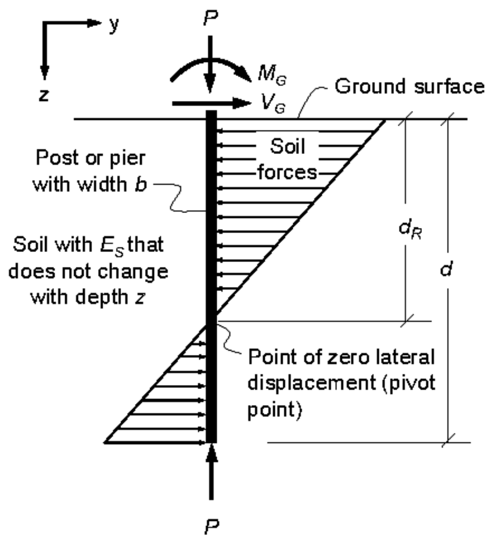

Figure 14 – Forces acting on a non-constrained post/pier of fixed width *b* when soil stiffness is constant with depth

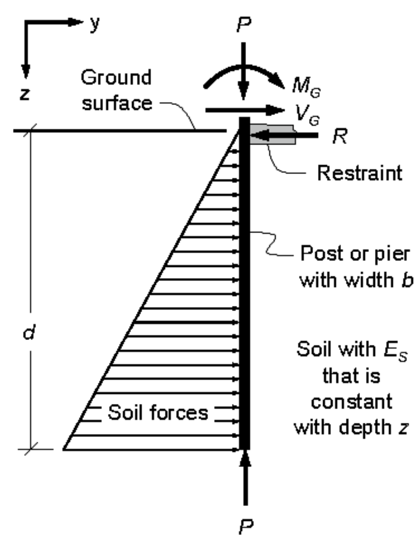

Figure 15 – Forces acting on a ground surface-constrained post/pier of fixed width *b* when soil stiffness is constant with depth

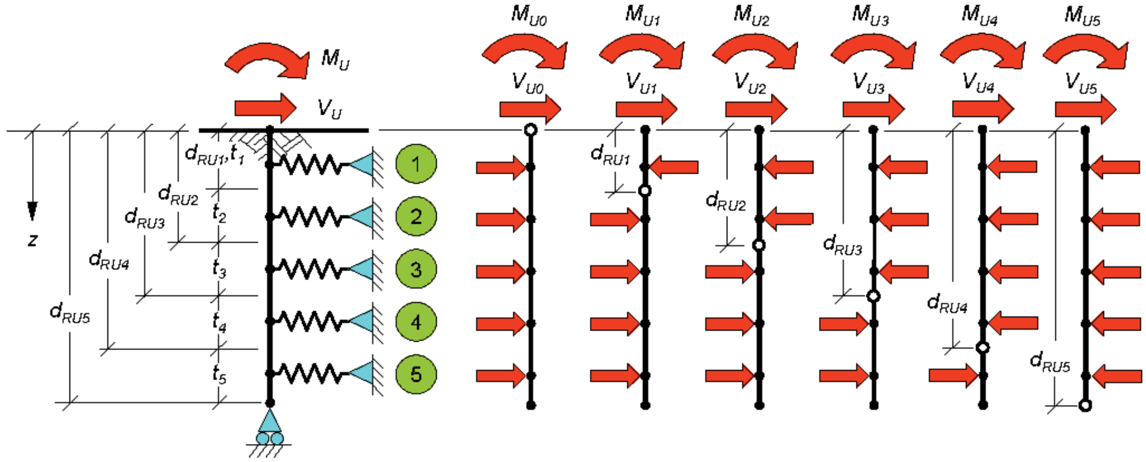

Figure 16 – Five soil spring model and associated free body diagrams for six different ultimate pivot point locations.

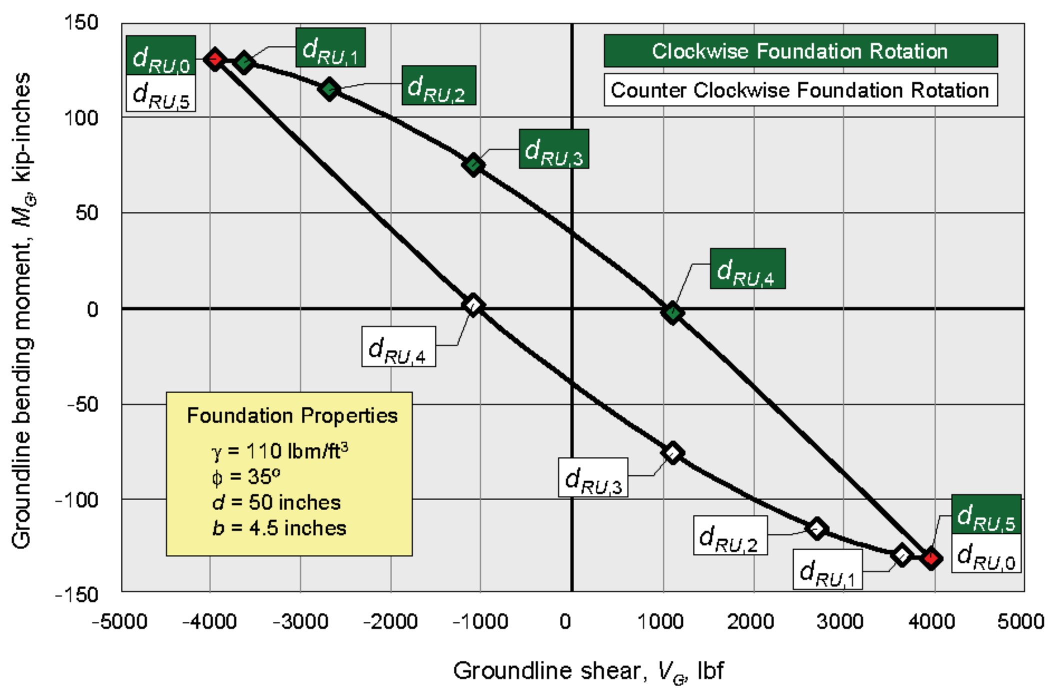

Figure 17 – V_U – M_U envelope developed using free body diagrams in Figure 16.

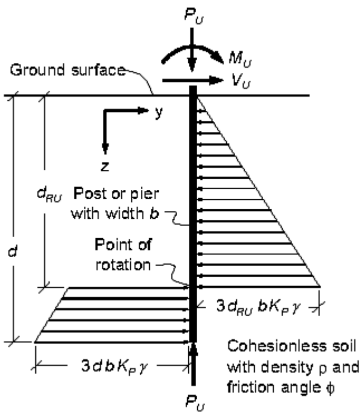

Figure 18 – Forces acting on a non-constrained post/pier of fixed width *b* in cohesionless soil at failure

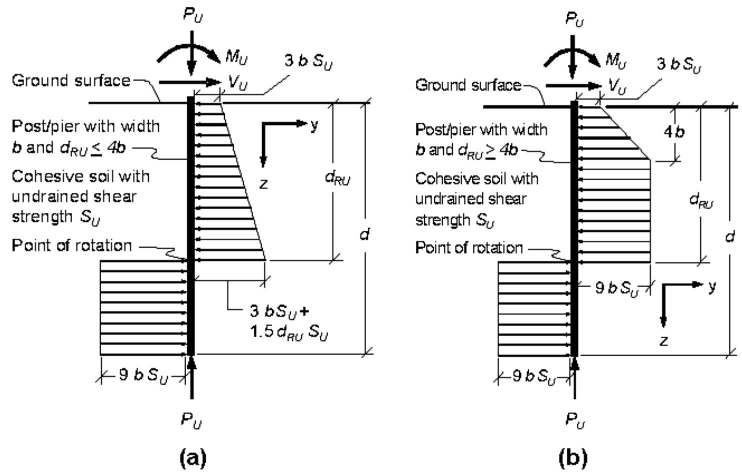

Figure 19 – Forces acting on a non-constrained post/pier of fixed width *b* in cohesive soil at failure (a) when d_{RU} is less than 4 *b*, and (b) when d_{RU} is greater than 4 *b*

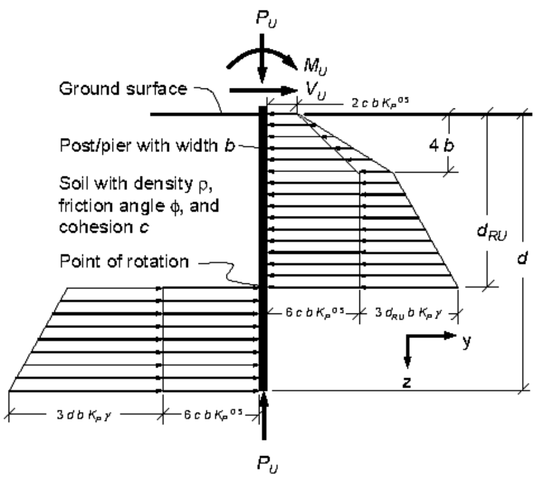

Figure 20 – Forces acting on a non-constrained post/pier of fixed width *b* in a homogenous soil at failure

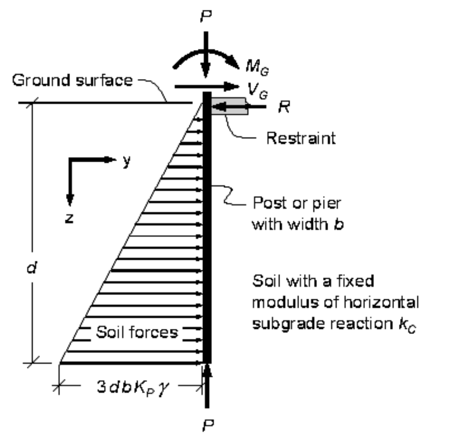

Figure 21 – Forces acting on a constrained post/pier of fixed width *b* in cohesionless soil at failure

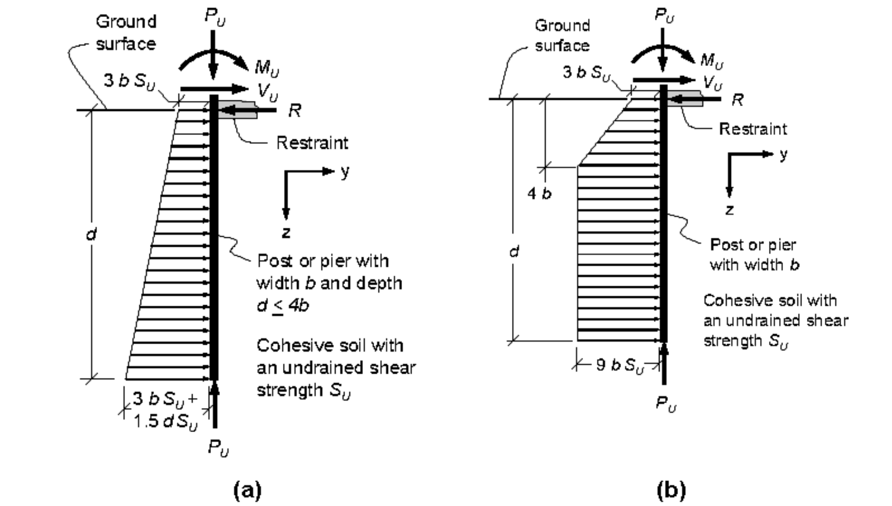

Figure 22 – Forces acting on a constrained post/pier of fixed width *b* in cohesive soil at failure (a) when *d* is less than 4 *b*, and (b) when *d* is greater than 4 *b*

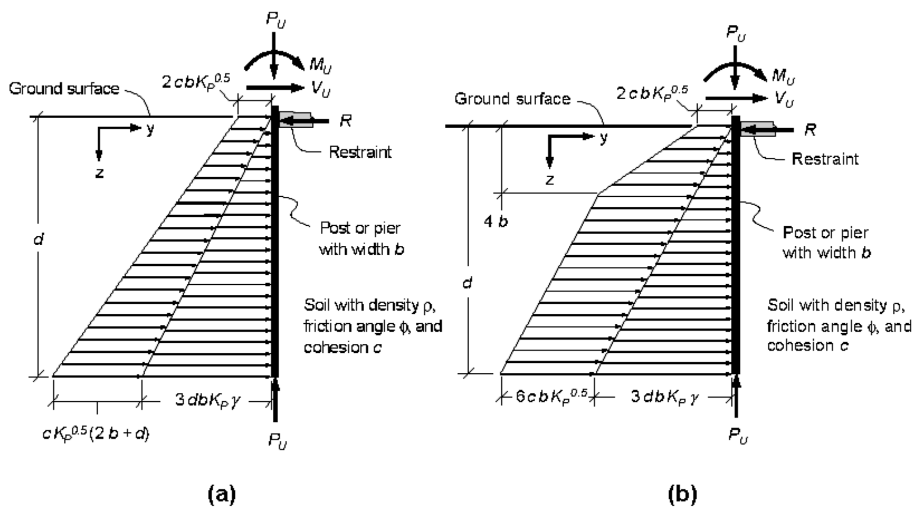

Figure 23 – Forces acting on a constrained post/pier of fixed width *b* in a homogenous soil at failure (a) when *d* is less than 4 *b*, and (b) when *d* is greater than 4 *b*

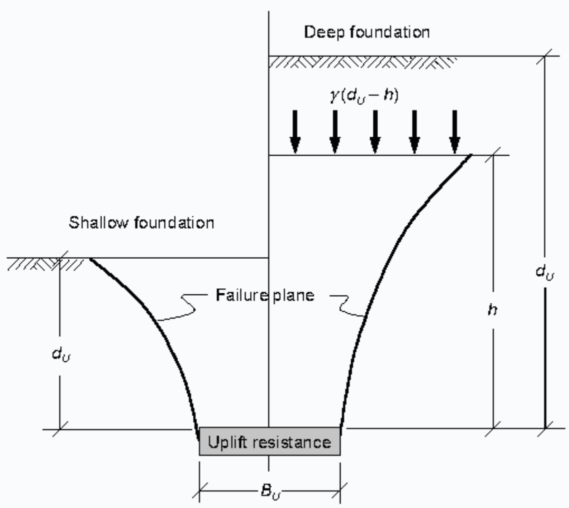

Figure 24 – Modes of uplift failure for uplift resistance systems at different depths

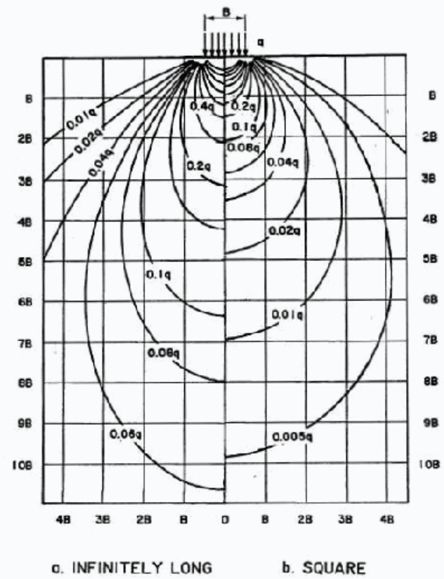

Figure 25 – Stress distributions under continuous and square footings as predicted via elastic theory

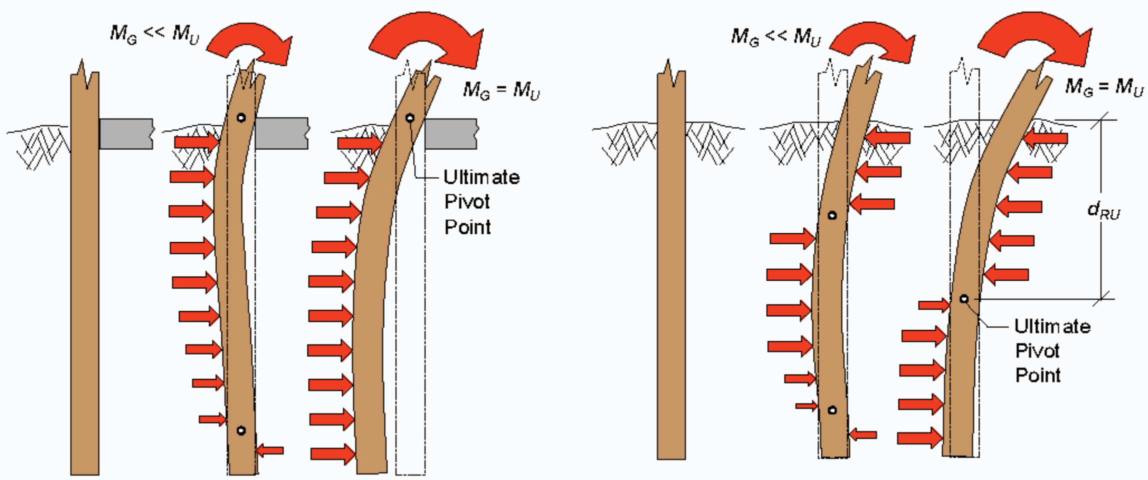

Figure 26 – Surface-constrained (left) and non-constrained (right) post foundations subjected to a groundline bending moment.

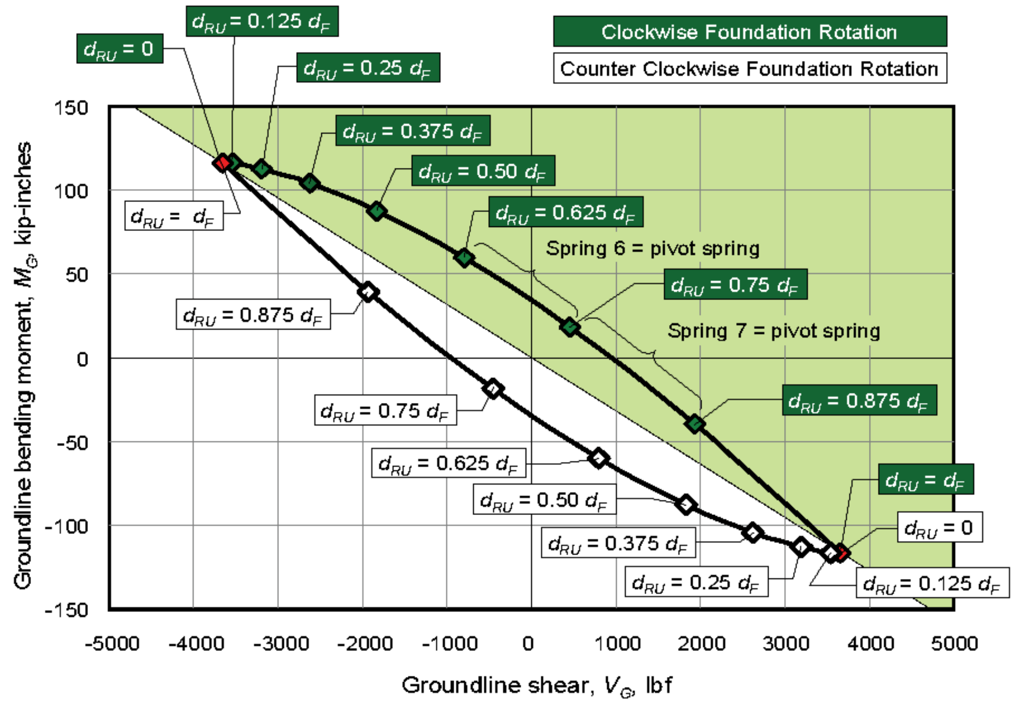

Figure 27 – A $V_U – M_U$ envelope for an 8 soil spring model based on data in Table 7.

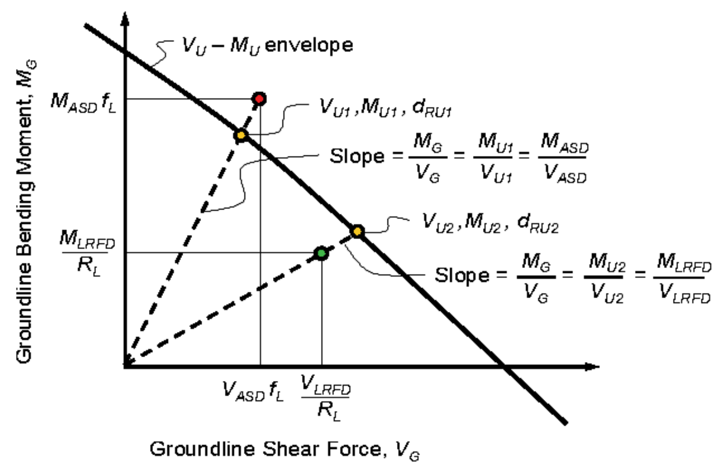

Figure 28. Using a $V_U – M_U$ envelope to check the adequacy of a foundation.

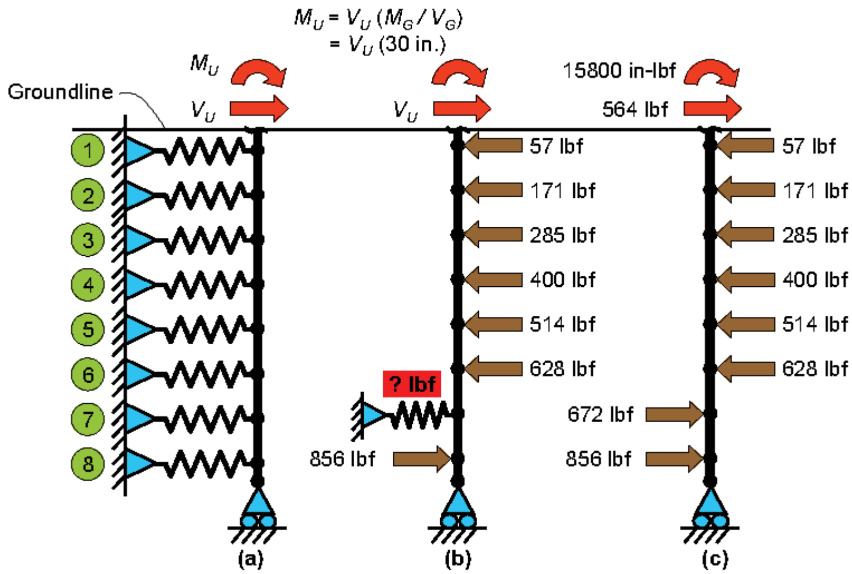

Figure 29. Determining V_U and M_U for a specified M_G/V_G ratio and associated pivot spring.

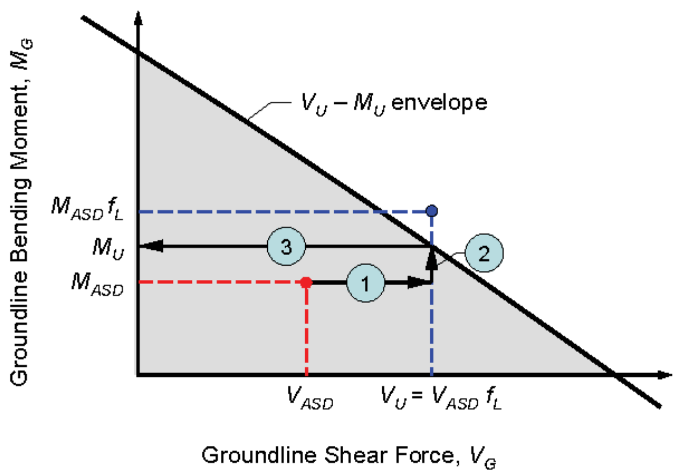

Figure 30. Graphical depiction of lateral strength checking process for Simplified Method of analysis.

ANSI/ASAE EP559.1 W/Corr. 1 AUG2010 (R2014)
Design Requirements and Bending Properties for Mechanically Laminated Wood Assemblies

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ANSI/ASAE EP559.1 W/Corr. 1 AUG2010 (R2014)
Revision approved August 2010; reaffirmed January 2015 as an American National Standard

Design Requirements and Bending Properties for Mechanically Laminated Wood Assemblies

Developed by the ASAE Mechanically Laminated Post Design Subcommittee of the Structures Group; approved by the Structures and Environment Division Standards Committee; adopted by ASAE December 1996; approved as an American National Standard February 1997; reaffirmed by ANSI February 2003; reaffirmed by ASAE February 2003; reaffirmed by ASABE and ANSI February 2008; revised and approved by ANSI August 2010; corrigenda 1 issued March 2011; reaffirmed by ASABE December 2014; reaffirmed by ANSI January 2015.

Corrigenda 1 corrected publication errors in equation 3 (7.3.1).

Keywords: Beams, Columns, Girders, Laminated Lumber, Laminating, Lumber, Wood Design, Wood Structures

1 Purpose and Scope

1.1 The purpose of this Engineering Practice is to establish guidelines for designing and calculating allowable bending properties of mechanically laminated wood assemblies used as structural members.

1.2 The scope of this Engineering Practice is limited to mechanically laminated assemblies with three or four wood laminations that have the following characteristics:

1.2.1 The actual thickness of each lamination is between 38 and 51 mm (1.5 and 2.0 in.).

1.2.2 All laminations have the same depth (face width), d.

1.2.3 Faces of adjacent laminations are in contact.

1.2.4 The centroid of each lamination is located on the centroidal axis of the assembly (axis Y-Y in Figure 1a), that is, no laminations are offset.

1.2.5 Concentrated loads are distributed to the individual laminations by a load distributing element.

1.2.6 All laminations are of the same grade and species of lumber or structural composite lumber.

1.2.7 There is no more than one common end joint per lamination within a splice region.

1.3 The provisions of this Engineering Practice do not apply to assemblies designed for biaxial bending. The design requirements in clause 4, and allowable bending properties in clauses 5 and 6, are only for uniaxial bending about axis Y-Y (Figure 1a). Spliced assemblies with butt joints shall have sufficient lateral support to prevent out-of-plane (lateral) movement or buckling, and/or delamination in the splice region.

1.4 This Engineering Practice does not preclude the use of assembly designs not meeting the criteria in clauses 1.2 and 1.3.

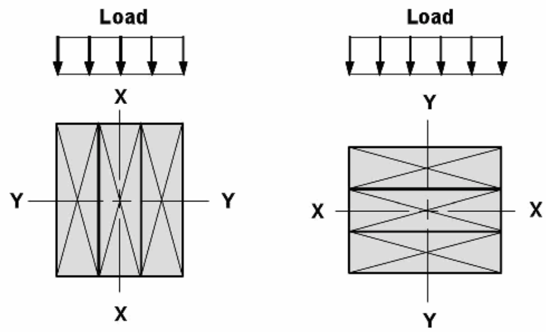

Figure 1 – (a) Vertically laminated, (b) horizontal laminated assemblies

2 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this Engineering Practice. At the time of publication, the editions were valid. All standards are subject to revision, and parties to agreements based on this Engineering Practice are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Standards organizations maintain registers of currently valid standards.

AF&PA (2005), National Design Specification (NDS) for Wood Construction

AITC Test T110-2007, Cyclic Delamination Test

ANSI/TPI 1-2007, National Design Standard for Metal Plate Connected Wood Truss Construction

ANSI/AITC 405-2008, Standard for Adhesives for Use in Structural Glued Laminated Timber

ASTM A153/A153M-05, Specifications for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A 653/A 653M-09, Standard Specification for Steel Sheet, Zinc-Coated (galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process

ASTM B 695, Standard Specification for Coating of Zinc Mechanically Deposited on Iron and Steel

ASTM D 198-08, Standard Methods of Static Testing of Timbers in Structural Sizes

ASTM D 245-06, Standard Methods for Establishing Structural Grades and Related Allowable Properties for Visually Graded Lumber

ASTM D 3737-08, Standard Methods for Establishing Stresses for Structural Glued-Laminated Timber (Glulam)

ASTM D 7469-08, Standard Test Methods for End Joints in Structural Wood Products

AWPA U1-09, Use Category System: User Specification for Treated Wood

NIST PS20-05, American Softwood Lumber Standard

3 Definitions

3.1 mechanically laminated assembly (mech-lam): A structural assembly consisting of suitably selected wood layers joined with nails, screws, bolts, and/or other mechanical fasteners. Individual wood layers may be comprised of solid-sawn lumber or structural composite lumber such as laminated strand lumber (LSL), laminated veneer lumber (LVL) or parallel strand lumber (PSL).

3.2 nail-laminated assembly (nail-lam): Used interchangeably with “mechanically laminated assembly” when nails are the only fastener used to join individual layers.

3.3 screw-laminated assembly (screw-lam): Used interchangeably with “mechanically laminated assembly” when screws are the only fastener used to join individual layers.

3.4 vertically laminated assembly: An assembly primarily designed to resist bending loads applied parallel to the planes of contact between individual layers (Figure 1a). Virtually all mechanically laminated assemblies are designed as vertically laminated assemblies.

3.5 horizontally laminated assembly: An assembly primarily designed to resist bending loads applied normal to the planes of contact between individual layers (Figure 1b). Mechanically laminated assemblies designed as horizontally laminated assemblies do not fall under the scope of this Engineering Practice.

3.6 unspliced assembly: A mechanically laminated assembly that contains no end joints or contains only certified structural glued end joints.

3.6.1 certified structural glued end joint: Any end joint that meets the material and manufacturing requirements outlined in clause 4.5.

3.7 spliced assembly: A mechanically laminated assembly that contains one or more common end joints.

3.7.1 common end joint: An end joint that does not meet requirements for classification as a certified structural glued end joint. Common end joints include, but are not limited to: glued scarf joints and glued finger joints that do not meet the requirements of clause 4.5, butt joints, and metal connector plate (MCP) reinforced butt joints.

3.8 overall splice length, *L:* The distance between the two farthest removed (extreme outer) common end joints in a group of end joints that contains one common end joint in each layer (Figure 2).

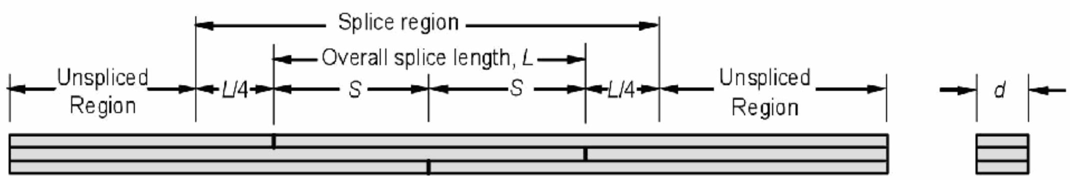

Figure 2 – Spliced assembly definitions

3.9 joint spacing, *S:* The distance between end joints (Figure 2). When end joints are equally spaced and there is only one end joint in each layer, *S* is equal to the overall splice length divided by *n* – 1, where n is the number of layers.

3.10 splice region: That portion of an assembly located between and within a distance of *L* /4 of a group of common end joints. In an assembly with one end joint in each layer, the total length of the splice region is equal to 1.5L (Figure 2). Although there can be more than one splice region per assembly, the splice regions shall not overlap.

3.11 unspliced region: Those portions of an assembly not included in a splice region (Figure 2).

3.12 joint arrangement: The relative location of end joints in a spliced assembly.

3.13 allowable stress design (ASD): A method of sizing a structural member such that elastically computed stresses produced in the member by design loads (a.k.a. nominal or service loads) do not exceed the member's specified allowable stress. Also called "working stress design".

3.14 load and resistance factor design (LRFD): A method of sizing a structural member such that the computed forces produced in the member by factored design loads do not exceed the member's factored resistance (design strength). Also called "strength design".

4 Material and Manufacturing Requirements

4.1 Lumber. Laminations (lumber) shall be identified by the grade mark of, or certificate of inspection issued by, a lumber grading or inspection bureau or agency recognized as being competent (see NIST PS20).

4.2 Preservative wood treatment. Any mechanically laminated assembly or portion thereof that is in ground contact or in fresh water shall be pressure preservative-treated in accordance with AWPA U1 Use Category 4B requirements for sawn products as given in Table 1. This level of treatment shall extend a minimum of 400 mm (16 in.) above the ground or waterline. Mech-lam assemblies that are located above ground, but are exposed to all weather cycles, including prolonged wetting, should be treated in accordance with AWPA U1 Use Category 4A requirements for sawn products as given in Table 1.

4.3 Restricted use of preservatives. The US Environmental Protection Agency has restricted, but not banned, the use of creosote, pentachlorophenol, and inorganic arsenicals, including CCA. The restrictions are variable. They may require only coating for a specific use, while in other cases they are prohibited. Generally, more restrictions occur where the environment is enclosed, and severe restrictions are imposed around feed and water. For specific criteria and limitations, refer to the appropriate government documents. The primary on-line source for U.S. government regulations is regulations.gov (http://www.regulations.gov/). Other sources for information relating to wood preservative treatments include the U.S Consumer Product Safety Commission (http://www.cpsc.gov/) and the National Pesticide Information Center (http://npic.orst.edu/index.html).

4.4 Fasteners in treated lumber. Mechanical fasteners used above grade to join waterborne preservative—treated lumber, shall be of AISI type 304 or 316 stainless steel, silicon bronze, or copper, or shall contain a coating applied in accordance with the treated wood or fastener manufacturer's recommendations for AWPA U1 Use Category 4A treatment levels for sawn lumber products. In the absence of manufacturer's recommendations, a minimum of ASTM A653, type G185 zinc-coated galvanized steel, or equivalent, shall be used. Mechanical fasteners that are used below grade to assure compatibility of deformation between treated laminates shall be of AISI type 304 or 316 stainless steel.

4.5 Certified structural glued end joints. Certified structural glued end joints shall be manufactured using adhesives meeting the requirements of 4.5.1. The production process shall be subject to initial qualification in accordance with 4.5.2, daily quality control in accordance with 4.5.3, and periodic auditing by an accredited inspection agency in accordance with 4.5.4.

4.5.1 Adhesives. Adhesives used in certified structural glued end joints shall conform to the requirements of AITC 405.

4.5.2 Initial Qualification. The production of certified structural glued end joints shall be subject to initial qualification by testing a minimum of 30 specimens for strength in accordance with ASTM D7469-08 and a minimum of 5 specimens for delamination in accordance with AITC Test T110.

4.5.2.1 Strength Requirement. The 5% tolerance limit with 75% confidence for bending strength shall meet or exceed 2.1 times the adjusted edgewise bending design value, F_b', calculated in accordance with the National Design Specifications (NDS®) for Wood Construction for normal load duration and dry-service conditions. When the end joint connects lumber with different F_b' values, the required strength shall be based on the lesser of the two F_b' values.

Table 1 – Minimum Preservation Treatment Levels for Mechanically Laminated Wood Assemblies[a)]

Wood Species→	Southern Pine, Mixed Southern Pine, Radiata Pine, Patula Pine, Caribbean Pine, Ponderosa Pine, Red Pine, Eastern White Pine, Coastal Douglas-fir, Hem-fir, Hem-fir North, Subalpine Fir		Jack Pine, Lodgepole Pine		Western White Spruce, Engelmann Spruce, Sitka Spruce		Spruce-Pine-Fir West		Redwood	
Mechanically Laminated Assemble Use Location →	Exposed Above Ground	In Freshwater or Ground Contact	Exposed Above Ground	In Freshwater or Ground Contact	Exposed Above Ground	In Freshwater or Ground Contact	Exposed Above Ground	In Freshwater or Ground Contact	Exposed Above Ground	In Freshwater or Ground Contact
AWPA Use Category for Sawn Products →	4A	4B	4A	4B	4A	4B	4A	4B	4A	4B
Oilborne and Creosote-Based Treatments	**Preservative Retentions kg/m³ (lbm/ft³)**									
Creosote (CR), Creosote Solution (CR-S), Creosote-Petroleum Solution (CR-PS)	160 (10.0)	160 (10.0)	160 (10.0)	160 (10.0)	160 (10.0)	160 (10.0)	#	#	160 (10.0)	160 (10.0)
Pentachlorophenol (penta) Solvent A (PCP-A), Pentachlorophenol (penta) Solvent C (PCP-C)	8.0 (0.50)	8.0 (0.50)	6.4 (0.40)	8.0 (0.50)	6.4 (0.40)	8.0 (0.50)	#	#	8.0 (0.50)	8.0 (0.50)
Copper Naphthenate	0.96 (0.06)	1.2 (0.075)	0.96 (0.06)	1.2 (0.075)	0.96 (0.06)	1.2 (0.075)	#	#	0.96 (0.06)	1.2 (0.075)
Waterborne Treatments	**Preservative Retentions kg/m³ (lbm/ft³)**									
Acid Copper Chromate (ACC)	8.0 (0.50)	#	8.0 (0.50)	#	8.0 (0.50)	#	#	#	8.0 (0.50)	#
Chromated Copper Arsenate Type C (CCA), Ammoniacal Copper Zinc Arsenate (ACZA)	6.4 (0.40)	9.6 (0.60)	6.4 (0.40)	9.6 (0.60)	6.4 (0.40)	9.6 (0.60)	6.4 (0.40)	9.6 (0.60)	6.4 (0.40)	9.6 (0.60)
Ammoniacal Copper Quat Type B (ACQ-B)	6.4 (0.40)	9.6 (0.60)	#	#	6.4 (0.40)	9.6 (0.60)	#	#	#	#
Ammoniacal Copper Quat Type C (ACQ-C)	6.4 (0.40)	9.6 (0.60)	6.4 (0.40)	9.6 (0.60)	#	9.6 (0.60)	6.4 (0.40)	9.6 (0.60)	#	9.6 (0.60)
Ammoniacal Copper Quat Type D (ACQ-D)	6.4 (0.40)	9.6 (0.60)	6.4 (0.40)	9.6 (0.60)	6.4 (0.40)	9.6 (0.60)	#	9.6 (0.60)	#	9.6 (0.60)
Copper Azole Type C (CA-C)	2.4 (0.15)	5.0 (0.31)	#	5.0 (0.31)	#	#	#	#	#	#
Copper Azole Type B (CA-B)	3.3 (0.21)	5.0 (0.31)	#	5.0 (0.31)	#	#	#	#	#	#
Copper Azole Type A (CBA-A)	6.5 (0.41)	9.8 (0.61)	#	9.8 (0.61)	#	#	#	#	#	#
Waterborne Copper Naphthenate (CuN-W)	1.76 (0.11)	#	1.76 (0.11)	#	#	#	#	#	#	#

a) From AWPA U1-09
Either no proposal for standardization and/or data demonstrating efficacy of a preservative/species combination has been submitted to AWPA; or the use of the preservative/species combination has been proven ineffective

4.5.2.2 Delamination Requirement. Delamination after one complete cycle shall not exceed 5% for softwoods or 8% for hardwoods. If delamination exceeds these values after one cycle, a second cycle shall be performed on the same specimens, in which case the delamination shall not exceed 10%.

4.5.3 Daily Quality Control. All glued end joints produced during a work shift shall qualify as certified structural glued end joints if all end joints sampled in accordance with clause 4.5.3.1 meet the strength requirements of clause 4.5.3.2 and the delamination requirements of 4.5.3.3.

4.5.3.1 Sampling. The number of end joints to be tested for strength and delamination shall be a minimum of 1 per 200 manufactured joints, but no less than 2 end joints per work shift, with one of these joints being the first produced during the work shift and the other being the last produced during the work shift. In addition, the first production joint produced following a change of end joint cutter heads shall be tested, and the first joint produced following any major change in end joint production variables shall be tested. Major changes include, but are not limited to, changes in lumber dimension, lumber grade, lumber species, lumber treatment, and curing procedure.

4.5.3.2 Strength. A glued end joint must not fail when subjected to the appropriate qualifying proof load (QPL). The QPL is an edge-wise bending load applied in accordance with the requirements of ASTM D7469 with the end joint located midway between load points. The magnitude of the QPL is the load that induces a maximum wood bending stress in the sample equal to 2.1 times the adjusted bending design value, F_b', calculated in accordance with the *National Design Specifications* (NDS®) for *Wood Construction* for normal load duration and dry-service conditions. When the end joint connects lumber with different F_b' values, the QPL shall be based on the lesser of the two F_b' values.

4.5.3.2.1 End joint failure. Is any failure that is initiated by the joint. This does not include wood fractures that originate at locations away from the joint and extend to the joint where they may then initiate a glue bond failure or wood fracture in the end joint.

4.5.3.2.2 Non joint failure. Is any failure that is not classified as an end joint failure. If a non joint failure occurs prior to full application of the QPL, the test is inconclusive with respect to end joint strength and another end joint specimen must be tested. Where possible, this replacement specimen should be the end joint manufactured immediately before or after the end joint associated with the inconclusive test.

4.5.3.2.3 Documentation of test. A record shall be kept of each test that includes: date and time of test; lumber size, species and grade; qualifying proof load; load rate; and details of any failure that occurs prior to reaching the QPL.

4.5.3.2.4 Use of test specimens. Test specimens that meet the strength requirements of clause 4.5.3.2 without visible or audible signs of failure can be used in the production of laminated assemblies.

4.5.3.3 Cyclic delamination. Tests shall be conducted in accordance with AITC Test T110. Delamination after one complete cycle shall not exceed 5% for softwoods or 8% for hardwoods. If delamination exceeds these values after one cycle, a second cycle shall be performed on the same specimens, in which case the delamination shall not exceed 10%.

4.5.3.3.1 Documentation of test. A record shall be kept of each test that includes: date and time of test, identifying information for batch of end joints being tested, and the required report from AITC Test T110.

4.5.4 Periodic Auditing. All certified structural glued end joints shall be manufactured in facilities that are subject to periodic, unannounced audits by an accredited inspection agency. All processes and records relevant to the production of such end joints shall be subject to audit.

4.5.4.1 Accredited Inspection Agency. An accredited inspection agency is defined as an entity that:

(a) Operates an inspection system which audits the quality control systems for certified structural end joints.

(b) Provides the facilities and personnel to perform the audit and to verify the required testing.

(c) Determines the individual facility's ability to produce certified structural end joints in accordance with this standard.

(d) Provides periodic auditing of the plant's production operations and production quality to ensure compliance with this standard.

(e) Enforces the proper use of the inspection agency quality marks and certificates

(f) Has no financial interest in, or is not financially dependent upon, any single company manufacturing any portion of the product being inspected or tested.

(g) Is not owned, operated, or controlled by any single company manufacturing any portion of the product being inspected or tested.

(h) Provides an arbitration review board to arbitrate disputes between the agency and the laminator. Such a board shall include, but not be limited to, three persons:

1. A recognized independent authority in the field of engineered timber construction to serve as chairman
2. At least one registered professional engineer knowledgeable in the design and use of the final product.
3. At least one person knowledgeable in the manufacture and quality control of certified structural glued end joints.

(i) Is accredited under ISO/IEC Standard 17020 as an Inspection Agency.

4.6 Metal connector plates. Metal connector plates used to reinforce common end joints shall meet all applicable requirements specified in ANSI/TPI 1 except that no specific structural design evaluation is required beyond that given in clause 5.4 of this EP.

5 Nail- and Screw-Laminated Assembly Design Requirements

5.1 End joint arrangement. End joint arrangement is dependent on the number of layers, type of end joints, and presence (or absence) of joint reinforcement. End joint arrangements described in Table 2 and shown in Figure 3 shall be used for common end joints.

5.2 Overall splice length. Wood stresses and fastener shear forces within the splice region can increase rapidly as overall splice length is reduced. For applications where the splice region is located at a point of high assembly bending moment, the minimum overall splice lengths in Table 3 are recommended. When the splice region is centered at a point of low assembly bending moment, overall splice lengths shorter than those in Table 3 may be more practical.

Table 2 – Recommended joint arrangements

Number of Layers	Common End Joint Type	Outside Butt Joint Reinforcement[1)]	Recommended Joint Arrangements[2)]
3	Butt joints	No	3A
	Butt joints	Yes	3A, 3B
	Glued end joints[3)]	NA	3A, 3B
4	Butt joints	No	4B, 4C
	Butt joints	Yes	4A
	Glued end joints[3)]	NA	4A, 4B, 4C

[1)] See clause 5.4.
[2)] See Figure 3.
[3)] Glued end joints that do not meet the requirements in clause 4.5 for certified structural glued end joints.

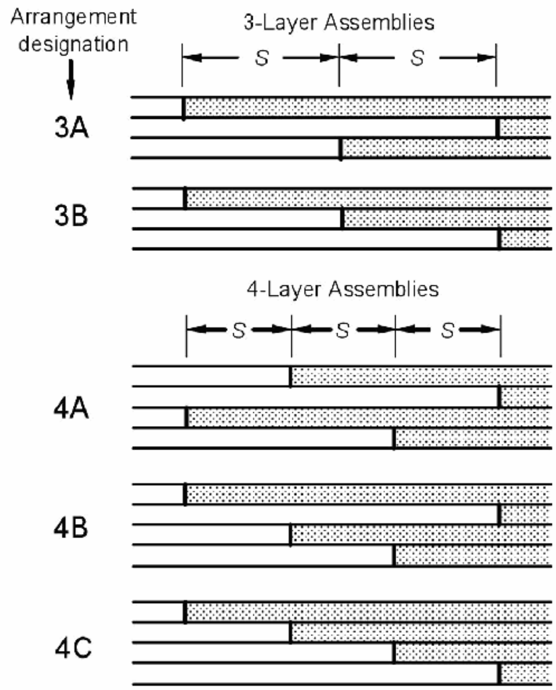

Figure 3 – Joint arrangements for three- and four-layer spliced assemblies

Table 3 – Recommended minimum overall splice lengths

Actual Face Width of Laminations, mm(in.)	Minimum Overall Splice Length, m (in.)	
	Glued End Joints[1)]	Butt Joints
140 (5.5)	0.61 (24)	1.22 (48)
184 (7.25)	0.91 (36)	1.52 (60)
235 (9.25)	0.91 (36)	1.83 (72)
286 (11.25)	1.22 (48)	2.44 (96)

[1)] See clause 4.5

5.3 Fastener requirements. The number of nails or screw fasteners required in an assembly is dependent on the amount of shear that must be transferred between layers (interlayer shear capacity). Fastener location is controlled by spacing requirements which reduce the likelihood of splitting, yet ensure a good distribution of fasteners.

5.3.1 Interlayer shear capacity. Minimum required interlayer shear capacities are expressed on the basis of force per interface per unit length of assembly. There are two design levels. Level I values are listed in Table 4 and apply to: (1) unspliced assemblies, (2) unspliced regions of spliced assemblies, and (3) spliced assemblies with common glued end joints (i.e., glued joints that do not meet the requirements of clause 4.5). Level II values apply to the splice region of all assemblies with butt joints even when the butt joints are reinforced. Use equation 1 to calculate level II values. This equation only applies to assemblies with overall splice lengths equal to or greater than the Table 3 minimums.

$$ISC = F_b' d\left(0.0024 + Ad/L^2 - E/B\right) \quad (1)$$

where:

ISC is minimum required interlayer shear capacity per interface per unit length of assembly, N/mm (lbf/in.);

F_b' is adjusted bending design value for the unspliced region (see clause 6.1), MPa (lbf/in.^{2});

d is assembly depth (lamination face width), mm (in.);

L is overall splice length, mm (in.);

E is wood modulus of elasticity, MPa (lbf/in.^{2});

A is a constant = 43.3 mm (1.708 in.);

B is a constant = 8,600,000 MPa (12.46×10^8 lbf/in.^{2}).

Table 4 – Minimum required interlayer shear capacities—Level I [1)]

Actual Face Width of Laminations, mm(in.)	Minimum Required Interlayer Shear Capacity per Interface per Unit Length of Assembly, N/mm (lbf/in.)	
	Allowable Stress Design (ASD)	Load and Resistance Factor Design (LRFD)
140 (5.5)	2.1 (12)	2.8 (16)
184 (7.25)	2.6 (15)	3.5 (20)
235 (9.25)	3.3 (19)	4.5 (26)
286 (11.25)	4.2 (24)	5.8 (32)

[1)] For unspliced assemblies, assemblies with either common glued end joints and/or certified structural glued end joints, and unspliced regions of assemblies with butt joints.

5.3.2 Fastener density. The minimum number of nails or screw fasteners required for lamination is obtained by dividing the minimum required interlayer shear capacity (ISC) by the adjusted lateral design load, *Z'*, of an individual fastener. The adjusted lateral design load for a fastener shall be calculated in accordance with AF&PA National Design Specification (NDS®) for Wood Construction.

5.3.3 Fastener diameter. Unless pre-bored holes are utilized, the diameter of fasteners without self-drilling capabilities shall not exceed one-eighth the actual thickness of a lamination. For screws and threaded nail fasteners, the diameter is taken as the diameter of the shank or unthreaded portion of the fastener.

5.3.4 Fastener location. To reduce the likelihood of wood splitting, the minimum fastener spacings in Table 5 shall be followed. To ensure a good distribution of fasteners, the following additional provisions shall be adhered to:

5.3.4.1 A minimum of two fastener rows shall be provided.

5.3.4.2 One fastener row shall be placed within 20 fastener diameters of one edge and another fastener row within 20 fastener diameters of the other edge. The spacing (pitch) between fasteners in each of these two rows shall not exceed 0.45 m (18 in.).

5.3.4.3 At least half of the fastener rows shall have a fastener within 20 diameters of each side of each butt joint. All fastener rows shall have a fastener within 35 fastener diameters of each side of each butt joint.

Table 5 – Minimum fastener spacings

	Nail/Screw Diameters
Edge distance	10
End distance	15
Spacing (pitch) between fasteners in a row	20
Spacing (gage) between rows of fasteners	
In-line	10
Staggered	5

5.4 Butt-joint reinforcement. The strength and stiffness of assemblies with simple butt joints can be improved by reinforcing joints in the outside laminations with metal plate connector. To apply the bending strength modification factor in Table 8, each outside joint shall be reinforced with one metal connector plate (MCP). The MCP shall be centered on the joint and meet the following requirements:

5.4.1 Width shall be no less than 90% of the actual face width of the laminations;

5.4.2 Length shall be no less than 1.5 times the MCP width;

5.4.3 Thickness shall be no less than 0.91 mm (0.036 in., 20 gage) for assemblies with depths of 140 and 184 mm (5.5 and 7.25 in.), and no less than 1.47 mm (0.058 in., 16 gage) for assemblies with depths of 235 and 286 mm (9.25 and 11.25 in.);

5.4.4 The allowable design value in tension, V_t, for the MCP must meet the following criteria:

$$V_t \geq 0.22 F_b' \, t \, d^2 / w^2 \quad (2)$$

where:

V_t is allowable MCP design value in tension (ASD allowable load per unit of plate width), N/mm (lbf/in.);

F_b' is ASD adjusted bending design value for the unspliced region of the assembly, MPa (lbf/in.^{2}), from clause 6.1;

t is thickness of an individual lamination, mm (in.);

d is assembly depth (lamination face width), mm (in.);

w is MCP width, mm (in.).

6 Bending Design Strength

6.1 Unspliced assemblies. The adjusted bending design value, F_b' for mechanically laminated assemblies without end joints and mechanically laminated assemblies with certified structural glued end joints shall be calculated according to AF&PA National Design Specification (NDS®) for Wood Construction. All provisions of the NDS shall apply with the exception that the appropriate repetitive member factor, C_r, from Table 6 can be used for any unspliced mechanically laminated assembly with an interlayer shear capacity that meets or exceeds the values in Table 4. Table 7a contains NDS® reference bending design values for selected visually graded softwood species that have been adjusted by the appropriate repetitive member factor and the appropriate NDS® size factor, C_F. Table 7b contains similarly adjusted NDS® reference bending stresses for machine stress rated lumber. To obtain fully adjusted bending design values (F_b') for allowable stress design (ASD), Table 7a and 7b values shall be multiplied by the load duration factor (C_D), wet service factor (C_M), temperature factor (C_t), beam stability factor (C_L), and incising factor (C_i). To obtain F_b' for load and resistance factor design (LRFD), Table 7a and 7b values shall be multiplied by the appropriate format conversion factor (K_F), resistance factor for bending (φ_b), time effect factor (λ), wet service factor (C_M), temperature factor (C_t), beam stability factor (C_L), and incising factor (C_i). For both ASD and LRFD, the beam stability factor (C_L) shall be calculated in accordance with clause 6.1.1. The wet-service factor (C_M) shall be applied where the moisture content in service will exceed 19% for an extended period of time. Generally this adjustment applies to any assembly requiring preservative treatment.

6.1.1 Beam stability factor. To adjust for stability, the NDS® beam stability factor, C_L, is used. The beam stability factor is a function of the slenderness ratio, R_B, which in turn is a function of dimensions d and b, and the effective span length of the bending member between points of lateral support, L_e. For the purpose of calculating the slenderness ratio, R_B, for mechanically laminated assemblies, b shall be equated to 60% of the actual assembly thickness, and d to the actual face width of a lamination. The effective span length, L_e, is a function of the unsupported length, L_u. The unsupported length shall be set equal to the on-center spacing of bracing that keeps the assembly from buckling laterally.

Table 6 – Repetitive member factors[1)]

	Number of Laminations	
	3	4
Visually graded	1.35	1.40
Mechanically graded	1.25	1.30

[1)] For mechanically laminated dimension lumber assemblies with minimum inlayer shear capacity as specified in Table 4.

Table 7a – Partially adjusted reference bending design values for visually graded dimension lumber used in unspliced mechanically laminated assemblies

Partially Adjusted Reference Bending Design Values[1)], MPa lbf/in.[2)]																			
Actual Width of Individual Layers, mm (in.)																			
		140 (5.5)				184 (7.25)				235 (9.25)				286 (11.25)					
Number of Laminations																			
Lumber Species[2)]	Lumber Grade	3		4		3		4		3		4		3		4		Modulus of Elasticity, GPa (×10^6 lbf/in.^{2})	
DFL	Sel St	18.2	2635	18.8	2730	16.8	2430	17.4	2520	15.4	2230	15.9	2310	14.0	2025	14.5	2100	13.1	1.9
DFL	No. 1 & Better	14.5	2105	15.1	2185	13.4	1945	13.9	2015	12.3	1780	12.7	1850	11.2	1620	11.6	1680	12.4	1.8
DFL	No. 1	12.1	1755	12.5	1820	11.2	1620	11.6	1680	10.2	1485	10.6	1540	9.3	1350	9.7	1400	11.7	1.7
DFL	No.2	10.9	1580	11.3	1640	10.1	1460	10.4	1510	9.2	1335	9.6	1385	8.4	1215	8.7	1260	11.0	1.6
HF	Sel Str	16.9	2455	17.6	2550	15.6	2270	16.2	2350	14.3	2080	14.9	2155	13.0	1890	13.5	1960	11.0	1.6
HF	No. 1 & Better	13.3	1930	13.8	2000	12.3	1780	12.7	1850	11.3	1635	11.7	1695	10.2	1485	10.6	1540	10.3	1.5
HF	No. 1	11.8	1710	12.2	1775	10.9	1580	11.3	1640	10.0	1450	10.4	1500	9.1	1315	9.4	1365	10.3	1.5
HF	No.2	10.3	1490	10.7	1545	9.5	1375	9.8	1430	8.7	1260	9.0	1310	7.9	1150	8.2	1190	9.0	1.3
SP	Dense Sel Str	25.1	3645	26.1	3780	22.8	3310	23.6	3430	20.0	2905	20.8	3010	19.1	2770	19.8	2870	13.1	1.9
SP	Sel Str	23.7	3445	24.6	3570	21.4	3105	22.2	3220	19.1	2770	19.8	2870	17.7	2565	18.3	2660	12.4	1.8
SP	Non-Dense SS	21.9	3175	22.7	3290	19.5	2835	20.3	2940	17.2	2500	17.9	2590	16.3	2365	16.9	2450	11.7	1.7
SP	No. 1 Dense	16.3	2365	16.9	2450	15.4	2230	15.9	2310	13.5	1960	14.0	2030	12.6	1825	13.0	1890	12.4	1.8
SP	No.1	15.4	2230	15.9	2310	14.0	2025	14.5	2100	12.1	1755	12.5	1820	11.6	1690	12.1	1750	11.7	1.7
SP	Non-Dense No. 1	14.0	2025	14.5	2100	12.6	1825	13.0	1890	11.2	1620	11.6	1680	10.7	1555	11.1	1610	11.0	1.6
SP	No. 2 Dense	13.5	1960	14.0	2030	13.0	1890	13.5	1960	11.2	1620	11.6	1680	10.7	1555	11.1	1610	11.7	1.7
SP	No. 2	11.6	1690	12.1	1750	11.2	1620	11.6	1680	9.8	1420	10.1	1470	9.1	1315	9.4	1365	11.0	1.6
SP	Non-Dense No. 2	10.7	1555	11.1	1610	10.2	1485	10.6	1540	8.8	1285	9.2	1330	8.4	1215	8.7	1260	9.7	1.4

[1)] Reference bending design values (F_b) from the 2005 NDS after adjustment for size (C_F) and repetitive member use (C_r). To obtain a fully adjusted bending design value (F_b') for allowable stress design (ASD) multiply table value by the load duration factor (C_D), wet service factor (C_M), temperature factor (C_t), beam stability factor (C_L), and incising factor (C_i). To obtain F_b' for load and resistance factor design (LRFD) multiply table value by the appropriate format conversion factor (K_F), resistance factor for bending (φ_b), time effect factor (λ), wet service factor (C_M), temperature factor (C_t), beam stability factor (C_L), and incising factor (C_i).

[2)] *DFL*, Douglas Fir-Larch; *HF*, HemFir; *SP*, Southern Pine.

Table 7b – Partially adjusted reference bending design values for machine stress rated dimension lumber used in unspliced mechanically laminated assemblies

Lumber Grade	Partially Adjusted Reference Bending Design Value[1)] MPa, lbf/in²				Lumber Grade	Partially Adjusted Reference Bending Design Value[1)] MPa, lbf/in²			
	Number of laminations					Number of laminations			
	3		4			3		4	
900f-1.0E	7.79	1125	8.07	1170	1800f-1.8E	15.5	2250	16.1	2340
1200f-1.2E	10.3	1500	10.8	1560	1950f-1.5E	16.8	2440	17.5	2535
1250f-1.4E	10.8	1565	11.2	1625	1950f-1.7E	16.8	2440	17.5	2535
1350f-1.3E	11.6	1690	12.1	1755	2000f-1.6E	17.2	2500	17.9	2600
1400f-1.2E	12.1	1750	12.5	1820	2100f-1.8E	18.1	2625	18.8	2730
1450f-1.3E	12.5	1815	13.0	1885	2250f-1.7E	19.4	2815	20.2	2925
1450f-1.5E	12.5	1815	13.0	1885	2250f-1.8E	19.4	2815	20.2	2925
1500f-1.4E	12.9	1875	13.4	1950	2250f-1.9E	19.4	2815	20.2	2925
1600f-1.4E	13.8	2000	14.3	2080	2250f-2.0E	19.4	2815	20.2	2925
1650f-1.3E	14.2	2065	14.8	2145	2400f-1.8E	20.7	3000	21.5	3120
1650f-1.5E	14.2	2065	14.8	2145	2400f-2.0E	20.7	3000	21.5	3120
1650f-1.6E	14.2	2065	14.8	2145	2500f-2.2E	21.5	3125	22.4	3250
1650f-1.8E	14.2	2065	14.8	2145	2550f-2.1E	22.0	3190	22.9	3315
1700f-1.6E	14.7	2125	15.2	2210	2700f-2.0E	23.3	3375	24.2	3510
1750f-2.0E	15.1	2190	15.7	2275	2700f-2.2E	23.3	3375	24.2	3510
1800f-1.5E	15.5	2250	16.1	2340	2850f-2.3E	24.6	3565	25.5	3705
1800f-1.6E	15.5	2250	16.1	2340	3000f-2.4E	25.9	3750	26.9	3900

[1)] Reference bending design values (F_b) from the 2005 NDS after adjustment for size (C_F) and repetitive member use (C_r). To obtain a fully adjusted bending design value (F_b') for allowable stress design (ASD) multiply table value by the load duration factor (C_D), wet service factor (C_M), temperature factor (C_t), beam stability factor (C_L), and incising factor (C_i). To obtain F_b' for load and resistance factor design (LRFD) multiply table value by the appropriate format conversion factor (K_F), resistance factor for bending (φ_b), time effect factor (λ), wet service factor (C_M), temperature factor (C_t), beam stability factor (C_L), and incising factor (C_i).

6.2 Spliced assemblies with simple butt joints. The strength and stiffness of a mechanically laminated assembly are reduced within the vicinity of simple butt joints. For design purposes, spliced assemblies shall be segmented into spliced and unspliced regions as defined in clauses 3.10 and 3.11. The adjusted bending design value F_b' for the unspliced regions shall be calculated in accordance with clause 6.1. The adjusted bending design value of the splice region shall be obtained by multiplying the adjusted bending design value for the unspliced regions of the assembly by an appropriate bending strength modification factor. Bending strength modification factors are determined by test according to clause 6.4. For nail- and screw-laminated assemblies that meet all requirements of clause 5, the bending strength modification factors in Table 8 can be used. In addition, within the splice region of assemblies with simple butt joints, the distance between points of lateral support shall not exceed 1.0 m (39 inches) unless a greater distance can be justified via testing.

Table 8 – Bending strength modification factors for nail-laminated assemblies[1)]

Joint Description	Bending Strength Modification Factor
Unreinforced butt joints	0.42
Each outside butt joint reinforced with one MCP	0.55

[1)] Factors apply only to nail-laminated assemblies that meet all requirements in clause 5. Recommended joint arrangements and minimum overall splice lengths in tables 2 and 3 shall be used.

6.3 Testing spliced, mechanically laminated assemblies. Tests used to determine the bending strength and stiffness of the splice region of an assembly shall be conducted in accordance with ASTM D198. A two-point loading shall be used with all end joints in spliced assemblies located between the load points (i.e., in the constant moment region). Specimens shall be fabricated according to clause 6.3.1. The bending strength modification factor shall be determined in accordance with clause 6.3.2.

6.3.1 Specimen fabrication. An equal number of spliced and unspliced assemblies (five minimum) shall be tested. The spliced and unspliced assemblies shall be identical in size and fabricated from the same batch of lumber. Lumber shall be allocated to the spliced and unspliced assembly groups such that the distribution of wood modulus of elasticity (*E*) values is similar for both groups. The latter can be accomplished by sorting lumber by *E* (in either ascending or descending order) and assigning every other piece to the same group.

6.3.2 Bending strength modification factor. When fewer than 25 assemblies of each type have been tested, the bending strength modification factor shall be obtained by dividing the mean ultimate bending moment for the spliced assemblies by the mean ultimate bending moment for the unspliced assemblies, and dividing the resulting value by the appropriate adjustment factor from Table 9. When 25 or more assemblies of each type have been tested, the bending strength modification factor shall be obtained by dividing the 5% point estimate of ultimate bending moment for the spliced assemblies by the 5% point estimate of ultimate bending moment for the unspliced assemblies.

Table 9 – Adjustment factors for mean strength ratio[1)]

n[2)]	Spliced Assemblies with Outside Butt-Joint Reinforcement Only	All Other Spliced Assemblies
5	0.88	0.77
10	0.92	0.80
15	0.93	0.81
20	0.935	0.815
25	0.94	0.82

[1)] Multiply adjustment factor by ratio of mean strengths of spliced and unspliced assemblies to obtain the bending strength modification factor.

[2)] n is the number of spliced (or unspliced) assemblies tested.

7 Bending Stiffness

7.1 Assemblies without end joints. The modulus of elasticity (*E*) of an assembly without end joints is equal to the average *E* of the individual laminations.

7.2 Assemblies with glued end joints. The *E* of spliced assemblies with common glued end joints and/or certified structural glued end joints is equal to the average *E* of the individual laminations.

7.3 Assemblies with butt joints. The stiffness of a mechanically laminated assembly is reduced within the vicinity of simple butt joints. For structural analysis purposes, spliced assemblies can be segmented into spliced and unspliced regions as defined in clauses 3.10 and 3.11, respectively. The E of the unspliced regions is equal to the average E of the individual laminations. An “effective” *E* for the spliced region is obtained by multiplying the E of the unspliced regions of the assembly by a bending stiffness modification factor.

7.3.1 Bending stiffness modification factors. The bending stiffness modification factor for any spliced assembly can be determined from tests conducted in accordance with clause 6.3. Use the equations in Table 10 to obtain stiffness modification factors from the test data. Equation 3 can be used to calculate the bending stiffness modification factor for spliced nail-lams and spliced screw-lams without butt-joint reinforcement that meet the requirements of clause 5.

$$\alpha = 0.887 - 1.329\left[d^3 E\, t / \left(L^5 K p\right)\right]^{0.25} \quad (3)$$

where:

α is bending stiffness modification factor;

d is face width of laminations, mm (in.);

t is thickness of an individual lamination, mm (in.);

L is overall splice length, mm (in.);

K is stiffness of an individual fastener joint (i.e., shear force divided by interlayer slip), N/mm (lbf/in.);

p is average fastener density in the splice region (fasteners per unit contact area), 1/mm^2 (1/in.^{2});

E is wood modulus of elasticity, MPa (lbf/in.^{2}).

Table 10 – Equations for calculating bending stiffness modification factors from test data[1)]

Location of Load Point	Location of Deflection Measurement	
	Load Point	Midspan
$b \geq a$	$\alpha = \dfrac{D - 2b}{4EI\Delta_l/(a^2P) + 4a/3 - 2b}$	$\alpha = \dfrac{D^2/4 - b^2}{4EL\Delta_m/(aP) + a^2/3 - b^2}$
$b \geq a$	$\alpha = \dfrac{3a^2D - 4a^3 - 2b^3}{12EI\Delta_l/P - 2b^3}$	$\alpha = \dfrac{3aD^2/8 - b^3 - 2a^3/2}{6EI\Delta_m/P - b^3}$

where:

α is bending stiffness modification factor

D is distance between supports

a is distance between support and load point

b is distance from support to spliced region. Equal to $(D - 1.5L)/2$

Δ_l is load point deflection for spliced assembly due to load P

Δ_m is midspan deflection for spliced assembly due to load P

P is total applied load (sum of both load points)

EI is effective flexural rigidity of the unspliced assembly. Equal to the product of wood modulus of elasticity and moment of inertia

L is overall splice length

1) See Figure 4 for graphical depiction of equation variables.

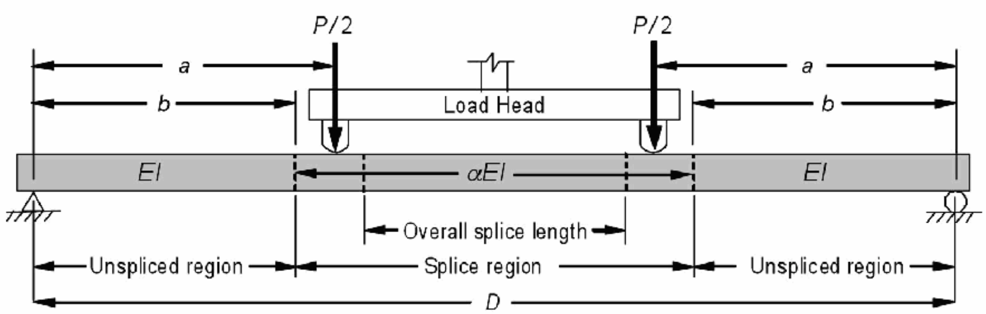

Figure 4 – Model of a spliced assembly under a two-point loading; reduced flexural stiffness in the splice region

8 Commentary

8.1 Purpose and scope

8.1.1 Mechanically laminated assemblies are widely used as structural columns in post-frame buildings. The suitability of such columns is generally dependent on their bending properties. Bending properties for a mechanically laminated assembly vary significantly depending upon orientation and whether or not it contains butt joints.

8.1.2 Although this Engineering Practice does not address axial assembly strength, the designer should consider all appropriate design conditions including possible axial and bending load combinations.

8.1.2.1 Adjusted compression design value parallel-to-grain, F_c'. Provisions in Section 15.3 of the NDS can be used to calculate the adjusted compression design value parallel-to-grain, F_c', for both spliced and unspliced mechanically laminated assemblies. In order to apply NDS Section 15.3 to spliced assemblies: (1) members must be in full contact at all end-joints; that is, there can be no gaps between members at an end joint, (2) lateral support must be provided to prevent weak axis buckling (i.e., buckling perpendicular to the wide faces of the individual layers) in the vicinity of all end joints, or face plates capable of preventing weak axis buckling must be installed, and (3) the slenderness ratio, l_{e1}/d_1, for buckling about the strong axis must be divided by the square root of the bending stiffness modification factor as determined in accordance with Clause 7.3.1. This adjustment to the slenderness ratio has the same net effect on the critical bucking design value for compression, F_{cE}, as multiplying the E_{min}' by the bending stiffness modification factor. Multiplying E_{min}' by the bending stiffness modification factor properly accounts for the increase in assembly bending flexibility (and hence the increased buckling potential) associated with the end joints. Note that if there is no end joint within the length le_1 used to define the effective length, l_{e1}, the bending stiffness modification factor for that length is equal to 1.0. In practice, it is not uncommon to also set the bending stiffness modification factor equal to 1.0 for lengths in which all end joints are no more than about 2 d_1 from a point of zero bending moment.

8.1.3 The scope of this Engineering Practice is limited to three- and four-layer assemblies because they represent the vast majority of assemblies used in post-frame building construction, and are the only mechanically laminated assemblies that have been extensively tested and modeled to date. The scope of this Engineering Practice is limited to uniaxial bending about axis Y-Y (Figure 1a) because: (1) mechanically laminated assemblies are generally substantially weaker when bent about axis X-X, and (2) calculating biaxial bending stresses in mechanically laminated assemblies is a complex function of boundary conditions, the stiffness of individual laminations, and the stiffness of interlayer connections.

8.2 Definitions

8.2.1 Splice region. Defining a splice region is very important for assemblies with simple butt joints. In such assemblies, the splice region is required to have more interlayer connectors and is assigned bending strength and stiffness values that are lower than those for unspliced regions of the assembly. The decision to terminate the splice region at a distance of *L* /4 from the outer end joints in a group of common end joints (resulting in a splice region length of 1.5 times the overall splice length, *L*) was based on finite element analyses of three- and four-layer assemblies. These analyses showed that fastener shear forces fall off rapidly as the distance from the extreme outer joints increases. At a distance *L* /4 from the extreme outer joints, the fastener shear forces have dropped to level where they are at or below the average shear force of the fasteners located between the two extreme outer end joints.

8.3 Material and manufacturing requirements

8.3.1 Preservative wood treatment. Treatment of exposed, above-ground assemblies in accordance with AWPA Use Category 4A (instead of AWPA Use Category 3B) recognizes the more critical nature of the assemblies, as well as the greater adsorption of water by the assemblies due to their interlayer planes. Water adsorbed between layers may not evaporate as rapidly as surface moisture. The addition of construction adhesive between layers may also impede interlayer drying.

8.3.2 Fasteners in treated lumber. Clause 4.4 was based in part on Section 2.4.1 of The Permanent Wood Foundation System—Design, Fabrication and Installation Manual (AF&PA, 1992). The requirements in this document are based on the results of a 17-year Forest Products Laboratory study (Baker, 1992).

8.3.3 Certified structural glued end joints. Sampling requirements in clause 4.5.3.1 are based in part on sampling requirements published in ANSI/AITC A19/0.1 for glued end joints used in glued laminated timber. Strength requirements in clause 4.5.3.2 are based in part on the Glued Lumber Policy published by the American Lumber Standard Committee. Clause 4.5.3.2.4 permits test specimens to be used in the production of laminated assemblies as long as the strength requirements of clause 4.5.3.2 are met during testing without visible or audible signs of a failure. While it is recognized that damage can accumulate within a specimen by subjecting it to the qualifying proof load (QPL), as long as this QPL is met (but not exceeded by more than 1 or 2 percent), and there are no visible or audible signs of failure, any accumulated damage should not be at a level that would justify a reduction in design strength. Allowing test specimens to be incorporated into production assemblies recognizes the value of minimizing solid waste and/or downcycling of wood resources.

8.4 Nail- and screw-laminated assembly design requirements

8.4.1 Most mechanically laminated assemblies used in construction are nail-laminated, although an increasing number of screw-laminated are being used. When these assemblies contain simple butt joints, the bending strength and stiffness of the assemblies are controlled by overall splice length, fastener location and density, and presence (or absence) of butt-joint reinforcement. Clause 5 of this Engineering Practice contains design requirements for these assembly variables. When these design requirements are followed (i.e., recommended minimum splice lengths, joint arrangements, and fastener capacities are used), the bending strength and stiffness of the spliced assemblies can be calculated according to procedures outlined in clauses 6 and 7. In other words, there is no need to conduct laboratory tests to determine bending properties of spliced nail-lams or of spliced screw-lams.

8.4.2 Joint arrangement. The recommended joint arrangements (Table 2) and minimum overall splice lengths (Table 3) were selected after extensive finite element analysis (FEA) and laboratory testing. The ability of FEA to accurately predict the behavior of assemblies has been demonstrated in four major studies (Bohnhoff et al., 1989; Bohnhoff et al., 1991; Bohnhoff et al., 1993; Williams et al., 1996). Assemblies featuring joint arrangements 3A, 4A, and 4B have been laboratory tested, while assemblies with joint arrangements 3B and 4C have not.

8.4.3 Overall splice length. Minimum overall splice length is primarily controlled by fastener shear forces in assemblies that are 140 and 184 mm (5.5 and 7.25 in.) deep, and by wood shear stresses in assemblies fabricated from 235 and 286 mm (9.25 and 11.25 in.) wide lumber. When overall splice lengths less than those in Table 3 are used for 140 and 184 mm deep assemblies, the number of fasteners required within the splice region to maintain strength becomes excessive and minimum fastener spacings are difficult to maintain.

8.4.3.1 The minimum splice lengths listed in Table 3 for mechanically laminated assemblies with common glued end joints are half as long as those specified for assemblies with simple butt joints. This decrease in required splice length reflects the fact that interlayer shear transfer is considerably less in mechanically laminated assemblies with glued end joints than it is in assemblies with simple butt joints. It is important to note that the effect of overall splice length on the strength of mechanically laminated assemblies with glued end joints has not been investigated, this despite the fact that such assemblies are commonly used in post-frame buildings. To this end, the minimum splice lengths listed in Table 3 for assemblies with common glued end joints are felt to be slightly conservative. Based on a brief review of literature, it would appear that the spacing of end joints in vertically glued-laminated (glulam) assemblies has also not been studied.

8.4.3.2 Recommended minimum overall splice lengths increase as the face width of the laminations increase because assembly bending strength increases as lamination width increases. Unless the minimum overall splice length is increased along with lamination face width, the strength gain associated with the increased width will be compromised by a lower bending strength in the splice region.

8.4.4 Interlayer shear capacity. The number of fasteners per interface per unit length of assembly, n_F, multiplied by the NDS® adjusted allowable lateral load per fastener, Z', is the design interlayer shear capacity per interface per unit length of assembly . For unspliced regions, this design capacity (i.e., the product of n_F and Z') must exceed the appropriate minimum required ISC value from Table 4 (i.e., the Level I ISC value). The minimum required ISC values in Table 4 for LRFD were obtained by multiplying the ASD values by a factor of 1.35. In theory, this ratio should be equal to $K_F\ \varphi\ \lambda\ /C_D$, where from the NDS®, K_F is a ASD to LRFD format conversion factor, φ a LRFD resistance factor, λ the LRFD time effect factor, and C_D, the ASD load duration factor. In accordance with the NDS, the product of K_F and φ is numerically equal to 2.16. The ratio of C_M to λ was taken as 1.60.

For spliced regions, the product of n_F and Z' must exceed the minimum required ISC value calculated using equation 1 (i.e., the Level II ISC value). Equation 1 produces different required ISC values for ASD and LRFD because the adjusted bending design stress, F_b', is different for ASD and LRFD methodologies. Equation 1 is based on an EISS (effective interlayer shear stress) equation developed by Bohnhoff (1996). The EISS equation predicts the average interlayer shear stress in the 25% most highly loaded fasteners within the splice region when the average interlayer slip of these fasteners is 0.38 mm (0.015 in.). Equation 1 yields values that are two-thirds of those obtained from the EISS equation. The two-thirds factor was applied because designs with this lower shear capacity did not experience nail-related failures when laboratory tested. Care should be taken not to over-specify shear capacity since over-nailing or over-screwing can negatively influence assembly strength.

8.4.4.1 Fastener location. The minimum fastener spacings in Table 5 are based on a study of actual assembly failures. These minimums are more conservative than those published in the NDS® Commentary (AF&PA, 2005). In addition to the minimum nail spacings, clause 5.3.4 also contains provisions to ensure a good distribution of fasteners. These provisions were based in part on the requirements given for mechanically laminated built-up columns in clause 15.3.3 of the NDS®.

8.4.5 Butt-joint reinforcement. Specifications in clause 5.4 are based on tests conducted by Bohnhoff et al. (1991) and Williams et al. (1994). Equation 2 ensures that the ratio of metal connector plate (MCP) bending capacity to lamination bending capacity is consistent with that for assembly designs used to establish the 0.55 factor in Table 8. For the MCP geometries specified in clause 5.4, tests show that plate bending strength is controlled by plate tensile strength and not by the lateral resistance of tooth-to-wood connections. The allowable MCP design value in tension V_t, is equal to the tensile force required to fracture the plate, multiplied by 0.6 (which is an ultimate-to-allowable strength conversion factor), and divided by plate width.

Ultimate tensile strength for a MCP is typically determined by simultaneously loading a pair of MCPs in accordance with ANSI/TPI 1-2007 Section 5.4. To obtain V_t for use in equation 2, divide the total tension load required to fracture the two MCPs (identified as P_{tp} in ANSI/TPI 1-2007) by 2.0 and the MCP width. Clause 5.4 in this document only applies to assemblies with a single MCP on each outside lamination and thus V_t in equation 2 is the force per unit width required to fracture a single plate.

8.5 Bending design stress

8.5.1 Repetitive member factors. Repetitive member factors in Table 6 are based on test results from four major studies (Bonnickson and Suddarth, 1966; Bohnhoff et al., 1991; Williams et al., 1994; Chiou, 1995).

8.5.2 Slenderness ratio. The slenderness ratio required for calculation of the beam stability factor is based on a width, b, that is equal to 60% of the actual width of the assembly. This 40% reduction is used to account for the decrease in bending stiffness about axis X-X (Figure 1) that is associated with slip between individual wood layers. This slip allows for additional lateral movement, which increases the potential for lateral torsional buckling. Actual reduction in lateral torsional buckling strength is a complex function of interlayer shear stiffness and strength, member depth, number of layers, presence and relative location of end joints, and spacing of lateral supports. To apply the 60% factor, the interlayer shear capacity should be no less than specified in Clause 5.3.1.

8.5.3 Bending strength modification factors. The Table 8 values are based on tests conducted by Bohnhoff et al. (1991) and Williams et al. (1994) on assemblies with minimum overall splice lengths.

8.5.4 Testing laminated assemblies. When the bending strength modification factors in Table 8 do not apply, a series of laboratory tests must be conducted. Both spliced assemblies and unspliced assemblies are tested and the bending strength modification factor is calculated from the test results using procedures outlined in clause 6.3.2. In the past, it was common practice to determine the ASD design bending strength of a new spliced assembly design by testing a series of the assemblies and then dividing the 5% point estimate of ultimate bending moment by a factor of 2.1. The drawbacks of this method were that (1) the reduction in strength due to splicing could not be calculated (since unspliced assemblies had not been tested), and (2) the resulting design value applies only to assemblies fabricated from the same batch of lumber as that used to fabricate the test specimens (lumber strength and stiffness can vary significantly from batch to batch, even though both batches may be of the same grade and species). Both of these shortcomings are avoided with the outlined procedure.

8.5.5 Calculation of bending strength modification factors from test data. The bending strength modification factor is defined as ratio of the 5% point estimate of ultimate bending moment for the spliced assemblies to the 5% point estimate of ultimate bending moment for the unspliced assemblies. Because 5% point estimates can be largely influenced by the number of assemblies tested and the distribution selected to represent the data, a generally conservative procedure is provided for use when the total number of each assembly type tested is less than 25. This more conservative procedure is easier to apply since it does not require that test data be fit to a probability density function, only that the mean ultimate bending moment for each assembly type be calculated. To obtain the bending strength modification factor, the ratio of mean ultimate bending moment for spliced assemblies to that for unspliced assemblies is multiplied by the appropriate adjustment factor from Table 9. This adjustment factor accounts for the number of assemblies tested and for the difference between mean assembly strength and the 5% point estimate of assembly strength. The Table 9 factors were developed assuming: (1) normal distributions of bending strength for all assembly types, (2) a ratio of 1.50 between the bending strength COV for spliced assemblies (without outside butt-joint reinforcement) and the bending strength COV of unspliced assemblies, (3) a ratio of 1.00 between the bending strength COV for spliced assemblies with outside butt-joint reinforcement and the bending strength COV of unspliced assemblies.

When more than 25 assemblies have been tested, clause 6.3.2 requires calculation of 5% point estimates. Although this is a more involved process, it will also yield results less conservative than those obtained using mean strengths and the Table 9 factors. If the distribution of ultimate bending strength for both spliced and unspliced assemblies is assumed to be normally distributed, the ratio of 5% point estimates (i.e., the bending strength modification factor) would be given as:

$$\text{Bending strength modification factor} = M_S\left(1 - 1.645S_S\right)/\left[M_U\left(1 - 1.645S_U\right)\right] \quad (4)$$

where:

M_S is mean strength of the spliced assemblies

S_S is standard deviation of spliced assembly strength

M_U is mean strength of the unspliced assemblies

S_U is standard deviation of unspliced assembly strength

8.6 Bending stiffness

8.6.1 Assemblies without end joints. When the layers of an unspliced assembly are forced (by a load-distributing element) to have the same displaced geometry, there is little, if any, slip between the individual layers. When there is little or no slip between individual layers, and each layer has (1) the same moment of inertia, and (2) a centroid located on the centroidal axis Y-Y (Figure 1), then the modulus of elasticity *E* of the assembly is equal to the average E of the layers.

8.6.2 Assemblies with glued end joints. The criteria for assemblies without end joints also applies to spliced assemblies with both common and certified structural glued end joints because at a glued end joint the members forming the joint have the same rotation and vertical displacement. Although an assembly with common glued end joints will not have the bending strength of an identical assembly with certified structural glued end joints, both assemblies will behave as assemblies void of end joints up until their respective points of failure.

8.6.3 Assemblies with butt joints. To be accurately represented in a plane-frame structural analog, an assembly with butt joints must be divided into elements. To be consistent with the rest of this Engineering Practice, spliced assemblies are segmented into spliced and unspliced regions as defined in clauses 3.10 and 3.11, respectively.

8.6.4 Bending stiffness modification factors. The equations in Table 10 apply only to assemblies tested under a symmetric two-point loading. They were derived using the conjugate beam method. Use of these equations requires a good estimate of the effective rigidity of the unspliced section, *EI*, which is the product of wood modulus of elasticity and moment of inertia. For the stiffness modification factor to be meaningful, EI must be determined by a laboratory test of lumber representative of that used to fabricate the spliced assemblies (either individual pieces or unspliced assemblies can be tested).

The load P used in the Table 10 equations should correspond to a total load that would induce design level stresses in the assembly. If a series of tests have been conducted, equate P/Δ to the average slope of the linear portion of the load-deflection plots, and set EI equal to the average flexural rigidity of the test assemblies.

8.6.4.1 Equation 3 is from Bohnhoff (1996) and requires an estimate of individual nail-joint stiffness, K, which is the slope of the relationship between nail shear force and interlayer slip. For common wire nails, the secant stiffness corresponding to an interlayer slip of 0.38 mm (0.015 in.) can be approximated as:

$$K = CG^{1.25}D^{1.25}$$

where:

K is interlayer stiffness, N/mm (lbf/in.);

G is specific gravity based on oven-dry weight and volume;

D is nail diameter, mm (in.);

C = 415.3 (for K in N/mm and D in mm);

= 303600 (for K in lbf/in and D in in.)

Annex A
(informative)
Bibliography

The following documents are cited as reference sources used in the development of this Engineering Practice:

American Forest and Paper Association (AF&PA). Revisions to the permanent wood foundation system—Design, fabrication, and installation manual. Washington D.C.; 1992.

American Forest and Paper Association (AF&PA). National design specifications for wood construction with commentary and supplement: design values for wood construction. Washington D.C.; 2005.

American Institute of Timber Construction (AITC). ANSI/AITC A190.1-2007, Structural glued laminated timber. Centennial, CO, 2007.

American Lumber Standard Committee. Glued lumber policy. February 18, 2009.

Baker, A. J. Corrosion of nails in CCA- and ACA-treated wood in two environments. Forest Products Journal 42(9):39-41; 1992.

Bohnhoff, D. R. Evaluation of spliced, nail-laminated wood members without butt joint reinforcement. Transactions of the ASAE 32(5):1797-1806; 1989.

Bohnhoff, D. R., S. M. Cramer, R. C. Moody, and C. O. Cramer. Modeling vertically mechanically laminated lumber. J. Structural Division ASCE 115(10):2661-2679; 1989.

Bohnhoff, D. R., R. C. Moody, S. P. Verrill, and L. F. Shirek. Bending properties of reinforced and unreinforced spliced nail-laminated posts. Res. Paper FPL-RP-503. USDA Forest Service, Forest Products Laboratory; 1991.

Bohnhoff, D. R., A. B. Senouci, R. C. Moody, and P. A. Boor. Bending properties of STP-laminated posts. ASAE Paper No. 93-4060, ASAE, St. Joseph, MI; 1993.

Bohnhoff, D. R. Interlayer shear and stiffness of spliced, nail-laminated posts. Transactions of the ASAE 39(2):713-719; 1996.

Bonnickson, L. W., and S. K. Suddarth. Structural reliability analysis for a wood load sharing system. J. Materials 1(3):491-508; 1966.

Chiou, Wen-Shan. Bending properties of unspliced, vertically mechanically laminated assemblies. Ph.D. Thesis. University of Wisconsin-Madison, Madison, WI; 1995.

Williams, G. D., D. R. Bohnhoff, and R. C. Moody. Bending properties of four-layer nail-laminated posts. Res. Pap. FPL-RP-528. USDA Forest Service, Forest Products Laboratory; 1994.

Williams, G. D., D. R. Bohnhoff, and R. C. Moody. Locating butt-joints in four-layer, nail-laminated assemblies . Transactions of the ASAE 39(2):699-711; 1996.

Annex B
(informative)
Spliced nail-laminated assembly design example (ASD)

Problem: Design a three-layer spliced nail-laminated assembly. Use nominal 2- by 6-in. No. 2 southern pine lumber and 10d common wire nails. End joints will not be glued or reinforced. Load is transferred to the assembly by secondary framing members spaced 36 inches apart. These framing members also provide lateral support. Controlling load combination includes wind and snow. One end of the assembly will be located below grade. The entire splice region will be located above grade in a dry environment.

Solution:

Step 1—Adjusted Bending Design Value for Unspliced Regions, F_b'

a. Partially adjusted reference bending value from Table 7a = 1690 lbf/in.^{2}

b. Adjustment factors from NDS®: load duration (CD) = 1.6; wet service factor (CM) for below grade regions = 0.85; wet service factor (CM) for above grade regions = 1.0; temperature factor (Ct) = 1.0; incising factor (Ci) = 1.0

c. Reference design value Fb multiplied by all appropriate ASD adjustment factors except CL:

Below grade regions: Fb* = 1690 lbf/in.2 (1.6)(0.85) = 2300 lbf/in.^{2}

Above grade regions: Fb* = 1690 lbf/in.2 (1.6) = 2700 lbf/in.2

d. Slenderness ratio ($R_B = (L_e\, d\, /\, b^2)^{0.5}$: From the NDS®, effective length L_e = 1.84 L_u = 66.2 inches (L_u is the 36 inch distance between points of lateral support). From clause 6.1.1, thickness b is equated to 60% of the actual assembly thickness or 0.60 (4.50 inches) = 2.70 inches, and d is the actual face width of a lamination or 5.50 inches.

$$R_B = (L_e\, d\, /\, b^2)0.5 = [(66.2 \text{ in.})(5.50 \text{ in.})/42.70 \text{ in.})^2]^{0.5} = 7.07 \text{ in.}$$

e. Beam stability factor, C_L. From NDS with E_{min} = 580,000 bf/in.^{2} (NDS® Table 4B) and R_B = 7.07 inches, C_L for above grade regions is equal to 0.988. For below grade regions, C_L = 1.00 because soil provides continuous lateral support.

f. Adjusted bending design value for unspliced regions above grade: F_b' = 2700 lbf/in.^{2} (0.988) = 2670 lbf/in.. For below grade, unspliced regions, F_b' = 2300 lbf/in.^{2}

Step 2—Adjusted Bending Design Value for Spliced Regions, F_b'

a. Allowable bending design value in above-grade splice region = 0.42 × F_b' for above grade splice region = 1120 lbf/in.^{2} The 0.42 value is the bending strength modification factor from Table 8. To use this value, all minimum design recommendations in clause 4 must be followed.

Step 3—Recommended Splice Arrangement & Overall Splice Length

a. For a three-layer assembly with unreinforced butt joints, splice arrangement 3A is recommended (Table 2)

b. Recommended minimum overall splice length, L, for a nominally 6-in.-deep assembly (Table 3) = 4 feet

Step 4—Required Interlayer Shear Capacity

a. Unspliced regions (level I value from Table 4) = 12 lbf/in.

b. Splice regions (Equation 1 with: F_b' = 2670 lbf/in.^{2}; d = 5.5 in.; L = 48 in.; and E = 1,600,000 lbf/in.^{2} = 76.3 lbf/in.

Step 5—Adjusted Lateral Design Load for a Nail Joint, Z'

a. Tabulated lateral design value (Z) for a 10d common wire nail in southern pine (from NDS table 11N) = 128 lbf. Applicable adjustment factors include the load duration factor of 1.60 and a wet service factor of 0.7 for nails located below grade.

Below grade regions: Z' = 128 lbf (1.60)(0.85) = 174 lbf

Above grade regions: Z' = 128 lbf (1.60) = 205 lbf

Step 6—Minimum Required Number of Nails

a. Nails required (per interface) for a 48 in. section of the splice region = (48 in.)(76.3 lbf/in.)/(205 lbf/nail) = 18 nails

b. Nails required (per interface) for a 12 in. section of the splice region=(12 in.)(76.3 lbf/in.)/(205 lbf/nail) = 5 nails

c. Nails required in unspliced regions above grade =(12 lbf/in.)/(205 lbf/nail) =0.058 nails/in.=1 nail every 17 in.

d. Nails required in unspliced regions below grade =(12 lbf/in.)/(174 lbf/nail) =0.069 nails/in.=1 nail every 14.5 in.

Step 7—Minimum spacings based on 0.148 in. nail diameter

a. Edge distance = 1.48 in.

b. End distance = 2.22 in.

c. Spacing (pitch) between fasteners in a row = 2.96 in.

d. Spacing (gage) between rows of fasteners (in-line) = 1.48 in.

e. Spacing (gage) between rows of fasteners (staggered) = 0.74 in.

Step 8—Nail Layout

a. A nail pattern that meets the proceeding requirements is shown in Figure 5.

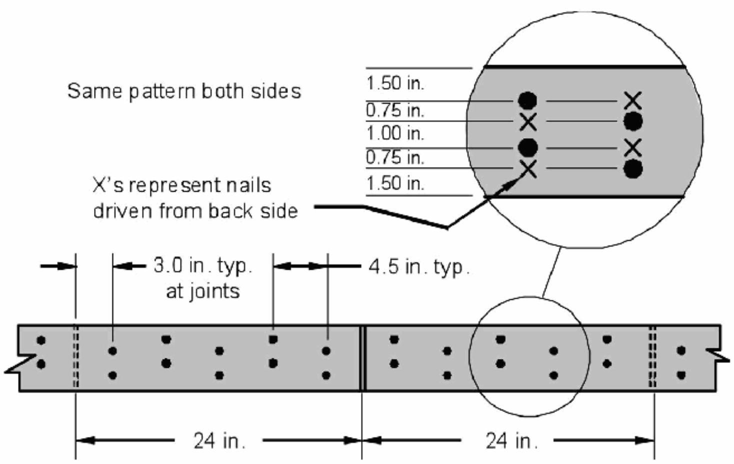

Figure 5 – Example nail pattern for a three-layer spliced assembly fabricated using 10 d common wire nails. Only a portion of the splice region is shown. The same nail pattern is used on both sides of the assembly.

ANSI/ASABE S618 DEC2010 (R2016)
Post Frame Building System Nomenclature

American Society of
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Approved January 2011 as an American National Standard

Post Frame Building System Nomenclature

Proposed by the ASABE Structure Group committee. Approved by the Structures and Environment Division. Adopted by ASABE December 2010; approved as an American National Standard January 2011; reaffirmed by ANSI January 2016.

Keywords: Pole building, Post frame, Wood design, Wood framing, Wood structures

1 Purpose and scope

1.1 This Standard provides definitions and classifications associated with post-frame building systems.

1.2 This Standard is intended to establish uniformity in terms used in the design, construction, marketing and regulation of post frame building systems.

2 Normative references

This Standard is intended to be consistent with terminology in the following documents. These documents are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the most recent editions of these documents.

ANSI/AF&PA NDS-2005 National Design Specification (NDS) for Wood Construction with Commentary

ANSI/ASAE EP484.2 Diaphragm Design of Metal-Clad, Wood-Frame Rectangular Buildings

ANSI/ASAE EP 486 Shallow Post Foundation Design

ANSI/ASAE EP559 Design Requirements and Bending Properties for Mechanically Laminated Wood Assemblies

NFBA Post Frame Building Design Manual

NFBA Accepted Practices for Post Frame Building Construction: Framing Tolerances

NFBA Accepted Practices for Post Frame Building Construction: Metal Panel and Trim Installation Tolerances

WTCA/TPI BSCI (Building Component Safety Information) 2008 Guide to Good Practice for Handling, Installing, Restraining & Bracing of Metal Plate Connected Wood Trusses

3 Building systems

3.1 Post-frame building system: A building characterized by primary structural frames of wood posts as columns and trusses or rafters as roof framing. Roof framing is attached to the posts, either directly or indirectly through girders. Posts are embedded in the soil and supported on isolated footings, or are attached to the top of piers, concrete or masonry walls, or slabs-on-grade. Secondary framing members, purlins in the roof and girts in the walls, are attached to the primary framing members to provide lateral support and to transfer sheathing loads, both in-plane and out-of-plane, to the posts and roof framing. See Figures 1–3.

3.1.1 Pole-frame building system: A post-frame building in which all posts are round poles. Commonly referred to as a pole building. See Figure 3.

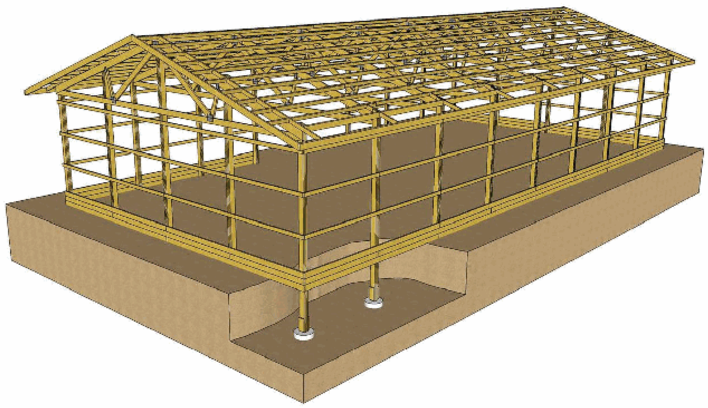

Figure 1 – Post-frame building with trusses supported directly by embedded posts

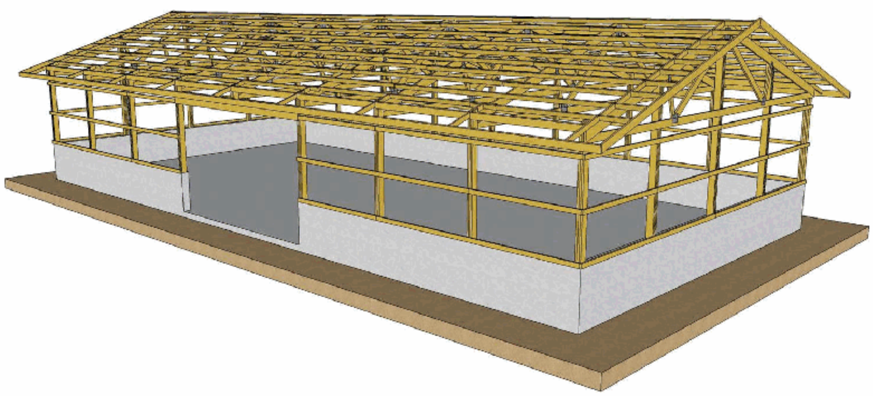

Figure 2 – Post-frame building mounted on a concrete stem wall

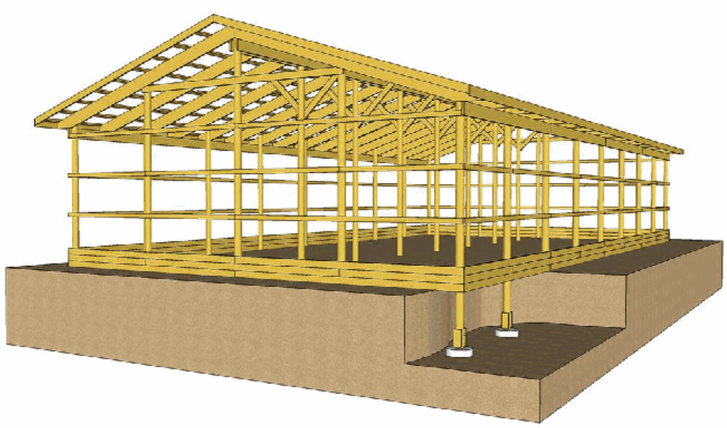

Figure 3 – Post-frame building featuring girder supported rafters and embedded poles. Since all posts are round poles, this post-frame building could also be identified as a pole building.

4 Building subsystems

4.1 Primary frame: The two-dimensional interior frame that is formed by the direct attachment of a roof truss/rafter to its respective posts. Also known as a post-frame or a main frame. See Figures 4–9.

4.1.1 Single-span primary frame: Primary frame without any interior supports. Also known as a clear span primary frame. See Figure 4.

4.1.2 Multi-span primary frame: Primary frame with one or more interior supports. See Figures 5–9.

4.1.3 Solid-web primary frame: Primary frame assembled without using any open-web trusses. See Figures 6 and 8.

4.1.4 Open-web primary frame: Primary frame fabricated with open-web trusses and no solid-web members for roof support. See Figures 4, 5, and 7.

4.1.5 Hybrid primary frame: Primary frame assembled with both open-web trusses and solid-web members for roof support. See Figure 9.

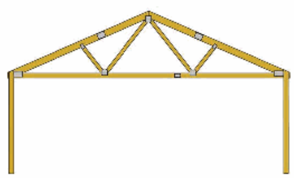

Figure 4 – A single-span, open-web primary frame

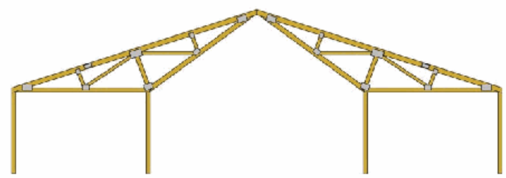

Figure 5 – A three-span, open-web primary frame featuring twin inverted trusses

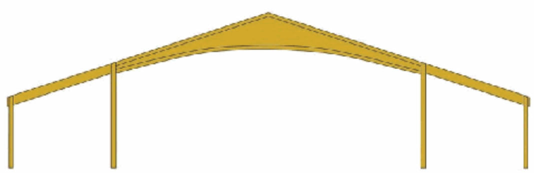

Figure 6 – A three-span, solid-web primary frame

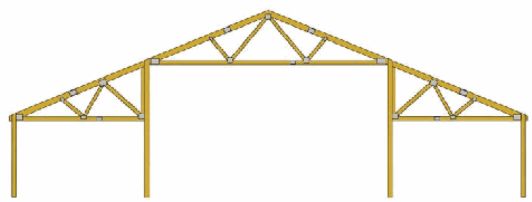

Figure 7 – A three-span, open-web primary frame featuring a raised center bay

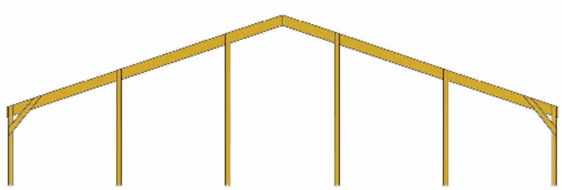

Figure 8 – A five-span, solid-web primary frame utilizing knee-braces on the sidewall posts

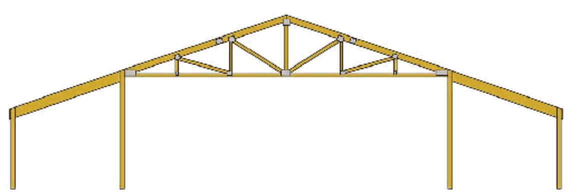

Figure 9 – A three-span, hybrid primary frame

4.2 Sidewall: An exterior wall oriented perpendicular to individual primary frames.

4.3 Endwall: An exterior wall oriented parallel to individual primary frames.

4.3.1 Endwall frame: Consists of endwall posts and the attached endwall truss or rake rafters.

4.3.2 Expandable endwall: Endwall frame designed with the load-bearing capability of an interior frame (i.e. primary frame) so it can serve as an interior frame when the building is expanded. See Figures 1–3.

4.4 Diaphragm: A structural assembly comprised of structural sheathing (e.g., plywood, metal cladding) that is fastened to roof, ceiling, floor or floor framing in such a manner that the entire assembly is capable of transferring in-plane shear forces.

4.4.1 Shearwall: A vertical diaphragm. Any endwall, sidewall, intermediate wall or portion thereof that is capable of transferring in-plane shear forces.

5 Primary framing members

Primary framing members are the main structural framing members in a building. In a post-frame building they include the posts, roof trusses/rafters, and any girders that transfer load between roof trusses/rafters and posts.

5.1 Post: A structural column. Functions as a major foundation element when it is embedded in the soil. Post-frame building posts include solid-sawn posts, structural composite lumber posts, glulam posts, mechanically-laminated lumber posts, and poles.

5.1.1 Solid-sawn post: Post comprised of a single piece of sawn lumber.

5.1.2 Structural composite lumber post (SCL post): Post comprised of a single piece of structural composite lumber. Structural composite lumber (SCL) includes, but is not limited to: parallel strand lumber (PSL), laminated veneer lumber (LVL), and laminated stand lumber (LSL).

5.1.3 Glued-laminated post (or glulam post): Post consisting of suitably selected sawn lumber laminations joined with a structural adhesive.

5.1.4 Mechanically-laminated post (or mechlam post): Post consisting of suitably selected sawn lumber laminations or structural composite lumber (SCL) laminations joined with nails, screws, bolts, and/or other mechanical fasteners.

5.1.4.1 Nail-laminated post (or nail-lam post): A mechanically laminated post in which only nails have been used to join individual wood layers.

5.1.4.2 Screw-laminated post (or screw-lam post): A mechanically laminated post in which only screws have been used to join individual wood layers.

5.1.4.3 Spliced post: A mechanically laminated post in which individual laminations are fabricated by end-joining shorter wood members. End joints are generally unreinforced butt joints, mechanically-reinforced butt joints, glued scarf joints, or glued finger joints.

5.1.4.4 Unspliced post: A mechanically laminated post in which individual laminations do not contain end joints.

5.1.5 Pole: A round, naturally tapered, unsawn, wood post. Poles are sometimes slabbed to aid in fastening framing members.

5.1.6 Endwall post: Post located in an endwall.

5.1.7 Sidewall post: Post located in a sidewall.

5.1.8 Corner post: Post that is part of both a sidewall and an endwall.

5.1.9 Jamb post: Post that frames the side of a door, window, or other framed opening.

5.2 Truss: A structural framework, generally two-dimensional (i.e. planar), whose members are almost always assembled to form a series of inter-connected triangles. Perimeter members of the assembly are called truss chords and interior members are called truss webs.

5.2.1 Light wood truss: A truss manufactured from wood members whose narrowest dimension is less than 5 nominal inches. Wood members include solid-sawn lumber, structural composite lumber, and glulams. Members may be connected with metal connector plates (MCP), bolts, timber connectors, and screwed- or nailed-on plywood gusset plates.

5.2.1.1 Metal plate connected wood truss (MPCWT): A truss composed of wood members joined with metal connector plates (also know as truss plates). Metal connector plates (MCP) are light-gage, toothed steel plates. The most common type of light wood truss.

5.2.2 Heavy timber truss: A truss manufactured from wood members whose narrowest dimension is equal to or greater than 5 nominal inches. Wood members include solid-sawn timber, structural composite lumber, and glulams. Members generally connected with steel gusset plates that are bolted in place.

5.2.3 Ganged wood truss: A truss designed to be installed as an assembly of two or more individual light wood trusses fastened together to act as one.

5.2.4 Girder truss: Truss designed to carry heavy loads from other structural members framing into it. Frequently a ganged wood truss.

5.2.5 Parallel chord truss: Truss with top and bottom chords with equal slopes

5.2.6 Roof truss: A truss that directly supports a roof.

5.3 Rafter: One of a series of sloped, structural beams that support a roof.

5.3.1 Rake rafter: A rafter located in an end wall. See Figure 11.

5.3.2 Fly rafter: Rafter at the rake overhang that is supported out from the endwall by rake purlins. See Figure 10.

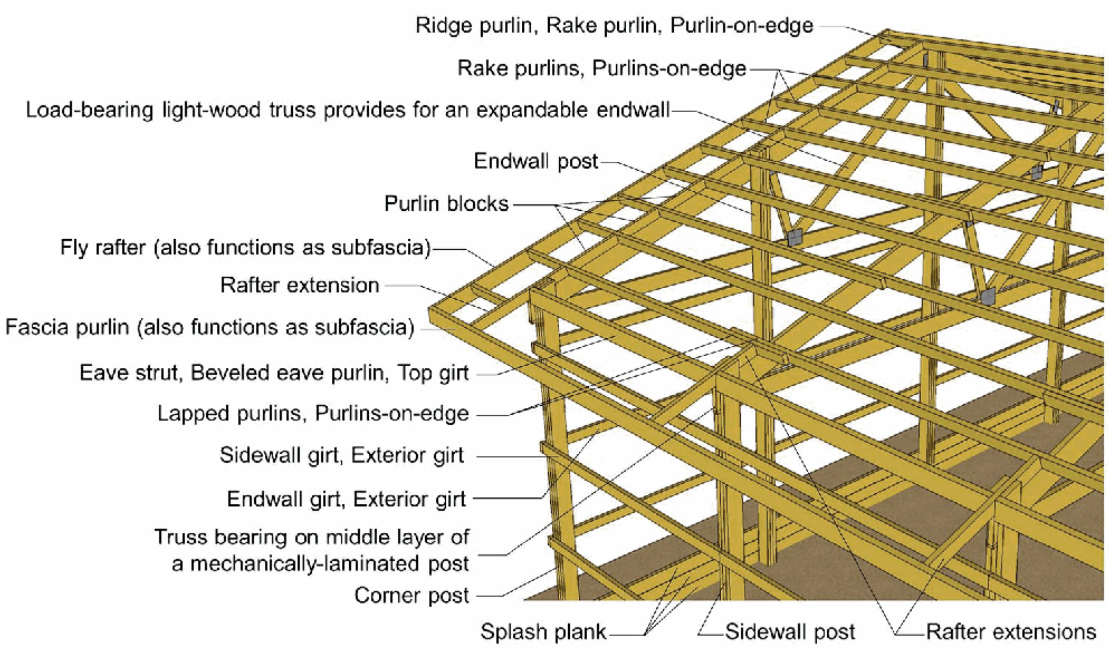

Figure 10 – Typical corner framing

5.3.3 Stacked rafter: A narrow, deep rafter made by placing one rafter on top of another and fastening them together. Generally made by fastening dimension lumber together with metal connector plates.

5.4 Girder: A large, generally horizontal, beam. Commonly used in post-frame buildings to support trusses whose bearing points do not coincide with a post. Frequently function as headers over large door and window openings.

5.4.1 Eave girder: Girder located at the eave of a building. See Figure 11.

5.4.2 Ridge beam: Girder located at the ridge of a building. See Figure 11.

5.4.3 Truss girder: A truss that functions as a girder. Top and bottom chords of a truss girder are generally parallel.

5.4.4 Spaced girder: A girder composed of two beams that are separated a fixed distance by special spacers and/or the girder supports. See Figures 11 and 20.

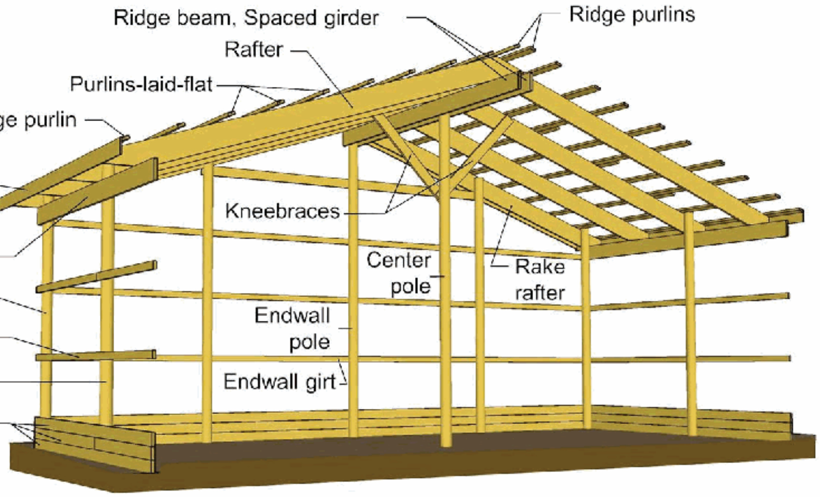

Figure 11 – Section of a pole building featuring girder-supported rafters

5.5 Header: Framing member at the top of a window, door or other framed opening. In general, any framing member that ties together the ends of adjacent framing members and may or may not be load bearing. See Figure 20.

5.6 Knee brace: A diagonally-oriented member used to stiffen and strengthen the connection between a post and the attached roof truss/ rafter, or between a post and an attached girder. See Figures 8 and 11.

5.7 Bearing block: A relatively short structural support used to transfer vertical load from one structural member to another. Frequently used to transfer load from a girder to a post or a truss to a post.

5.8 Rafter extension: A framing member attached to the end of a truss or rafter that extends the effective slope length of the roof by supporting additional purlins and/or subfascia. Rafter extensions are commonly used to help form eave overhangs as well as over shot roofs. See Figures 10, 17, 18, and 19.

5.9 Tie-down block: A framing member used to attach a roof truss/rafter to a girder. See Figure 20.

6 Secondary framing members

Structural framing members that are used to transfer load between exterior sheathing and primary framing members, and/or laterally brace primary framing members. The secondary framing members in a post-frame building include girts, purlins, eave struts and any structural wood bracing.

6.1 Girt: A member attached (typically at a right angle) to posts. Girts laterally support posts and transfer loads between any attached wall sheathing and the posts. See Figure 12.

6.1.1 Exterior girt: A girt located entirely on the outside of posts. Also known as an outset girt. See Figure 12.

6.1.2 Inset girt: A girt located entirely between adjacent posts. Frequently used to support both exterior and interior wall sheathing and horizontally-placed batt insulation. See Figure 12.

6.1.3 Interior girt: A girt located entirely on the inside of posts. Generally used to support interior wall sheathing in buildings with exterior girts. See Figure 12.

6.1.4 Notched girt: A girt that is notched to facilitate attachment to a post. Notching places a portion of the girt between adjacent posts, with the remainder located outside or inside the posts. See Figure 12.

6.1.5 Bottom girt: The lowest girt. This could be a regular girt, grade girt, or a splash plank. See Figures 24 and 25.

6.1.5.1 Grade girt: A bottom girt located at grade. May also function as a splash plank. See Figures 22 and 24.

6.1.6 Splash plank: Any decay and corrosion resistant girt that is in soil contact or located near the soil surface, that remains visible from the building exterior upon building completion, and is 2 to 4 inches in nominal thickness. Frequently, multiple rows of tongue and groove (T&G) splash plank are used along the base of a wall. See Figures 10, 11, and 24.

6.1.7 Top girt: The highest girt. A top girt to which both roof and wall sheathing are attached is known as an eave strut. See Figures 10, 11, 17, and 18.

6.1.8 Bookshelf girt: A girt with its wide faces horizontally oriented thus enabling it to effectively function as a shelf when left exposed. See Figure 12.

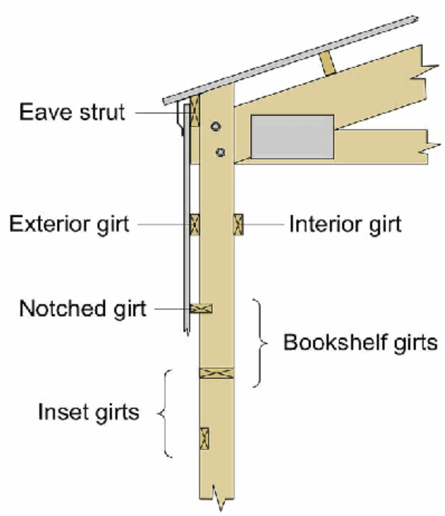

Figure 12 – Girt types

6.2 Purlin: A member attached (typically at a right angle) to roof trusses/ rafters. Purlins laterally support trusses/rafters and transfer load between roof sheathing and roof trusses/rafters. See Figures 10, 11, and 13.

6.2.1 Purlin-on-edge: A purlin that rests on top of roof trusses/rafters with its narrow face in contact with the trusses/rafters. See Figures 10 and 13.

6.2.2 Purlin-laid-flat: A purlin that rests on top of roof trusses/rafters with its wide face in contact with the trusses/rafters. See Figures 11 and 13.

6.2.3 Recessed purlin: A purlin located entirely between adjacent trusses/rafters. Single-span components that are typically held in place with special metal hangers. Also known as an inset purlin or dropped purlin. See Figure 13.

6.2.3.1 Fully recessed purlin: Recessed purlin whose top edge aligns with or is below the top edge of the trusses/rafters to which it is connected. See Figure 13.

6.2.3.2 Partially recessed purlin: Recessed purlin whose top edge is above the top edge of the trusses/rafters to which it is connected. See Figure 13.

6.2.4 Notched purlin: A purlin that is notched to fit over roof trusses/ rafters. See Figure 13.

6.2.5 Lapped purlins: Two non-recessed purlins (i.e., purlins-on-edge, purlins-laid-flat, or notched purlins) that bypass each other where they are connected to the same truss/rafter. See Figures 10 and 13.

6.2.6 Rake purlin: A purlin that overhangs the endwall of a building. See Figure 10.

6.2.7 Ridge purlin: A purlin adjacent to the building ridge. See Figures 10 and 11.

6.2.8 Eave purlin: A purlin located at the eave line of a building. An eave purlin to which both wall and roof sheathing are attached is known as an eave strut. See Figure 17.

6.2.9 Fascia purlin: A purlin that helps form the fascia of a building. Also known as an edge purlin. See Figures 17 and 18.

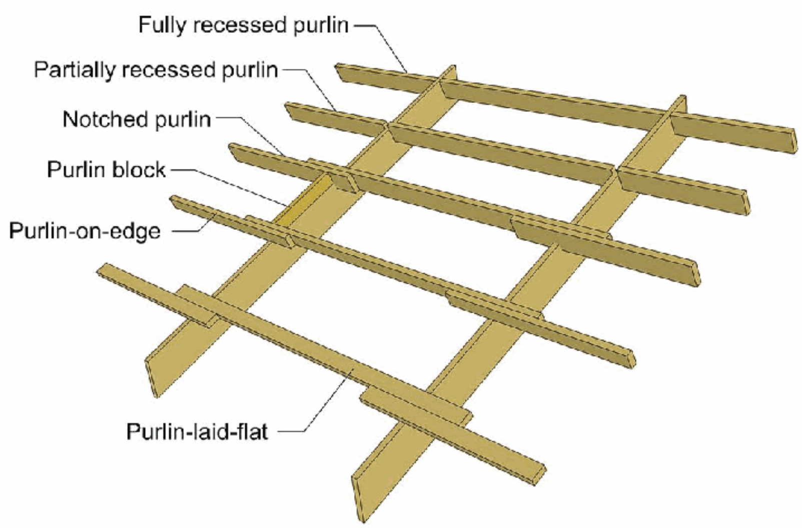

Figure 13 – Purlin types

6.2.10 Edge purlin: A purlin in the most outer row of purlins. All fascia purlins are edge purlins but not all edge purlins are fascia purlins. The edge purlins shown in Figure 11 are not fascia purlins as they do not help form the fascia of the building.

6.2.11 Beveled purlin: A purlin with an edge that has been cut at an angle, generally to facilitate cladding attachment. See Figures 17 and 18.

6.3 Eave strut: An eave purlin to which both wall and roof sheathing are attached or a top girt to which both wall and roof sheathing are attached. Simultaneous attachment of an eave strut to both wall and roof sheathing generally provides the strut with effective continuous lateral support to resist bending about both primary axes. See Figures 12 and 20.

6.4 Base plate: A corrosion and decay resistant member that is attached to the top of a concrete floor or wall. A base plate is generally located between posts and may function like a bottom girt. Unlike a girt, primary attachment of a base plate is to the concrete and not the posts. See Figures 21 and 25.

6.4.1 Sill plate: A corrosion and decay resistant member that is attached to the top of a concrete foundation wall, and upon which posts are attached.

6.5 Bracing: Axially-loaded structural members used to help stabilize other structural components. The definitions in this section pertain to permanent bracing. Additional temporary bracing is generally required during construction.

6.5.1 Continuous lateral restraint (CLR): An uninterrupted row of structural framing members connecting a series of trusses. The row is perpendicular to truss members and thus provides lateral support to the truss members it connects. See Figures 14 and 15.

6.5.1.1 Bottom chord continuous lateral restraint: A row of structural framing members that provides lateral support to the bottom chords of adjacent trusses. See Figure 15.

6.5.1.2 Web member continuous lateral restraint: A row of structural framing members that provides lateral support to the web members of adjacent trusses. See Figure 14.

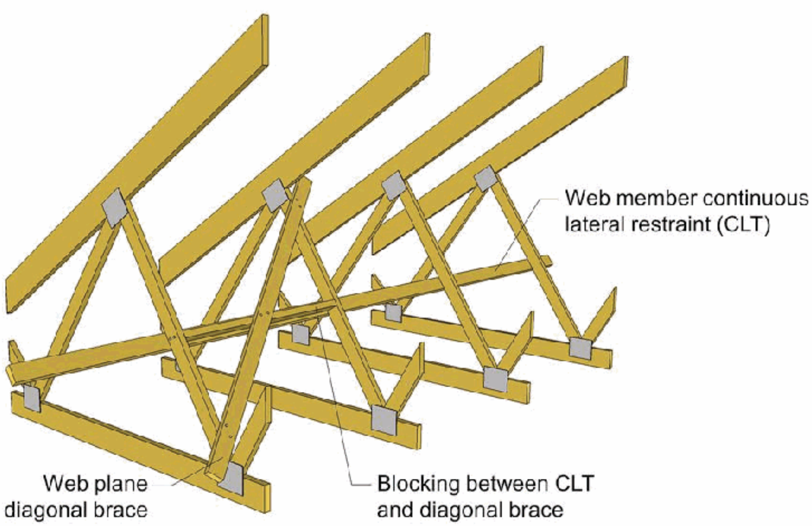

Figure 14 – Components of a continuous lateral restraint system for web members. For larger truss spacing, individual web member reinforcement may be more economical for lateral bracing of webs than a continuous lateral restraint system.

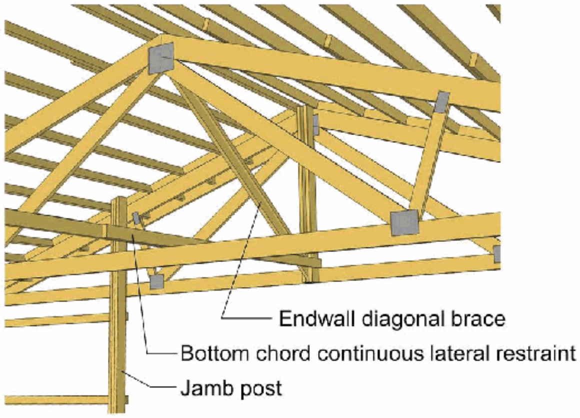

Figure 15 – Endwall diagonal brace used to transfer endwall forces into roof diaphragm and to keep bottom chord continuous lateral restraint from shifting

6.5.2 Diagonal brace: A framing member that runs at an angle to other framing members, and with other framing members generally forms a structurally-stable triangular assembly.

6.5.2.1 Web plane diagonal brace: A diagonal brace that lies in the plane formed by the web members of adjacent trusses. The brace generally runs from the roof plane to the ceiling plane, and is required in truss web planes that contain continuous lateral restraints to keep the CLR from shifting. See Figure 14.

6.5.2.2 Bottom chord diagonal brace: A diagonal brace that lies in the plane formed by the bottom chords of adjacent trusses (a.k.a., the ceiling plane). The braces are used to prevent bottom chord continuous lateral restraints from shifting.

6.5.2.3 X-brace: A pair of diagonal braces that cross each other thus forming an "X". Generally, one brace will be in axial tension while the other brace is loaded in axial compression.

6.5.2.4 V-brace: A pair of diagonal braces that meet at one of their ends, thus forming a "N". Generally, one brace will be in axial tension while the other brace is loaded in axial compression.

6.5.2.5 Endwall diagonal brace: A framing member used to transfer load from an endwall to the roof plane. Generally used above large endwall openings or where an endwall post is not continuous from grade to the rake (e.g., an endpost is terminated near the bottom chord of an endwall truss). See Figure 15.

6.5.3 Bracing for individual members: The buckling resistance of an individual framing member is often increased by attaching a T-, L-, or scab reinforcement to the side of the member. See Figure 16.

6.5.3.1 T-reinforcement: A member that is attached to a structural framing member such that the cross-section of the two adjoined members forms a tee. See Figure 16.

6.5.3.2 L-reinforcement: A member that is attached to a structural framing member such that the cross-section of the two adjoined members forms an el. See Figure 16.

6.5.3.3 Scab reinforcement: A member whose wide face is attached to the wide face of a structural framing member. See Figure 16.

6.5.4 Compression-edge brace: A brace used to provide lateral support to the compressive edge of a beam or column. More commonly referred to as flange brace when used to support the compressive edge of an I-shaped section.

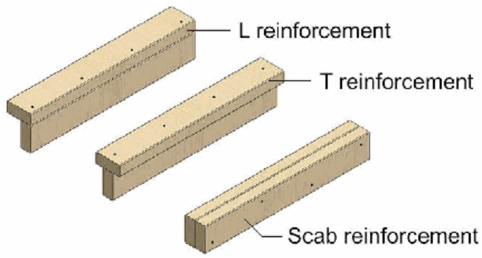

Figure 16 – Types of individual member reinforcement

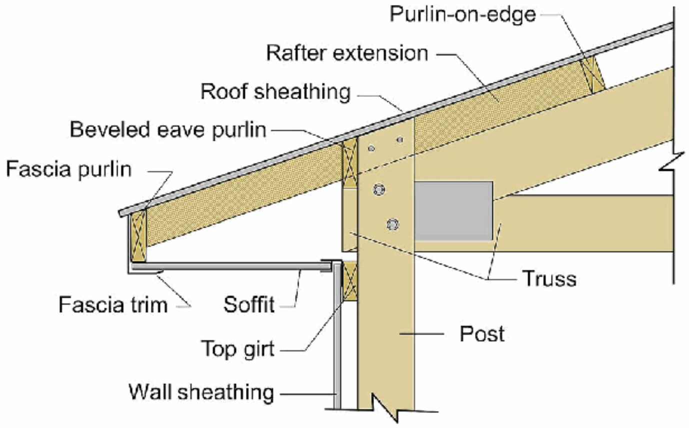

Figure 17 – Cross-sectional view through an eave overhang that is supported by a rafter extension that runs continuously from the fascia purlin/sub-fascia to the first purlin above the post. The rafter extension is fastened to the post, purlin, and top of the truss.

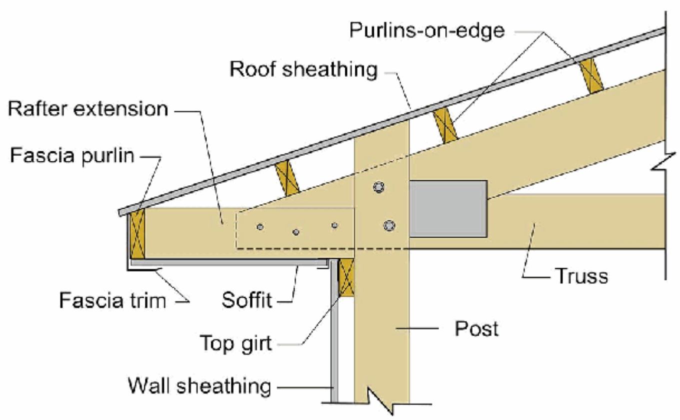

Figure 18 – Cross-sectional view through an eave overhang that is supported by rafter extensions (one on each side of the truss) that are attached to the tail end of the truss

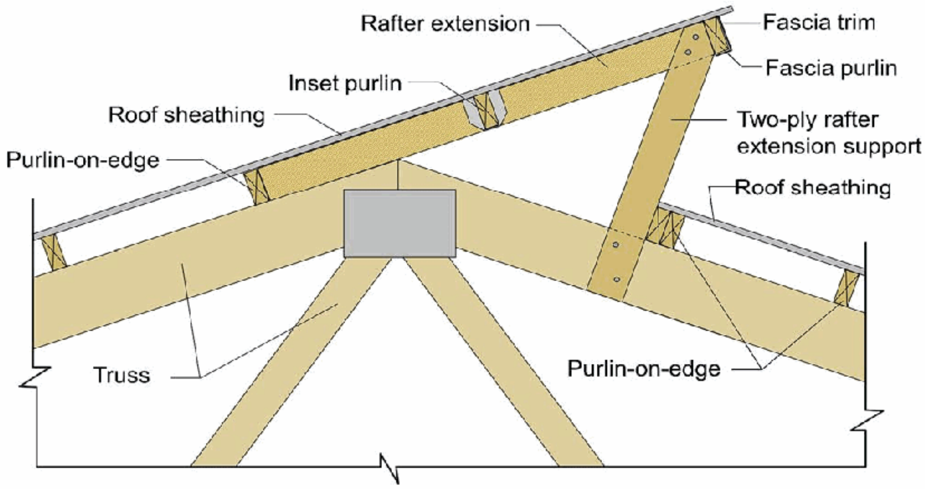

Figure 19 – Overshot ridge with rafter extension supported by a two-ply rafter extension support. One ply is located between the rafter extension and truss top chord; the second ply extends along the sides of the rafter extension and truss chord.

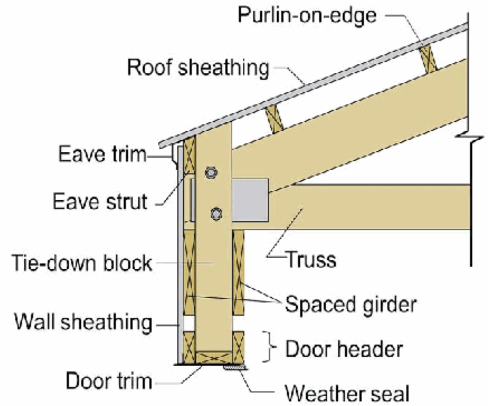

Figure 20 – Cross-sectional view through an overhead door in the sidewall of a building without an eave overhang

6.6 Purlin block: A member placed between purlins to help transfer load from roof sheathing to roof framing, to reduce purlin roll, and/or to eliminate bird perch points. See Figures 10 and 13.

6.7 Sub-fascia: A structural member located under the fascia or eave/ fascia trim. In a building with overhangs, the edge purlins and fly rafters generally function as subfasica. In a building without overhangs, the eave strut and rake rafters generally function as sub-fascia. See Figures 10 and 11.

6.8 Lookout: A short member in an eave overhang that connects the sub-fascia and wall. Generally used to support soffit. Unlike a rafter extension, a lookout is not used to structurally support purlins or eave sub-fascia.

6.9 Track board: A member to which a sliding door track is directly attached.

6.10 Track board support: A structural framing member that is used to support a track board.

7 Diaphragm components

When post-frame building components (e.g., purlins, girts, purlin blocks, mechanical fasteners, etc.) are positioned and connected in such a way as to form a diaphragm (see clause 4.4), these components take on additional names as defined in this section.

7.1 Diaphragm structural framing: Primary and secondary framing members to which structural sheathing panels are attached to form a diaphragm assembly.

7.2 Structural sheathing: Frame coverings that are selected in part for their ability to absorb and transfer structural loads. Common structural sheathings include plywood, oriented strand board, and corrugated steel.

7.2.1 Structural sheathing panel: An individual piece of structural sheathing.

7.3 Edge fastener: A sheathing-to-framing connector that is located along the sides or ends of a structural sheathing panel.

7.4 Field fastener: A sheathing-to-framing connector that is not located along the sides or ends of a structural sheathing panel.

7.5 Seam or stitch fastener: An edge fastener that connects two structural sheathing panels thereby adding in-plane shear continuity between the panels.

7.5.1 Anchored seam fastener: A seam fastener that penetrates the underlying structural framing a sufficient amount so as to significantly affect the shear characteristics of the connection.

7.6 Shear blocks: Short framing members used to help transfer shear force into or out of the structural sheathing of a diaphragm. For roof diaphragms, properly connected purlin blocks function as shear blocks.

7.7 Diaphragm chords: Diaphragm structural framing members that run perpendicular to the applied load, and thus are subjected to axial forces when the load works to bend the diaphragm.

7.8 Drag strut: A member, typically horizontal, that transfers shear from a floor, roof or ceiling diaphragm to a shear wall.

7.9 Structural ridge cap: A component that covers the ridge of a building and is capable of transferring shear force between diaphragms located on opposite sides of the ridge.

8 Foundation components

This section contains descriptions of foundation components that are used to define foundation types in Section 9.

8.1 Embedded pier: A relatively short column embedded in the soil to provide support for an above-grade post, beam, wall, or other structure. Piers include members of any material with assigned structural properties such as solid or laminated wood, steel, or concrete. Embedded piers differ from embedded posts in that they seldom extend above the lowest horizontal framing element in a structure, and when they do, it is often no more than a couple decimeters. See Figure 24.

8.2 Footing: Foundation component at the base of a post, pier or wall that provides resistance to vertical downward forces. When a footing is located below grade and properly attached to a post, pier or wall, it aids in the resistance of lateral and vertical uplift forces. See Figures 22–25.

8.3 Uplift anchor: Any element mechanically attached to an embedded post or pier to increase the uplift resistance of the foundation. Common uplift anchors include concrete footings, concrete collars, preservative-treated wood blocks, steel angles, and concrete backfill. See Figures 22–24.

8.4 Collar: Foundation component attached below grade to an embedded post or pier, and that moves with it to resist lateral and vertical loads. See Figure 23.

8.5 Grade beam: A corrosion and decay resistant beam located on the soil surface. Also a long, thickened, and more heavily-reinforced portion of a slab-on-grade foundation. See Figure 21.

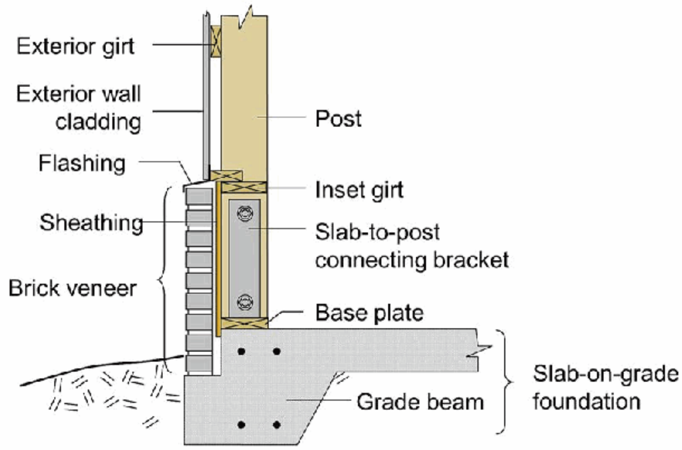

Figure 21 – Slab-on-grade foundation

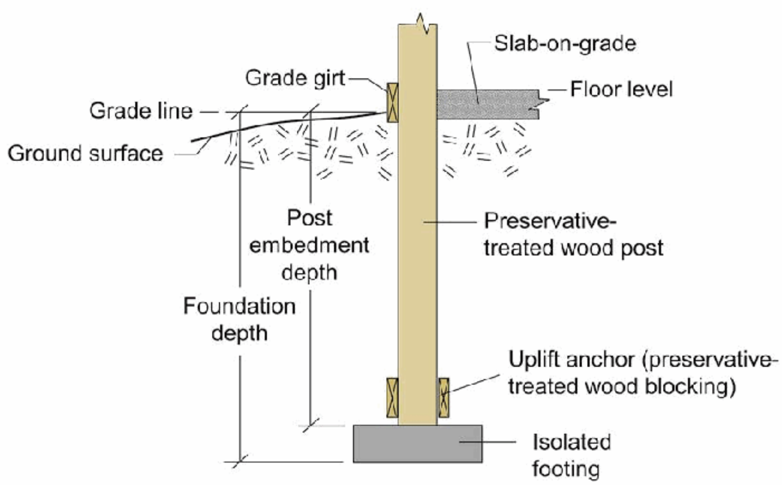

Figure 22 – Post foundation featuring preservative-treated wood blocks for uplift anchorage

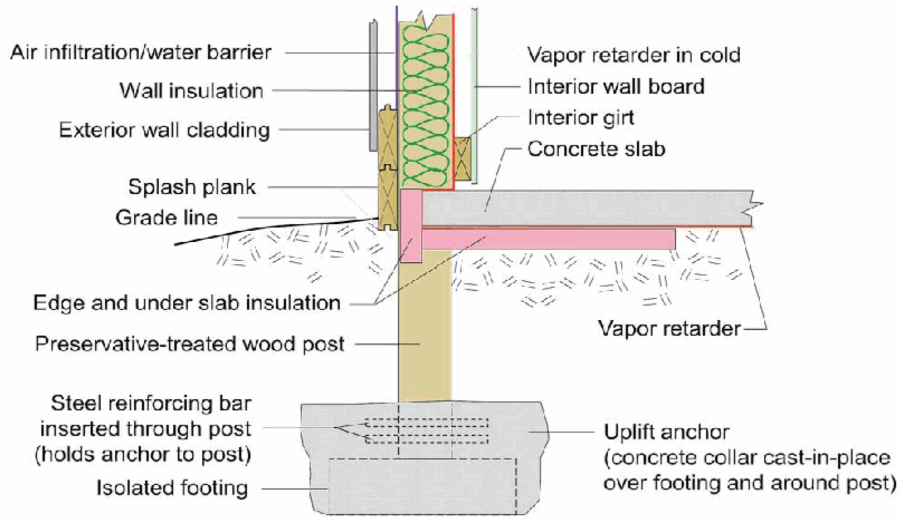

Figure 23 – Post foundation featuring a cast-in-place concrete collar for uplift anchorage and increased lateral resistance

9 Foundation types

This section defines foundation types that are commonly used to support post-frame building systems.

9.1 Post foundation: A foundation consisting of an embedded post and all attached below-grade elements, which may include a footing, uplift resistance system, and collar. See Figures 22 and 23.

9.2 Pier foundation: A foundation consisting of an embedded pier and all attached below-grade elements, which may include a footing, uplift resistance system, and collar. See Figure 24.

9.2.1 Pier and beam foundation: A pier foundation that supports a grade beam.

9.3 Slab-on-grade foundation: A reinforced concrete slab that rests on the soil surface. Slab areas located directly beneath structural columns or walls are generally thicker and more heavily reinforced. Long, thickened and reinforced portions are generally referred to as grade beams. See Figure 21.

9.4 Stem wall foundation: A foundation consisting of a continuous wall that may be placed on a continuous footing. The base of the foundation is generally located below expected frost penetration depths. See Figure 25.

10 Dimensions

10.1 Grade line grade level: The line of intersection between the building exterior and the finished ground surface and/or top of the pavement in contact with the building exterior. See Figures 22–25.

10.2 Floor level: Elevation of the finished floor surface. In the absence of a finished floor, the floor level is taken as the elevation of the bottom edge of the bottom girt. In buildings with stem wall foundations and no finished floor, floor level is taken as the elevation of the unfinished floor. See Figure 22.

10.3 Eave line: Line formed by the intersection of the plane formed by the top edge of the purlins and the plane formed by the outside edge of the sidewall girts

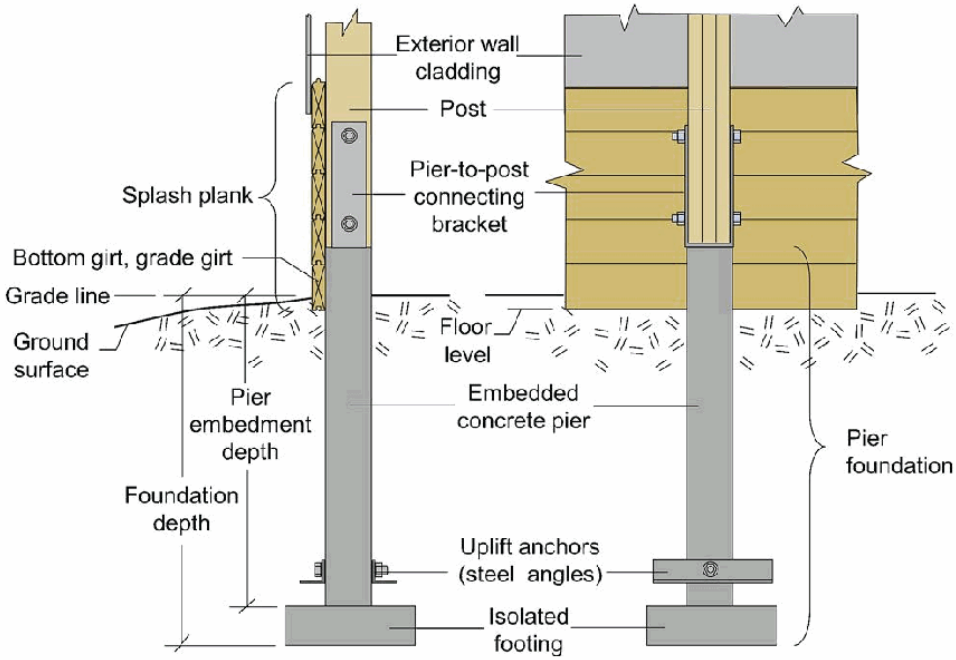

Figure 24 – Pier foundation featuring steel angles for uplift anchorage

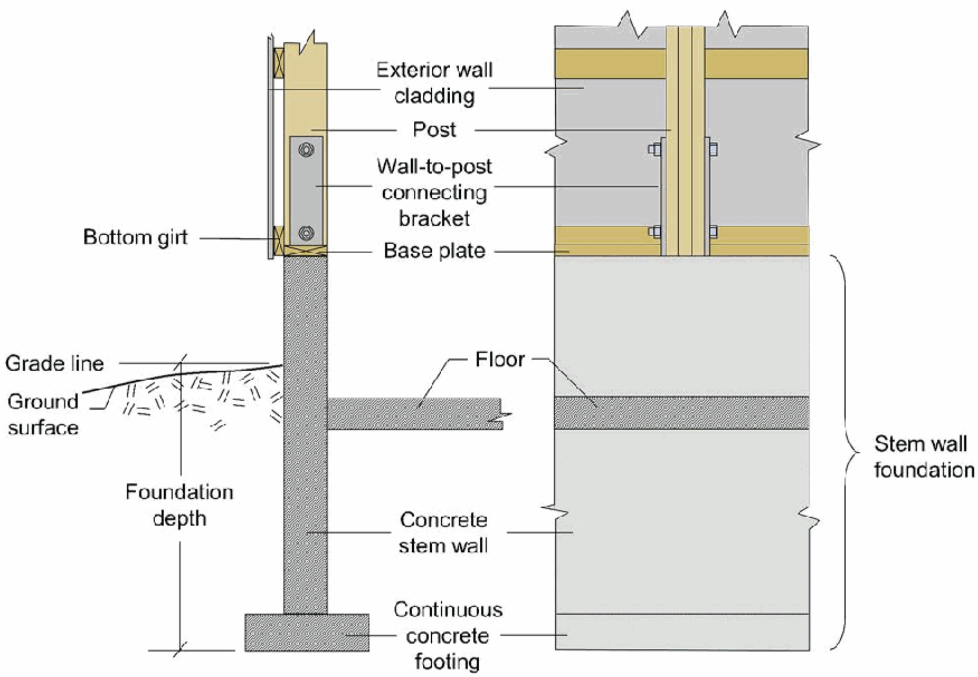

Figure 25 – Stem wall foundation

10.4 Rake line: Line formed by the intersection of the plane formed by the top edge of the purlins and the plane formed by the outside edge of the endwall girts

10.5 Ridge line: Line formed by the intersection of the plane formed by the top edge of the purlins on one side of the roof and the plane formed by the top edge of the purlins on the opposite side of the roof. For a mono-slope roof, the ridge line is the line formed by the intersection of the plane formed by the top edge of the purlins and the plane formed by the outside edge of the girts in the tallest sidewall.

10.6 Foundation depth: Vertical distance from the grade line to the bottom of the foundation. Typically the vertical distance from the ground surface to the base of the footing. Also known as foundation embedment depth. See Figures 22–25.

10.7 Post embedment depth: Vertical distance from the grade line to the bottom of an embedded post. Equal to the foundation depth when the post does not bear on a footing or other foundation element. See Figure 22.

10.8 Pier embedment depth: Vertical distance from the grade line to the bottom of a pier. Equal to the foundation depth when the footing is part of the pier (i.e., the footing is cast integrally with the pier). See Figure 24.

10.9 Clear height: Vertical distance between the finished floor and the lowest part of a truss, rafter, or girder.

10.10 Post height: The length of the non-embedded portion of a post.

10.11 Eave height: Vertical distance between the floor level and the eave line.

10.12 Building height: Vertical distance between the floor level and the ridge line. Also known as ridge height.

10.13 Building bay: The area between adjacent post-frames

10.14 Frame spacing: On-center horizontal spacing of primary frames. Frame spacing may vary within a building. Also known as bay width.

10.15 Clear span: Horizontal distance from the face of one support to the face of the opposite support.

10.16 Building width: Horizontal distance between the outside face of the girts in one sidewall and the outside face of the girts in the opposite sidewall.

10.17 Building length: Horizontal distance between the outside face of the girts in one endwall and the outside face of the girts in the opposite endwall.

10.18 Eave overhang distance: Horizontal distance from the eave line to the outside of the subfacia.

10.19 Rake overhang distance: Horizontal distance from the rake line to the outside of the fly rafter.

10.20 Girt spacing: On-center vertical spacing of girts.

10.21 Purlin spacing: On-center spacing of purlins.

11 Commentary

11.1 Building systems: A post-frame building system is structurally analogous to the typical low-rise metal building system. Conventional buildings of both types have two-dimensional primary frames that are connected with secondary framing members. Nomenclature for both building systems is similar. The major difference is that the majority of framing members in a post-frame building are wood-based.

11.2 Post size and spacing: Post size and post spacing are dictated by such factors as: size of wall openings, wall heights, spacing of primary roof framing, and type and magnitude of structural loads.

11.3 Secondary framing: Bracing is a primary function of virtually all secondary framing members not just those listed under clause 6.5. For example, a principal function of purlins and girts is to provide lateral bracing to trusses and posts, respectively. Unlike the braces listed under clause 6.5, purlins and girts are generally located to facilitate sheathing attachment, and their sizes are normally based on the magnitude of the loads applied to the sheathing, and on the spacing of the primary framing members to which they must transfer load.

11.4 Individual web member bracing versus web member continuous lateral restraint: T-, L- or scab reinforcement of compressive web members is an alternative to web member continuous lateral restraint, and is generally more economical when truss configuration varies along the length of the building, and/or truss spacing is greater than four feet. The probability of a progressive collapse may also be reduced by using T-, L-, or scab reinforcement since a truss connected to another truss via web member continuous lateral restraint may have its lateral support compromised when the adjacent truss fails.

11.5 Compression edge bracing: A compression edge brace may be used to support the bottom edge of a stacked rafter at locations near interior supports. In this case, the brace would be a diagonal member that connects the bottom edge of the rafter to nearby purlins.

11.6 Purlin blocks: Purlin blocks located in an endwall between rake purlins are key to transferring shear forces from the roof plane to the endwall plane. They also keep birds from entering and nesting in rake overhangs.

11.7 Diaphragm structural framing: Diaphragm structural framing (1) resists bending moments applied to the diaphragm, (2) helps transfer in-plane shear forces across the diaphragm, and (3) prevents out-of-plane buckling of structural sheathing.

11.8 Diaphragm chord forces: Chords developing the largest axial forces are often eave and ridge purlins or members near the eave and ridge purlins.

S8186

Date Submitted	12/14/2018	**Section**	2303.1.9	**Proponent**	Joseph Crum
Chapter	23	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** | **Alternate Language** **No**

Related Modifications

S40-16 MOD 7308 TABLE 1507.9.6
S40-16-2 MOD 8183 1807.1.4

Summary of Modification

The existing text was outdated, requiring clarification and updates to current AWPA section numbering.

Rationale

The existing text was outdated, requiring clarification and updates to current AWPA section numbering.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Clarifies code due to updated language

Impact to building and property owners relative to cost of compliance with code

These changes merely clarify and update the existing text without any impact on the required specifications for materials used. Will not increase the cost of construction

Impact to industry relative to the cost of compliance with code

These changes merely clarify and update the existing text without any impact on the required specifications for materials used. Will not increase the cost of construction

Impact to small business relative to the cost of compliance with code

These changes merely clarify and update the existing text without any impact on the required specifications for materials used. Will not increase the cost of construction

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Revises outdated language for clarification only.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Revises outdated language for clarification only.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Revises outdated language for clarification only. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

Revises outdated language for clarification only. Does not degrade the effectiveness of the code.

2303.1.9 Preservative-treated wood. Lumber, timber, plywood, piles and poles supporting permanent structures required by Section 2304.12 to be preservative treated shall conform to ~~the requirements of the~~ ~~applicable~~ AWPA ~~Standard~~ U1 and M4 ~~for the species, product, preservative and end use. Preservatives shall be listed in Section 4 of AWPA U1~~. Lumber and plywood used in permanent wood foundation systems shall conform to Chapter 18.

S8258

Date Submitted	12/14/2018	**Section**	2308.4.1.1	**Proponent**	Paul Coats
Chapter	23	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No | **Alternate Language** No

Related Modifications

Summary of Modification

Replacement table for T2308.4.1.1(1) Header and Girder Spans for Exterior Bearing Walls

Rationale

This modification was approved by the ICC committee and membership and appears in the 2018 edition of the International Residential Code. The update of Table 2308.4.1.1(1) Header and Girder Spans for Exterior Bearing Walls is proposed. Updated spans address use of Southern Pine No. 2 in lieu of Southern Pine No. 1. Footnote "f" is added to clarify that header spans are based on laterally braced assumption such as when the header is raised. For dropped headers consisting of 2x8, 2x10, or 2x12 sizes that are not laterally braced, a factor of 0.7 can be applied to determine the spans or alternatively the header or girder can be designed to include any adjustment for potential buckling. Laterally braced (raised) and not laterally braced (dropped) header conditions and building widths for which header spans are tabulated represent the same conditions used to develop header span tables in the Wood Frame Construction Manual (WFCM).

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Code officials will need to become familiar with the use of the new table and footnotes.

Impact to building and property owners relative to cost of compliance with code

Increased cost may be associated with reduced spans that result from the unbraced header condition and application of footnote f. Due to certain new options in the table, in some circumstances it may reduce the cost of construction.

Impact to industry relative to the cost of compliance with code

Increased cost may be associated with reduced spans that result from the unbraced header condition and application of footnote f. Due to certain new options in the table, in some circumstances it may reduce the cost of construction.

Impact to small business relative to the cost of compliance with code

Increased cost may be associated with reduced spans that result from the unbraced header condition and application of footnote f. Due to certain new options in the table, in some circumstances it may reduce the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Maintains correct header sizing for safety and serviceability.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

Completely delete the current Table 2308.4.1.1(1) and replace with a new table:

~~TABLE 2308.4.1.1(1)~~

~~HEADER AND GIRDER SPANS$_{a, b}$ FOR EXTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine and Spruce-Pine-Fir$_{b}$ and required number of jack studs)~~

TABLE 2308.4.1.1(1)

HEADER AND GIRDER SPANS[a,b] FOR EXTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir and required number of jack studs)

See uploaded support file for contents of new Table 2308.4.1.1(1)

Revise as follows:

~~2308.4.1.1~~ (1)

~~HEADER AND GIRDER SPANS[a, b] FOR EXTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine and Spruce-Pine-Fir[b] and required number of jack studs)~~

~~GIRDERS AND HEADERS SUPPORTING~~	~~SIZE~~	~~GROUND SNOW LOAD (psf)[e]~~											
		~~30~~						~~50~~					
		~~Building width[c] (feet)~~											
		~~20~~		~~28~~		~~36~~		~~20~~		~~28~~		~~36~~	
		~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~
~~Roof and ceiling~~	~~2-2 × 4~~	~~3-6~~	~~1~~	~~3-2~~	~~1~~	~~2-10~~	~~1~~	~~3-2~~	~~1~~	~~2-9~~	~~1~~	~~2-6~~	~~1~~
	~~2-2 × 6~~	~~5-5~~	~~1~~	~~4-8~~	~~1~~	~~4-2~~	~~1~~	~~4-8~~	~~1~~	~~4-1~~	~~1~~	~~3-8~~	~~2~~
	~~2-2 × 8~~	~~6-10~~	~~1~~	~~5-11~~	~~2~~	~~5-4~~	~~2~~	~~5-11~~	~~2~~	~~5-2~~	~~2~~	~~4-7~~	~~2~~
	~~2-2 × 10~~	~~8-5~~	~~2~~	~~7-3~~	~~2~~	~~6-6~~	~~2~~	~~7-3~~	~~2~~	~~6-3~~	~~2~~	~~5-7~~	~~2~~
	~~2-2 × 12~~	~~9-9~~	~~2~~	~~8-5~~	~~2~~	~~7-6~~	~~2~~	~~8-5~~	~~2~~	~~7-3~~	~~2~~	~~6-6~~	~~2~~
	~~3-2 × 8~~	~~8-4~~	~~1~~	~~7-5~~	~~1~~	~~6-8~~	~~1~~	~~7-5~~	~~1~~	~~6-5~~	~~2~~	~~5-9~~	~~2~~
	~~3-2 × 10~~	~~10-6~~	~~1~~	~~9-1~~	~~2~~	~~8-2~~	~~2~~	~~9-1~~	~~2~~	~~7-10~~	~~2~~	~~7-0~~	~~2~~
	~~3-2 × 12~~	~~12-2~~	~~2~~	~~10-7~~	~~2~~	~~9-5~~	~~2~~	~~10-7~~	~~2~~	~~9-2~~	~~2~~	~~8-2~~	~~2~~
	~~4-2 × 8~~	~~9-2~~	~~1~~	~~8-4~~	~~1~~	~~7-8~~	~~1~~	~~8-4~~	~~1~~	~~7-5~~	~~1~~	~~6-8~~	~~1~~
	~~4-2 × 10~~	~~11-8~~	~~1~~	~~10-6~~	~~1~~	~~9-5~~	~~2~~	~~10-6~~	~~1~~	~~9-1~~	~~2~~	~~8-2~~	~~2~~
	~~4-2 × 12~~	~~14-1~~	~~1~~	~~12-2~~	~~2~~	~~10-11~~	~~2~~	~~12-2~~	~~2~~	~~10-7~~	~~2~~	~~9-5~~	~~2~~
~~Roof, ceiling and one center-bearing floor~~	~~2-2 × 4~~	~~3-1~~	~~1~~	~~2-9~~	~~1~~	~~2-5~~	~~1~~	~~2-9~~	~~1~~	~~2-5~~	~~1~~	~~2-2~~	~~1~~
	~~2-2 × 6~~	~~4-6~~	~~1~~	~~4-0~~	~~1~~	~~3-7~~	~~2~~	~~4-1~~	~~1~~	~~3-7~~	~~2~~	~~3-3~~	~~2~~
	~~2-2 × 8~~	~~5-9~~	~~2~~	~~5-0~~	~~2~~	~~4-6~~	~~2~~	~~5-2~~	~~2~~	~~4-6~~	~~2~~	~~4-1~~	~~2~~
	~~2-2 × 10~~	~~7-0~~	~~2~~	~~6-2~~	~~2~~	~~5-6~~	~~2~~	~~6-4~~	~~2~~	~~5-6~~	~~2~~	~~5-0~~	~~2~~
	~~2-2 × 12~~	~~8-1~~	~~2~~	~~7-1~~	~~2~~	~~6-5~~	~~2~~	~~7-4~~	~~2~~	~~6-5~~	~~2~~	~~5-9~~	~~3~~
	~~3-2 × 8~~	~~7-2~~	~~1~~	~~6-3~~	~~2~~	~~5-8~~	~~2~~	~~6-5~~	~~2~~	~~5-8~~	~~2~~	~~5-1~~	~~2~~

	~~3 2 × 10~~	~~8 9~~	~~2~~	~~7 8~~	~~2~~	~~6 11~~	~~2~~	~~7 11~~	~~2~~	~~6 11~~	~~2~~	~~6 3~~	~~2~~
	~~3 2 × 12~~	~~10 2~~	~~2~~	~~8 11~~	~~2~~	~~8 0~~	~~2~~	~~9 2~~	~~2~~	~~8 0~~	~~2~~	~~7 3~~	~~2~~
	~~4 2 × 8~~	~~8 1~~	~~1~~	~~7 3~~	~~1~~	~~6 7~~	~~1~~	~~7 5~~	~~1~~	~~6 6~~	~~1~~	~~5 11~~	~~2~~
	~~4 2 × 10~~	~~10 1~~	~~1~~	~~8 10~~	~~2~~	~~8 0~~	~~2~~	~~9 1~~	~~2~~	~~8 0~~	~~2~~	~~7 2~~	~~2~~
	~~4 2 × 12~~	~~11 9~~	~~2~~	~~10 3~~	~~2~~	~~9 3~~	~~2~~	~~10 7~~	~~2~~	~~9 3~~	~~2~~	~~8 4~~	~~2~~
~~Roof , ceiling and one clear span floor~~	~~2 2 × 4~~	~~2 8~~	~~1~~	~~2 4~~	~~1~~	~~2 1~~	~~1~~	~~2 7~~	~~1~~	~~2 3~~	~~1~~	~~2 0~~	~~1~~
	~~2 2 × 6~~	~~3 11~~	~~1~~	~~3 5~~	~~2~~	~~3 0~~	~~2~~	~~3 10~~	~~2~~	~~3 4~~	~~2~~	~~3 0~~	~~2~~
	~~2 2 × 8~~	~~5 0~~	~~2~~	~~4 4~~	~~2~~	~~3 10~~	~~2~~	~~4 10~~	~~2~~	~~4 2~~	~~2~~	~~3 9~~	~~2~~
	~~2 2 × 10~~	~~6 1~~	~~2~~	~~5 3~~	~~2~~	~~4 8~~	~~2~~	~~5 11~~	~~2~~	~~5 1~~	~~2~~	~~4 7~~	~~3~~
	~~2 2 × 12~~	~~7 1~~	~~2~~	~~6 1~~	~~3~~	~~5 5~~	~~3~~	~~6 10~~	~~2~~	~~5 11~~	~~3~~	~~5 4~~	~~3~~
	~~3 2 × 8~~	~~6 3~~	~~2~~	~~5 5~~	~~2~~	~~4 10~~	~~2~~	~~6 1~~	~~2~~	~~5 3~~	~~2~~	~~4 8~~	~~2~~
	~~3 2 × 10~~	~~7 7~~	~~2~~	~~6 7~~	~~2~~	~~5 11~~	~~2~~	~~7 5~~	~~2~~	~~6 5~~	~~2~~	~~5 9~~	~~2~~
	~~3 2 × 12~~	~~8 10~~	~~2~~	~~7 8~~	~~2~~	~~6 10~~	~~2~~	~~8 7~~	~~2~~	~~7 5~~	~~2~~	~~6 8~~	~~2~~
	~~4 2 × 8~~	~~7 2~~	~~1~~	~~6 3~~	~~2~~	~~5 7~~	~~2~~	~~7 0~~	~~1~~	~~6 1~~	~~2~~	~~5 5~~	~~2~~
	~~4 2 × 10~~	~~8 9~~	~~2~~	~~7 7~~	~~2~~	~~6 10~~	~~2~~	~~8 7~~	~~2~~	~~7 5~~	~~2~~	~~6 7~~	~~2~~
	~~4 2 × 12~~	~~10 2~~	~~2~~	~~8 10~~	~~2~~	~~7 11~~	~~2~~	~~9 11~~	~~2~~	~~8 7~~	~~2~~	~~7 8~~	~~2~~
~~Roof , ceiling and two center bearing floors~~	~~2 2 × 4~~	~~2 7~~	~~1~~	~~2 3~~	~~1~~	~~2 0~~	~~1~~	~~2 6~~	~~1~~	~~2 2~~	~~1~~	~~1 11~~	~~1~~
	~~2 2 × 6~~	~~3 9~~	~~2~~	~~3 3~~	~~2~~	~~2 11~~	~~2~~	~~3 8~~	~~2~~	~~3 2~~	~~2~~	~~2 10~~	~~2~~
	~~2 2 × 8~~	~~4 9~~	~~2~~	~~4 2~~	~~2~~	~~3 9~~	~~2~~	~~4 7~~	~~2~~	~~4 0~~	~~2~~	~~3 8~~	~~2~~
	~~2 2 × 10~~	~~5 9~~	~~2~~	~~5 1~~	~~2~~	~~4 7~~	~~3~~	~~5 8~~	~~2~~	~~4 11~~	~~2~~	~~4 5~~	~~3~~
	~~2 2 × 12~~	~~6 8~~	~~2~~	~~5 10~~	~~3~~	~~5 3~~	~~3~~	~~6 6~~	~~2~~	~~5 9~~	~~3~~	~~5 2~~	~~3~~
	~~3 2 × 8~~	~~5 11~~	~~2~~	~~5 2~~	~~2~~	~~4 8~~	~~2~~	~~5 9~~	~~2~~	~~5 1~~	~~2~~	~~4 7~~	~~2~~
	~~3 2 × 10~~	~~7 3~~	~~2~~	~~6 4~~	~~2~~	~~5 8~~	~~2~~	~~7 1~~	~~2~~	~~6 2~~	~~2~~	~~5 7~~	~~2~~
	~~3 2 × 12~~	~~8 5~~	~~2~~	~~7 4~~	~~2~~	~~6 7~~	~~2~~	~~8 2~~	~~2~~	~~7 2~~	~~2~~	~~6 5~~	~~3~~
	~~4 2 × 8~~	~~6 10~~	~~1~~	~~6 0~~	~~2~~	~~5 5~~	~~2~~	~~6 8~~	~~1~~	~~5 10~~	~~2~~	~~5 3~~	~~2~~
	~~4 2 × 10~~	~~8 4~~	~~2~~	~~7 4~~	~~2~~	~~6 7~~	~~2~~	~~8 2~~	~~2~~	~~7 2~~	~~2~~	~~6 5~~	~~2~~
	~~4 2 × 12~~	~~9 8~~	~~2~~	~~8 6~~	~~2~~	~~7 8~~	~~2~~	~~9 5~~	~~2~~	~~8 3~~	~~2~~	~~7 5~~	~~2~~
~~Roof , ceiling, and two clear span floors~~	~~2 2 × 4~~	~~2 1~~	~~1~~	~~1 8~~	~~1~~	~~1 6~~	~~2~~	~~2 0~~	~~1~~	~~1 8~~	~~1~~	~~1 5~~	~~2~~
	~~2 2 × 6~~	~~3 1~~	~~2~~	~~2 8~~	~~2~~	~~2 4~~	~~2~~	~~3 0~~	~~2~~	~~2 7~~	~~2~~	~~2 3~~	~~2~~
	~~2 2 × 8~~	~~3 10~~	~~2~~	~~3 4~~	~~2~~	~~3 0~~	~~3~~	~~3 10~~	~~2~~	~~3 4~~	~~2~~	~~2 11~~	~~3~~

~~GIRDERS AND HEADERS SUPPORTING~~	~~SIZE~~	~~GROUND SNOW LOAD (psf)~~[e]											
		~~30~~						~~50~~					
		~~Building width~~[c] ~~(feet)~~											
		~~20~~		~~28~~		~~36~~		~~20~~		~~28~~		~~36~~	
		~~Span~~	~~NJ~~[d]	~~Span~~	~~NJ~~[d]	~~Span~~	~~NJ~~[d]	~~Span~~	~~NJ~~[d]	~~Span~~	~~NJ~~[d]	~~Span~~	~~NJ~~[d]
~~Roof, ceiling, and two clear span floors~~	~~2-2 × 10~~	~~4-9~~	~~2~~	~~4-1~~	~~3~~	~~3-8~~	~~3~~	~~4-8~~	~~2~~	~~4-0~~	~~3~~	~~3-7~~	~~3~~
	~~2-2 × 12~~	~~5-6~~	~~3~~	~~4-9~~	~~3~~	~~4-3~~	~~3~~	~~5-5~~	~~3~~	~~4-8~~	~~3~~	~~4-2~~	~~3~~
	~~3-2 × 8~~	~~4-10~~	~~2~~	~~4-2~~	~~2~~	~~3-9~~	~~2~~	~~4-9~~	~~2~~	~~4-1~~	~~2~~	~~3-8~~	~~2~~
	~~3-2 × 10~~	~~5-11~~	~~2~~	~~5-1~~	~~2~~	~~4-7~~	~~3~~	~~5-10~~	~~2~~	~~5-0~~	~~2~~	~~4-6~~	~~3~~
	~~3-2 × 12~~	~~6-10~~	~~2~~	~~5-11~~	~~3~~	~~5-4~~	~~3~~	~~6-9~~	~~2~~	~~5-10~~	~~3~~	~~5-3~~	~~3~~
	~~4-2 × 8~~	~~5-7~~	~~2~~	~~4-10~~	~~2~~	~~4-4~~	~~2~~	~~5-6~~	~~2~~	~~4-9~~	~~2~~	~~4-3~~	~~2~~
	~~4-2 × 10~~	~~6-10~~	~~2~~	~~5-11~~	~~2~~	~~5-3~~	~~2~~	~~6-9~~	~~2~~	~~5-10~~	~~2~~	~~5-2~~	~~2~~
	~~4-2 × 12~~	~~7-11~~	~~2~~	~~6-10~~	~~2~~	~~6-2~~	~~3~~	~~7-9~~	~~2~~	~~6-9~~	~~2~~	~~6-0~~	~~3~~

~~For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.~~

~~a. Spans are given in feet and inches.~~

~~b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir and Spruce-Pine-Fir. No. 1 or better grade lumber shall be used for Southern Pine.~~

~~c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.~~

~~d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.~~

~~e. Use 30 psf ground snow load for cases in which ground snow load is less than 30 psf and the roof live load is equal to or less than 20 psf.~~

TABLE 2308.4.1.1(1)

HEADER AND GIRDER SPANS[a,b] FOR EXTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir and required number of jack studs)

GIRDERS AND HEADERS SUPPORTING	SIZE	GROUND SNOW LOAD (psf)[e]																	
		30						50						70					
		Building width[c] (feet)																	
		12		24		36		12		24		36		12		24		36	
		Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]
Roof and ceiling	1-2x6	4 - 0	1	3 - 1	2	2 - 7	2	3 - 5	1	2 - 8	2	2 - 3	2	3 - 0	2	2 - 4	2	2 - 0	2
	1-2x8	5 - 1	2	3 - 11	2	3 - 3	2	4 - 4	2	3 - 4	2	2 - 10	2	3 - 10	2	3 - 0	2	2 - 6	3
	1-2x10	6 - 0	2	4 - 8	2	3 - 11	2	5 - 2	2	4 - 0	2	3 - 4	3	4 - 7	2	3 - 6	3	3 - 0	3
	1-	7 - 1	2	5 - 5	2	4 - 7	3	6 - 1	2	4 - 8	3	3 - 11	3	5 - 5	2	4 - 2	3	3 - 6	3

	2x12																		
	2-2x4	4 - 0	1	3 - 1	1	2 - 7	1	3 - 5	1	2 - 7	1	2 - 2	1	3 - 0	1	2 - 4	1	2 - 0	1
	2-2x6	6 - 0	1	4 - 7	1	3 - 10	1	5 - 1	1	3 - 11	1	3 - 3	2	4 - 6	1	3 - 6	2	2 - 11	2
	2-2x8	7 - 7	1	5 - 9	1	4 - 10	2	6 - 5	1	5 - 0	2	4 - 2	2	5 - 9	1	4 - 5	2	3 - 9	2
	2-2x10	9 - 0	1	6 - 10	2	5 - 9	2	7 - 8	2	5 - 11	2	4 - 11	2	6 - 9	2	5 - 3	2	4 - 5	2
	2-2x12	10 - 7	2	8 - 1	2	6 - 10	2	9 - 0	2	6 - 11	2	5 - 10	2	8 - 0	2	6 - 2	2	5 - 2	3
	3-2x8	9 - 5	1	7 - 3	1	6 - 1	1	8 - 1	1	6 - 3	1	5 - 3	2	7 - 2	1	5 - 6	2	4 - 8	2
	3-2x10	11 - 3	1	8 - 7	1	7 - 3	2	9 - 7	1	7 - 4	2	6 - 2	2	8 - 6	1	6 - 7	2	5 - 6	2
	3-2x12	13 - 2	1	10 - 1	2	8 - 6	2	11 - 3	2	8 - 8	2	7 - 4	2	10 - 0	2	7 - 9	2	6 - 6	2
	4-2x8	10 - 11	1	8 - 4	1	7 - 0	1	9 - 4	1	7 - 2	1	6 - 0	1	8 - 3	1	6 - 4	1	5 - 4	2
	4-2x10	12 - 11	1	9 - 11	1	8 - 4	1	11 - 1	1	8 - 6	1	7 - 2	2	9 - 10	1	7 - 7	2	6 - 4	2
	4-2x12	15 - 3	1	11 - 8	1	9 - 10	2	13 - 0	1	10 - 0	2	8 - 5	2	11 - 7	1	8 - 11	2	7 - 6	2
Roof, ceiling and one center-bearing floor	1-2x6	3 - 3	1	2 - 7	2	2 - 2	2	3 - 0	2	2 - 4	2	2 - 0	2	2 - 9	2	2 - 2	2	1 - 10	2
	1-2x8	4 - 1	2	3 - 3	2	2 - 9	2	3 - 9	2	3 - 0	2	2 - 6	3	3 - 6	2	2 - 9	2	2 - 4	3
	1-2x10	4 - 11	2	3 - 10	2	3 - 3	3	4 - 6	2	3 - 6	3	3 - 0	3	4 - 1	2	3 - 3	3	2 - 9	3
	1-2x12	5 - 9	2	4 - 6	3	3 - 10	3	5 - 3	2	4 - 2	3	3 - 6	3	4 - 10	3	3 - 10	3	3 - 3	4
	2-2x4	3 - 3	1	2 - 6	1	2 - 2	1	3 - 0	1	2 - 4	1	2 - 0	1	2 - 8	1	2 - 2	1	1 - 10	1
	2-2x6	4 - 10	1	3 - 9	1	3 - 3	2	4 - 5	1	3 - 6	2	3 - 0	2	4 - 1	1	3 - 3	2	2 - 9	2
	2-2x8	6 - 1	1	4 - 10	2	4 - 1	2	5 - 7	2	4 - 5	2	3 - 9	2	5 - 2	2	4 - 1	2	3 - 6	2
	2-2x10	7 - 3	2	5 - 8	2	4 - 10	2	6 - 8	2	5 - 3	2	4 - 5	2	6 - 1	2	4 - 10	2	4 - 1	2
	2-2x12	8 - 6	2	6 - 8	2	5 - 8	2	7 - 10	2	6 - 2	2	5 - 3	3	7 - 2	2	5 - 8	2	4 - 10	3
	3-2x8	7 - 8	1	6 - 0	1	5 - 1	2	7 - 0	1	5 - 6	2	4 - 8	2	6 - 5	1	5 - 1	2	4 - 4	2

	3-2x10	9 - 1	1	7 - 2	2	6 - 1	2	8 - 4	1	6 - 7	2	5 - 7	2	7 - 8	2	6 - 1	2	5 - 2	2
	3-2x12	10 - 8	2	8 - 5	2	7 - 2	2	9 - 10	2	7 - 8	2	6 - 7	2	9 - 0	2	7 - 1	2	6 - 1	2
	4-2x8	8 - 10	1	6 - 11	1	5 - 11	1	8 - 1	1	6 - 4	1	5 - 5	2	7 - 5	1	5 - 11	1	5 - 0	2
	4-2x10	10 - 6	1	8 - 3	2	7 - 0	2	9 - 8	1	7 - 7	2	6 - 5	2	8 - 10	1	7 - 0	2	6 - 0	2
	4-2x12	12 - 4	1	9 - 8	2	8 - 3	2	11 - 4	2	8 - 11	2	7 - 7	2	10 - 4	2	8 - 3	2	7 - 0	2
Roof, ceiling and one clear span floor	1-2x6	2 - 11	2	2 - 3	2	1 - 11	2	2 - 9	2	2 - 1	2	1 - 9	2	2 - 7	2	2 - 0	2	1 - 8	2
	1-2x8	3 - 9	2	2 - 10	2	2 - 5	3	3 - 6	2	2 - 8	2	2 - 3	3	3 - 3	2	2 - 6	3	2 - 2	3
	1-2x10	4 - 5	2	3 - 5	3	2 - 10	3	4 - 2	2	3 - 2	3	2 - 8	3	3 - 11	2	3 - 0	3	2 - 6	3
	1-2x12	5 - 2	2	4 - 0	3	3 - 4	3	4 - 10	3	3 - 9	3	3 - 2	4	4 - 7	3	3 - 6	3	3 - 0	4
	2-2x4	2 - 11	1	2 - 3	1	1 - 10	1	2 - 9	1	2 - 1	1	1 - 9	1	2 - 7	1	2 - 0	1	1 - 8	1
	2-2x6	4 - 4	1	3 - 4	2	2 - 10	2	4 - 1	1	3 - 2	2	2 - 8	2	3 - 10	1	3 - 0	2	2 - 6	2
	2-2x8	5 - 6	2	4 - 3	2	3 - 7	2	5 - 2	2	4 - 0	2	3 - 4	2	4 - 10	2	3 - 9	2	3 - 2	2
	2-2x10	6 - 7	2	5 - 0	2	4 - 2	2	6 - 1	2	4 - 9	2	4 - 0	2	5 - 9	2	4 - 5	2	3 - 9	3
	2-2x12	7 - 9	2	5 - 11	2	4 - 11	3	7 - 2	2	5 - 7	2	4 - 8	3	6 - 9	2	5 - 3	3	4 - 5	3
	3-2x8	6 - 11	1	5 - 3	2	4 - 5	2	6 - 5	1	5 - 0	2	4 - 2	2	6 - 1	1	4 - 8	2	4 - 0	2
	3-2x10	8 - 3	2	6 - 3	2	5 - 3	2	7 - 8	2	5 - 11	2	5 - 0	2	7 - 3	2	5 - 7	2	4 - 8	2
	3-2x12	9 - 8	2	7 - 5	2	6 - 2	2	9 - 0	2	7 - 0	2	5 - 10	2	8 - 6	2	6 - 7	2	5 - 6	3
	4-2x8	8 - 0	1	6 - 1	1	5 - 1	2	7 - 5	1	5 - 9	2	4 - 10	2	7 - 0	1	5 - 5	2	4 - 7	2
	4-2x10	9 - 6	1	7 - 3	2	6 - 1	2	8 - 10	1	6 - 10	2	5 - 9	2	8 - 4	1	6 - 5	2	5 - 5	2
	4-2x12	11 - 2	2	8 - 6	2	7 - 2	2	10 - 5	2	8 - 0	2	6 - 9	2	9 - 10	2	7 - 7	2	6 - 5	2
Roof, ceiling and two center-	1-2x6	2 - 8	2	2 - 1	2	1 - 10	2	2 - 7	2	2 - 0	2	1 - 9	2	2 - 5	2	1 - 11	2	1 - 8	2

bearing floors	1-2x8	3 - 5	2	2 - 8	2	2 - 4	3	3 - 3	2	2 - 7	2	2 - 2	3	3 - 1	2	2 - 5	3	2 - 1	3
	1-2x10	4 - 0	2	3 - 2	3	2 - 9	3	3 - 10	2	3 - 1	3	2 - 7	3	3 - 8	2	2 - 11	3	2 - 5	3
	1-2x12	4 - 9	3	3 - 9	3	3 - 2	4	4 - 6	3	3 - 7	3	3 - 1	4	4 - 3	3	3 - 5	3	2 - 11	4
	2-2x4	2 - 8	1	2 - 1	1	1 - 9	1	2 - 6	1	2 - 0	1	1 - 8	1	2 - 5	1	1 - 11	1	1 - 7	1
	2-2x6	4 - 0	1	3 - 2	2	2 - 8	2	3 - 9	1	3 - 0	2	2 - 7	2	3 - 7	1	2 - 10	2	2 - 5	2
	2-2x8	5 - 0	2	4 - 0	2	3 - 5	2	4 - 10	2	3 - 10	2	3 - 3	2	4 - 7	2	3 - 7	2	3 - 1	2
	2-2x10	6 - 0	2	4 - 9	2	4 - 0	2	5 - 8	2	4 - 6	2	3 - 10	3	5 - 5	2	4 - 3	2	3 - 8	3
	2-2x12	7 - 0	2	5 - 7	2	4 - 9	3	6 - 8	2	5 - 4	3	4 - 6	3	6 - 4	2	5 - 0	3	4 - 3	3
	3-2x8	6 - 4	1	5 - 0	2	4 - 3	2	6 - 0	1	4 - 9	2	4 - 1	2	5 - 8	2	4 - 6	2	3 - 10	2
	3-2x10	7 - 6	2	5 - 11	2	5 - 1	2	7 - 1	2	5 - 8	2	4 - 10	2	6 - 9	2	5 - 4	2	4 - 7	2
	3-2x12	8 - 10	2	7 - 0	2	5 - 11	2	8 - 5	2	6 - 8	2	5 - 8	3	8 - 0	2	6 - 4	2	5 - 4	3
	4-2x8	7 - 3	1	5 - 9	1	4 - 11	2	6 - 11	1	5 - 6	2	4 - 8	2	6 - 7	1	5 - 2	2	4 - 5	2
	4-2x10	8 - 8	1	6 - 10	2	5 - 10	2	8 - 3	2	6 - 6	2	5 - 7	2	7 - 10	2	6 - 2	2	5 - 3	2
	4-2x12	10 - 2	2	8 - 1	2	6 - 10	2	9 - 8	2	7 - 8	2	6 - 7	2	9 - 2	2	7 - 3	2	6 - 2	2
Roof, ceiling and two clear span floors	1-2x6	2 - 3	2	1 - 9	2	1 - 5	2	2 - 3	2	1 - 9	2	1 - 5	3	2 - 2	2	1 - 8	2	1 - 5	3
	1-2x8	2 - 10	2	2 - 2	3	1 - 10	3	2 - 10	2	2 - 2	3	1 - 10	3	2 - 9	2	2 - 1	3	1 - 10	3
	1-2x10	3 - 4	2	2 - 7	3	2 - 2	3	3 - 4	3	2 - 7	3	2 - 2	4	3 - 3	3	2 - 6	3	2 - 2	4
	1-2x12	4 - 0	3	3 - 0	3	2 - 7	4	4 - 0	3	3 - 0	4	2 - 7	4	3 - 10	3	3 - 0	4	2 - 6	4
	2-2x4	2 - 3	1	1 - 8	1	1 - 4	1	2 - 3	1	1 - 8	1	1 - 4	1	2 - 2	1	1 - 8	1	1 - 4	2
	2-2x6	3 - 4	1	2 - 6	2	2 - 2	2	3 - 4	2	2 - 6	2	2 - 2	2	3 - 3	2	2 - 6	2	2 - 1	2
	2-2x8	4 - 3	2	3 - 3	2	2 - 8	2	4 - 3	2	3 - 3	2	2 - 8	2	4 - 1	2	3 - 2	2	2 - 8	3
	2-2x10	5 - 0	2	3 - 10	2	3 - 2	3	5 - 0	2	3 - 10	2	3 - 2	3	4 - 10	2	3 - 9	3	3 - 2	3

	2-2x12	5 - 11	2	4 - 6	3	3 - 9	3	5 - 11	2	4 - 6	3	3 - 9	3	5 - 8	2	4 - 5	3	3 - 9	3
	3-2x8	5 - 3	1	4 - 0	2	3 - 5	2	5 - 3	2	4 - 0	2	3 - 5	2	5 - 1	2	3 - 11	2	3 - 4	2
	3-2x10	6 - 3	2	4 - 9	2	4 - 0	2	6 - 3	2	4 - 9	2	4 - 0	2	6 - 1	2	4 - 8	2	4 - 0	3
	3-2x12	7 - 5	2	5 - 8	2	4 - 9	3	7 - 5	2	5 - 8	2	4 - 9	3	7 - 2	2	5 - 6	3	4 - 8	3
	4-2x8	6 - 1	1	4 - 8	2	3 - 11	2	6 - 1	1	4 - 8	2	3 - 11	2	5 - 11	1	4 - 7	2	3 - 10	2
	4-2x10	7 - 3	2	5 - 6	2	4 - 8	2	7 - 3	2	5 - 6	2	4 - 8	2	7 - 0	2	5 - 5	2	4 - 7	2
	4-2x12	8 - 6	2	6 - 6	2	5 - 6	2	8 - 6	2	6 - 6	2	5 - 6	2	8 - 3	2	6 - 4	2	5 - 4	3

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. Spans are given in feet and inches.

b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir.

c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.

d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.

e. Use 30 psf ground snow load for cases in which ground snow load is less than 30 psf and the roof live load is equal to or less than 20 psf.

f. Spans are calculated assuming the top of the header or girder is laterally braced by perpendicular framing. Where the top of the header or girder is not laterally braced (e.g. cripple studs bearing on the header), tabulated spans for headers consisting of 2x8, 2x10, or 2x12 sizes shall be multiplied by 0.70 or the header or girder shall be designed.

Final Action: AS (Approved as Submitted)

S289-16

IBC: 2308.4.1.1, 2308.4.1.1(1) (New).

Proponent : David Tyree, representing American Wood Council (dtyree@awc.org)

2015 International Building Code

Revise as follows:

2308.4.1.1 (1)
HEADER AND GIRDER SPANS[a, b] FOR EXTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine and Spruce-Pine-Fir[b] and required number of jack studs)

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GIRDERS AND HEADERS SUPPORTING	SIZE	GROUND SNOW LOAD (psf)[e]											
		30						50					
		Building width[c] (feet)											
		20		28		36		20		28		36	
		Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]
Roof and ceiling	2-2 × 4	3-6	1	3-2	1	2-10	1	3-2	1	2-9	1	2-6	1
	2-2 × 6	5-5	1	4-8	1	4-2	1	4-8	1	4-1	1	3-8	2
	2-2 × 8	6-10	1	5-11	2	5-4	2	5-11	2	5-2	2	4-7	2
	2-2 × 10	8-5	2	7-3	2	6-6	2	7-3	2	6-3	2	5-7	2
	2-2 × 12	9-9	2	8-5	2	7-6	2	8-5	2	7-3	2	6-6	2
	3-2 × 8	8-4	1	7-5	1	6-8	1	7-5	1	6-5	2	5-9	2
	3-2 × 10	10-6	1	9-1	2	8-2	2	9-1	2	7-10	2	7-0	2
	3-2 × 12	12-2	2	10-7	2	9-5	2	10-7	2	9-2	2	8-2	2
	4-2 × 8	9-2	1	8-4	1	7-8	1	8-4	1	7-5	1	6-8	1
	4-2 × 10	11-8	1	10-6	1	9-5	2	10-6	1	9-1	2	8-2	2
	4-2 × 12	14-1	1	12-2	2	10-11	2	12-2	2	10-7	2	9-5	2
Roof, ceiling and one center-bearing floor	2-2 × 4	3-1	1	2-9	1	2-5	1	2-9	1	2-5	1	2-2	1
	2-2 × 6	4-6	1	4-0	1	3-7	2	4-1	1	3-7	2	3-3	2
	2-2 × 8	5-9	2	5-0	2	4-6	2	5-2	2	4-6	2	4-1	2
	2-2 × 10	7-0	2	6-2	2	5-6	2	6-4	2	5-6	2	5-0	2
	2-2 × 12	8-1	2	7-1	2	6-5	2	7-4	2	6-5	2	5-9	3
	3-2 × 8	7-2	1	6-3	2	5-8	2	6-5	2	5-8	2	5-1	2

	~~3 2 × 10~~	~~8 9~~	~~2~~	~~7 8~~	~~2~~	~~6 11~~	~~2~~	~~7 11~~	~~2~~	~~6 11~~	~~2~~	~~6 3~~	~~2~~
	~~3 2 × 12~~	~~10 2~~	~~2~~	~~8 11~~	~~2~~	~~8 0~~	~~2~~	~~9 2~~	~~2~~	~~8 0~~	~~2~~	~~7 3~~	~~2~~
	~~4 2 × 8~~	~~8 1~~	~~1~~	~~7 3~~	~~1~~	~~6 7~~	~~1~~	~~7 5~~	~~1~~	~~6 6~~	~~1~~	~~5 11~~	~~2~~
	~~4 2 × 10~~	~~10 1~~	~~1~~	~~8 10~~	~~2~~	~~8 0~~	~~2~~	~~9 1~~	~~2~~	~~8 0~~	~~2~~	~~7 2~~	~~2~~
	~~4 2 × 12~~	~~11 9~~	~~2~~	~~10 3~~	~~2~~	~~9 3~~	~~2~~	~~10 7~~	~~2~~	~~9 3~~	~~2~~	~~8 4~~	~~2~~
~~Roof, ceiling and one clear span floor~~	~~2 2 × 4~~	~~2 8~~	~~1~~	~~2 4~~	~~1~~	~~2 1~~	~~1~~	~~2 7~~	~~1~~	~~2 3~~	~~1~~	~~2 0~~	~~1~~
	~~2 2 × 6~~	~~3 11~~	~~1~~	~~3 5~~	~~2~~	~~3 0~~	~~2~~	~~3 10~~	~~2~~	~~3 4~~	~~2~~	~~3 0~~	~~2~~
	~~2 2 × 8~~	~~5 0~~	~~2~~	~~4 4~~	~~2~~	~~3 10~~	~~2~~	~~4 10~~	~~2~~	~~4 2~~	~~2~~	~~3 9~~	~~2~~
	~~2 2 × 10~~	~~6 1~~	~~2~~	~~5 3~~	~~2~~	~~4 8~~	~~2~~	~~5 11~~	~~2~~	~~5 1~~	~~2~~	~~4 7~~	~~3~~
	~~2 2 × 12~~	~~7 1~~	~~2~~	~~6 1~~	~~3~~	~~5 5~~	~~3~~	~~6 10~~	~~2~~	~~5 11~~	~~3~~	~~5 4~~	~~3~~
	~~3 2 × 8~~	~~6 3~~	~~2~~	~~5 5~~	~~2~~	~~4 10~~	~~2~~	~~6 1~~	~~2~~	~~5 3~~	~~2~~	~~4 8~~	~~2~~
	~~3 2 × 10~~	~~7 7~~	~~2~~	~~6 7~~	~~2~~	~~5 11~~	~~2~~	~~7 5~~	~~2~~	~~6 5~~	~~2~~	~~5 9~~	~~2~~
	~~3 2 × 12~~	~~8 10~~	~~2~~	~~7 8~~	~~2~~	~~6 10~~	~~2~~	~~8 7~~	~~2~~	~~7 5~~	~~2~~	~~6 8~~	~~2~~
	~~4 2 × 8~~	~~7 2~~	~~1~~	~~6 3~~	~~2~~	~~5 7~~	~~2~~	~~7 0~~	~~1~~	~~6 1~~	~~2~~	~~5 5~~	~~2~~
	~~4 2 × 10~~	~~8 9~~	~~2~~	~~7 7~~	~~2~~	~~6 10~~	~~2~~	~~8 7~~	~~2~~	~~7 5~~	~~2~~	~~6 7~~	~~2~~
	~~4 2 × 12~~	~~10 2~~	~~2~~	~~8 10~~	~~2~~	~~7 11~~	~~2~~	~~9 11~~	~~2~~	~~8 7~~	~~2~~	~~7 8~~	~~2~~
~~Roof, ceiling and two center bearing floors~~	~~2 2 × 4~~	~~2 7~~	~~1~~	~~2 3~~	~~1~~	~~2 0~~	~~1~~	~~2 6~~	~~1~~	~~2 2~~	~~1~~	~~1 11~~	~~1~~
	~~2 2 × 6~~	~~3 9~~	~~2~~	~~3 3~~	~~2~~	~~2 11~~	~~2~~	~~3 8~~	~~2~~	~~3 2~~	~~2~~	~~2 10~~	~~2~~
	~~2 2 × 8~~	~~4 9~~	~~2~~	~~4 2~~	~~2~~	~~3 9~~	~~2~~	~~4 7~~	~~2~~	~~4 0~~	~~2~~	~~3 8~~	~~2~~
	~~2 2 × 10~~	~~5 9~~	~~2~~	~~5 1~~	~~2~~	~~4 7~~	~~3~~	~~5 8~~	~~2~~	~~4 11~~	~~2~~	~~4 5~~	~~3~~
	~~2 2 × 12~~	~~6 8~~	~~2~~	~~5 10~~	~~3~~	~~5 3~~	~~3~~	~~6 6~~	~~2~~	~~5 9~~	~~3~~	~~5 2~~	~~3~~
	~~3 2 × 8~~	~~5 11~~	~~2~~	~~5 2~~	~~2~~	~~4 8~~	~~2~~	~~5 9~~	~~2~~	~~5 1~~	~~2~~	~~4 7~~	~~2~~
	~~3 2 × 10~~	~~7 3~~	~~2~~	~~6 4~~	~~2~~	~~5 8~~	~~2~~	~~7 1~~	~~2~~	~~6 2~~	~~2~~	~~5 7~~	~~2~~
	~~3 2 × 12~~	~~8 5~~	~~2~~	~~7 4~~	~~2~~	~~6 7~~	~~2~~	~~8 2~~	~~2~~	~~7 2~~	~~2~~	~~6 5~~	~~3~~
	~~4 2 × 8~~	~~6 10~~	~~1~~	~~6 0~~	~~2~~	~~5 5~~	~~2~~	~~6 8~~	~~1~~	~~5 10~~	~~2~~	~~5 3~~	~~2~~
	~~4 2 × 10~~	~~8 4~~	~~2~~	~~7 4~~	~~2~~	~~6 7~~	~~2~~	~~8 2~~	~~2~~	~~7 2~~	~~2~~	~~6 5~~	~~2~~
	~~4 2 × 12~~	~~9 8~~	~~2~~	~~8 6~~	~~2~~	~~7 8~~	~~2~~	~~9 5~~	~~2~~	~~8 3~~	~~2~~	~~7 5~~	~~2~~
~~Roof, ceiling, and two clear span floors~~	~~2 2 × 4~~	~~2 1~~	~~1~~	~~1 8~~	~~1~~	~~1 6~~	~~2~~	~~2 0~~	~~1~~	~~1 8~~	~~1~~	~~1 5~~	~~2~~
	~~2 2 × 6~~	~~3 1~~	~~2~~	~~2 8~~	~~2~~	~~2 4~~	~~2~~	~~3 0~~	~~2~~	~~2 7~~	~~2~~	~~2 3~~	~~2~~
	~~2 2 × 8~~	~~3 10~~	~~2~~	~~3 4~~	~~2~~	~~3 0~~	~~3~~	~~3 10~~	~~2~~	~~3 4~~	~~2~~	~~2 11~~	~~3~~

~~GIRDERS AND HEADERS SUPPORTING~~	~~SIZE~~	~~GROUND SNOW LOAD (psf)[e]~~											
		~~30~~						~~50~~					
		~~Building width[c] (feet)~~											
		~~20~~		~~28~~		~~36~~		~~20~~		~~28~~		~~36~~	
		~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~
~~Roof, ceiling, and two clear span floors~~	~~2-2 × 10~~	~~4-9~~	~~2~~	~~4-1~~	~~3~~	~~3-8~~	~~3~~	~~4-8~~	~~2~~	~~4-0~~	~~3~~	~~3-7~~	~~3~~
	~~2-2 × 12~~	~~5-6~~	~~3~~	~~4-9~~	~~3~~	~~4-3~~	~~3~~	~~5-5~~	~~3~~	~~4-8~~	~~3~~	~~4-2~~	~~3~~
	~~3-2 × 8~~	~~4-10~~	~~2~~	~~4-2~~	~~2~~	~~3-9~~	~~2~~	~~4-9~~	~~2~~	~~4-1~~	~~2~~	~~3-8~~	~~2~~
	~~3-2 × 10~~	~~5-11~~	~~2~~	~~5-1~~	~~2~~	~~4-7~~	~~3~~	~~5-10~~	~~2~~	~~5-0~~	~~2~~	~~4-6~~	~~3~~
	~~3-2 × 12~~	~~6-10~~	~~2~~	~~5-11~~	~~3~~	~~5-4~~	~~3~~	~~6-9~~	~~2~~	~~5-10~~	~~3~~	~~5-3~~	~~3~~
	~~4-2 × 8~~	~~5-7~~	~~2~~	~~4-10~~	~~2~~	~~4-4~~	~~2~~	~~5-6~~	~~2~~	~~4-9~~	~~2~~	~~4-3~~	~~2~~
	~~4-2 × 10~~	~~6-10~~	~~2~~	~~5-11~~	~~2~~	~~5-3~~	~~2~~	~~6-9~~	~~2~~	~~5-10~~	~~2~~	~~5-2~~	~~2~~
	~~4-2 × 12~~	~~7-11~~	~~2~~	~~6-10~~	~~2~~	~~6-2~~	~~3~~	~~7-9~~	~~2~~	~~6-9~~	~~2~~	~~6-0~~	~~3~~

~~For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.~~

~~a. Spans are given in feet and inches.~~

~~b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir and Spruce-Pine-Fir. No. 1 or better grade lumber shall be used for Southern Pine.~~

~~c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.~~

~~d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.~~

~~e. Use 30 psf ground snow load for cases in which ground snow load is less than 30 psf and the roof live load is equal to or less than 20 psf.~~

TABLE 2308.4.1.1(1)
HEADER AND GIRDER SPANS[a,b] FOR EXTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir and required number of jack studs)

GIRDERS AND HEADERS SUPPORTING	SIZE	GROUND SNOW LOAD (psf)[e]																	
		30						50						70					
		Building width[c] (feet)																	
		12		24		36		12		24		36		12		24		36	
		Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]
Roof and ceiling	1-2x6	4 - 0	1	3 - 1	2	2 - 7	2	3 - 5	1	2 - 8	2	2 - 3	2	3 - 0	2	2 - 4	2	2 - 0	2
	1-2x8	5 - 1	2	3 - 11	2	3 - 3	2	4 - 4	2	3 - 4	2	2 - 10	2	3 - 10	2	3 - 0	2	2 - 6	3
	1-2x10	6 - 0	2	4 - 8	2	3 - 11	2	5 - 2	2	4 - 0	2	3 - 4	3	4 - 7	2	3 - 6	3	3 - 0	3
	1-	7 - 1	2	5 - 5	2	4 - 7	3	6 - 1	2	4 - 8	3	3 - 11	3	5 - 5	2	4 - 2	3	3 - 6	3

	2x12																		
	2-2x4	4 - 0	1	3 - 1	1	2 - 7	1	3 - 5	1	2 - 7	1	2 - 2	1	3 - 0	1	2 - 4	1	2 - 0	1
	2-2x6	6 - 0	1	4 - 7	1	3 - 10	1	5 - 1	1	3 - 11	1	3 - 3	2	4 - 6	1	3 - 6	2	2 - 11	2
	2-2x8	7 - 7	1	5 - 9	1	4 - 10	2	6 - 5	1	5 - 0	2	4 - 2	2	5 - 9	1	4 - 5	2	3 - 9	2
	2-2x10	9 - 0	1	6 - 10	2	5 - 9	2	7 - 8	2	5 - 11	2	4 - 11	2	6 - 9	2	5 - 3	2	4 - 5	2
	2-2x12	10 - 7	2	8 - 1	2	6 - 10	2	9 - 0	2	6 - 11	2	5 - 10	2	8 - 0	2	6 - 2	2	5 - 2	3
	3-2x8	9 - 5	1	7 - 3	1	6 - 1	1	8 - 1	1	6 - 3	1	5 - 3	2	7 - 2	1	5 - 6	2	4 - 8	2
	3-2x10	11 - 3	1	8 - 7	1	7 - 3	2	9 - 7	1	7 - 4	2	6 - 2	2	8 - 6	1	6 - 7	2	5 - 6	2
	3-2x12	13 - 2	1	10 - 1	2	8 - 6	2	11 - 3	2	8 - 8	2	7 - 4	2	10 - 0	2	7 - 9	2	6 - 6	2
	4-2x8	10 - 11	1	8 - 4	1	7 - 0	1	9 - 4	1	7 - 2	1	6 - 0	1	8 - 3	1	6 - 4	1	5 - 4	2
	4-2x10	12 - 11	1	9 - 11	1	8 - 4	1	11 - 1	1	8 - 6	1	7 - 2	2	9 - 10	1	7 - 7	2	6 - 4	2
	4-2x12	15 - 3	1	11 - 8	1	9 - 10	2	13 - 0	1	10 - 0	2	8 - 5	2	11 - 7	1	8 - 11	2	7 - 6	2
Roof, ceiling and one center-bearing floor	1-2x6	3 - 3	1	2 - 7	2	2 - 2	2	3 - 0	2	2 - 4	2	2 - 0	2	2 - 9	2	2 - 2	2	1 - 10	2
	1-2x8	4 - 1	2	3 - 3	2	2 - 9	2	3 - 9	2	3 - 0	2	2 - 6	3	3 - 6	2	2 - 9	2	2 - 4	3
	1-2x10	4 - 11	2	3 - 10	2	3 - 3	3	4 - 6	2	3 - 6	3	3 - 0	3	4 - 1	2	3 - 3	3	2 - 9	3
	1-2x12	5 - 9	2	4 - 6	3	3 - 10	3	5 - 3	2	4 - 2	3	3 - 6	3	4 - 10	3	3 - 10	3	3 - 3	4
	2-2x4	3 - 3	1	2 - 6	1	2 - 2	1	3 - 0	1	2 - 4	1	2 - 0	1	2 - 8	1	2 - 2	1	1 - 10	1
	2-2x6	4 - 10	1	3 - 9	1	3 - 3	2	4 - 5	1	3 - 6	2	3 - 0	2	4 - 1	1	3 - 3	2	2 - 9	2
	2-2x8	6 - 1	1	4 - 10	2	4 - 1	2	5 - 7	2	4 - 5	2	3 - 9	2	5 - 2	2	4 - 1	2	3 - 6	2
	2-2x10	7 - 3	2	5 - 8	2	4 - 10	2	6 - 8	2	5 - 3	2	4 - 5	2	6 - 1	2	4 - 10	2	4 - 1	2
	2-2x12	8 - 6	2	6 - 8	2	5 - 8	2	7 - 10	2	6 - 2	2	5 - 3	3	7 - 2	2	5 - 8	2	4 - 10	3
	3-2x8	7 - 8	1	6 - 0	1	5 - 1	2	7 - 0	1	5 - 6	2	4 - 8	2	6 - 5	1	5 - 1	2	4 - 4	2

	3-2x10	9 - 1	1	7 - 2	2	6 - 1	2	8 - 4	1	6 - 7	2	5 - 7	2	7 - 8	2	6 - 1	2	5 - 2	2
	3-2x12	10 - 8	2	8 - 5	2	7 - 2	2	9 - 10	2	7 - 8	2	6 - 7	2	9 - 0	2	7 - 1	2	6 - 1	2
	4-2x8	8 - 10	1	6 - 11	1	5 - 11	1	8 - 1	1	6 - 4	1	5 - 5	2	7 - 5	1	5 - 11	1	5 - 0	2
	4-2x10	10 - 6	1	8 - 3	2	7 - 0	2	9 - 8	1	7 - 7	2	6 - 5	2	8 - 10	1	7 - 0	2	6 - 0	2
	4-2x12	12 - 4	1	9 - 8	2	8 - 3	2	11 - 4	2	8 - 11	2	7 - 7	2	10 - 4	2	8 - 3	2	7 - 0	2
Roof, ceiling and one clear span floor	1-2x6	2 - 11	2	2 - 3	2	1 - 11	2	2 - 9	2	2 - 1	2	1 - 9	2	2 - 7	2	2 - 0	2	1 - 8	2
	1-2x8	3 - 9	2	2 - 10	2	2 - 5	3	3 - 6	2	2 - 8	2	2 - 3	3	3 - 3	2	2 - 6	3	2 - 2	3
	1-2x10	4 - 5	2	3 - 5	3	2 - 10	3	4 - 2	2	3 - 2	3	2 - 8	3	3 - 11	2	3 - 0	3	2 - 6	3
	1-2x12	5 - 2	2	4 - 0	3	3 - 4	3	4 - 10	3	3 - 9	3	3 - 2	4	4 - 7	3	3 - 6	3	3 - 0	4
	2-2x4	2 - 11	1	2 - 3	1	1 - 10	1	2 - 9	1	2 - 1	1	1 - 9	1	2 - 7	1	2 - 0	1	1 - 8	1
	2-2x6	4 - 4	1	3 - 4	2	2 - 10	2	4 - 1	1	3 - 2	2	2 - 8	2	3 - 10	1	3 - 0	2	2 - 6	2
	2-2x8	5 - 6	2	4 - 3	2	3 - 7	2	5 - 2	2	4 - 0	2	3 - 4	2	4 - 10	2	3 - 9	2	3 - 2	2
	2-2x10	6 - 7	2	5 - 0	2	4 - 2	2	6 - 1	2	4 - 9	2	4 - 0	2	5 - 9	2	4 - 5	2	3 - 9	3
	2-2x12	7 - 9	2	5 - 11	2	4 - 11	3	7 - 2	2	5 - 7	2	4 - 8	3	6 - 9	2	5 - 3	3	4 - 5	3
	3-2x8	6 - 11	1	5 - 3	2	4 - 5	2	6 - 5	1	5 - 0	2	4 - 2	2	6 - 1	1	4 - 8	2	4 - 0	2
	3-2x10	8 - 3	2	6 - 3	2	5 - 3	2	7 - 8	2	5 - 11	2	5 - 0	2	7 - 3	2	5 - 7	2	4 - 8	2
	3-2x12	9 - 8	2	7 - 5	2	6 - 2	2	9 - 0	2	7 - 0	2	5 - 10	2	8 - 6	2	6 - 7	2	5 - 6	3
	4-2x8	8 - 0	1	6 - 1	1	5 - 1	2	7 - 5	1	5 - 9	2	4 - 10	2	7 - 0	1	5 - 5	2	4 - 7	2
	4-2x10	9 - 6	1	7 - 3	2	6 - 1	2	8 - 10	1	6 - 10	2	5 - 9	2	8 - 4	1	6 - 5	2	5 - 5	2
	4-2x12	11 - 2	2	8 - 6	2	7 - 2	2	10 - 5	2	8 - 0	2	6 - 9	2	9 - 10	2	7 - 7	2	6 - 5	2
Roof, ceiling and two center-	1-2x6	2 - 8	2	2 - 1	2	1 - 10	2	2 - 7	2	2 - 0	2	1 - 9	2	2 - 5	2	1 - 11	2	1 - 8	2

bearing floors	1-2x8	3 - 5	2	2 - 8	2	2 - 4	3	3 - 3	2	2 - 7	2	2 - 2	3	3 - 1	2	2 - 5	3	2 - 1	3
	1-2x10	4 - 0	2	3 - 2	3	2 - 9	3	3 - 10	2	3 - 1	3	2 - 7	3	3 - 8	2	2 - 11	3	2 - 5	3
	1-2x12	4 - 9	3	3 - 9	3	3 - 2	4	4 - 6	3	3 - 7	3	3 - 1	4	4 - 3	3	3 - 5	3	2 - 11	4
	2-2x4	2 - 8	1	2 - 1	1	1 - 9	1	2 - 6	1	2 - 0	1	1 - 8	1	2 - 5	1	1 - 11	1	1 - 7	1
	2-2x6	4 - 0	1	3 - 2	2	2 - 8	2	3 - 9	1	3 - 0	2	2 - 7	2	3 - 7	1	2 - 10	2	2 - 5	2
	2-2x8	5 - 0	2	4 - 0	2	3 - 5	2	4 - 10	2	3 - 10	2	3 - 3	2	4 - 7	2	3 - 7	2	3 - 1	2
	2-2x10	6 - 0	2	4 - 9	2	4 - 0	2	5 - 8	2	4 - 6	2	3 - 10	3	5 - 5	2	4 - 3	2	3 - 8	3
	2-2x12	7 - 0	2	5 - 7	2	4 - 9	3	6 - 8	2	5 - 4	3	4 - 6	3	6 - 4	2	5 - 0	3	4 - 3	3
	3-2x8	6 - 4	1	5 - 0	2	4 - 3	2	6 - 0	1	4 - 9	2	4 - 1	2	5 - 8	2	4 - 6	2	3 - 10	2
	3-2x10	7 - 6	2	5 - 11	2	5 - 1	2	7 - 1	2	5 - 8	2	4 - 10	2	6 - 9	2	5 - 4	2	4 - 7	2
	3-2x12	8 - 10	2	7 - 0	2	5 - 11	2	8 - 5	2	6 - 8	2	5 - 8	3	8 - 0	2	6 - 4	2	5 - 4	3
	4-2x8	7 - 3	1	5 - 9	1	4 - 11	2	6 - 11	1	5 - 6	2	4 - 8	2	6 - 7	1	5 - 2	2	4 - 5	2
	4-2x10	8 - 8	1	6 - 10	2	5 - 10	2	8 - 3	2	6 - 6	2	5 - 7	2	7 - 10	2	6 - 2	2	5 - 3	2
	4-2x12	10 - 2	2	8 - 1	2	6 - 10	2	9 - 8	2	7 - 8	2	6 - 7	2	9 - 2	2	7 - 3	2	6 - 2	2
Roof, ceiling and two clear span floors	1-2x6	2 - 3	2	1 - 9	2	1 - 5	2	2 - 3	2	1 - 9	2	1 - 5	3	2 - 2	2	1 - 8	2	1 - 5	3
	1-2x8	2 - 10	2	2 - 2	3	1 - 10	3	2 - 10	2	2 - 2	3	1 - 10	3	2 - 9	2	2 - 1	3	1 - 10	3
	1-2x10	3 - 4	2	2 - 7	3	2 - 2	3	3 - 4	3	2 - 7	3	2 - 2	4	3 - 3	3	2 - 6	3	2 - 2	4
	1-2x12	4 - 0	3	3 - 0	3	2 - 7	4	4 - 0	3	3 - 0	4	2 - 7	4	3 - 10	3	3 - 0	4	2 - 6	4
	2-2x4	2 - 3	1	1 - 8	1	1 - 4	1	2 - 3	1	1 - 8	1	1 - 4	1	2 - 2	1	1 - 8	1	1 - 4	2
	2-2x6	3 - 4	1	2 - 6	2	2 - 2	2	3 - 4	2	2 - 6	2	2 - 2	2	3 - 3	2	2 - 6	2	2 - 1	2
	2-2x8	4 - 3	2	3 - 3	2	2 - 8	2	4 - 3	2	3 - 3	2	2 - 8	2	4 - 1	2	3 - 2	2	2 - 8	3
	2-2x10	5 - 0	2	3 - 10	2	3 - 2	3	5 - 0	2	3 - 10	2	3 - 2	3	4 - 10	2	3 - 9	3	3 - 2	3

	2-2x12	5 - 11	2	4 - 6	3	3 - 9	3	5 - 11	2	4 - 6	3	3 - 9	3	5 - 8	2	4 - 5	3	3 - 9	3
	3-2x8	5 - 3	1	4 - 0	2	3 - 5	2	5 - 3	2	4 - 0	2	3 - 5	2	5 - 1	2	3 - 11	2	3 - 4	2
	3-2x10	6 - 3	2	4 - 9	2	4 - 0	2	6 - 3	2	4 - 9	2	4 - 0	2	6 - 1	2	4 - 8	2	4 - 0	3
	3-2x12	7 - 5	2	5 - 8	2	4 - 9	3	7 - 5	2	5 - 8	2	4 - 9	3	7 - 2	2	5 - 6	3	4 - 8	3
	4-2x8	6 - 1	1	4 - 8	2	3 - 11	2	6 - 1	1	4 - 8	2	3 - 11	2	5 - 11	1	4 - 7	2	3 - 10	2
	4-2x10	7 - 3	2	5 - 6	2	4 - 8	2	7 - 3	2	5 - 6	2	4 - 8	2	7 - 0	2	5 - 5	2	4 - 7	2
	4-2x12	8 - 6	2	6 - 6	2	5 - 6	2	8 - 6	2	6 - 6	2	5 - 6	2	8 - 3	2	6 - 4	2	5 - 4	3

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. Spans are given in feet and inches.

b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir.

c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.

d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.

e. Use 30 psf ground snow load for cases in which ground snow load is less than 30 psf and the roof live load is equal to or less than 20 psf.

f. Spans are calculated assuming the top of the header or girder is laterally braced by perpendicular framing. Where the top of the header or girder is not laterally braced (e.g. cripple studs bearing on the header), tabulated spans for headers consisting of 2x8, 2x10, or 2x12 sizes shall be multiplied by 0.70 or the header or girder shall be designed.

Reason: The update of Table 2308.4.1.1(1) Header and Girder Spans for Exterior Bearing Walls is proposed. Updated spans address use of Southern Pine No. 2 in lieu of Southern Pine No. 1. Footnote "f" is added to clarify that header spans are based on laterally braced assumption such as when the header is raised. For dropped headers consisting of 2x8, 2x10, or 2x12 sizes that are not laterally braced, a factor of 0.7 can be applied to determine the spans or alternatively the header or girder can be designed to include any adjustment for potential buckling. Laterally braced (raised) and not laterally braced (dropped) header conditions and building widths for which header spans are tabulated represent the same condtions used to develop header span tables in the Wood Frame Construction Manual (WFCM).

Cost Impact: Will increase the cost of construction
Increased cost may be associated with reduced spans that result from the not laterally braced condition and application of footnote f. Due to smaller building width column (12'), permissible use of Southern Pine No. 2, and the laterally braced assumption for tabulated spans, there are also cases where this change will not increase the cost of construction and may reduce cost of construction.

S289-16 : TABLE 2308.4.1.1-TYREE12519

Final Action: AS (Approved as Submitted)

S8260

Date Submitted	12/14/2018	**Section**	2308.4.1.1	**Proponent**	Paul Coats
Chapter	23	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** | **Alternate Language** **No**

Related Modifications

Summary of Modification

Replacement table for T2308.4.1.1(2) Header and Girder Spans for Interior Bearing Walls

Rationale

The update of Table 2308.4.1.1(2) Header and Girder Spans for Interior Bearing Walls is proposed. Updated spans address use of Southern Pine No. 2 in lieu of Southern Pine No. 1. Footnote "e" is added to clarify that header spans are based on laterally braced assumption such as when the header is raised. For dropped headers consisting of 2x8, 2x10, or 2x12 size framing and not laterally braced, a factor of 0.7 can be applied to determine the spans or alternatively the header or girder can be designed to include any adjustment for potential buckling. Laterally braced (raised) and not laterally braced (dropped) header conditions and building widths for which header spans are tabulated represent the same conditions used to develop header span tables in the Wood Frame Construction Manual (WFCM).

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Code officials will need to become familiar with the use of the new table and footnotes.

Impact to building and property owners relative to cost of compliance with code

Increased cost may be associated with reduced spans that result from the unbraced header condition and application of footnote e. Due to certain new options in the table, in some circumstances it may reduce the cost of construction.

Impact to industry relative to the cost of compliance with code

Increased cost may be associated with reduced spans that result from the unbraced header condition and application of footnote e. Due to certain new options in the table, in some circumstances it may reduce the cost of construction.

Impact to small business relative to the cost of compliance with code

Increased cost may be associated with reduced spans that result from the unbraced header condition and application of footnote e. Due to certain new options in the table, in some circumstances it may reduce the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Maintains correct header sizing for safety and serviceability.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

Completely delete the current Table 2308.4.1.1(2) and replace with a new table:

~~**TABLE 2308.4.1.1(2)**~~

~~**HEADER AND GIRDER SPANS$_{a, b}$ FOR INTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine and Spruce-Pine-Fir$_{b}$ and required number of jack studs)**~~

TABLE 2308.4.1.1(2)

HEADER AND GIRDER SPANS[a,b] FOR INTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir and required number of jack studs)

See uploaded support file for contents of new Table 2308.4.1.1(2)

Revise as follows:

2308.4.1.1 (2)
HEADER AND GIRDER SPANS[a, b] FOR INTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine and Spruce-Pine-Fir[b] and required number of jack studs)

-

HEADERS AND GIRDERS SUPPORTING	SIZE	BUILDING WIDTH[c] (feet)					
		20		28		36	
		Span	NJ[d]	Span	NJ[d]	Span	NJ[d]
One floor only	2-2 × 4	3-1	1	2-8	1	2-5	1
	2-2 × 6	4-6	1	3-11	1	3-6	1
	2-2 × 8	5-9	1	5-0	2	4-5	2
	2-2 × 10	7-0	2	6-1	2	5-5	2
	2-2 × 12	8-1	2	7-0	2	6-3	2
	3-2 × 8	7-2	1	6-3	1	5-7	2
	3-2 × 10	8-9	1	7-7	2	6-9	2
	3-2 × 12	10-2	2	8-10	2	7-10	2
	4-2 × 8	9-0	1	7-8	1	6-9	1
	4-2 × 10	10-1	1	8-9	1	7-10	2
	4-2 × 12	11-9	1	10-2	2	9-1	2
	2-2 × 4	2-2	1	1-10	1	1-7	1

~~Two floors~~	~~2-2 × 6~~	~~3-2~~	~~2~~	~~2-9~~	~~2~~	~~2-5~~	~~2~~
	~~2-2 × 8~~	~~4-1~~	~~2~~	~~3-6~~	~~2~~	~~3-2~~	~~2~~
	~~2-2 × 10~~	~~4-11~~	~~2~~	~~4-3~~	~~2~~	~~3-10~~	~~3~~
	~~2-2 × 12~~	~~5-9~~	~~2~~	~~5-0~~	~~3~~	~~4-5~~	~~3~~
	~~3-2 × 8~~	~~5-1~~	~~2~~	~~4-5~~	~~2~~	~~3-11~~	~~2~~
	~~3-2 × 10~~	~~6-2~~	~~2~~	~~5-4~~	~~2~~	~~4-10~~	~~2~~
	~~3-2 × 12~~	~~7-2~~	~~2~~	~~6-3~~	~~2~~	~~5-7~~	~~3~~
	~~4-2 × 8~~	~~6-1~~	~~1~~	~~5-3~~	~~2~~	~~4-8~~	~~2~~
	~~4-2 × 10~~	~~7-2~~	~~2~~	~~6-2~~	~~2~~	~~5-6~~	~~2~~
	~~4-2 × 12~~	~~8-4~~	~~2~~	~~7-2~~	~~2~~	~~6-5~~	~~2~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.~~

~~a. Spans are given in feet and inches.~~

~~b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir and Spruce-Pine-Fir. No. 1 or better grade lumber shall be used for Southern Pine.~~

~~c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.~~

~~d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.~~

TABLE 2308.4.1.1(2)

HEADER AND GIRDER SPANS[a,b] FOR INTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir and required number of jack studs)

HEADERS AND GIRDERS SUPPORTING	SIZE	BUILDING Width[c] (feet)					
		12		24		36	
		Span[e]	NJ[d]	Span[e]	NJ[d]	Span[e]	NJ[d]
One floor only	2-2x4	4 - 1	1	2 - 10	1	2 - 4	1
	2-2x6	6 - 1	1	4 - 4	1	3 - 6	1
	2-2x8	7 - 9	1	5 - 5	1	4 - 5	2

	2-2x10	9 - 2	1	6 - 6	2	5 - 3	2
	2-2x12	10 - 9	1	7 - 7	2	6 - 3	2
	3-2x8	9 - 8	1	6 - 10	1	5 - 7	1
	3-2x10	11 - 5	1	8 - 1	1	6 - 7	2
	3-2x12	13 - 6	1	9 - 6	2	7 - 9	2
	4-2x8	11 - 2	1	7 - 11	1	6 - 5	1
	4-2x10	13 - 3	1	9 - 4	1	7 - 8	1
	4-2x12	15 - 7	1	11 - 0	1	9 - 0	2
Two floors	2-2x4	2 - 7	1	1 - 11	1	1 - 7	1
	2-2x6	3 - 11	1	2 - 11	2	2 - 5	2
	2-2x8	5 - 0	1	3 - 8	2	3 - 1	2
	2-2x10	5 - 11	2	4 - 4	2	3 - 7	2
	2-2x12	6 - 11	2	5 - 2	2	4 - 3	3
	3-2x8	6 - 3	1	4 - 7	2	3 - 10	2
	3-2x10	7 - 5	1	5 - 6	2	4 - 6	2
	3-2x12	8 - 8	2	6 - 5	2	5 - 4	2
	4-2x8	7 - 2	1	5 - 4	1	4 - 5	2
	4-2x10	8 - 6	1	6 - 4	2	5 - 3	2
	4-2x12	10 - 1	1	7 - 5	2	6 - 2	2

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. Spans are given in feet and inches.

b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir.

c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.

d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.

e. Spans are calculated assuming the top of the header or girder is laterally braced by perpendicular framing. Where the top of the header or girder is not laterally braced (e.g. cripple studs bearing on the header), tabulated spans for headers consisting of 2x8, 2x10, or 2x12 sizes shall be multiplied by 0.70 or the header or girder shall be designed.

Final Action: AS (Approved as Submitted)

S288-16

IBC: 2308.4.1.1, 2308.4.1.1(2) (New).

Proponent : David Tyree, representing American Wood Council (dtyree@awc.org)

2015 International Building Code

Revise as follows:

~~2308.4.1.1~~ (2)

~~HEADER AND GIRDER SPANS[a, b] FOR INTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine and Spruce-Pine-Fir[b] and required number of jack studs)~~

~~HEADERS AND GIRDERS SUPPORTING~~	~~SIZE~~	~~BUILDING WIDTH[e] (feet)~~					
		~~20~~		~~28~~		~~36~~	
		~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~
	~~2-2 × 4~~	~~3-1~~	~~1~~	~~2-8~~	~~1~~	~~2-5~~	~~1~~
	~~2-2 × 6~~	~~4-6~~	~~1~~	~~3-11~~	~~1~~	~~3-6~~	~~1~~
	~~2-2 × 8~~	~~5-9~~	~~1~~	~~5-0~~	~~2~~	~~4-5~~	~~2~~
	~~2-2 × 10~~	~~7-0~~	~~2~~	~~6-1~~	~~2~~	~~5-5~~	~~2~~
	~~2-2 × 12~~	~~8-1~~	~~2~~	~~7-0~~	~~2~~	~~6-3~~	~~2~~
~~One floor only~~	~~3-2 × 8~~	~~7-2~~	~~1~~	~~6-3~~	~~1~~	~~5-7~~	~~2~~
	~~3-2 × 10~~	~~8-9~~	~~1~~	~~7-7~~	~~2~~	~~6-9~~	~~2~~
	~~3-2 × 12~~	~~10-2~~	~~2~~	~~8-10~~	~~2~~	~~7-10~~	~~2~~
	~~4-2 × 8~~	~~9-0~~	~~1~~	~~7-8~~	~~1~~	~~6-9~~	~~1~~
	~~4-2 × 10~~	~~10-1~~	~~1~~	~~8-9~~	~~1~~	~~7-10~~	~~2~~
	~~4-2 × 12~~	~~11-9~~	~~1~~	~~10-2~~	~~2~~	~~9-1~~	~~2~~
	~~2-2 × 4~~	~~2-2~~	~~1~~	~~1-10~~	~~1~~	~~1-7~~	~~1~~

	~~2-2 × 6~~	~~3-2~~	~~2~~	~~2-9~~	~~2~~	~~2-5~~	~~2~~
	~~2-2 × 8~~	~~4-1~~	~~2~~	~~3-6~~	~~2~~	~~3-2~~	~~2~~
	~~2-2 × 10~~	~~4-11~~	~~2~~	~~4-3~~	~~2~~	~~3-10~~	~~3~~
	~~2-2 × 12~~	~~5-9~~	~~2~~	~~5-0~~	~~3~~	~~4-5~~	~~3~~
~~Two floors~~	~~3-2 × 8~~	~~5-1~~	~~2~~	~~4-5~~	~~2~~	~~3-11~~	~~2~~
	~~3-2 × 10~~	~~6-2~~	~~2~~	~~5-4~~	~~2~~	~~4-10~~	~~2~~
	~~3-2 × 12~~	~~7-2~~	~~2~~	~~6-3~~	~~2~~	~~5-7~~	~~3~~
	~~4-2 × 8~~	~~6-1~~	~~1~~	~~5-3~~	~~2~~	~~4-8~~	~~2~~
	~~4-2 × 10~~	~~7-2~~	~~2~~	~~6-2~~	~~2~~	~~5-6~~	~~2~~
	~~4-2 × 12~~	~~8-4~~	~~2~~	~~7-2~~	~~2~~	~~6-5~~	~~2~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.~~

~~a. Spans are given in feet and inches.~~

~~b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir and Spruce-Pine-Fir. No. 1 or better grade lumber shall be used for Southern Pine.~~

~~c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.~~

~~d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.~~

TABLE 2308.4.1.1(2)

HEADER AND GIRDER SPANS[a,b] FOR INTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir and required number of jack studs)

HEADERS AND GIRDERS SUPPORTING	SIZE	BUILDING Width[c] (feet)					
		12		24		36	
		Span[e]	NJ[d]	Span[e]	NJ[d]	Span[e]	NJ[d]
One floor only	2-2x4	4 - 1	1	2 - 10	1	2 - 4	1
	2-2x6	6 - 1	1	4 - 4	1	3 - 6	1
	2-2x8	7 - 9	1	5 - 5	1	4 - 5	2

	2-2x10	9 - 2	1	6 - 6	2	5 - 3	2
	2-2x12	10 - 9	1	7 - 7	2	6 - 3	2
	3-2x8	9 - 8	1	6 - 10	1	5 - 7	1
	3-2x10	11 - 5	1	8 - 1	1	6 - 7	2
	3-2x12	13 - 6	1	9 - 6	2	7 - 9	2
	4-2x8	11 - 2	1	7 - 11	1	6 - 5	1
	4-2x10	13 - 3	1	9 - 4	1	7 - 8	1
	4-2x12	15 - 7	1	11 - 0	1	9 - 0	2
Two floors	2-2x4	2 - 7	1	1 - 11	1	1 - 7	1
	2-2x6	3 - 11	1	2 - 11	2	2 - 5	2
	2-2x8	5 - 0	1	3 - 8	2	3 - 1	2
	2-2x10	5 - 11	2	4 - 4	2	3 - 7	2
	2-2x12	6 - 11	2	5 - 2	2	4 - 3	3
	3-2x8	6 - 3	1	4 - 7	2	3 - 10	2
	3-2x10	7 - 5	1	5 - 6	2	4 - 6	2
	3-2x12	8 - 8	2	6 - 5	2	5 - 4	2
	4-2x8	7 - 2	1	5 - 4	1	4 - 5	2
	4-2x10	8 - 6	1	6 - 4	2	5 - 3	2
	4-2x12	10 - 1	1	7 - 5	2	6 - 2	2

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. Spans are given in feet and inches.

b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir.

c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.

d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.

e. Spans are calculated assuming the top of the header or girder is laterally braced by perpendicular framing. Where the top of the header or girder is not laterally braced (e.g. cripple studs bearing on the header), tabulated spans for headers consisting of 2x8, 2x10, or 2x12 sizes shall be multiplied by 0.70 or the header or girder shall be designed.

Reason: The update of Table 2308.4.1.1(2) Header and Girder Spans for Interior Bearing Walls is proposed. Updated spans address use of Southern Pine No. 2 in lieu of Southern Pine No. 1. Footnote "e" is added to clarify that header spans are based on laterally braced assumption such as when the header is raised. For dropped headers consisting of 2x8, 2x10, or 2x12 size framing and not laterally braced, a factor of 0.7 can be applied to determine the spans or alternatively the header or girder can be designed to include any adjustment for potential buckling. Laterally braced (raised) and not laterally braced (dropped) header conditions and building widths for which header spans are tabulated represent the same conditions used to develop header span tables in the Wood Frame Construction Manual (WFCM).

Cost Impact: Will increase the cost of construction
Increased cost may be associated with reduced spans that result from the not laterally braced condition and application of footnote e. Due to smaller building width column (12'), permissible use of Southern Pine No. 2, and the laterally braced assumption for tabulated spans, there are also cases where this change will not increase the cost of construction and may reduce cost of construction.

S288-16 : TABLE 2308.4.1.1-TYREE11413

Final Action: AS (Approved as Submitted)

S8262

Date Submitted	12/14/2018	**Section**	2308.5.5.1	**Proponent**	Paul Coats
Chapter	23	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** | **Alternate Language** **No**

Related Modifications

Summary of Modification

Adds provisions for single-member headers in exterior walls

Rationale

This modification was approved by the ICC committee and membership and appears in the 2018 edition of the International Building Code. This proposal adds prescriptive framing and connection requirements for single member (single ply) headers consistent with the residential code. Additionally, provisions of 2308.5.5.1 are revised to coordinate with tabulated header sizes consisting of 2, 3, or 4-member headers.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

New framing detail for certain headers.

Impact to building and property owners relative to cost of compliance with code

No cost-related impact.

Impact to industry relative to the cost of compliance with code

No cost-related impact.

Impact to small business relative to the cost of compliance with code

No cost-related impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Provides a framing option related to headers and therefore safety.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Provides equivalent methods of construction.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

2308.5.5.1Openings in exterior bearing walls.

Headers shall be provided over each opening in exterior bearing walls. The size and spans in Table 2308.4.1.1(1) are permitted to be used for one- and two-family *dwellings*. Headers for other buildings shall be designed in accordance with Section 2301.2, Item 1 or 2. Headers ~~shall be~~ of two or more pieces of nominal 2-inch (51 mm) framing lumber set on edge ~~as~~ shall be permitted ~~by~~ in accordance with Table 2308.4.1.1(1) and nailed together in accordance with Table 2304.10.1 or of solid lumber of equivalent size.

Single member headers of nominal 2-inch thickness shall be framed with a single flat 2-inchnominal (51 mm) member or wall plate not less in width than the wall studs on the top and bottom of the header in accordance with Figures 2308.5.5.1(1) and 2308.5.5.1(2) and face nailed to the top and bottom of the header with 10d box nails (3 inches × 0.128 inches) spaced 12 inches on center.

Wall studs shall support the ends of the header in accordance with Table 2308.4.1.1(1). Each end of a lintel or header shall have a bearing length of not less than 1 1/2 inches (38 mm) for the full width of the lintel.

(See uploaded support file for new figures, Figure 2308.5.5.1(1) Single Member Header in Exterior Bearing Wall and Figure 2308.5.5.1(2) Alternative Single Member Header Without Cripple)

Revise as follows:

2308.5.5.1 Openings in exterior bearing walls. Headers shall be provided over each opening in exterior bearing walls. The size and spans in Table 2308.4.1.1(1) are permitted to be used for one- and two-family *dwellings*. Headers for other buildings shall be designed in accordance with Section 2301.2, Item 1 or 2. Headers ~~shall be~~ of two or more pieces of nominal 2-inch (51 mm) framing lumber set on edge ~~as~~ shall be permitted ~~by~~ in accordance with Table 2308.4.1.1(1) and nailed together in accordance with Table 2304.10.1 or of solid lumber of equivalent size.

Single member headers of nominal 2-inch thickness shall be framed with a single flat 2-inch-nominal (51 mm) member or wall plate not less in width than the wall studs on the top and bottom of the header in accordance with Figures 2308.5.5.1(1) and 2308.5.5.1(2) and face nailed to the top and bottom of the header with 10d box nails (3 inches × 0.128 inches) spaced 12 inches on center.

Wall studs shall support the ends of the header in accordance with Table 2308.4.1.1(1). Each end of a lintel or header shall have a bearing length of not less than $1^1/_2$ inches (38 mm) for the full width of the lintel.

Add new text as follows:

FIGURE 2308.5.5.1(1)
Single Member Header in Exterior Bearing Wall

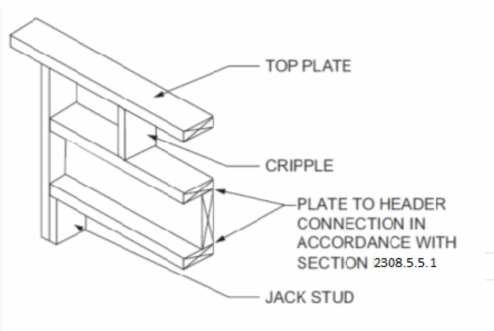
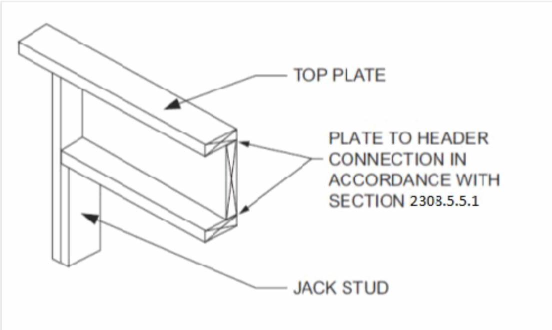


FIGURE 2308.5.5.1(2)

Alternative Single Member Header Without Cripple



Final Action: AS (Approved as Submitted)

S292-16

IBC: 2308.5.5.1, 2308.5.5.1(1) (New), 2308.5.5.1(2) (New).

Proponent : Paul Coats, PE CBO, representing American Wood Council (pcoats@awc.org)

2015 International Building Code

Revise as follows:

2308.5.5.1 Openings in exterior bearing walls. Headers shall be provided over each opening in exterior bearing walls. The size and spans in Table 2308.4.1.1(1) are permitted to be used for one- and two-family *dwellings*. Headers for other buildings shall be designed in accordance with Section 2301.2, Item 1 or 2. Headers ~~shall be~~ of two or more pieces of nominal 2-inch (51 mm) framing lumber set on edge ~~as~~ shall be permitted ~~by~~ in accordance with Table 2308.4.1.1(1) and nailed together in accordance with Table 2304.10.1 or of solid lumber of equivalent size.

Single member headers of nominal 2-inch thickness shall be framed with a single flat 2-inch-nominal (51 mm) member or wall plate not less in width than the wall studs on the top and bottom of the header in accordance with Figures 2308.5.5.1(1) and 2308.5.5.1(2) and face nailed to the top and bottom of the header with 10d box nails (3 inches × 0.128 inches) spaced 12 inches on center.

Wall studs shall support the ends of the header in accordance with Table 2308.4.1.1(1). Each end of a lintel or header shall have a bearing length of not less than $1^{1}/_{2}$ inches (38 mm) for the full width of the lintel.

Add new text as follows:

FIGURE 2308.5.5.1(1)
Single Member Header in Exterior Bearing Wall

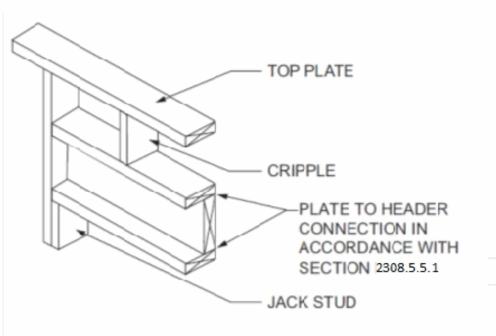
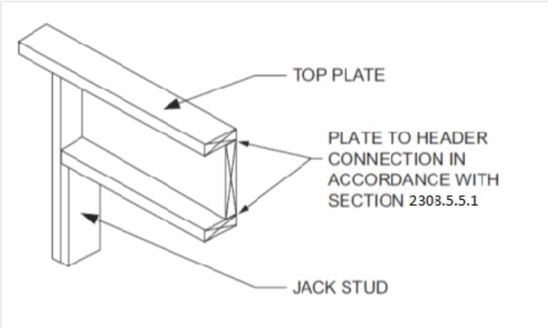


FIGURE 2308.5.5.1(2)

Alternative Single Member Header Without Cripple



Reason: This propsoal adds prescriptive framing and connection requirements for single member (single ply) headers consistent with the IRC. Additionally, provisions of 2308.5.5.1 are revised to coordinate with tabulated header sizes consisting of 2, 3, or 4 member headers.

Cost Impact: Will not increase the cost of construction
This change adds a more efficient single member header option in some cases and will not raise the cost of construction.

S292-16 : 2308.5.5.1-COATS13384

Final Action: AS (Approved as Submitted)

S8266

Date Submitted	12/14/2018	**Section**	2304.12.2	**Proponent**	Joseph Crum
Chapter	23	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

S7-16

Summary of Modification

This change clarifies that when a balcony or elevated walkway is enclosed ventilation is required to prevent decay and rot.

Rationale

This change clarifies that when a balcony or elevated walkway is enclosed ventilation is required to prevent decay and rot.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Code clarification to enhance the code.

Impact to building and property owners relative to cost of compliance with code

There may be minimal cost increase if vents are not already being installed.

Impact to industry relative to the cost of compliance with code

There may be minimal cost increase if vents are not already being installed.

Impact to small business relative to the cost of compliance with code

There may be minimal cost increase if vents are not already being installed.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Will improve the code by clarifying that ventilation is required to prevent decay and rot.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Will improve the code by clarifying that ventilation is required to prevent decay and rot.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Will improve the code by clarifying that ventilation is required to prevent decay and rot. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not degrade the effectiveness of the code

Will improve the code by clarifying that ventilation is required to prevent decay and rot. Does not degrade the effectiveness of the code rather enhances the code for protection of property.

ADD NEW SECTION AS FOLLOWS:

2304.12.2.6 Ventilation required beneath balcony or elevated walking surfaces. Enclosed framing in exterior balconies and elevated walking surfaces that are exposed to rain, snow, or drainage from irrigation shall be provided with openings that provide a net free cross ventilation area not less than 1/150 of the area of each separate space.

Date Submitted	12/15/2018	**Section**	2304.12.2.2	**Proponent**	Randall Shackelford
Chapter	23	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Restore provisions of code dealing with 1" standoff of posts

Rationale

The purpose of this code change is to return the text of this section to be more closer to the text that existed in earlier versions of the FBC, without creating a conflict with Section 2304.12.2.3.
For the 2015 IBC, the American Wood Council did a major re-write of 2304.12 on Protection against decay and termites. As part of that, they completely changed the meaning of this section by adding the word "not" to the first sentence of the exception.
From 2000 to 2102 IBC, this exception has read "Posts and columns that are either exposed to the weather or located in basements or cellars, supported by concrete piers or metal pedestals projected at least 1 inch (25 mm) above the slab or deck and 6 inches (152 mm) above exposed earth, and are separated therefrom by an impervious moisture barrier."
2000 and 2003 IBC: Section 2304.11.2.6
2006, 2009, and 2012 IBC: Section 2304.11.2.7.
The AWC code change that was accepted was S268-12. Its only statement about this section was that "The first exception was worded incorrectly and would seem to exempt exposed wood from protection; the proposed wording is a fix." I am not sure you can say definitively that this was worded incorrectly since it was exactly this way in 5 editions of the IBC from 2000 to 2012.
However, the language in 2304.12.2.2 now simply says "not exposed to the weather", which could easily be interpreted to exempt any outdoor wood member.
So this proposal attempts to better define exposed to the weather by referencing the clearer description in 2304.12.2.3.
It breaks out all three requirements so they are easier to read. It also changes "projected" to "projecting", which sounds like it better describes the situation.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Makes code easier to enforce by simplifying section and making the requirements similar to previous versions of the Florida Building Code

Impact to building and property owners relative to cost of compliance with code

Will lower cost of compliance since some posts will be able to be untreated if they meet the requirements of the exception.

Impact to industry relative to the cost of compliance with code

Will lower cost of compliance since some posts will be able to be untreated if they meet the requirements of the exception.

Impact to small business relative to the cost of compliance with code

Will lower cost of compliance since some posts will be able to be untreated if they meet the requirements of the exception.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Specifies the situation when a wood post should be treated, while clarifying the situations for when the post can be untreated

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code by clarifying this section.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code

2304.12.2.2Posts or columns.

Posts or columns supporting permanent structures and supported by a concrete or masonry slab or footing that is in direct contact with the earth shall be of naturally durable or preservative-treated wood.

Exception: Posts or columns that meet all of the following: ~~are not exposed to the weather, are supported by concrete piers or metal pedestals projected at least 1 inch (25 mm) above the slab or deck and 8 inches (203 mm) above exposed earth and are separated by an impervious moisture barrier.~~

1. Are not exposed to the weather, or are protected by a roof, eave, overhang, or other covering if exposed to the weather, and
2. Are supported by concrete piers or metal pedestals projecting at least 1 inch (25 mm) above the slab or deck and are
separated from the concrete pier by an impervious moisture barrier, and
3. Are located at least 8 inches (203 mm) above exposed earth.

S7595

Date Submitted	11/30/2018	**Section**	2407.1.1	**Proponent**	Rick Hopkins
Chapter	24	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

2407.1.1

Summary of Modification

Consistent with 1406.3

Rationale

Rewording for clarification

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

It does not

Does not degrade the effectiveness of the code

It does not

2407.1.1 Loads. The panels and their support system shall be designed to withstand the loads specified in Section 1607.8. ~~A design~~, using a safety factor of four ~~shall be used for safety~~.

S7736

Date Submitted	12/6/2018	**Section**	2401	**Proponent**	Dick Wilhelm
Chapter	24	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

This modification removes reference standards no longer maintained by AAMA.

Rationale

Modification removes reference standards no longer maintained by the American Architectural Manufacturers Association. Further provides a reference to AAMA/WDMA/CSA/101/I.S.2/A440 for forced entry testing requirements. Removed reference standards have been incorporated into AAMA/WDMA/CSA 101/I.S.2/A440.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification does not impact the enforcement of the building code

Impact to building and property owners relative to cost of compliance with code

This document does not impact the cost associated with the enforcement of the building code

Impact to industry relative to the cost of compliance with code

This modification does not impact the cost of enforcement.

Impact to small business relative to the cost of compliance with code

This modifcation has no effect on small business, compliance or otherwise.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This modifcation removes archaic reference standards no longer maintained. Has no affect on the health,welfare or safety of the public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Updating testing and performance standards provides the consumer with the latest innovative technology.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate in any fashion.

Does not degrade the effectiveness of the code

Supports the effectiveness of the building code and the Florida Product Approval Program.

2411.3.2Tests.

2411.3.2.1

Operative window and door assemblies shall be tested in accordance with the requirements of this section, TAS 202 andthe forced entry resistance requirements from ~~provisions~~ AAMA/WDMA/CSA 101/I.S.2/A440. ~~and the forced entry requirements of the American Architectural Manufacturers Association (AAMA) Standards 1302.5 and 1303.5.~~

Exceptions:

1. 1.Door assemblies installed in nonhabitable areas, where the door assembly and area are designed to accept water infiltration, need not be tested for water infiltration.
2. 2.Door assemblies installed where the overhang (OH) ratio is equal to or more than 1 need not be tested for water infiltration. The overhang ratio shall be calculated by the following equation:
   where:
   OH length = The horizontal measure of how far an overhang over a door projects out from the door's surface.
   OH height = The vertical measure of the distance from the door's sill to the bottom of the overhang over a door.
3. 3.Pass-through windows for serving from a single-family kitchen, where protected by a roof overhang of 5 feet (1.5 m) or more shall be exempted from the requirements of the water infiltration test.

2411.3.2.1.1

Glazed curtain wall, window wall and storefront systems shall be tested in accordance with the requirements of this section and the laboratory test requirements of the American Architectural Manufacturers Association (AAMA) Standard 501, following test load sequence and test load duration in TAS 202.

S7825

Date Submitted	12/10/2018	**Section**	2405	**Proponent**	Roger LeBrun
Chapter	24	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Clarify the exceptions and other language dealing with broken glass retention.

Rationale

The current language that states when screens are required below unit skylights and sloped glazing has frequently been difficult to interpret by jurisdictions, causing consumers and others great concern when they are incorrectly told they need to install a glass retention screen below conforming (30-mil interlayer) laminated glass. Skylight and sloped glazing system manufacturers are asked to intervene far too frequently to ensure that unsightly, unnecessary screens are not installed in these instances. Furthermore, it is believed that many times an optional skylight installation is removed from submitted plans due to misinterpretation at the plan check stage, where the supplier may never know that the issue was raised because the permit applicant may surrender rather than appeal.
The current code language addresses qualifying laminated glass by simple omission from the "screens required" section. It is this omission that seems to create the confusion within the industry, especially considering Exception 5, which mentions that screens may be required when non-qualifying (15-mil interlayer) laminated glass is used. The proposed rewriting of this section states positively that laminated glass with 30-mil interlayer does not require screens. Specifically addressing the inapplicability of screens under laminated glass in the new section 2405.3.3 should reduce the frequency of misinterpretations that have been experienced.
Adding the modifier, "broken glass retention" fully describes the screen's purpose. This is to ensure readers do not confuse them with insect screens or fall protection screens, which are physically different and will not serve as effective retention screens.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Reduced confusion about the screening provisions.

Impact to building and property owners relative to cost of compliance with code

Smoother approval of plans, and less chance of failing inspections.

Impact to industry relative to the cost of compliance with code

Fewer requests for intervention due to misinterpretation of current language.

Impact to small business relative to the cost of compliance with code

No significant impact

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Provides protection from falling glass only when needed.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Less ambiguous language

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Yes

Does not degrade the effectiveness of the code

Yes

SECTION 2405
SLOPED GLAZING AND SKYLIGHTS

2405.1 Scope.

This section applies to the installation of glass and other transparent, translucent or opaque glazing material installed at a slope of more than 15 degrees (0.26 rad) from the vertical plane, including glazing materials in skylights, roofs and sloped walls.

2405.2 Allowable glazing materials and limitations.

Sloped glazing shall be any of the following materials, subject to the listed limitations.

1. 1.For monolithic glazing systems, the glazing material of the single light or layer shall be laminated glass with a minimum 30-mil (0.76 mm) polyvinyl butyral (or equivalent) interlayer, wired glass, light-transmitting plastic materials meeting the requirements of Section 2607, heat-strengthened glass or fully tempered glass.
2. 2.For multiple-layer glazing systems, each light or layer shall consist of any of the glazing materials specified in Item 1 above.
   Annealed glass is permitted to be used as specified in Exceptions 2 and 3 of Section 2405.3.

For additional requirements for plastic skylights, see Section 2610. Glass-block construction shall conform to the requirements of Section 2110.1.

2405.3 Screening.

Broken glass retention screens, where required, shall: (1) be capable of supporting twice the weight of the glazing; (2) be firmly and substantially fastened to the framing members and (3) be installed within 4 inches (102 mm) of the glass. The screens shall be constructed of a noncombustible material not thinner than No. 12 B&S gage (0.0808 inch) with mesh not larger than 1 inch by 1 inch (25 mm by 25 mm). In a corrosive atmosphere, structurally equivalent non-corrosive screen materials shall be used.

2405.3.1 Screens under monolithic glazing.

~~Where used in monolithic glazing systems,~~ H~~h~~eat-strengthened glass and fully tempered glass shall have screens installed below the full area of the glazing material. ~~The screens and their fastenings shall: (1) be capable of supporting twice the weight of the glazing; (2) be firmly and substantially fastened to the framing members and (3) be installed within 4 inches (102 mm) of the glass. The screens shall be constructed of a noncombustible material not thinner than No. 12 B&S gage (0.0808 inch) with mesh not larger than 1 inch by 1 inch (25 mm by 25 mm). In a corrosive atmosphere, structurally equivalent noncorrosive screen materials shall be used.~~

2405.3.2 Screens under multiple-layer glazing.

Heat-strengthened glass, fully tempered glass and wired glass~~, when used in multiple-layer glazing systems~~ used as the bottom glass layer shall have screens installed below the full area of the glazing material.~~over the walking surface, shall be equipped with screening that conforms to the requirements for monolithic glazing systems.~~

2405.3.3 Screens not required. For all other types of glazing complying with 2405.2, retention screens shall not be required.

Exceptions: In monolithic and multiple-layer sloped glazing systems, the following apply~~applies~~:

1. 1.Fully tempered glass shall be permitted to be installed without retention ~~protective~~ screens where glazed between intervening floors at a slope of 30 degrees (0.52 rad) or less from the vertical plane, and ~~shall~~ having ~~have~~ the highest point of the glass 10 feet (3048 mm) or less above the walking surface.
2. 2. Retention S~~s~~creens ~~are~~ shall not be required below any glazing material, including annealed glass, where the walking surface below the glazing material is permanently protected from the risk of falling glass or the area below the glazing material is not a walking surface.
3. 3.Retention screens shall not be required below A~~a~~ny glazing material, including annealed glass~~, is permitted to be installed without screens~~ in the sloped glazing systems of commercial or detached noncombustible greenhouses used exclusively for growing plants and not open to the public, provided that the height of the greenhouse at the ridge does not exceed 30 feet (9144 mm) above grade.

4. 4. Retention Sscreens shall not be required in individual *dwelling units* in Groups R-2, R-3 and R-4 where fully tempered glass is used as single glazing or as both panes in an insulating glass unit, and all of the following conditions are met:
   1. 4.1.Each pane of the glass is 16 square feet (1.5 m^2) or less in area.
   2. 4.2.The highest point of the glass is 12 feet (3658 mm) or less above any walking surface or other accessible area.
   3. 4.3.The glass thickness is $^3/_{16}$ inch (4.8 mm) or less.
5. 5.Retention Sscreens shall not be required for laminated glass with a 15-mil (0.38 mm) polyvinyl butyral (or equivalent) interlayer used in individual *dwelling units* in Groups R-2, R-3 and R-4, and both of the following conditions are metwithin the following limits:
   1. 5.1.Each pane of glass is 16 square feet (1.5 m^2) or less in area.
   2. 5.2.The highest point of the glass is 12 feet (3658 mm) or less above a walking surface or other accessible area.

S7433

Date Submitted	11/26/2018	**Section**	2510.3	**Proponent**	George Starks
Chapter	25	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

2511.1.1; 2511.3; 25111.4;2512.1; 2512.1.1; 2512.1.2; 2512.2; 2512.6; 2512.8; 2512.9; 2513.7;2109.3.4.8;

Summary of Modification

Seeks to update the Referenced Standards to the current published versions: C 926-18b and C 1063-18b. Significant clarifications and reorganization, to produce more user-friendly documents, have been incorporated since the 15a and 15b versions of these standards.

Rationale

Significant changes to these Standards, in the form of reorganization and re-wording, have been instituted in an effort to make the Standards more user-friendly and less confusing. Comparison files are attached.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will not impact enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

Will not impact the cost to building and property owners relative to compliance with the code.

Impact to industry relative to the cost of compliance with code

Will not impact the cost to the industry relative to compliance with the code.

Impact to small business relative to the cost of compliance with code

Will not impact the cost to small business relative to compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Proper installation of exterior cladding systems have direct impact to the health and welfare of the general public as key elements in the building envelope.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by providing to the general public, as well as industry professionals, a more clear and concise standard through re-wording, reorganization and removal of some antiquated provisions.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Makes no discriminatory remarks or statements in regards to materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

Chapter 35

ASTM

C926—~~15b~~18b Specification for Application of Portland Cement-based Plaster . . . . 2109.3.4.8, 2510.3, Table 2511.1.1, 2511.3, 2511.4, 2512.1,

2512.1.2, 2512.2, 2512.6, 2512.8.2, 2512.9, 2513.7

C1063—~~15a~~18b Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-based Plaster .. . . 2109.3.4.8, 2510.3, Table 2511.1.1, 2512.1.1

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Designation: C926–~~18b~~15b

Disclaimer: This document is not an ASTM standard and is intended only to provide the user of an ASTM standard an indication of what changes have been made to the previous version. Because it may not be technically possible to adequately depict all changes accurately, ASTM recommends that users consult prior editions as appropriate. In all cases, only the current version of the standard as published by ASTM is to be considered the official document.

Standard Specification for Application of Portland Cement-Based Plaster [1]

This standard is issued under the fixed designation C926; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

IN THIS STANDARD:

1 SCOPE *A Summary of Changes section appears at the end of this standard.

1.1 This specification covers the requirements for the application of full thickness portland cement-based plaster for exterior (stucco) and interior work. ~~These requirements do not by default define a unit of work or assign responsibility for contractual purposes, which is the purview of a contract or contracts made between contracting entities.~~

1.2 This specification sets forth tables for proportioning of various plaster mixes and plaster thickness.

NOTE 1: General information will be found in Annex A1. Design considerations will be found in Annex A2.

1.3 The values stated in inch-pound units are to be regarded as the standard. The SI (metric) values given in parentheses are approximate and are provided for information purposes only.

1.4 The text of this specification references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the specification.

1.5 Details of construction for a specific assembly to achieve the required fire resistance shall be obtained from reports of fire-resistance tests, engineering evaluations, or listings from recognized fire testing laboratories. ~~1.6 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.~~

2 REFERENCED DOCUMENTS

2.1 ASTM Standards: [2]

C11 Terminology Relating to Gypsum and Related Building Materials and Systems

C25 Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime

C35 Specification for Inorganic Aggregates for Use in Gypsum Plaster

C91 Specification for Masonry Cement

C150 Specification for Portland Cement

C206 Specification for Finishing Hydrated Lime

C207 Specification for Hydrated Lime for Masonry Purposes

C219 Terminology Relating to Hydraulic Cement

C260 Specification for Air-Entraining Admixtures for Concrete

C578 Specification for Rigid, Cellular Polystyrene Thermal Insulation

C595 Specification for Blended Hydraulic Cements

C631 Specification for Bonding Compounds for Interior Gypsum Plastering

C897 Specification for Aggregate for Job-Mixed Portland Cement-Based Plasters

C932 Specification for Surface-Applied Bonding Compounds for Exterior Plastering

C1063 Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster

C1116 Specification for Fiber-Reinforced Concrete and Shotcrete

C1328 Specification for Plastic (Stucco) Cement ~~C1787 Specification for Installation of Non Metallic Plaster Bases (Lath) Used with Portland Cement Based Plaster in Vertical Wall Applications~~

E90 Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

E119 Test Methods for Fire Tests of Building Construction and Materials

E492 Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine

2.2 ANSI Standard:

A108.1 Specification for Installation of Ceramic Tile [3]

3 TERMINOLOGY

3.1 Terms shall be defined as in Terminologies C11 and C219, except as modified herein.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *accelerator, n*—an admixture that will shorten the setting time of plaster.

3.2.2 *admixture, n*—a material other than water, aggregate, or basic cementitious material added to the batch before or during job mixing.

3.2.3 *acid etching, n*—the cleansing and controlled erosion of a solid surface, using an acid wash.

3.2.4 *air entrainment, n*—the use of an air-entraining admixture or air-entraining cementitious material in a plaster mix to yield a controlled quantity of minute (typically between 10 and 1000 μm in diameter) disconnected air bubbles in the plaster (see *entrapped air*).

3.2.5 *back wrap, n*—a means of terminating a polymer-modified, fabric reinforced cementitious base coat by wrapping the reinforcing mesh, which has been affixed to the substrate onto the outboard surface of the foam plastic core to provide continuity of the reinforced base coat and protection for the foam plastic core.

3.2.6 *backplaster, n*—plaster applied to the face of metal lath opposite a previously applied plaster.

3.2.7 *barrier wall, n*—type of wall system that is intended to block or interrupt the movement of water to the interior.

3.2.8 *bond, n*—the state of adhesion between plaster coats or between plaster and plaster base.

3.2.9 *bonding compound or agent, n*—compounds surface applied or integrally mixed with plaster to improve the quality of bond between plaster and plaster base or between plaster coats.

3.2.10 cementitious material, n—a material that, when mixed with water and with or without aggregate, provides the plasticity and the cohesive and adhesive properties necessary for placement and the formation of a rigid mass.

3.2.11 coat, n—a thickness of plaster applied in a single operation.

3.2.11.1 basecoat, n—all plaster applied before the application of the finish coat.

3.2.11.2 bedding coat, n—a plaster coat that receives aggregate or other decorative material impinged into its surface before it sets.

3.2.11.3 brown coat, n—in three-coat work, the second coat, applied over the scratch coat. In two-coat work, brown coat refers to the double-up basecoat. In either use, the brown coat is the coat directly beneath the finish coat.

3.2.11.4 dash-bond coat, n—a thick wet mixture of portland cement and water, with or without aggregate, dashed onto the surface of a plaster base such as smooth monolithic concrete or concrete block surfaces to improve the mechanical key for subsequent plaster coats.

3.2.11.5 double-up coat, n—the brown-coat plaster applied to the scratch coat plaster before the scratch-coat plaster has set.

3.2.11.6 finish coat, n—the final layer of plaster applied over basecoat plaster.

3.2.11.7 fog coat, n—a light coat of cement and water, with or without aggregate or color pigment, applied by machine spray to improve color consistency.

3.2.11.8 scratch coat, n—the first coat of plaster applied to a plaster base.

3.2.11.9 skim coat, n—a thin finish coat applied to an existing plaster surface or other substrate to improve appearance.

3.2.11.10 three-coat work, n—application of plaster in three successive coats with time between coats for setting or drying, or both.

3.2.12 cold joint ("joining" or "jointing"), n—the juncture of fresh plaster application adjacent to set plaster, in the same plane.

3.2.13 curing, v—the act or processes of producing a moisture environment favorable to cement hydration, resulting in the setting or hardening of the plaster.

3.2.14 drainage wall, n—a wall system in which the cladding provides a substantial barrier to water intrusion, and which also incorporates a concealed water-resistive barrier over which drainage will occur.

3.2.15 entrapped air, n—unintentional air voids in the plaster generally larger than 1 mm.

3.2.16 factory prepared ("mill-mixed" or "ready mixed"), adj—pertaining to material combinations that have been formulated and dry-blended by the manufacturer, requiring only the addition of and mixing with water to produce plaster.

3.2.17 fiber, natural or synthetic, n—an elongated fiber or strand admixture added to plaster mix to improve cohesiveness or pumpability, or both.

3.2.18 floating, v—act of compacting and leveling brown-coat plaster to a reasonably true surface plane using a float tool or the act of bringing the aggregate to the surface of finish-coat plaster.

3.2.19 key (also mechanical key), n—plaster that physically surrounds, penetrates, or deforms to lock onto the perforations or irregularities of the plaster base or previous coat of plaster.

3.2.20 metal plaster base, n—expanded metal lath, or welded or woven wire lath.

3.2.21 plaster, n—portland cement-based cementitious mixture (see *stucco*).

3.2.22 polymer modified cementitious base coat, n—A base coat containing portland cement modified with chemical admixtures (typically polymer latexes) to improve characteristics of the finished product, such as workability, plasticity, water resistance, and adhesion.

3.2.23 required, adj—pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.

3.2.24 rustication (also "break"), n—an interruption or change in plane of a plastered surface.

3.2.25 scoring (also known as "scratching"), n—the grooving of the surface of an unset plaster coat to provide a key for a subsequent coat.

3.2.26 set, n—the chemical and physical change in plaster as it goes from a plastic, workable state to a rigid state.

3.2.27 solid plaster bases, n—substrates that do not require a metal plaster base, including cast in place and precast concrete, concrete and stone masonry, clay brick, and tile.

3.2.28 stucco, n—portland cement-based plaster used on exterior locations.

3.2.29 stucco finish, n—a factory-prepared, dry blend of materials for finish coat applications.

3.2.30 temper, v—to mix or restore unset plaster with water to a workable consistency.

3.2.31 texture, n—any surface appearance as contrasted to a smooth surface. ~~3.3 Definitions of Terms Not Specific to This Standard 3.3.1 contract documents, n—a series of several individual items that generally include drawings and specifications. Either or both of these documents may exist for any particular project.~~

4 ~~DELIVERY AND STORAGE OF~~ MATERIALS

4.1 ~~Delivery: 4.1.1 Packaged materials shall be delivered in factory-sealed, unopened, and unbroken packages, containers, or bundles. 4.1.2 Bulk materials shall be delivered in clean transport vessels, free of contaminates. 4.2 Storage: 4.2.1 Weather-sensitive materials shall be kept in a dry condition until ready for use. (See A2.4.) 4.2.2 Bulk materials shall be stored to prevent subsequent contamination and segregation. 5~~ Materials ~~5.1 Materials~~ shall conform to the requirements of the referenced specifications and standards and to the requirements specified herein. ~~5.2~~

4.2 Cement: ~~5.2.1~~

4.2.1 *Portland Cement*—Specification C150, Type I, II, and III, as specified. White where specified. ~~5.2.2~~

4.2.2 *Air-Entraining Portland Cement*—Specification C150, type as specified. White where specified. ~~5.2.3~~

4.2.3 *Masonry Cement*—Specification C91, Types N, S, and M. White where specified. ~~5.2.4~~

4.2.4 *Blended Hydraulic Cement*—Specification C595, Type IP, IS(με70), IL, and IT(Sμε70), as specified. ~~5.2.5~~

4.2.5 *Air-Entraining Blended Hydraulic Cement*—Specification C595, Type IP-(A), IS(με70)-(A), IL-(A), and IT (Sμε70)-(A), as specified. ~~5.2.6~~

4.2.6 *Plastic Cement*—Plastic Cement shall meet the requirements of Specification C1328, Standard Specification for Plastic (Stucco) Cement.

NOTE 2: Plastic cements are not available nationally. ~~5.3~~

4.3 Type "S" Hydrated Lime—A hydrated lime that contains not more than 8 % unhydrated oxides when tested in accordance with Test Methods C25. See Specifications C206 and C207 for a complete description of a Type "S" hydrated lime. ~~5.4~~

4.4 Aggregates: ~~5.4.1~~

4.4.1 *Sand for Base Coats*—Specification C897. Aggregate failing to meet gradation limits in Specification C897 shall be permitted to be used, provided the plaster made with this sand has an acceptable demonstrated performance record in similar construction and climate conditions. 5.4.2

4.4.2 *Perlite*—Specification C35. 5.4.3

4.4.3 *Sand for Job-Mixed Finish Coats*—Specification C897. 5.5

4.5 Water—Water used in mixing, application, and finishing of plaster shall be clean, fresh, suitable for domestic water consumption, and free of such amounts of mineral or organic substances as would affect the set, the plaster, or any metal in the system. 5.6

4.6 Admixtures—See 3.2.2 and A2.5. 5.7

4.7 Fibers—Specification C1116 on alkali-resistant fibers, glass fibers, nylon, polypropylene or carbon fibers. 5.8

5 PRODUCT MARKING—PACKAGED MATERIALS SHALL BE CLEARLY MARKED OR LABELED TO INDICATE PRODUCT, BRAND NAME, THE MANUFACTURER, AND THE WEIGHT OF THE MATERIAL CONTAINED THEREIN. SIMILAR INFORMATION SHALL BE PROVIDED IN THE SHIPPING ADVICES ACCOMPANYING THE SHIPMENT OF BULK MATERIALS. 6 REQUIREMENTS FOR BASES TO RECEIVE PORTLAND CEMENT-BASED PLASTER 6.1

5.1 Metal plaster bases bases, and lathing accessories, furring accessories and fasteners used to receive plaster shall be installed in conformance with Specification C1063, except as otherwise specified. Non-metallic

NOTE PLASTER 3: bases All used metal, to or receive PVC, plaster or shall CPVC be plastic installed members in should conformance with Specification C1787. Note 3: Plaster bases and lathing accessories shall be free of deleterious amounts of rust, oil, or other foreign matter, which could cause bond failure or unsightly discoloration. 6.2

5.2 Surfaces of solid bases to receive plaster, such as masonry, stone, cast-in-place or precast concrete shall be straight and true within $^1/_4$ in. (6 mm) in 10 ft (3 (2.1 m) mm/m) and shall be free of form oil or other elements, which would interfere with bonding. Conditions where the surfaces are out of tolerance shall be corrected prior to the application of the plaster. Ferrous-containing form ties or other obstructions shall be removed or receded a minimum 1 1/8/8 in. (3 mm) below the surface of the solid base and treated with a corrosion-resistant coating. Non-ferrous protuberances shall be permitted to be trimmed back even with the surface of the solid base. 6.2.1

5.2.1 Solid surfaces shall have the suction (ability to absorb water) or surface roughness, or both, to provide the bond required for the plaster. 6.2.2

5.2.2 Smooth or nonabsorbent solid surfaces, such as cast-in-place or precast concrete, shall be prepared to receive portland cement plaster by one of the following methods: 6.2.2.1

5.2.2.1 Sandblasting, wire brushing, acid etching, or chipping or a combination thereof, 6.2.2.2

5.2.2.2 Application of a dash-bond coat applied forcefully against the surface, left untroweled, undisturbed, and moist cured for at least 24 h, or 6.2.2.3

5.2.2.3 Application of a bonding compound suitable for exterior or interior exposure solid surfaces in accordance with the manufacturer's written directions. 6.2.3

5.2.3 Where bond cannot be obtained by one or more of the methods in 6.2.2 5.2.2, a furred or self-furring metal plaster base shall be installed in accordance with Specification C1063 or. C1787 as appropriate. Where metal plaster base is used in areas where bond cannot be obtained by one or more of the methods in 6.2.2 5.2.2, accessories shall be installed in accordance with Specification C1063 or. C1787

6 AS PLASTER APPROPRIATE. PROPORTIONS 7 AND APPLICATION MIXING 7.1

6.1 Plaster Proportions: 7.1.1

6.1.1 All portland cement plasters shall be mixed and proportioned in accordance with the following tables and accompanying requirements, using measuring devices of known volume with successive batches proportioned alike. ~~7.1.2~~

6.1.2 Plaster mix used shall be as designated and referenced to Table 1.

TABLE 1 Plaster Bases—Permissible Mixes

NOTE 1: See Table 2 for plaster mix symbols.

Property of Base	Mixes for Plaster Coats	
	First (Scratch)	Second (Brown)
Low absorption, such as dense, smooth clay tile, brick, or concrete	C	C, CL, M, or CM
	CM or MS	CM, MS, or M
	P	P
High Absorption, such as concrete masonry, absorptive brick, or tile	CL	CL
	M	M
	CM or MS	CM, MS, or M
	P	P
Metal plaster base	C	C, CL, M, CM, or MS
	CL	CL
	CM or MS	CM, MS, or M
	M	M
	CP	CP or P
	P	P ~~7.1.3~~

6.1.3 Base-coat proportions shall be as shown in Table 2 for the mix specified from Table 1.

TABLE 2 Base-Coat Proportions,[A] Parts by Volume[B]

Plaster Mix Symbols	Cementitious Materials					Volume of Aggregate per Sum of Separate Volumes of Cementitious Materials	
	Portland Cement or Blended Cement	Plastic Cement	Masonry Cement		Lime		
			N	M or S		1st Coat	2nd[C] Coat
C	1	. . .	. . .	. . .	$0–^{3}/_{4}$	$2^{1}/_{2}–4$	3–5
CL	1	. . .	. . .	. . .	$^{3}/_{4}–1^{1}/_{2}$	$2^{1}/_{2}–4$	3–5
M	. . .	. . .	1	. . .	. . .	$2^{1}/_{2}–4$	3–5
CM	1	. . .	1	. . .	. . .	$2^{1}/_{2}–4$	3–5
MS	. . .	. . .	. . .	1	. . .	$2^{1}/_{2}–4$	3–5

Plaster Mix Symbols	Cementitious Materials					Volume of Aggregate per Sum of Separate Volumes of Cementitious Materials	
	Portland Cement or Blended Cement	Plastic Cement	Masonry Cement		Lime		
			N	M or S		1st Coat	2nd Coat
P	. . .	1	. . .	. . .	. . .	$2^1/_2$–4	3–5
CP	1	1	. . .	. . .	. . .	$2^1/_2$–4	3–5

(A) The mix proportions for plaster scratch and brown coats to receive ceramic tile shall be in accordance with the applicable requirements of ANSI A108.1 series applicable to specified method of setting time.

(B) Variations in lime, sand, and perlite contents are allowed due to variation in local sands and insulation and weight requirements. A higher lime content will generally support a higher aggregate content without loss of workability. The workability of the plaster mix will govern the amounts of lime, sand, or perlite.

(C) The same or greater sand proportion shall be used in the second coat than is used in the first coat. ~~7.1.3.1~~

6.1.3.1 *Measurement of Materials*—**The method of measuring materials for the plaster shall be such that the specified proportions are controlled and accurately maintained. The weights per cubic foot of the materials are considered to be as follows:**

Material	Weight, lb/ft^3 (kg/m^3)
Portland cement	94 (1505)
Blended cement	Weight printed on bag
Masonry or plastic cement	Weight printed on bag
Hydrated Lime	40 (640)
Lime Putty	80 (1280)
Sand, Damp and Loose (~~7.1.3.2~~6.1.3.2)	80 (1280) of dry sand ~~7.1.3.2~~

6.1.3.2 **For purposes of this specification, a weight of 80 lb (1280 kg) of oven-dried sand shall be used. This is, in most cases, equivalent to one cubic foot of loose, damp sand.** ~~7.1.4~~

6.1.4 **Finish-coat proportions for job-mixed finish coats shall be as specified in** Table 3.

TABLE 3 Job-Mixed Finish Coat Proportion Parts by Volume

Plaster Mix Symbols[A]	Cementitious Materials					Volume of Aggregate per Sum of Separate Volumes of Cementitious Materials[B]
	Portland Cement or Blended Cement	Plastic Cement	Masonry Cement[A]		Lime	
			N	M or S		
F	1	. . .	. . .	. . .	$^3/_4$–$1^1/_2$	$1^1/_2$–3
FL	1	. . .	. . .	. . .	$1^1/_2$–2	$1^1/_2$–3
FM	. . .	. . .	1	. . .	. . .	$1^1/_2$–3
FCM	1	. . .	1	. . .	. . .	$1^1/_2$–3
FMS	. . .	. . .	. . .	1	. . .	$1^1/_2$–3

Plaster Mix Symbols	Cementitious Materials					Volume of Aggregate per Sum of Separate Volumes of Cementitious Materials
	Portland Cement or Blended Cement	Plastic Cement	Masonry Cement		Lime	
			N	M or S		
FP	. . .	1	. . .	. . .	. . .	$1^1/_2$ –3

(A) Additional portland cement is not required when Type S or M masonry cement is used.

(B) In areas not subject to impact, perlite aggregate shall be permitted to be used over base-coat plaster containing perlite aggregate. 7.1.5

6.1.5 ***Factory-Prepared Finish Coats***—See 3.2.16. 7.1.6

6.1.6 Dash-bond coat proportions shall be 1 volume part portland cement and not more than 2 volume parts of aggregate mixed to a consistency that will permit application as specified in 7.3.5 7.1.5. 7.1.7

6.1.7 Admixtures shall be proportioned, mixed, and applied in accordance with the printed directions of the manufacturer. (See A2.5.) 7.1.8

6.2 ~~Where specified, natural or synthetic fibers shall be free of contaminants and used only in the base coat(s). The quantities per batch shall be in accordance with the published directions of the fiber manufacturer. 7.2~~ Mixing: ~~7.2.1~~

6.2.1 All plaster shall be prepared in a mechanical mixer, using sufficient water to produce a workable consistency and uniform color. (See X1.1.) 7.2.2

6.2.2 Base-coat plasters that have stiffened because of evaporation of water shall be permitted to be tempered one time only to restore the required consistency. Plaster not used within $1^1/_2$ h from start of initial mixing shall be discarded.

NOTE 4: Severe hot, dry climate conditions accelerate the stiffening of plaster and require reduction of this limit. The use of cold waters will slow the stiffening process. 7.2.3

6.2.3 Finish-coat plaster shall not be tempered. 7.3

7 ~~GENERAL~~ APPLICATION ~~APPLICATION:~~

7.1 ~~7.3.1~~ General:

7.1.1 Portland cement plaster shall be applied by hand ~~trowel~~ or machine to the nominal thickness specified in Table 4. The nominal values expressed in Table 4 represent neither a maximum nor minimum value. They consider the inherent variation of thickness due to the nature of the application process, and the allowable variation of the substrate and the finished plane of the plaster.

TABLE 4 Nominal Plaster Thickness[A] for Three- and Two-Coat Work, in. (mm)

BASE	Vertical				Horizontal			
	1st Coat	2nd Coat	3rd Coat[B]	Total	1st Coat	2nd Coat	3rd Coat[B]	Total
	Interior/Exterior							
Three-coat work:[C]								
Metal plaster base	$^3/_8$ ~~(10)~~ (9.5)	$^3/_8$ ~~(10)~~ (9.5)	$^1/_8$ (3)	$^7/_8$ (22)	$^1/_4$ (6)	$^1/_4$ (6)	$^1/_8$ (3)	$^5/_8$ (16)
Solid plaster base:								

BASE	Vertical				Horizontal			
	1st Coat	2nd Coat	3rd Coat	Total	1st Coat	2nd Coat	3rd Coat	Total
	Interior/Exterior							
Unit masonry	1/4 (6)	1/4 (6)	1/8 (3)	5/8 (16)	Use two-coat work			
Cast-in-place or precast concrete	1/4 (6)	1/4 (6)	1/8 (3)	5/8 (16)				3/8 ~~(10),~~ (9.5), max
Metal plaster base over solid base	1/2 ~~(13)~~ (12.5)	1/4 (6)	1/8 (3)	7/8 (22)	1/2 ~~(13)~~ (12.5)	1/4 (6)	1/8 (3)	7/8 (22)
Two-coat work:								
Solid plaster base:								
Unit masonry	3/8 ~~(10)~~ (9.5)	1/8 (3)		1/2 ~~(13)~~ (12.5)				3/8 ~~(10)~~ (9.5)
Cast-in-place or pre-cast concrete	1/4 (6)	1/8 (3)		3/8 ~~(10)~~ (9.5)				3/8 ~~(10)~~ (9.5)

(A) Exclusive of texture.

(B) For solid plaster partitions, additional coats shall be applied to meet the finished thickness specified.

(C) For exposed aggregate finishes, the second (brown) coat shall become the "bedding" coat and shall be of sufficient thickness to receive and hold the aggregate. ~~7.3.2~~

7.1.2 Plaster nominal thickness shall be measured from the back plane of the metal plaster base, exclusive of ribs or dimples, or from the face of the solid backing with or without metal plaster base, to the outer surface exclusive of texture variations. ~~7.3.3~~

7.1.3 Portland cement-based plaster shall be applied on furred metal plaster base when the surface of solid backing consists of gypsum board, gypsum plaster, wood, or rigid foam board-type products.

NOTE 5: On horizontal ceiling supports or roof soffits protected by a drip ~~edge~~ edge, ~~or designated drainage screed,~~ gypsum board products shall be permitted to be used as backing for metal base to receive portland cement plaster. ~~7.3.4~~

7.1.4 Separation shall be provided where plaster abuts dissimilar construction materials or openings. (See ~~A2.1.3~~ A2.1.4.) ~~7.3.5~~

7.1.5 Each plaster coat shall be applied to an entire wall or ceiling panel without interruption to avoid cold joints and abrupt changes in the uniform appearance of succeeding coats. Wet plaster shall abut set plaster at naturally occurring interruptions in the plane of the plaster, such as corner angles, rustications, openings, expansion joints, and control joints where this is possible. Joinings, where necessary, shall be cut square and straight and not less than 6 in. (152 mm) away from a joining in the preceding coat. ~~7.3.6~~

7.1.6 Metal plaster base shall be covered with three-coat work with or without solid backing. The combined total nominal thickness shall be as shown in Table 4. A dash-bond coat shall not replace one of the specified number of coats. ~~7.3.7~~

7.1.7 Two-coat work shall be used only over solid bases meeting the requirements of ~~6.2~~ 5.2. The combined total nominal thickness shall be as shown in Table 4. A dash-bond coat shall not replace one of the specified number of coats. ~~7.3.8~~

7.1.8 Backplaster where required, shall be applied only after the coat on the opposite side has set sufficiently to resist breaking or cracking the plaster keys. ~~7.3.9~~

7.1.9 Each coat shall be permitted to set before the next coat is applied. (See X1.5.2.) ~~7.3.10~~

7.1.10 Plaster coats that have become dry shall be evenly dampened with water prior to applying subsequent coats to obtain uniform suction. There shall be no visible water on the surface when plaster is applied. 7.4

7.2 Plaster Application on Metal and Non-Metallic Plaster Bases: 7.4.1

7.2.1 The first (scratch) coat shall be applied with sufficient material and pressure to form full keys through, and to embed the metal base, and with sufficient thickness of material over the metal to allow for scoring the surface. 7.4.1.1

7.2.1.1 As soon as the first (scratch) coat becomes firm, the entire surface shall be scored in one direction only. The vertical surfaces shall be scored horizontally. 7.4.1.2

7.2.1.2 The first (scratch) coat shall become sufficiently rigid to support the application of the second (brown) coat without damage to the monolithic continuity of the first (scratch) coat or its key. 7.4.2

7.2.2 The second (brown) coat shall be applied with sufficient material and pressure to ensure tight contact with the first (scratch) coat and to bring the combined thickness of the base coat to the nominal thickness shown in Table 4. 7.4.2.1

7.2.2.1 The surface of the second (brown) coat shall be brought to a true, even plane with a rod or straightedge, filling surface defects in plane with plaster. Dry rodding the surface of the brown coat shall be permitted. 7.4.2.2

7.2.2.2 The surface shall be floated uniformly to promote densification of the coat and to provide a surface receptive to bonding of the finish coat. 7.4.3

7.2.3 The third (finish) coat shall be applied with sufficient material and pressure to ensure tight contact with, and complete coverage of the base coat and to the nominal thickness shown in Table 4 and 7.5.1.1 7.3.1.1. 7.5

7.3 Plaster Application on Solid Plaster Bases: 7.5.1

7.3.1 High-suction bases shall be evenly dampened with clean water prior to the application of plaster. Do not dampen low-suction solid bases, such as dense concrete or smooth brick. 7.5.1.1

7.3.1.1 Where masonry or concrete surfaces vary in plane, plaster thickness required to produce level surfaces shall not be required to be uniform. 7.5.2

7.3.2 *Three-Coat Application on Solid Bases:* 7.5.2.1

7.3.2.1 The first (scratch) coat shall be applied with sufficient material and pressure to ensure tight contact and complete coverage of the solid base, to the nominal thickness shown in Table 4. As soon as the first (scratch) coat becomes firm, the entire surface shall be scored in one direction only. The vertical surfaces shall be scored horizontally. 7.5.2.2

7.3.2.2 The second (brown) coat shall be applied using the same procedures specified in 7.4.2 7.2.2 and 7.4.2.1 7.2.2.1, bringing the surface to a true, even plane with a rod or straightedge, filling any defects in plane with plaster and darbying. The surface shall be floated uniformly to provide a surface receptive to the application of the third (finish) coat. 7.5.2.3

7.3.2.3 The third (finish) coat shall be applied as specified in 7.4.3 7.2.3. 7.5.3

7.3.3 *Two-Coat Application on Solid Plaster Bases:* 7.5.3.1

7.3.3.1 The first (scratch) coat shall be applied as specified in 7.5.2.1 7.3.2.1. 7.5.3.2

7.3.3.2 The second (finish) coat shall be applied as specified in 7.4.3 7.2.3. 7.6

7.4 Finish-Coat Application: 7.6.1

7.4.1 Job-mixed or factory-prepared finish coats shall be applied, by machine or by hand, as specified in ~~7.4.3~~ 7.2.3. ~~7.6.2~~

7.4.2 The use of excessive water during the application and finishing of finish-coat plaster shall be avoided. ~~7.7~~

7.5 Fog-Coat Application—Job-mixed or factory-prepared fog coats shall be applied in accordance with the directions of the manufacturer. ~~7.8~~

8 CURING AND TIME BETWEEN COATS ~~7.8.1~~

8.1 Provide sufficient moisture in the plaster mix or by moist or fog curing to permit continuous hydration of the cementitious materials. The most effective procedure for curing and time between coats will depend on climatic and job conditions. (See X1.5.2.) ~~7.8.2~~

8.2 Sufficient time between coats shall be allowed to permit each coat to cure or develop enough rigidity to resist cracking or other physical damage when the next coat is applied. (See X1.5.2.) ~~7.9~~

9 PRODUCT MARKING

9.1 Packaged materials shall be clearly marked or labeled to indicate product, brand name, the manufacturer, and the weight of the material contained therein. Similar information shall be provided in the shipping advices accompanying the shipment of bulk materials.

10 DELIVERY OF MATERIALS

10.1 Packaged materials shall be delivered in factory-sealed, unopened, and unbroken packages, containers, or bundles.

10.2 Bulk materials shall be delivered in clean transport vessels, free of contaminates.

11 PROTECTION OF MATERIALS

11.1 Weather-sensitive materials shall be kept in a dry condition until ready for use. (See A2.4.)

11.2 Bulk materials shall be stored to prevent subsequent contamination and segregation.

12 ENVIRONMENTAL ~~CONDITIONS:~~ CONDITIONS ~~7.9.1~~

12.1 Portland cement-based plaster shall not be applied to frozen base or to a base containing frost. Plaster mixes shall not contain frozen ingredients. Plaster coats shall be protected from freezing for a period of not less than 24 h after set has occurred. ~~7.9.2~~

12.2 Portland cement plaster shall be protected from uneven and excessive evaporation during dry weather and from strong blasts of dry air. ~~7.9.3~~

12.3 Plaster Application—When artificial heat is required, heaters shall be located to prevent a concentration of heat on uncured plaster. Heaters shall be vented to the outside to prevent toxic fumes and other products of combustion from adhering to or penetrating plaster bases and plaster. Adequate ventilation shall be maintained in all areas, particularly in interior areas with little or no natural air movement. ~~7.9.3.1~~

12.3.1 Interior environment shall be maintained at a temperature above 40 °F not less than 48 h prior to and during application of portland cement-based plaster. Interior temperature shall be maintained above 40 °F until normal occupancy. ~~7.9.3.2~~

12.3.2 For exteriors, plaster shall be applied when the ambient temperature is higher than 40 °F (4.4 °C), unless the work area is enclosed and heat is provided as described in 7.9.3 12.3. 8

13 KEYWORDS 8.4

13.1 bond; brown coat; cementitious; exterior plaster; fog coat; portland cement; scratch coat; stucco

ANNEXES

(Mandatory Information)

A1 GENERAL INFORMATION

A1.1 The work shall include all labor, materials, services, equipment, and scaffolding required to complete the plastering of the project in accordance with the drawings and specifications, except heat, electric power, and potable water.

A1.2 Where a specific degree of fire resistance is required for plastered assemblies and constructions, details of construction shall be in accordance with official reports of fire tests conducted by recognized testing laboratories, in accordance with Test Methods E119. A1.2

A1.3 Where a specific degree of sound control is required for plastered assemblies and constructions, details of construction shall be in accordance with official reports of tests conducted by recognized testing laboratories, in accordance with applicable sound tests of Test Methods E90 or E492. A1.3

A1.4 Scaffolding shall be constructed and maintained in strict conformity with applicable laws and ordinances. A1.4

A1.5 Work schedules shall provide for completion of work affecting supports, framework or lath of a suspended ceiling (such as loading) before plastering work is accomplished. A1.5

A1.6 Surfaces and lathing accessories to receive plaster shall be examined before plastering is applied thereto. The proper authorities shall be notified and unsatisfactory conditions shall be corrected prior to the application of plaster. The plastering contractor shall use this portion of the construction specifications for acceptance or rejection of such surfaces. A1.5.1

A1.6.1 Metal plaster bases, backing, attachment, and lathing accessories to receive plaster shall be examined to determine if the applicable requirements of Specification C1063 have been met unless otherwise required by the contract specifications. A1.5.2

A1.6.2 Lathing Accessories accessories shall be installed prior to the application of plaster; therefore, their type, location, depth, ground dimension, and orientation location shall be included in the project contract documents. Where

A1.6.3 masonry or concrete surfaces vary in plane, plaster thickness required to produce level surfaces shall not be required to be uniform. A1.5.3 The construction specifier shall describe, in the proper section of the contract specifications, the physical characteristics of solid surface bases to receive plaster, including measures to promote bond. The plane tolerance shall be not more than $^1/_4$ in. (6 mm) in 10 ft (3 (3.1 m). mm/m). The mortar joints shall be flush and not struck. Dissimilar ferrous-containing materials such as ties, reinforcing steel, and so forth, shall be cut back a minimum $^1/_8$ in. (3 mm) below the surface and treated with a corrosion-resistant coating. Dissimilar non-ferrous protuberances shall be permitted to be trimmed back even with the surface of the solid base. Masonry shall be solid at corners and where masonry changes thickness in a continuous construction. Form release compounds shall be compatible with plaster or be completely removed from surfaces to receive plaster.

A2 DESIGN CONSIDERATIONS

A2.1 Exterior plaster (stucco) is applied to outside surfaces of all types of structures to provide a durable, fire-resistant covering. Interior plaster is applied to inside surfaces that will be subjected to various exposures, such as abrasion, vibration, or to continuous or frequent moisture and wetting, or to freezing or thawing.

A2.1.1 Sufficient slope on faces of plastered surfaces shall be provided to prevent water, snow, or ice from accumulating or standing. Air-entrained portland cement plaster provides improved resistance to freeze/thaw deterioration. Resistance to rain penetration is improved where plaster has been adequately densified during application and properly cured. Plaster shall not, however, be considered to be "waterproof."

A2.1.2 The construction specifier shall describe, in the appropriate section of the contract specifications, the requirements for furnishing and application of flashing. Flashing shall be specified at openings, perimeters, and terminations to prevent water from getting behind plaster. Flashing shall be corrosion-resistant material. Aluminum flashing shall not be used. Flashing supplemented with sealant shall be permitted. ~~provided the flashing and sealant are designed in a manner that does not inhibit drainage.~~

A2.1.3 Sealing or caulking of V-grooves, exposed ends, and edges of plaster panels or exterior work to prevent entry of water shall be provided.

A2.1.4 To reduce spalling where interior plaster abuts openings, such as wood or metal door or window frames, or fascia boards, the edge of three-coat plaster shall be tooled through the second and finish coats to produce a continuous small V-joint of uniform depth and width. On two-coat work, the V-joint shall be tooled through the finish coat only.

A2.1.5 Provide in the appropriate project specification section that solid bases to receive plaster shall not be treated with bond breakers, parting compounds, form oil, or other material that will prevent or inhibit the bond of the plaster to the base.

A2.1.6 Maximum allowable deflection for vertical or horizontal framing for plaster, not including cladding, shall be L/360.

A2.2 *Provisions for Drainage Behind Exterior Plaster:*

A2.2.1 At the bottom of exterior ~~drainage~~ walls where the ~~drainage~~ wall ~~plane~~ is ~~interrupted~~ supported by a ~~floor,~~ floor ~~supporting structure,~~ or foundation, ~~or~~ a ~~when~~ drip ~~drainage~~ screed ~~wall~~ and ~~assemblies~~ throughwall ~~are~~ flashing ~~constructed~~ or ~~above~~ weep ~~barrier~~ holes ~~wall assemblies, a designated drainage screed, flashing,~~ or other effective means to drain away any water that may get behind the plaster shall be provided.

A2.2.2 Where vertical and horizontal exterior plaster surfaces meet, both surfaces shall be terminated with casing beads with the vertical surface extending at least $^1/_4$ in. (6 mm) below the intersecting horizontal plastered surface, thus providing a drip edge. The casing bead for the horizontal surface shall be terminated not less than $^1/_4$ in. ~~(6 mm)~~ from the back of the vertical surface to provide drainage.

A2.3 *Relief from Stresses:*

A2.3.1 For information on the requirements for control joints and perimeter relief, where a metal plaster base is installed; see the Installation Section of ~~Specifications~~ Specification C1063 ~~or~~. ~~C1787 as applicable.~~ Solid plaster bases are exempt from these criteria, except as stated in Specification C1063, subsection 7.11.4.3.

A2.3.1.1 ~~Clean~~ Control ~~cement~~ joints ~~plaster~~ shall ~~residue~~ be ~~from~~ cleaned ~~the~~ and ~~movement~~ clear ~~gaps~~ of ~~expansion~~ plaster ~~joints~~ within ~~and from~~ the ~~flexible~~ control ~~pleats~~ area ~~of~~ after ~~control~~ plaster ~~joints~~ application and before ~~cement~~ final plaster ~~hardens.~~ set.

A2.3.1.2 Prefabricated control joints and expansion joint members shall be installed prior to the application of plaster. Their type, location, ~~ground~~ depth, ~~dimension, orientation,~~ and method of installation shall be determined by the characteristics of the substrate and included in the project contract documents.

A2.3.1.3 A groove or cut in plaster only shall not be considered a control or expansion joint.

A2.3.2 Where plaster and metal plaster base continues across the face of a concrete column, or other structural member, ~~a~~ water-resistive ~~barrier~~ building paper or felt shall be placed between the metal plaster base and the structural member (paper or plastic-backed metal plaster base shall be permitted). Where the width of the structural member exceeds the approved span capability of the metal plaster base, self-furring metal plaster base shall be used and sparingly scatter nailed to bring ~~the~~ paper ~~plaster~~ and metal base to general plane.

A2.3.3 Where dissimilar base materials abut and are to receive a continuous coat of plaster: (*1*) a two-piece expansion joint, casing beads back-to-back, or premanufactured control-expansion joint member shall be installed; or (*2*) the juncture shall be covered with a 6-in. (152 mm) wide strip of galvanized, self-furring metal plaster base extending 3 in. (76 mm) on either side of the juncture; or (*3*) where one of the bases is metal plaster base, self-furring metal plaster base shall be extended 4 in. (102 mm) onto the abutting base.

A2.4 *Weather-Sensitive Materials*—Water-sensitive materials shall be stored off the ground or floor and under cover, avoiding contact with damp floor or wall surfaces. Temperature-sensitive materials shall be protected from freezing. Bulk materials shall be stored in the area of intended use and caution shall be exercised to prevent contamination and segregation of bulk materials prior to use.

A2.5 *Admixtures*—Admixtures shall be proportioned and mixed in accordance with the published directions of the admixture manufacturer.

A2.5.1 The quantity of admixtures required to impart the desired performance is generally very small in relation to the quantities of the other mix ingredients. Batch-to-batch quantities shall be measured accurately.

A2.5.2 Air-entraining agents cause air to be incorporated in the plaster in the form of minute bubbles, usually to improve frost or freeze-thaw resistance, or workability of the plaster during application. Air-entraining agents for portland cement-based plaster shall meet the requirements of Specification C260.

A2.6 *Design and Application of Ornamental Features*:

A2.6.1 The design and construction requirements of ornamental features that project beyond the surface of the cement plaster scratch and brown coat assembly (including quoins, bands, or other similar ornamentation) are to be described in the ~~contract~~ Contract ~~documents.~~ Documents. The ~~contract~~ Contract ~~documents~~ Documents shall provide details to indicate the location, nature, and extent of the ornamental feature. The ~~design~~ Design ~~authority~~ Authority shall be responsible for compliance with applicable building code(s) and prescribed design loads. The ~~design~~ Design ~~authority~~ Authority shall also consider fire ratings and combustibility requirements in the design and selection of the ornamental feature.

A2.6.2 Ornamental features with sky-facing top surfaces that are exposed to the elements shall include sufficient slope for drainage as required by A2.1.1 or as minimally acceptable to the finish coat manufacturer, whichever is more restrictive.

A2.6.3 Ornamental features shall be isolated from load-bearing members, penetrating elements, and wall openings (such as fenestrations) as required by Specification C1063 to avoid the transfer of structural loads and to provide separation from dissimilar materials.

A2.6.4 Ornamental features shall not obstruct the function of control joints or expansion joints. The ~~design~~ Design ~~authority~~ Authority shall provide details as to how to the ornamental feature shall interact with applicable joints.

A2.6.5 Application of Field-Coated Foam Core Ornamental Features—Field-finished ornamental features consist of foam plastic cores encapsulated with a polymer-modified cementitious base coat with an acrylic finish coat or other approved manufactured finish. The foam plastic cores are adhesively attached to the brown coat either before or after encapsulation in the field.

A2.6.5.1 Ornamental features shall be adhered to the plaster brown coat with an adhesive compatible with portland cement plaster and the ornamental core manufacturer. The ornamental feature shall be integrated with the plaster brown coat with consideration provided to crack control and moisture infiltration. The base coat of the material that encapsulates the core of the ornamental feature shall continue onto the surface of the plaster brown coat without interruption. Crack control and moisture penetration resistance of the ornamental feature shall be addressed in the ~~contract~~ Contract ~~documents~~ Documents for plaster thickness that is less than those values provided in Table 4.

A2.6.5.2 Cores of ornamental features shall be permitted to be fabricated of expanded polystyrene (EPS) conforming to Specification C578 Type I or II having a minimum density of 0.9 lb/ft^3 (14.4 kg/m^3). The thickness of the core shall be no less than ¾ in. (19 mm).

A2.6.5.3 Foam core ornamental features shall be permitted to be covered with a variety of materials. A polymer-modified, fabric reinforced cementitious base coat and an acrylic finish coat shall be an acceptable finish over the ornamental feature. The design authority shall give consideration to profile differences in the finish coat (such as variation in shade, color, and sheen) that may result at the transition of the polymer-modified and portland cement base coat materials.

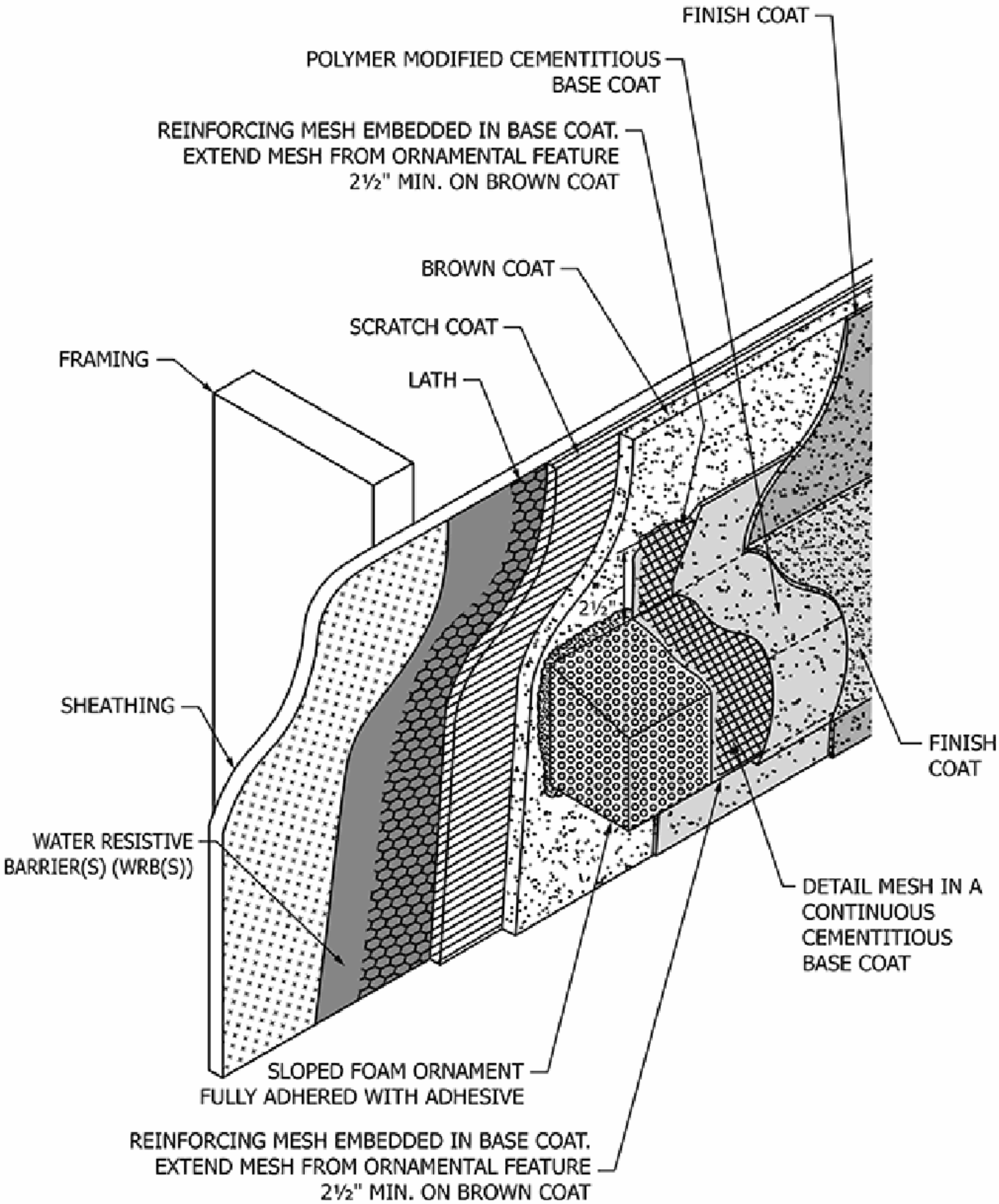
Nominal thickness for standard impact resistant base coats shall range from ~~1~~ 1/16~~/16~~ to ~~3~~ 3/32~~/32~~ in. ~~(2~~ (1.58 to ~~3~~ 2.38 mm) and be applied over nominal 4 oz/yd^2 (135.6 g/m^2) standard impact mesh. Thickness of impact-resistant base coats and nominal weight of impact-resistant mesh shall follow the manufacturer's installation instructions. The design authority shall give consideration to prevent impact damage to ornamental features.

Mesh shall be embedded in the base coat and extend a minimum of 2.5 in. ~~(64~~ (63.5 mm) beyond the ornamental feature. Where extension beyond the ornamental feature is not possible, backwrapping shall be provided.

A2.6.5.4 Application of the finish coat shall follow the manufacturer's installation instructions for the specific finish type. When cement-based finishes are applied, a bonding agent or admixture shall be used to insure proper adhesion to the polymer-modified base coat.

A2.6.5.5 A sample detail of an ornamental feature encapsulated with an exterior polymermodified cementitious base coat and detailing mesh is provided in Fig. A2.1. As depicted in the sample detail, the encapsulating material is continuous onto the surface of the plaster brown coat without interruption, providing a seamless transition between the ornamental feature and wall surface.

FIG. A2.1 Sample Detail of Ornamental Feature Consisting of Foam Plastic Core Encapsulated with Polymer Modified Cementitious Base Coat and Finish Coat



APPENDIX

(Nonmandatory Information)

X1 GENERAL INFORMATION

X1.1 *Additions*—Bonding compounds or agents may be pre-applied to a surface to receive plaster. In this usage it is not considered an admixture. Bonding compounds that are integrally mixed with plaster prior to its application are considered admixtures. Where exterior exposure and cyclic wetting are anticipated, the re-emulsification capability of the bonding material must be considered. Bonding agents are only as good as the material surface to which they are applied; therefore, form release materials must be removed from concrete or be compatible with the bonding material used. Bonding agents, agents in plaster mixes may increase the cohesive properties of the plaster. Bonding agents, agents where used, should meet the requirements of Specifications C631 for interior plastering or C932 for. exterior plastering.

X1.1.1 By the use of a suitable admixture or additive, it is possible to improve plaster's resistance to moisture movement. However, the use of the terms dampproofing or water proofing is misleading, and their use shall be discouraged.

X1.1.2 Natural or synthetic fibers fibers, 1/2 to 2 in. (13 to 51 mm) in length and free of contaminates may be specified to mitigate improve resistance to cracking or to impart improved pumpability characteristics. The quantities per batch shall be in accordance with the formation published directions of visible the cracking fiber during manufacturer. hydration. No more than 2 lb (0.90 kg) of fiber should be used per cubic foot of cementitious material. Asbestos fibers should not be used. Alkaline-resistant glass fibers are recommended where glass fiber is used.

X1.1.3 Plasticizers containing hydrated lime putty, air-entraining agents, or approved fatteners to increase the workability of a portland cement plaster may be used. Plaster consistency and workability are affected by plasticizers that are beneficial in proper quantities from an economic standpoint, but in excess can be detrimental to the long-term performance of the plaster in place.

X1.1.4 Color material for integral mixing with plaster should not significantly alter the setting, strength development, or durability characteristics of the plaster. Natural or mineral pigments that are produced by physical processing of materials mined directly from the earth appear to offer the best long-term performance with respect to resistance to fading. Plaster color is determined by the natural color of the cementitious materials, aggregate, and any color pigment, and their proportions to each other. The use of white cement with the desired mineral oxide pigment color material may result in truer color.

X1.1.4.1 The uniformity of color cannot be guaranteed by the materials manufacturer of the component materials or by the applicating contractor. Color uniformity is affected by the uniformity of proportioning, thoroughness of mixing, cleanliness of equipment, application technique, and curing conditions and procedure, which are generally under the control of the applicator. Color uniformity is affected to an even greater degree by variations in thickness and differences in the suction of the base coat from one area or location to another, the type of finish selected, the migration of color pigments with moisture, and with job site climatic and environmental conditions. These factors are rarely under the control of the applicator.

X1.1.5 Corrective measures for conditions cited in 6.2 5.2 include sandblasting, the chipping, installation or of grinding a of furred the or solid self-furring metal plaster base, base; application of a repair/build-out mortar, mortar; installation grinding/chipping of a the self-furring concrete plaster base; base, or combinations thereof. Because these measures may have structural or integrity consequences, they should be considered by all concerned parties with the ultimate selection left to the discretion of the design authority as defined by the Owner-Contractor Agreement.

X1.1.6 The contract "Project documents Documents" consist of many individual items but includes both the specifications Project Specifications and the contract Contract drawings. Drawings. It is the intent of this standard to have the type, location, depth, and orientation of control and expansion joints both stated in the specifications Project Specifications as well as shown and detailed on the contract Contract drawings Drawings where either or both of these documents exist for any particular project.

X1.2 *Finish Coat Categories* (applicable to both natural and colored finishes):

X1.2.1 Texture, as a description of surface appearance, is identified generally with the method and tools used to achieve the finish. Texture can be varied by the size and shape of the aggregate used, the equipment or tools employed, the consistency of the finish coat mix, the condition of the base to which it is applied, and by subsequent decorative or protective treatment.

X1.2.2 There are many factors that affect the ultimate appearance of textured and integrally colored plaster. A suitably sized sample panel should be submitted for approval by the architect and the owner. Once approved, the sample should be maintained on site for reference and comparison.

X1.2.3 With the almost limitless variations possible for finish appearance or texture, the same term may not have the same meaning to the specifier, the contractor, and the actual applicator. The specifier is cautioned to use an approved range of sample panels. To provide some guidance, the following categories are generally understood and recognized to imply a particular method of application technique or resulting finished appearance:

X1.2.4 Smooth Trowel—Hand- or machine-applied plaster floated as smooth as possible and then steel-troweled. Steel troweling should be delayed as long as possible and used only to eliminate uneven points and to force aggregate particles into the plaster surface. Excessive troweling should be avoided.

X1.2.5 Float—A plaster devoid of coarse aggregate applied in a thin coat completely covering the base coat, followed by a second coat that is floated to a true plane surface yielding a relatively smooth to fine-textured finish, depending on the size of aggregate and technique used. It is also known as sand finish.

X1.2.6 Trowel-Textured (such as Spanish Fan, Trowel Sweep, English Cottage)—A freshly applied plaster coat is given various textures, designs, or stippled effects by hand troweling. The effects achieved may be individualized and may be difficult to duplicate by different applicators.

X1.2.7 Rough-Textured (such as Rough Cast, Wet Dash, Scottish Harl)—Coarse aggregate is mixed intimately with the plaster and is then propelled against the base coat by trowel or by hand tool. The aggregate is largely unexposed and deep textured.

X1.2.8 Exposed Aggregate (also known at Marblecrete)—Varying sizes of natural or manufactured stone, gravel, shell, or ceramic aggregates are embedded by hand or machine propulsion into a freshly applied finish "bedding" coat. The size of the aggregate determines the thickness of the "bedding" coat. It is generally thicker than a conventional finish coat.

X1.2.9 Spray-Textured—A machine-applied plaster coat directed over a previously applied thin smooth coat of the same mix. The texture achieved depends on the consistency of the sprayed mixture, moisture content of the base to which it is applied, the angle and distance of the nozzle to the surface, and the pressure of the machine.

X1.2.10 Brush-Finish—A method of surfacing or resurfacing new or existing plaster. The plaster is applied with a brush to a thickness of not less than $^1/_{16}$ in. ~~(2~~ (1.6 mm). For an existing plaster surface the bond capability must be determined by test application or a bonding compound must be applied prior to the brush application.

X1.2.11 Miscellaneous Types—This finish coat category is somewhat similar to trowel-textured finishes, except that the freshly applied plaster is textured with a variety of instruments other than the trowel, such as swept with a broom or brush, corrugated by raking or combing, punched with pointed or blunt instrument, scored by aid of a straightedge into designs of simulated brick, block, stone, and so forth. A variation of texturing a finish coat involves waiting until it has partially set and then flattening by light troweling of the unevenly applied plaster or by simulating architectural terracotta.

X1.2.12 Scraffitto—A method of applying two or more successive coats of different colored plaster and then removing parts of the overlaid coats to reveal the underlaying coats, usually following a design or pattern. This is not generally considered a finish coat operation because of the number of thickness of coats.

X1.3 When specified as alternate for final coat, trowel- or plaster machine-applied textured acrylic finishes containing aggregate may be substituted for portland cement finish coats, provided brown coat is properly prepared and finish is applied according to the manufacturer's directions.

X1.4 *Staining of Plaster*—Staining and discoloration of plaster, caused by free water draining from one plane of plaster to another or from a dissimilar material onto a plaster surface, can be minimized by providing sufficient depth and angle for drip caps and the use of water-resistive surface coatings.

X1.4.1 Staining of plaster due to entrapment of moisture behind the plaster, can be avoided or minimized by providing an air space for ventilation between the back of the plaster and adjacent material. This type of staining may occur where insulation with or without vapor barrier, or other material containing asphaltic or coal tar derivatives, fireproofing salts, and so forth, can migrate with moisture movement to the finished plaster surface.

X1.4.2 Integrally colored plaster can be discolored or altered in shade if subjected to moisture, either from uncured base coats or external sources, such as rain, too soon after applications.

X1.5 *Installation Instructions:*

X1.5.1 Hand mixing should not be permitted, except as approved by the contract specifier.

X1.5.1.1 After all ingredients are in the mixer, mix the plaster for 3 to 5 min.

X1.5.1.2 The amount of water used in the plaster mix should be determined by the plasterer. Factors such as the suction of the base, or of the previous coat, water content of the aggregate, drying conditions, and finishing operations should be considered in determining water usage. Use of excessive water may result in dropouts, fall or slide off, excessive shrinkage, high porosity, and lower strength.

X1.5.2 Time Between Coats and Curing for Portland Cement-Based Plaster:

X1.5.2.1 The timing between coats will vary with climatic conditions and types of plaster base. Temperature and relative humidity extend or reduce the time between consecutive operations. Cold or wet weather lengthens and hot or dry weather shortens the time period. Moderate changes in temperature and relative humidity can be overcome by providing additional heating materials during cold weather and by reducing the absorption of the base by pre-wetting during hot or dry weather.

X1.5.2.2 In order to provide more intimate contact and bond between coats and to reduce rapid water loss, the second coat should be applied as soon as the first coat is sufficiently rigid to resist cracking, the pressures of the second coat application, and the leveling process.

X1.5.2.3 The amount of water and the timing for curing portland cement plaster will vary with the climatic conditions, the type of base, and use or nonuse of water-retentive admixtures.

X1.5.2.4 Some moisture must be retained in or added back to freshly applied portland cement-based plaster. If the relative humidity is relatively high (above 75 %), the frequency for rewetting a surface may be reduced. If it is hot, dry, and windy, the frequency of rewetting must be increased.

X1.5.2.5 Consider the physical characteristics of the structure as well as the previously mentioned conditions when selecting the method of curing. The method can be one or a combination of the following:

(1) Moist curing is accomplished by applying a fine fog spray of water as frequently as required, generally twice daily in the morning and evening. Care must be exercised to avoid erosion damage to portland cement-based plaster surfaces. Except for severe drying conditions, the wetting of finish coat should be avoided, that is, wet the base coat prior to application of the finish coat.

(2) Plastic film, when taped or weighted down around the perimeter of the plastered area, can provide a vapor barrier to retain the moisture between the membrane and plaster. Care must be exercised in placing the film: if too soon, the film may damage surface texture; if too late, the moisture may have already escaped.

(3) Canvas, cloth, or sheet material barriers can be erected to deflect sunlight and wind, both of which will reduce the rate of evaporation. If the humidity is very low, this option alone may not provide adequate protection.

X1.5.2.6 Application of Plaster Basecoats:

(1) Conventional, three-coat plaster is applied over a metal plaster base in two, nominal $^3/_8$ in. (10 mm) coats. The traditional application brings the plaster brown coat out to the lathing accessory accessories grounds which are installed set to approximately $^3/_4$ in. (19 ofl mm) from the substrate. Lathing The lathing accessories that traditionally provide cement the plaster thickness grounds screed point include weep screeds at the base of drainage wall assemblies, casing beads beads, used to terminate the plaster into a dissimilar materials, material, control joints and expansion joints, joints designated installed drainage in screeds accordance with Specification C1063, corner transition trims, typically used at a vertical to horizontal transitions, transition, and external outside corner reinforcement (corner aids and corner beads).

(2) The interface of other exterior wall envelope systems, such as door and window frames, metal flashings and surrounds, drift joint framing, and other components often create build up that the lathing and plastering must cover. Further impacting this build-up are self-adhering flashing and multiple layers of water-resistive barriers used to enhance the ability of the exterior wall to provide a weather-resistive exterior wall envelope.

(3) In load-bearing wood framed and wood sheathed walls, build-up can occur from the wood and sheathing and any structural connection plates and bolts required to complete the structure.

(4) As a result of these factors that can impact the thickness of the plaster and are usually out of the control of the plastering contractor, references to plaster thickness use the term nominal to qualify the required thickness. The term nominal is intentionally ambiguous so as not to unnecessarily burden the plastering contractor with an expectation to provide a thickness of plaster that cannot reliably be achieved. Nominal is a term commonly associated with lumber that was many years ago actually a dimensional reference, but due to changes in the manufacturing of studs and timber, has become simply a name, and not an exact dimension.

X1.6 Design Considerations

X1.6.1 Provisions for Drainage Behind Exterior Plaster Base Systems:

X1.6.1.1 A barrier wall system where the plaster is applied directly to a solid substrate will not require any provisions for drainage to the exterior of the wall assembly.

X1.6.1.2 A drainage wall system where plaster is applied to a metal or non metallic plaster base shall include a water resistive barrier and a defined drainage plane, including provisions for moisture to escape to the exterior of the wall.

SUMMARY OF CHANGES

Committee C11 has identified the location of selected changes to this standard since the last issue (C926 – 18a) 15) that may impact the use of this standard. (Approved Aug. July 1, 15, 2018.) 2015.)

(1) Revised 6.1, subsections 7.3.4, 5.2 A1.5 A1.5.2, A2.2.1, A2.3.1.1, A2.3.1.2, and X1.5.2.6(1). A1.6.3 (2). Revised Notes 3 and 5.

Committee C11 has identified the location of selected changes to this standard since the last issue (C926 – 18) 15) that may impact the use of this standard. (Approved March June 1, 2018.) 2015.)

(1) Revised Added A2.1.2. Specification Committee C578 C11 has identified the location of selected changes to this Referenced standard Documents since subsection the 2.1 last issue (C926 17) that may impact the use of this standard. (Approved Jan. 1, 2018.) (1) Revised X1.5.2.6. Committee C11 has identified the location of selected changes to this standard since the last issue (C926 16c) that may impact the use of this standard. (Approved Jan. 1, 2017.) (1) Revised X1.1 and X1.1.1.

(2) Added X1.1.2 "back; wrap" Committee (C113.2.5 has) identified and the "polymer location modified of cementitious selected base changes coat" to this standard since the last issue (C9263.2.22) 16b) that may impact the use of this standard. (Approved Dec. 1, 2016.) (1) Removed previous Subsection A1.1. (2) Added "contract

documents[2] to Terminology (Subsection Section. 3.3).

(3) *Revised* Added 1.1 subsections, A2.6 A1.5.2 , A2.6.5.5 A2.3.1.2, and X1.1.6 Fig. A2.1 Committee C11 has identified the location of selected changes to this standard since the last issue (C926-16a) that may impact the use of this standard. (Approved Sept. 1, 2016.) (1) Revised Subsection 7.3.1.

Committee C11 has identified the location of selected changes to this standard since the last issue (C926 – 16) 14a) that may impact the use of this standard. (Approved March Feb. 1, 2016.) 2015.)

(1) *Added Specification C1787 to 2.1. (2)* Revised 6.1 4.2.4, 6.2.3 4.2.5, 7.4, A2.3.1, A2.3.2, and X1.6.1.2 6.1.5. (3)

(2) *Revised* Renumbered Note X1.4 3 – X1.4.2 (4) (formerly Revised X1.3.1 A2.3.2 through: X1.3.3).

Committee C11 has identified the location of selected changes to this standard since the last issue (C926 – 15b 14)ε1) that may impact the use of this standard. (Approved Jan. April 1, 15, 2016.) 2014.)

(1) Revised A1.5.2 5.2.3, A2.2.1, and X1.1.5.

FOOTNOTES

(1) This specification is under the jurisdiction of ASTM Committee C11 on Gypsum and Related Building Materials and Systems and is the direct responsibility of Subcommittee C11.03 on Specifications for the Application of Gypsum and Other Products in Assemblies.

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(2) For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

(3) Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

Designation: C1063—–18b15a

Disclaimer: This document is not an ASTM standard and is intended only to provide the user of an ASTM standard an indication of what changes have been made to the previous version. Because it may not be technically possible to adequately depict all changes accurately, ASTM recommends that users consult prior editions as appropriate. In all cases, only the current version of the standard as published by ASTM is to be considered the official document.

Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster [1]

This standard is issued under the fixed designation C1063; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

IN THIS STANDARD:

SUMMARY OF CHANGES

Footnotes

1 SCOPE *A Summary of Changes section appears at the end of this standard.

1.1 This specification covers the minimum technical requirements for lathing and furring for the application of exterior and interior portland cement cement-based a hydraulic cement produced by pulverizing clinker consisting essentially of hydraulic calcium silicates, and usually containing one or more forms of calcium sulfate as an interground addition.Subcommittee: C11.91 Standard: C11-based plaster, as in Specifications C841 or C926. These requirements do not by default define a unit of work or assign responsibility for contractual purposes, which is the purview of a contract or contracts made between contracting entities.

1.2 Where a fire resistance rating is required pertaining to a mandatory obligation imposed by a force outside this standard, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C840pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C926 for plastered assemblies and constructions, details of construction shall be in accordance with reports of fire tests of assemblies that have met the requirements of the fire rating imposed.

1.3 Where a specific degree of sound control is required pertaining to a mandatory obligation imposed by a force outside this standard, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C840pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C926 for plastered assemblies and constructions, details of construction shall be in accordance with official reports of tests conducted in recognized testing laboratories in accordance with the applicable requirements of Test Method E90.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard. 1.5

2 THIS REFERENCED INTERNATIONAL DOCUMENTS STANDARD

2.1 was ASTM developed Standards: in [2] accordance

A641/A641M with Specification internationally for recognized Zinc-Coated principles (Galvanized) on Carbon standardization Steel established Wire in

A653/A653M the Specification Decision on Principles for the Steel Development Sheet, of Zinc-Coated International (Galvanized) Standards, or Guides Zinc-Iron and Alloy-Coated Recommendations (Galvannealed) issued by the World Hot-Dip Trade Process Organization

B69 Technical Specification Barriers for to Rolled Trade Zinc (TBT)

B221 Committee. 2 Referenced Documents 2.1 ASTM Standards:2 A653/A653M Specification for Steel Aluminum Sheet, and Zinc-Coated Aluminum-Alloy (Galvanized) Extruded or Bars, Zinc-Iron Rods, Alloy-Coated Wire, (Galvannealed) Profiles, by and the Tubes Hot-Dip Process

C11 Terminology Relating to Gypsum and Related Building Materials and Systems

C841 Specification for Installation of Interior Lathing and Furring

C847 Specification for Metal Lath

C926 Specification for Application of Portland Cement-Based Plaster

C933 Specification for Welded Wire Lath C1032

C954 Specification for Woven Steel Wire Drill Plaster Screws Base C1280 Specification for the Application of Exterior Gypsum Panel Products for or Use Metal as Plaster Sheathing Bases C1861 to Specification Steel for Studs Lathing from and 0.033 Furring in. Accessories, (0.84 and mm) Fasteners, to for 0.112 Interior in. and (2.84 Exterior mm) Portland in Cement-Based Thickness Plaster

C1002 E90 Specification Test Method for Laboratory Steel Measurement Self-Piercing of Tapping Airborne Screws Sound for Transmission Application Loss of Building Gypsum Partitions Panel and Products Elements or 2.2 Metal US Plaster Department Bases of to Commerce Wood (DOC) Studs Standards or PS Steel 1 Studs Voluntary

C1032 Product Specification Standard for PS Woven 1, Wire Structural Plaster Plywood Base PS

D1784 2 Specification Voluntary for Product Rigid Standard Poly(Vinyl PS Chloride) 2, (PVC) Performance Compounds Standard and for Chlorinated Wood-Based Poly(Vinyl Structural Chloride) Use (CPVC) Panels Compounds 3

D4216 Terminology Specification 3.1 for Definitions: Rigid 3.1.1 Poly(Vinyl For Chloride) definitions (PVC) relating and to Related ceilings PVC and walls, Chlorinated see Poly(Vinyl Terminology Chloride) C11 (CPVC). Building 3.1.2 Products For Compounds definitions

E90 relating Test to Method lathing accessories products fabricated for the Laboratory purpose Measurement of forming Airborne corners, Sound edges, Transmission control Loss joints, of or Building decorative Partitions effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control Elements joints,

3 SUCH TERMINOLOGY AS

3.1 casing *Definitions*—For beads, definitions bull relating noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form ceilings corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516. furring accessories and fasteners, walls, see Specification Terminology C1861 C11.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 building *barrier enclosure wall, system n*—type of building wall assemblies system and that materials is designed intended and to installed block in or such interrupt a the manner movement as of water to provide the a interior. barrier

3.2.2 between *building different enclosure, environments.Subcommittee: C11.03 Standard: C1063, n—system*—system of building assemblies and materials designed and installed in such a manner as to provide a barrier between different environments. 3.2.2

3.2.3 *control joint joint, n*—a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines. Subcommittee:

3.2.4 C11.03 *drainage Standard: plane, C1063 n a*—surface formed product used for designed or required separations between adjacent the surfaces back of gypsum the boards cladding or and gypsum the veneer front base. ofSubcommittee: the C11.02 water Standard: resistive C1047 barrier, which n resists—a liquid joint moisture that infiltration accommodates and movement provides of for plaster gravitational shrinkage flow and to curing a the collection act or processes exhaust of location. producing

3.2.5 a *drainage moisture space, environment n favorable*—volumetric to area cement that hydration, allows resulting in the setting gravitational or flow hardening of the liquid plaster. moistureSubcommittee: to C11.03 a Standard: collection C926 or along exhaust predetermined, location. usually

3.2.6 straight, *drainage lines. wall, 3.2.3 n expansion joint*—a joint wall that system accommodates in movement which beyond the plaster cladding shrinkage provides and a curing. substantialNote barrier 1—For to design water consideration intrusion, of control and expansion which joints, also see incorporates Annex A2.3.1.2 of Specification C926.Subcommittee: C11.03 Standard: C1063see control (expansion-contraction) joint.Subcommittee: C11.91 Standard: C11 a structural concealed separation water between resistive building barrier elements over that which allows drainage independent will movement occur. without

3.2.7 damage *expansion to joint, the assembly.Subcommittee: C11.05 Standard: C1516, n—a*—a joint that accommodates movement beyond plaster shrinkage and curing. the act or processes of producing a moisture environment favorable to cement hydration, resulting in the setting or hardening of the plaster.Subcommittee: C11.03 Standard: C926.

NOTE 1: For design consideration of control and expansion joints, see Annex A2.3.1.2 of Specification C926. 3.2.4

3.2.8 *framing member member, n*—studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel. Subcommittee:

3.2.9 C11.03 *hangers, Standard: n C1063*—wirestud, or plate, steel track, rods joist, or furring, straps and used other to support to main which runners a for gypsum suspended panel ceilings product, beneath floor or metal roof plaster constructions. base

3.2.10 is *inserts, attached. nSubcommittee:*—devices C11.91 embedded Standard: in C11 concretemetal structural studs, members runners (track), and rigid furring channels designed to receive provide screw-attached a gypsum loop panel or products. openingSubcommittee: for C11.03 attachment Standard: of C754 hangers.that

3.2.11 portion *saddle of tie, the n framing,*—see furring, Figs. blocking, 1 and so 2 forth., to

FIG. which 1 the Saddle gypsum Tie base

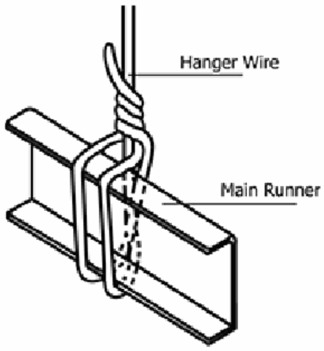
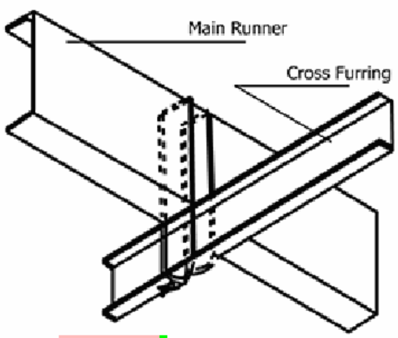


FIG. is 2 attached. Saddle Unless Tie otherwise



3.2.12 specified, *self-furring, the adj surface*—a to metal which plaster abutting base edges manufactured or with ends evenly-spaced are indentations attached that shall hold be the not body less of than the 1 lath1 approximately2 in. (38 mm) wide for wood members, not less than $^{11}/_4$ in. (32 (6.4 mm) wide away for from steel solid members, surfaces and to not which less it than is 6 applied. in.

3.2.13 (152 *water mm) resistive wide barrier, for n gypsum*—a studs. material For that internal resists corners or angles, the bearing infiltration surface of shall liquid be moisture not through less the than building 3 enclosure system.4

3.2.14 in. *water (19 resistive mm). barrierSubcommittee: system, C11.03 n Standard:*—a C844 combinationstuds, of headers, water bracing, resistive and barrier blocking assemblies that serve resist to receive the gypsum infiltration panel of product. liquidSubcommittee: moisture C11.03 through Standard: the C1280 buildingstuds, enclosure joist, system. runners (tracks), bridging, bracing, and related facilitates accessories its manufactured gravitational or flow supplied to in a wood collection or hot drainage or location. cold

4 FORMED DELIVERY STEEL. OFSUBCOMMITTEE: MATERIALS C11.05

4.1 Standard: All C1516 materialssee shall Specification be C1063. deliveredSubcommittee: in C11.03 the Standard: original C1787 packages,, containers, n or—studs, bundles joist, bearing runners the (track), brand-name bridging, bracing, and related manufacturer's accessories (or products supplier's) fabricated identification. for

5 THE STORAGE PURPOSE OF FORMING MATERIALS CORNERS,

5.1 edges, All control materials joints, shall or be decorative kept effects. dry.Subcommittee: Materials C11.91 shall Standard: be C11 stackedcornerbeads, off edge the trims, ground, and supported control on joints, a such level as platform, casing and beads, protected bull from noses, the weather and stops. surfaceSubcommittee: contamination. C11.02

5.2 Standard: Materials C1047 shallpreformed be metal, neatly fiberglass stacked or with plastic care members taken used to form avoid corners, damage to edges, control ends, joints, or decorative surfaces. effects.

5.3Subcommittee: Paper C11.05 backed Standard: metal C1516 plaster manufactured bases or shall supplied be in handled wood carefully or in light delivery, gauge storage, steel. and 3.2.5 erection hangers to wires prevent or puncturing steel rods or straps removal used of to paper. support

6 MAIN MATERIALS RUNNERS

6.1 for Metal suspended Plaster ceilings Bases: beneath

6.1.1 floor Expanded or Metal roof Lath—Specification constructions. C847Subcommittee: C11.03 Standard: C1063, n galvanized. —wires

6.1.2 or Wire steel Laths: rods

6.1.2.1 or Welded straps Wire used Lath—Specification to C933 support. main

6.1.2.2 runners Woven the Wire members Lath—Specification that C1032 are, attached

6.1.2.3 to Paper or Backed suspended Plaster from Bases—Specification the C847 construction, above

6.2 for Accessories: the

6.2.1 support General—All of accessories cross shall furring, haveSubcommittee: perforated C11.03 or Standard: expanded C841 flanges for suspended ceilings beneath floor or roof clips constructions. shaped 3.2.6 to inserts, permit n complete—devices embedment embedded in concrete the framing plaster, members to provide a means loop for or accurate opening alignment, for and to secure attachment of hangers the wires accessory or to steel the rods underlying or surface. straps Accessories used shall be designed to support receive main application runners of for the suspended specified ceilings plaster beneath thickness. floor

6.2.2 or Accessories roof shall constructions. beSubcommittee: fabricated C11.03 from Standard: Zinc C1063 Alloy: (99 3.2.7 % saddle pure tie zinc), see galvanized Figs. (zinc-coated) 1 steel, and rigid 2. PVCSubcommittee: or C11.03 CPVC Standard: plastic, C1063 or, anodized n aluminum—see alloy Figs. (see 1 Specification and B221 2).. (See FIG. Table 1 Saddle for Tie minimum FIG. allowable 2 thicknesses.) Saddle

TABLE Tie 1 3.2.8 Minimum self furring Thickness a of metal Accessories plaster

Accessory base	Base manufactured Material, with in. evenly spaced (mm) indentations		
	Steel that	Zinc hold Alloy the	P.V.C. body
Corner of Beads the	0.0172 lath (0.44) approximately	0.0207 1 (0.53)	0.0354 (0.89) in.
Casing (6 Beads mm)	0.0172 away (0.44) from	0.0207 solid (0.53) surfaces	0.035 to (0.89) which
Weep it Screeds is	0.0172 installed. (0.44)Subcommittee:	0.0207 C11.03 (0.53) Standard:	0.050 C1063 (1.27).
Control adj Joints — a	0.0172 metal (0.44) plaster	0.018 base (0.46) manufactured	0.050 with (1.27) evenly spaced

NOTE INDENTATIONS 2: that The hold selection the body of the an lath appropriate see type gypsum of lath material Subcommittee: for C11.91 accessories Standard: shall C11 be approximately determined 1 by applicable 4 surrounding in. climatic (6 and mm) environmental away conditions from specific solid surfaces to which the it project is location, installed. such 3.2.9 as water salt resistive air, barrier industrial a pollution, material high that moisture, resists or the humidity. infiltration

6.2.3 of Steel—Specification liquid A653/A653M moisture and through shall the have building a enclosure G60 system. coating.Subcommittee:

6.2.4 C11.03 PVC Standard: Plastic—Specification C1063 D1784; or n D4216—a. material

6.2.5 that Zinc resists Alloy—Specification the B69 infiltration, of 99 liquid % moisture pure through zinc. the

6.2.6 building Thickness enclosure system of building base assemblies material and shall materials be designed as and shown installed in such Table a 1 manner. as

6.2.7 to Cornerite—1.75 provide lb/yd a[2 barrier] (0.059 between kg/m different[2 environments.]),Subcommittee: galvanized C11.03 expanded Standard: metal C1063 lath, system. 1.7 4 lb/yd Delivery[2 and] (0.057 Storage kg/m of[2 Materials]) 4.1 galvanized Delivery woven of or Materials: welded 4.1.1 wire All fabric materials of shall 0.0410 be delivered in. the (1.04 original mm) packages, wire. containers, When or shaped bundles for bearing angle the reinforcing, brand-name it and shall manufacturer's have (or outstanding supplier's) flanges identification. (legs) 4.2 Storage of Materials: not 4.2.1 less All than materials 2 shall in. be (51 kept mm). dry.

6.3 Materials Channels—Shall shall be stacked cold-formed off from the steel ground with the minimum element 33 of 000 a psi lathing (228 accessory MPa) that yield provides strength an and edge, 0.0538 end, in. or (1.37 termination mm) for minimum a bare cement steel plaster thickness. panel Channel area, shall with have a ground protective dimension coating conforming to assist Specification in A653/A653M cement–G60, plaster or thickness have control.Subcommittee: C11.02 Standard: C1861, supported on a level protective platform, coating and with protected an from equivalent the corrosion weather resistance and for surface exterior contamination. applications, 4.2.2 or Materials shall be neatly coated stacked with care a taken rust to inhibitive avoid paint, damage for to interior edges, applications, ends and the shall end have perpendicular to the paper-bound following edge minimum or weights long in edge. poundsSubcommittee: per C11.01 1000 Standard: linear C473 ft, (kg/m). or

Sizes, surfaces. in. 4.2.3 (mm) Paper	Weight, backed lb/1000 metal ft plaster (kg/m) bases	Flange expanded Width, metal in. lath. (mm) sheet
3 metal/lath, 4 welded (19) or	277 woven (0.412) wire	1 lath./Subcommittee: 2 C11.03 (13) Standard:
1 C841 1 shall/be 2 handled (38) carefully	414 in (0.616) delivery,	1 storage,/and 2 erection (13) to
2 prevent (51) puncturing	506 or (0.753) removal	1 of/paper. 2 5 (13) Materials
2 5.1 1 Metallic/materials 2 including (64) lathing,	597 lathing (0.888) accessories	1 products/fabricated 2 for (13) the

NOTE PURPOSE 3: of Channels forming used corners, in edges, areas control subject joints, to or corrosive decorative action effects. ofSubcommittee: salt C11.01 air Standard: shall C11 becornerbeads, hot-dipped edge galvanized, trims, G60 and coating control

6.3.1 joints, External such Corner as Reinforcement—Expanded casing lath, beads, welded bull wire, noses, or and woven stops. wireSubcommittee: mesh C11.02 bent Standard: to C1047 approximatelypreformed 90 metal, ° fiberglass or plastic members used to form reinforce corners, portland edges, cement control stucco joints, at or external decorative corners. effects. ThisSubcommittee: accessory C11.05 Standard: C1516, furring, furring accessories, and fasteners shall be selected fully for embedded compatibility in to the minimize stucco. galvanic

6.3.2 corrosion Weep between Screed—Accessory adjacent used metallic to materials terminate installed portland in the cement plaster based see stucco gypsum at plaster, the gypsum bottom neat of plaster. exteriorSubcommittee: framed C11.91 walls. Standard: This C11 accessoryportland shall cement-based have cementitious a mixture sloped, (see solid, stucco). orSubcommittee: perforated, C11.03 ground, Standard: or C926 screed cladding flange assembly. to 5.2 facilitate Metal the Plaster removal Bases: of 5.2.1 moisture Expanded from Metal the Lath—Specification wall C847 cavity., and galvanized. a 5.2.2 vertical Wire attachment Laths: flange 5.2.2.1 not Welded less Wire than Lath—Specification 3 C933[1]/ 5.2.2.2 2 Woven in. Wire (89 Lath—Specification mm) C1032 long.

6.4 5.2.2.3 Wire—As Paper specified Backed in Plaster Specification Bases—Specification A641/A641M C847 with, a 5.3 Class Lathing I Accessories, zinc-coated Furring (galvanized), Accessories soft-temper and steel. Fasteners: Wire 5.3.1 diameters Lathing (uncoated) Accessories, specified Furring herein Accessories correspond and with Fasteners—Specification United C1861 States. Steel 5.3.2 Wire The Gauge selection numbers of as an follows: appropriate

Wire type Gauge of (US material Steel for Wire lathing Gauge) accessories	Diameter products (in.) fabricated	mm for

No. the 20 purpose	0.0348 of	.88 forming
No. corners, 19 edges,	0.0410 control	1.04 joints,
No. or 18 decorative	0.0475 effects.	1.21 Subcommittee:
No. C11.01 17 Standard:	0.0540 C11	1.37 cornerbeads,
No. edge 16 trims,	0.0625 and	1.59 control
No. joints, 14 such	0.0800 as	2.03 casing
No. beads, 13 bull	0.0915 noses,	2.32 and
No. stops. 12 Subcommittee:	0.1055 C11.02	2.68 Standard:
No. C1047 11 preformed	0.1205 metal,	3.06 fiberglass
No. or 10 plastic	0.1350 members	3.43 used
No. to 9 form	0.1483 corners,	3.77 edges,
No. control 8 joints,	0.1620 or	4.12 decorative

6.5 effects. Rod Subcommittee: and C11.05 Strap Standard: Hangers—Mild C1516 steel, shall zinc be or based cadmium upon plated, applicable or surrounding protected climatic with and a environmental rust-inhibiting conditions paint. specific

6.6 to Clips—Form the from project steel location, wire, such Specification as A641/A641M salt zinc-coated air, (galvanized), industrial Specification pollution, A641/A641M high moisture, or humidity. steel 6 sheet, Requirements Specification for A653/A653M Substrates, to depending Receive on Metal use Lathing and Furring manufacturer's 6.1 requirements. Framed,

6.7 or Fasteners: Framed

6.7.1 and *Nails*—For Sheathed attaching Substrates: metal 6.1.1 plaster Framing bases member to deflection wood shall supports, not 0.1205-in. exceed 11 L/360 gauge (0.33 (3.06 in. mm) in diameter, 10 7/16 / 6.1.2 16 Plywood in. and (11.1 oriented mm) strand head, board barbed, sheathing galvanized panels roofing shall nails be marked in accordance with DOC PS1 or DOC galvanized PS common 2 nails.

6.7.1.1 6.1.3 Nails Plywood for and attaching oriented metal strand plaster board bases sheathing to panels solid substrates shall be installed not with less 1 than $^3/_4$ in. (3 (19 mm) minimum panel edge the paper-bound edge, or long. edge,

6.7.2 as Screws manufactured. for Subcommittee: attaching C11.01 metal Standard: plaster C473 base the bound edge as manufactured.Subcommittee: C11.01 Standard: C1177/C1177M, C1178/C1178M, C1396/C1396M gaps, and panel edges shall be offset fabricated 4 in (10 accordance cm) with minimum either from Specification wall C954 opening or reentrant C1002 corners. 6.1.4 Wood framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007, plywood and oriented strand board sheathing panels shall have a moisture 7 content / not 16 to in. exceed (11.1 19 mm) % diameter immediately pan before wafer plastering. head 6.1.5 and Exterior a gypsum 0.120 sheathing in. a (3.0 gypsum mm) board diameter used shank. as Screws a used backing for exterior attachment surface to materials; metal manufactured framing with members water-repellant shall paper and may be manufactured self-drilling with and a self-tapping. water-resistant Screws core. used Subcommittee: for C11.91 attachment Standard: to C11 wood panels framing members shall be installed sharp-point. in compliance with Specification C1280.

7 INSTALLATION

7.1 Workmanship—Metal Workmanship—Metal lathing, furring lathing accessories, furring, and furring lathing accessories shall be erected so that the finished cement plaster surfaces are true to line (allowable tolerance of $^1/_4$ in. (6 (6.4 mm) in 10 ft (3 (3.05 m)), level, plumb, square, or curved as required to receive the specified pertaining to a mandatory requirement of this standard or a referenced requirement (see 3.2.17).Subcommittee: C11.03 Standard: C840pertaining to a mandatory requirement of this specification or a referenced requirement.Subcommittee: C11.03 Standard: C1280 cement plaster see gypsum plaster, gypsum neat plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926 thickness.

7.2 Hangers and Inserts:

7.2.1 Hangers shall be of ample length and shall conform to the requirements of Table ~~1~~ 2, both as to size and maximum ~~cement plaster panel~~ area to be supported, except as modified in this section.

TABLE ~~1~~ 2 Allowable Support or Hanger Wire Spacing ft-in. (mm) and Cold-Rolled Channel ~~Furring~~ Main Runner Spans, ft-in. (mm) ~~1—7~~ 1–10

NOTE 1: 1 in. = 25.4 mm; 1 ft² = 0.093 m²

Member Size, in. (mm)	Member Weight, lb/1000 ft (kg/m)	Span Condition ~~6,7~~ 9,10	Uniform Load = 12 psf (0.479 kPa)				
			Member Spacing, in. (mm)				
			24 (610)	36 (914)	48 (1220)	60 (1520)	72 (1830)
			Allowable Hanger Wire or Support Spacing, ft-in. (mm)				
1 1/2	414	Single	3-6 (1070)	3-1 (940)	2-9 (840)	2-9 (790)	2-5 (740) ~~(38)~~
(38.1)	(0.615)	2 or More	4-11 (1500)	4-2 (1270)	3-7 (1090)	3-2 (970)	2-11 (890)
2	506	Single	3-9 (1140)	3-3 (990)	3-0 (910)	2-9 (840)	2-8 (810) ~~(51)~~
(50.8)	(0.753)	2 or More	5-2 (1570)	4-6 (1370)	4-1 (1240)	3-10 (1170)	3-7 (1090)
2 1/2	597	Single	3-11 (1190)	3-5 (1040)	3-2 (970)	2-11 (890)	2-9 (840) ~~(64)~~
(63.5)	(0.888)	2 or More	5-5 (1650)	4-9 (1450)	4-4 (1320)	4.0 (1220)	3-10 (1170)

Member Size, in. (mm)	Member Weight, lb/1000 ft (kg/m)	Span Condition ~~6,7~~ 9,10	Uniform Load = 15 psf (0.287 kPa)				
			Member Spacing, in. (mm)				
			24 (610)	36 (914)	48 (1220)	60 (1520)	72 (1830)
1 1/2	414	Single	3-3 (990)	2-10 (860)	2-7 (790)	2-4 (710)	2-2 (660) ~~(38)~~
(38.1)	(0.616)	2 or More	4-6 (1370)	3-8 (1120)	3-2 (970)	2-10 (860)	2-7 (790)
2	506	Single	3-6 (1070)	3-1 (940)	2-10 (880)	2-7 (790)	2-5 (740) ~~(51)~~
(50.8)	(0.753)	2 or More	4-10 (1470)	4-3 (1300)	3-10 (1170)	3-6 (1070)	3-3 (990)
2 1/2	597	Single	3-8 (1120)	3-3 (990)	2-11 (890)	2-9 (840)	2-7 (790) ~~(64)~~
(63.5)	(0.888)	2 or More	5-0 (1520)	4-5 (1350)	4-0 (1220)	3.9 (1140)	3-6 (1070)

Allowable Spans Notes:

1 ~~Spans~~ Bare ~~based~~ metal ~~on~~ thickness ~~upper flange~~ of cold-rolled main runners ~~the~~ shall ~~members~~ be ~~that~~ not ~~are~~ less ~~attached~~ than ~~to~~ 0.0538 ~~or~~ in. ~~suspended~~ (1.367 ~~from~~ mm). ~~the~~

2 ~~construction~~ Inside ~~above~~ corner ~~for~~ radii ~~the~~ shall ~~support~~ not ~~of~~ be ~~cross~~ greater ~~furring.~~ than ~~Subcommittee:~~ 1 ~~C11.03~~ / ~~Standard:~~ 8 ~~C841~~ in. (3.19 mm).

3 Spans based on upper flange of main runners laterally unbraced. ~~2~~

4 Maximum deflection limited to 1/360 of the span length. ~~3~~

5 ~~Uniform~~ Steel ~~load~~ yield ~~12~~ stress, ~~psf~~ Fy, ~~(dry density)~~ shall be ~~used~~ not ~~for~~ less ~~portland~~ than ~~cement~~ 33 ~~plaster~~ 000 ~~a~~ psi ~~plaster~~ (228 ~~mix~~ MPa). ~~in~~

6 ~~which~~ Uniform ~~portland~~ load ~~cement~~ 12 ~~or~~ psf ~~combinations~~ (dry ~~of~~ density) ~~portland~~ shall ~~and~~ be ~~masonry~~ used ~~cements~~ for ~~or~~ portland cement ~~and~~ plaster ~~lime are the principal cementitious materials mixed with aggregate.Subcommittee: C11.01 Standard: C11~~ ceilings with plaster thicknesses up to 7/8 in. (22 mm) and 15 psf shall be used for ceilings with plaster ~~see gypsum plaster, gypsum neat plaster.Subcommittee: C11.01 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926~~ thicknesses over 7/8 in. (22 mm) and not more than 1 1/4 in. (32 mm). ~~4~~

7 ~~"2~~ "2 or ~~More"~~ More" spans refers to two or more continuous, equal spans. ~~5~~

8 For the ~~"2~~ "2 or ~~More"~~ More" span condition, listed spans represent the center-to-center distance between adjacent ~~framing~~ supports. ~~members 9 studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007. 6~~ These tables are designed for dead loads. Specific conditions such as exterior installations in high wind areas require ~~to mandate by a force outside this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C1280~~ additional engineering. ~~7~~

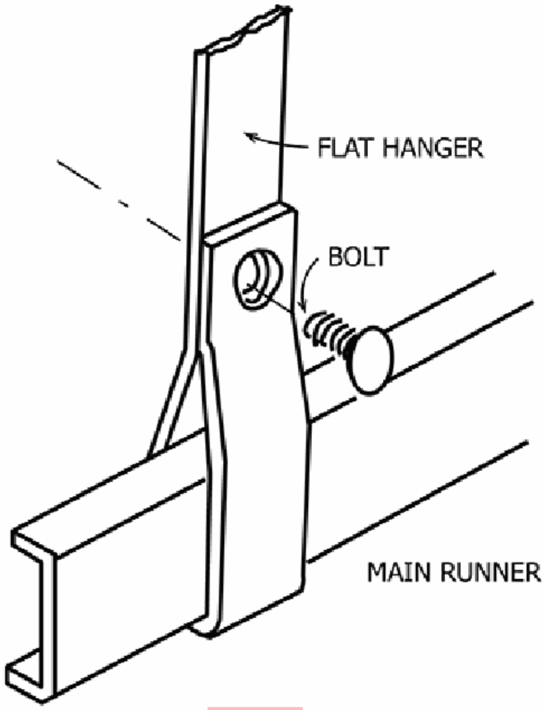
10 Where uplift resistance is required ~~pertaining to a mandatory obligation imposed by a force outside this standard, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C840pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C926~~ for suspended ceilings to resist negative forces, the architect or engineer of record shall select the method to be used. ~~TABLE~~

7.2.2 ~~2~~ When ~~Spans~~ 1 ~~and~~ by ~~Spacing of Cold-Rolled Channel Cross-Furring MembersA, B, C Design Load, 12 psf (575 Pa) Allowable Span, Main Runners or Supports Ft-in. (mm) Member Depth Spacing, in. (mm) Simple Span Two or More SpansD, E $^3/_4$ (19) 13.5 (343) 2-9 (840) 3-5 (1040)$_{16}$ (406)~~ -in. ~~2-7~~ (25 ~~(790)~~ by ~~3-3~~ 4.8 ~~(990)~~ mm) ~~19~~ flat ~~(483)~~ inserts ~~2-7 (740) 3-0 (910) 24 (610) 2-3 (690) 2-10 (860) 11/2 (38) 13.5 (343) 4-6 (1370) 5-8 (1730) 16 (406) 4-3 (1300) 5-5 (1650) 19 (483) 4-0 (1220) 5-1 (1550) 24 (610) 3-8 (1120) 4-9 (1450)(A) Spans based on upper flange of cross-furring laterally unbraced.(B) Maximum deflection limited to 1/360 th of span length unbraced.(C) Tabulated spans apply only to cross-furring with webs oriented vertically.(D) "Two or more" spans refers to two or more continuous, equal spans.(E) For the "two or more" span conditions, listed spans represent the center-to-center distance between adjacent framing members studs joist, runners (tracks), bridging~~ and ~~bracing and related accessories.Subcommittee: C11.03 Standard: C1007. TABLE 3 Types and Weights of Metal Plaster Bases and Corresponding Maximum Permissible Spacing of Wall and Ceiling Framing Members or Furring Type of Metal Plaster Base Minimum Weight of Metal Plaster Base, lb/yd2 (kg/m2) Specific Installation Requirements and Maximum Permissible Spacing of Wall and Ceiling Framing Members or Furring, Center to Center, in. (mm) Walls Ceilings 24 (610) 16 (406) 24 (610) 16 (406) 12 (305) Expanded Sheet Metal 2.5 (1.4) Permitted only for self-furred lath on sheathed wall framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 or solid wall bases Permitted Not Permitted Not Permitted Permitted 3.4 (1.8) Permitted Flat Rib 2.75 (1.5) Not Permitted Permitted only for unsheathed wall framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 3/8 in. Rib 3.4 (1.8) Not Permitted Permitted 4.0 (2.1) Welded Wire 1.14 (0.618) Not Permitted Permitted Not Permitted 1.95 (1.058) Permitted Permitted Woven Wire 1.4 (0.76) Permitted only for wood wall framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007, wood furring preparing a wall or ceiling with framing or furring members to provide a level surface or airspace.Subcommittee: C11.03 Standard: C754spacer strips fastened to a wall, ceiling, or planar element that create an even surface for the application of metal plaster bases or gypsum lath.Subcommittee: C11.03 Standard: C841spacer elements added to a building structure to facilitate fastening of gypsum panel products.Subcommittee: C11.03 Standard: C1546 Permitted Permitted only for wood and concrete ceiling framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 Not Permitted Permitted only for steel ceiling framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 7.2.2 When strap~~ hangers are used, $^7/_{16}$-in. ~~(11~~ (11.1 mm) diameter holes shall be provided on the center line at the ~~upper~~ lower end of the ~~strap~~ insert ~~hanger~~ and ~~to~~ upper ~~permit~~ end ~~the attachment~~ of the ~~strap~~ hanger ~~The~~ to ~~edge~~ permit the ~~paper-bound~~ attachment ~~edge,~~ of ~~or~~ the ~~long~~ hanger ~~edge,~~ to ~~as manufactured.Subcommittee: C11.01 Standard: C473~~ the ~~bound~~ insert. The edge ~~as manufactured.Subcommittee: C11.01 Standard: C1177/C1177M, C1178/C1178M, C1396/C1396M~~ of the holes in both the ~~strap~~ inserts and the hangers shall be not less than $^3/_8$ in. ~~(10~~ (9.5 mm) from the ends. ~~the end perpendicular to the paper-bound edge or long edge.Subcommittee: C11.01 Standard: C473.~~

7.2.3 In concrete, ~~rod or strap~~ hangers shall be attached to inserts ~~devices~~ embedded in ~~concrete framing members to provide a loop or opening for attachment of hangers.Subcommittee: C11.03 Standard: C1063 embedded in~~ the concrete, or to other attachment devices designed for this purpose, and able to develop full strength of the hanger.

7.2.4 ~~Strap~~ Flat, steel hangers shall be bolted to 1 by $^3/_{16}$-in. (25 by 4.8 mm) inserts with ~~machine~~ $^3/_8$-in. (9.5 mm) diameter round-head stove bolts. (See Fig. 3.)

FIG. 3 Flat ~~(Strap)~~ Hanger Attached to ~~Cold-rolled Channel Furring~~ Main Runner Using ~~Machine~~ Round-head Stove Bolt



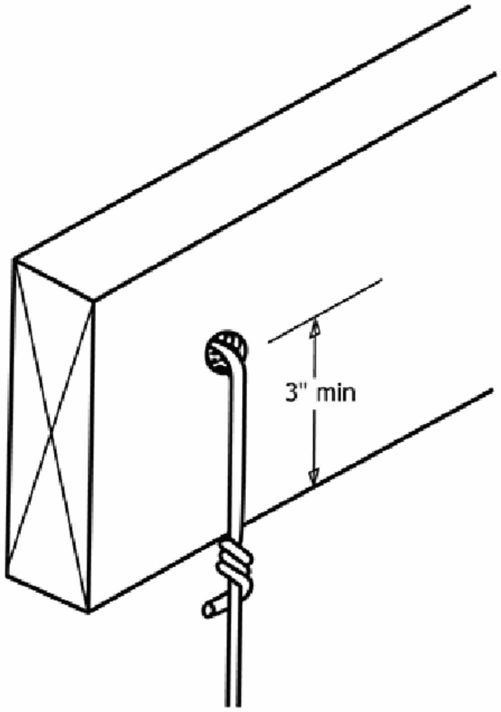
7.2.5 The nuts of the ~~machine~~ bolts shall be drawn up tight.

NOTE ~~2:~~ 4: Hangers required ~~pertaining~~ to ~~a mandatory obligation imposed by a force outside this standard, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C840pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C926 to~~ withstand upward wind pressures shall be of a type to resist compression. Struts of formed channels shall be permitted.

7.3 Installation of Hangers for Suspended Ceilings Under Wood ~~Constructions—Hangers~~ Constructions—Hangers shall be attached to ~~framing~~ supports ~~members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ by any of the following methods:

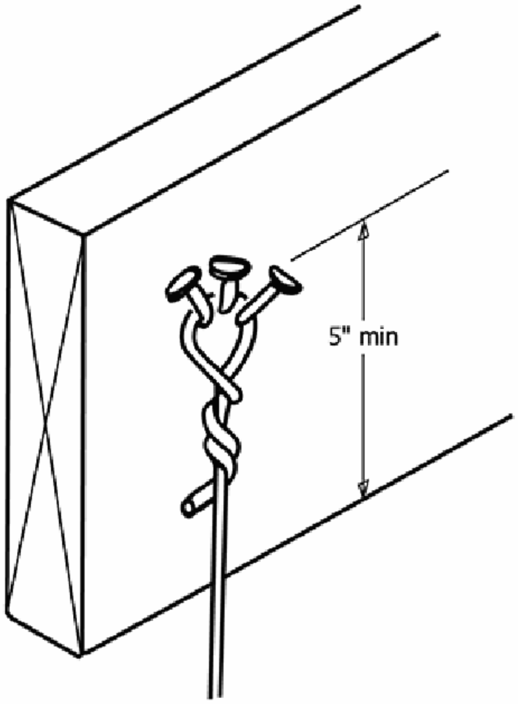
7.3.1 A hole shall be drilled through the wood ~~framing~~ member ~~studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be~~ not less than ~~112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than~~ 34 in. ~~(19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787 not less than 3 in.~~ (76 mm) above the bottom, with the upper end of the wire hanger passed through the hole and twisted three times around itself. (See Fig. 4.)

FIG. 4 Hanger Attached to ~~Framing~~ Support ~~Member~~ Through Drilled Hole



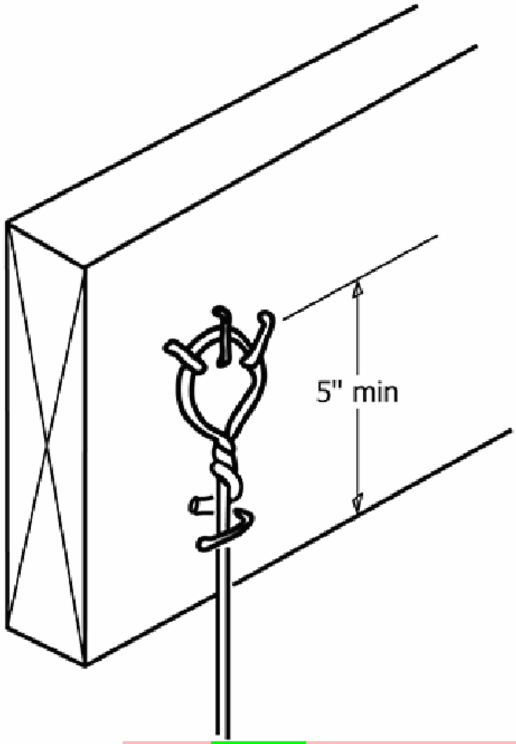
7.3.2 Three 12d nails shall be driven, on a downward slant, into the sides of the wood framing member studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787 with not less than $1^1/_4$ in. (32 (31.8 mm) penetration and not less than 5 in. (127 mm) from the bottom edges, and not more than 36 in. (914 mm) on the center with the upper end of the wire hanger wrapped around the nails and twisted three times around itself. (See Fig. 5.)

FIG. 5 Hanger Attached to Framing Support Member Using Nails



7.3.3 A loop shall be formed in the upper end of the wire hanger and secured to the wood framing member studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787 by four $1^1/_2$-in. (38 (38.1 mm), not less than 9 gauge, 0.1483-in. (3.77 mm) diameter wire staples driven horizontally or on a downward slant into the sides of the wood framing members, three near the upper end of the loop and the fourth to fasten the loose end. (See Fig. 6.)

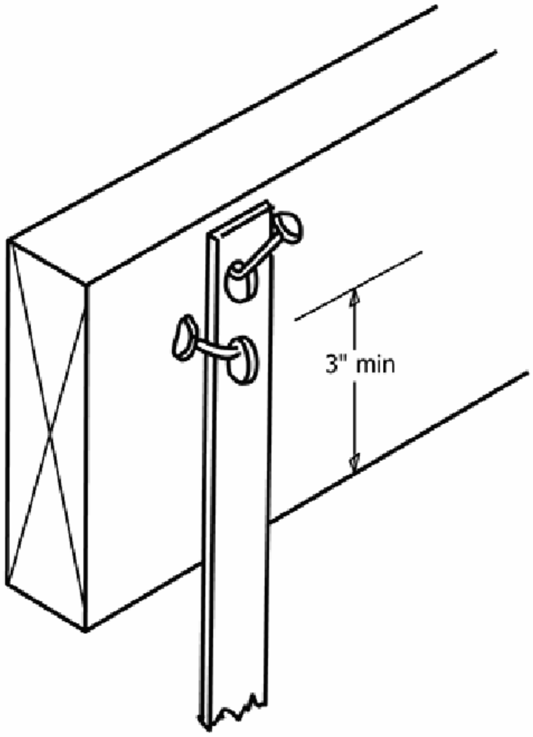
FIG. 6 Hanger Attached to Framing Support Member Using Staples



7.3.4 Where ~~framing~~ supports ~~members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ for flooring are thicker than $1^1/_2$ in. ~~(38~~ (38.1 mm) and are spaced more than 4 ft (1.2 m) on center, $1^1/_2$ in. (38.1 mm) No. 1/0 (0.3065 in.) (7.78 mm) eye screws (or equivalent), spaced not more than 3 ft ~~(914~~ (0.9 ~~mm)~~ m) on centers shall be screwed into the flooring ~~framing~~ supports ~~members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ with the upper end of the wire hanger inserted through the eye screws and twisted three times around itself.

7.3.5 Two holes shall be drilled in the upper end of the flat hangers and nailed to the sides of the wood ~~framing~~ members with 12d nails driven through the holes and clinched. Nails shall be not less than 3 in. (76 mm) above the bottom edge of the framing member. ~~studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787.~~ (See Fig. 7.)

FIG. 7 Flat ~~(Strap)~~ Hanger Attached to ~~Framing~~ Support ~~Member~~ Using Nails



7.4 Attachment of Hangers to ~~Cold-rolled Channel Furring~~ Main Runners:

7.4.1 Wire hangers shall be saddle-tied to ~~cold-rolled~~ the ~~channel furring main~~ runners. ~~the members that are attached to or suspended from the construction above for the support of cross furring.Subcommittee: C11.03 Standard: C841.~~ (See Fig. 1.)

7.4.2 Smooth or threaded rod hangers shall be fastened to ~~cold-rolled~~ the ~~channel furring main~~ runners ~~the members that are attached to or suspended from the construction above for the support of cross furring.Subcommittee: C11.03 Standard: C841~~ with special attachments appropriate to the design.

7.4.3 The lower ends of ~~strap~~ flat hangers shall be bolted to ~~cold-rolled~~ the ~~channel furring~~ main ~~runners~~ runners, ~~the members that are attached to~~ or ~~suspended from the construction above for the support of cross furring.Subcommittee: C11.03 Standard: C841, or~~ bent tightly around the ~~cold-rolled channel furring main~~ runners and carried up and above the ~~cold-rolled channel furring main~~ runners ~~the~~ and ~~members~~ bolted ~~that are attached~~ to ~~or suspended from~~ the ~~construction~~ main ~~above~~ part ~~for~~ of the ~~support~~ hanger. ~~of~~ Bolts ~~cross~~ shall ~~furring.~~ be ~~Subcommittee:~~ 3 ~~C11.03~~ / ~~Standard:~~ 8 ~~C841~~ -in. ~~and~~ (9.5 ~~bolted~~ mm) ~~to~~ diameter, ~~the~~ round-head ~~main~~ stove ~~part~~ bolts. ~~of the hanger.~~ (See Fig. 3.)

7.5 Installation of ~~Cold-rolled Channel Furring~~ Main Runners:

7.5.1 Minimum sizes and maximum spans and spacings of ~~cold-rolled channel furring~~ main runners for the various spans between hangers or other ~~framing~~ supports ~~members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ shall be in accordance with the requirements of Table ~~1~~ 2.

7.5.2 A clearance of not less than 1 in. (25 mm) shall be maintained between the ends of the ~~cold-rolled channel furring~~ main runners ~~the members that are attached to or suspended from the construction above for the support of cross furring.Subcommittee: C11.03 Standard: C841~~ and the abutting masonry or the concrete walls, partitions, and columns. Where special conditions require that ~~cold-rolled channel furring~~ main runners let into abutting masonry or concrete construction, within such constructions maintain a clearance of not less than 1 in. (25 mm) from the ends and not less than $^1/_4$ in. ~~(6~~ (6.4 mm) from the tops and sides of the ~~cold-rolled channel furring main~~ runners. ~~the members that are attached to or suspended from the construction above for the support of cross furring.Subcommittee: C11.03 Standard: C841.~~

7.5.3 A ~~cold-rolled channel furring~~ main runner shall be located within 6 in. (152 mm) of the paralleling walls to support the ends of the ~~cold-rolled channel~~ cross furring. ~~furring member attached perpendicular to main runners or framing members.Subcommittee: C11.03 Standard: C754furring members that are attached at right angles to the underside of the main~~

runners or construction above for support of the lath.Subcommittee: C11.03 Standard: C841. The ends of cold-rolled channel furring main runners shall be supported by hangers located not more than 6 in. (152 mm) from the ends. the end perpendicular to the paper-bound edge or long edge.Subcommittee: C11.01 Standard: C473.

7.5.4 Where cold-rolled channel furring main runners are spliced, the ends shall be overlapped not less than 12 in. (305 mm) with flanges of cold-rolled channels channel furring main runners interlocked and securely tied near each end of the splice, with double loops of 0.0625 in. (1.59 mm) or double loops of twin strands of 0.0475-in. (1.21 mm) galvanized wire. However, when the splice occurs at an expansion joint or control joint joint, a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047, the cold-rolled channel furring preparing a wall or ceiling with framing or furring members to provide a level surface or airspace.Subcommittee: C11.03 Standard: C754spacer strips fastened to a wall, ceiling, or planar element that create an even surface for the application of metal plaster bases or gypsum lath.Subcommittee: C11.03 Standard: C841spacer elements added to a building structure to facilitate fastening of gypsum panel products.Subcommittee: C11.03 Standard: C1546 shall be nested and loosely tied to hold together but still allow movement.

7.5.5 Hanger wires shall hang straight down. If an obstacle prevents this, a trapeze type device shall be used to allow hanger wires to hang straight.

7.6 Installation of Cold-rolled Channel Cross Furring:

7.6.1 Minimum size and maximum spans and spacings of various types of cold-rolled channel cross furring for various spans between cold-rolled channel furring main runners and framing supports members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 shall conform to the requirements of Table 2.

7.6.2 Cold-rolled Cross channel cross furring furring member attached perpendicular to main runners or framing members.Subcommittee: C11.03 Standard: C754furring members that are attached at right angles to the underside of the main runners or construction above for support of the lath.Subcommittee: C11.03 Standard: C841 shall be saddle-tied to cold-rolled channel furring main runners with 0.0625-in. 16 gauge (1.59 mm) galvanized wire, or a double strand of 0.0475-in. 18 gauge (1.21 mm) galvanized wire or with special galvanized clips, or equivalent attachments. (See Fig. 2.)

7.6.3 Where cold-rolled channel cross furring furring member attached perpendicular to main runners or framing membersSubcommittee: C11.03 Standard: C754furring members that are attached at right angles to the underside of the main runners or construction above for support of the lath.Subcommittee: C11.03 Standard: C841 members are spliced, the ends shall be overlapped not less than 8 in. (203 mm), with flanges of cold-rolled channels channel cross furring furring member attached perpendicular to main runners or framing members.Subcommittee: C11.03 Standard: C754furring members that are attached at right angles to the underside of the main runners or construction above for support of the lath.Subcommittee: C11.03 Standard: C841 interlocked, and securely tied near each end of the splice with double loops of 0.0625-in. (1.59 mm) 16 gauge galvanized wire or twin strands of 0.0475-in. 18 gauge (1.21 mm) galvanized wire.

7.6.4 Cold-rolled Cross channel cross furring furring member attached perpendicular to main runners or framing members.Subcommittee: C11.03 Standard: C754furring members that are attached at right angles to the underside of the main runners or construction above for support of the lath.Subcommittee: C11.03 Standard: C841 shall not come into contact with abutting masonry or reinforced concrete walls or partitions, except, where special conditions require that cold-rolled channel cross furring be let into abutting masonry or concrete construction, the applicable provisions of 7.5.2 shall apply.

7.6.5 Cold-rolled Main channel furring main runners and cold-rolled channel cross furring runners shall be interrupted at expansion joints or control joints. However when the splice occurs at an expansion joint or control joint joint, a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047, the cold-rolled channel furring preparing a wall or ceiling with framing or furring members to provide a level surface or airspace.Subcommittee: C11.03 Standard: C754spacer strips fastened to a wall, ceiling, or planar element that create an even surface for the application of metal plaster bases or gypsum lath.Subcommittee: C11.03 Standard: C841spacer elements added to a building structure to facilitate fastening of gypsum panel products.Subcommittee: C11.03 Standard: C1546 shall be nested and loosely tied to hold together but still allow movement.

7.7 Metal Furring for Walls:

7.7.1 Attachments for furring accessories shall products be fabricated concrete for nails the driven purpose securely of into forming concrete corners, edges, control joints, or decorative into effects. masonrySubcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints, such short as pieces casing of beads, 3 bull/ noses, 4 and in. stops. (19.1Subcommittee: mm) C11.02 channels Standard: C1047preformed metal, fiberglass or plastic members used to as form anchors corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516 shall be concrete nails driven securely into concrete or into masonry joints, power-actuated fasteners, or other devices specifically designed as spacer elements, spaced horizontally not more than 2 ft (610 (0.6 mm) m) on centers. They shall be spaced vertically in accordance with horizontal stiffener spacing so that they project from the face the surface designed to be left exposed to view or to receive decoration or additional finishes.Subcommittee: C11.91 Standard: C11the coated surface.Subcommittee: C11.01 Standard: C1178/C1178M of the wall in order for ties to be made.

7.7.2 Horizontal stiffeners shall be not less than $^3/_4$ in. (19 (19.5 mm) cold-rolled channel channels, furring, spaced not to exceed 54 in. (1372 mm) on centers vertically, with the lower and upper cold-rolled channels channel furring not more than 6 in. (152 mm) from the ends of vertical framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 and not less than $^1/_4$ in. (6 (6.4 mm) clear from the wall face, securely tied to attachments with three loops of galvanized, soft-annealed wire, or equivalent devices. Approved furring preparing a wall or ceiling with framing or furring members to provide a level surface or airspace.Subcommittee: C11.03 Standard: C754spacer strips fastened to a wall, ceiling, or planar element that create an even surface for the application of metal plaster bases or gypsum lath.Subcommittee: C11.03 Standard: C841spacer elements added to a building structure to facilitate fastening of gypsum panel products.Subcommittee: C11.03 Standard: C1546 is not prohibited from use in this application.

7.7.3 Vertical framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 shall be not less than $^3/_4$ in. (19 (19.5 mm) cold-rolled channel channels furring in accordance with the requirements of Table 3. Vertical framing members shall be saddle-tied to horizontal stiffeners with three loops of 0.0475-in. (1.21 mm) galvanized soft-annealed wire, or equivalent devices, at each crossing, and securely anchored to the floor and ceiling constructions. Where cold-rolled furring channel is furring not preparing in a contact wall with or the ceiling wall, with channel framing braces or shall furring be members installed to between provide horizontal a stiffeners level and surface the or wall, airspace. spacedSubcommittee: horizontally C11.03 not Standard: more C754 thanspacer 2 strips ft fastened (600 to mm) a on wall, centers. ceiling,

TABLE or 3 planar Types element and that Weights create of an Metal even Plaster surface Bases for and the Corresponding application Maximum Permissible Spacing of metal Supports plaster

Type bases of or Metal gypsum Plaster lath. BaseSubcommittee:	Minimum C11.03 Weight Standard: of C841 Metal spacer Plaster elements Base added lb/yd^2 a to (kg/m^2 building structure) to	Maximum facilitate Permissible fastening Spacing of gypsum Supports panel Center products. toSubcommittee: Center, C11.03 in. Standard: (mm) C1546				
		Walls is (Partitions) not			Ceilings in	
		Wood contact Studs with or the Furring wall,	Solid cold-rolled Partitions channel^A furring	Steel preparing Studs a or wall Furring	Wood or ceiling Concrete with	Metal framing
U.S. or Nominal furring Weights: members						
Diamond to Mesh provide^B a	2.5 level (1.4) surface	16 or (406) airspace.^{C}Subcommittee:	16 C11.03 (406) Standard:	16 C754 (406) spacer^C strips	12 fastened (305) to	12 a (305) wall,
	3.4 ceiling, (1.8) or	16 planar (406) element^C that	16 create (406) an	16 even (406) surface^C for	16 the (406) application	16 of (406) metal
Flat plaster Rib bases	2.75 or (1.5) gypsum	16 lath. (406)Subcommittee:	16 C11.03 (406) Standard:	16 C841 (406) spacer	16 elements (406) added	16 to (406) a
	3.4 building (1.8) structure	19 to (482) facilitate	24 fastening (610) of	19 gypsum (482) panel	19 products. (482)Subcommittee:	19 C11.03 (482) Standard:

		of				
					or	
Flat C1546 Rib braces (large shall opening) be	1.8 installed (0.95) between	24 horizontal (610) stiffeners	24 and (610) the	24 wall, (610) spaced	16 horizontally (406) not	16 more (406) than
3-2/ ft 8 (610 in. mm) Rib on	3.4 centers. (1.8) 7.7.4	24 Where (610) the	N/A water D resistive	24 barrier (610) a	24 material (610) that	24 resists (610) the
	4.0 infiltration (2.1) of	24 liquid (610) moisture	N/A through	24 the (610) building	24 enclosure (610) system.	24Subcommittee: (610) C11.03
3 Standard: / C1063 4 has in. been Rib damaged	5.4 during (2.9) installation	24 of (610) attachments,	N/A the	24 water (610) resistive	36 barrier (914) shall	36 be (914) repaired
Welded with Wire the B same	1.14 or (0.62) an	16 alternative (406) material,	16 compatible (406) with	16 the (406) water	16 resistive (406) barrier	16 a (406) material
	1.95 that (1.1) resists	24 the (610) infiltration	24 of (610) liquid	24 moisture (610) through	24 the (610) building	24 enclosure (610) system.
Woven Subcommittee: Wire C11.03 B Standard:	1.4 C1063 (0.6),	24 before (610) proceeding	16 with (406) the	16 installation (406) of	24 the (610) furring	16 preparing (406) a
Canadian wall Nominal or Weights: ceiling						
Diamond with Mesh framing B or	2.5 furring (1.4) members	16 to (406) provide	12 a (305) level	12 surface (305) or	12 airspace. (305) Subcommittee:	12 C11.03 (305) Standard:
	3.0 C754 (1.6) spacer	16 strips (406) fastened	12 to (305) a	12 wall, (305) ceiling,	12 or (305) planar	12 element (305) that
	3.4 create (1.8) an	16 even (406) surface	16 for (406) the	16 application (406) of	16 metal (406) plaster	16 bases (406) or
Flat gypsum Rib lath.	2.5 Subcommittee: (1.4) C11.03	16 Standard: (406) C841	12 spacer (305) elements	12 added (305) to	12 a (305) building	12 structure (305) to
	3.0 facilitate (1.6) fastening	16 of (406) gypsum	16 panel (406) products.	16 Subcommittee: (406) C11.03	16 Standard: (406) C1546	13 1 7.8/ Z-furring 2 used (343) to
3 support / lathing 8 and in. lathing Rib accessories	3.0 and (1.6) its	19 fasteners (482) for	N/A fastening	16 to (406) framing	16 members (406) studs	16 joist, (406) runners
	3.5 (tracks), (1.9) bridging	24 and (610) bracing	N/A and	19 related (482) accessories.	19 Subcommittee: (482) C11.03	19 Standard: (482) C1007
	4.0 or (2.1) solid	24 bases, (610)	N/A	24 (610)	24 (610)	24 (610)

(A) Where plywood is used for sheathing, a customized minimum furring of preparing 1 a/ wall 8 or in. ceiling (3.2 with mm) framing separation or shall furring be members provided to between provide adjoining a sheets level to surface allow or for airspace. expansion Subcommittee:

(B) C11.03 Metal Standard: plaster C754 bases spacer shall strips be fastened furred to away a from wall, vertica ceiling, supports or planar solid element surfaces that at create least an 1 even/ surface 4 for in. the Self-furring application lath of meets metal furring plaster requirements, bases except or furring gypsum of lath. expandedSubcommittee: metal C11.03 lath Standard: is C841 notspacer required elements on added supports to having a building bearing structure surface to of facilitate 1 fastening 5 of / gypsum 8 pane in. products. orSubcommittee: less. C11.03

(C) Standard: These C1546 spacings system are which based shall on be unsheathed engineered. walls. 7.9 Where Lapping self-furring of lath Metal is Plaster placed Bases: over 7.9.1 sheathing Side or laps a of solid metal surface, plaster the bases permissible expanded spacing metal of lath; supports sheet shall metal be lath; no welded more or than woven 24 wire in. lath. (610Subcommittee: mm). C11.03

(D) Standard: Not C841 applicable shall

7.7.4 be Where secured the to water framing resistive members. barrier They has shall been be damaged tied during between installation framing of members attachments, studs the joist, water runners resistive (tracks); barrier bridging shall and be bracing repaired and with related the accessories. sameSubcommittee: or C11.03 an Standard: alternative C1007 material, compatible with 0.0475 in. the (1.21 water mm) resistive wire barrier, at before intervals proceeding not with more the than installation 9 of in. the (229 furring. mm).

TABLE 7.9.2 4 Side Spans laps and Spacing of expanded Cold-Rolled metal Channel lath Cross-Furring shall Members be A lapped, 2 B in. (50 C mm), nominal D and, not E less, than F 1

Design / Load, 2 12 in. psi (13 (575 mm). Pa) Side		Allowable laps Span, of Main rib Runners lath or shall Supports be Ft-in. lapped (mm) 2	
Member Depth	Spacing, in. (50 (mm) mm)	Simple nominal Span and	Two not or less More than Spans 1 in. G / 2 H
3 (13 / mm), 4 or (19) nest	13.5 the (343) edge	2-9 ribs. (840) End	3-5 laps (1040) of
	16 expanded (406) metal	2-7 lath (790) and	3-3 rib (990) metal
	19 lath (483) 2	2-7 in. (740) (50	3-0 mm) (910) nominal
	24 and (610) not	2-3 less (690) than	2-10 (860)
1 in. 1 (25 / mm), 2 Wire (38) lath	13.5 shall (343) be	4-6 lapped (1370) minimum	5-8 one (1730) mesh
	16 at (406) the	4-3 sides (1300) and	5-5 ends. (1650) Where
	19 end (483) laps	4-0 occur (1220) between	5-1 the (1550) framing
	24 members, (610) the	3-8 ends (1120) of	4-9 the (1450) sheets

(A) of Bare all metal plaster thickness bases of expanded cold-rolled metal members lath, shall sheet not metal be lath; less welded than or 0.0538 woven in. wire (1.367 lath. mm).Subcommittee:

(B) C11.03 Inside Standard: corner C841 radii shall not be laced greater or than wire 1 tied / with 8 0.0475 in. in. (1.21 (3.17 mm). wire.

(C) 7.9.3 Spans Where based metal on plaster upper base flange with of an cross-furring attached laterally water unbraced resistive

(D) barrier Maximum a deflection material limited that to resists 1 the / infiltration 360 th of liquid span moisture length through unbraced. the

(E) building Steel enclosure yield system stress Subcommittee: *Fy*, C11.03 shall Standard: not C1063 be is less installed, than the 33 vertical 000 and psi horizontal (228 lap MPa). joints

(F) shall Tabulated be spans water apply resistive only barrier to on cross-furring water with resistive webs barrier oriented a vertically material

(G) that "Two resists or the more" infiltration spans of refers liquid to moisture two through or the more building continuous, enclosure equal system spans.Subcommittee:

(H) C11.03 For Standard: the C1063 "two and or metal more" plaster span base conditions, expanded listed metal spans lath, represent or the welded center-to-center or distance woven between wire adjacent lath. supports.Subcommittee:

7.8 C11.03 Lapping Standard: of C926 Metal on Plaster metal Bases: plaster

7.8.1 base Side expanded laps of metal lath, plaster or bases welded shall or be woven secured wire to lath. framingSubcommittee: members. C11.03 They Standard: shall C926 be: tied 7.9.3.1 between Where supports metal with plaster 0.0475 in. base (1.21 with mm) an wire attached at water intervals resistive not barrier more a than material 9 that in. resists (229 the mm). infiltration

7.8.2 of Metal liquid lath moisture shall through be the lapped building 1 enclosure / system. 2Subcommittee: in. C11.03 minimum Standard: (12.7 C1063 mm) is at installed, the sides, or nest the water edge resistive ribs. barrier Wire lath shall be lapped not minimum less one than mesh 2 at in. the (51 sides mm). and shall the be ends. lapped Lap not metal less lath than minimum 2

1 in. (51 (25 mm) On at walls, ends. the Where water end resistive laps barrier occur a between material the that framing resists members, the infiltration ends of liquid the moisture sheets through of the all building metal enclosure plaster system. basesSubcommittee: shall C11.03 be Standard: laced C1063 or shall wire be tied lapped with so 0.0475-in. water (1.21 will mm) flow galvanized, to annealed steel wire.

7.8.3 Where metal plaster base with backing is used, the exterior. vertical Except and for horizontal weep lap screeds, joints designated shall drainage be screeds, backing on backing and drainage metal flashings, on the metal. water

7.8.3.1 resistive Backing barrier shall a be material lapped that not resists less than 2 in. (50 mm). On walls, the infiltration backing of shall liquid be moisture lapped through so water will flow to the building exterior. enclosure Except system. forSubcommittee: weep C11.03 screeds Standard: (as C1063 described in 7.11.5), backing shall not be placed between metal plaster base (lath) and lath flanges accessory of attachment accessories. flanges. Metal plaster lath base to lath accessory key attachment flange contact shall be required to ensure that the flanges metal are plaster mechanically base locked expanded together. metal

7.9 lath, Spacing or of welded Attachments or for woven Metal wire Plaster lath. Bases—AttachmentsSubcommittee: for C11.03 securing Standard: metal C926 plaster and bases lath to accessory framing key members the shall grip be or spaced mechanical not bond more of than one 7 coat in. of (178 plaster mm) to apart another for coat, diamond or mesh to and a flat substrate. ribSubcommittee: laths C11.91 and Standard: at C11 each attachment rib flanges for are ^{3} mechanically/ locked$_{8}$ together. in. (9.5 mm) rib lath.

7.10 Installation Application of Metal Plaster Bases:

7.10.1 General:

7.10.1.1 Metal plaster bases shall be furred away from vertical framing supports members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 or solid surfaces at least $^1/_4$ in. (6 mm). Self furring lath meets furring requirements; except, furring of expanded metal lath is not required on framing supports members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 having a bearing surface of $1^5/_8$ in. (41 mm) or less.

7.10.1.2 The spacing of framing members for the type and weight of metal plaster base expanded metal lath, or welded or woven wire lath.Subcommittee: C11.03 Standard: C926 shall conform to the requirements of Table 3. Metal plaster bases shall be attached to framing members at not more than 7 in. (178 mm) on center, along framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 except for $^3/_8$-in. (10 (9.5 mm) rib metal lath that shall be attached at each rib. Attachment penetrations between the framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 shall be avoided.

7.10.1.3 Lath shall be installed applied with the long dimension at right angles to the framing supports, members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007, unless otherwise specified. pertaining to a mandatory requirement of this standard or a referenced requirement (see 3.2.17).Subcommittee: C11.03 Standard: C840pertaining to a mandatory requirement of this specification or a referenced requirement.Subcommittee: C11.03 Standard: C1280.

7.10.1.4 Ends of adjoining plaster bases shall be staggered.

7.10.1.5 Lath shall not be continuous through control joints, but shall be stopped and tied at each side.

7.10.1.6 Where furred or suspended ceilings butt into or are penetrated by columns, walls, beams, or other elements, the edges and ends of the ceiling lath shall be terminated at the horizontal internal corners angles with a casing bead bead, lathing accessory, control joint joint, a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessory, or similar device designed to keep the edges and ends of the ceiling lath and plaster free of the adjoining vertically oriented, or penetrating elements. Internal Cornerite corner reinforcement lathing accessories shall not be used at these locations. A clearance of not less than $^3/_8$ in. (10 (9.5 mm) shall be maintained between the casing bead lathing accessory, control joint a joint that accommodates movement of plaster shrinkage and curing all along such predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessory, or similar device and penetrating elements.

7.10.1.7 Where load bearing walls or partitions butt into structural walls, columns, or floor or roof slabs, the sides or ends of the wall or partition lath shall be terminated at the internal ~~corners~~ angles with a casing ~~bead~~ bead, ~~lathing accessory,~~ expansion joint ~~lathing~~ or ~~accessory,~~ control ~~joint~~ joint, ~~a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed~~ or ~~required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessory, or~~ similar device designed to keep the sides and ends of the wall or partition lath free of the adjoining elements. ~~Internal~~ Cornerite ~~corner reinforcement lathing accessories products fabricated for the purpose of forming corners, edges, control joints, or decorative effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints, such as casing beads, bull noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516~~ shall not be used at these internal ~~corners.~~ angles. A clearance of not less than $^3/_8$ in. ~~(10~~ (9.5 mm) shall be maintained from all abutting walls, columns, or other vertical elements.

7.10.2 Attachments for Metal Plaster Bases to Wood Framing Members:

7.10.2.1 Lath shall be attached to framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ with attachments spaced not more than 7 in. (178 mm) on center along framing members. Attachment penetrations between the framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ shall be avoided.

7.10.2.2 Diamond-mesh expanded metal lath, flat-rib expanded metal lath, and wire lath shall be attached to horizontal wood framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ with $1^1/_2$-in. ~~(38~~ (38.1 mm) roofing nails driven flush with the plaster base and attached to vertical wood framing members with 6d common nails, or 1-in. (25 mm) roofing nails driven to a penetration of not less than $^3/_4$ in. ~~(19~~ (19.1 mm), or 1-in. (25 mm) wire staples driven flush with the plaster base. Staples shall have crowns not less than $^3/_4$ in. (19.05 mm) and shall engage not less than three strands of diamond mesh and flat rib expanded metal lath or not less than two strands of wire lath and penetrate the wood framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ not less than $^3/_4$ in. ~~(19~~ (19.05 mm). When metal lath is ~~installed~~ applied over sheathing, use fasteners that will penetrate the ~~framing~~ structural members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ not less than $^3/_4$ in. (19 mm).

7.10.2.3 Expanded $^3/_8$ in. ~~(10~~ (9.5 mm) rib lath shall be attached to horizontal and vertical wood framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ with nails or staples to provide not less than $1^3/_4$-in. ~~(44~~ (44.5 mm) penetration into horizontal wood framing ~~members~~ members, ~~studs~~ and ~~joist,~~ 3 ~~runners~~/ ~~(tracks),~~4 ~~bridging~~ -in. ~~and~~ (19.1 ~~bracing~~ mm) ~~and~~ penetration ~~related~~ into ~~accessories.~~ vertical~~Subcommittee:~~ wood ~~C11.03~~ framing ~~Standard:~~ members. ~~C1007.~~

7.10.2.4 Common nails shall be bent over to engage not less than three strands of diamond mesh and flat rib expanded metal lath ~~see gypsum lath.Subcommittee: C11.91 Standard: C11~~ or not less than two strands of wire lath, or be bent over a rib when rib lath ~~see gypsum lath.Subcommittee: C11.91 Standard: C11~~ is installed.

7.10.2.5 Screws used to attach metal plaster base ~~expanded metal lath, or welded or woven wire lath.Subcommittee: C11.03 Standard: C926~~ to horizontal and vertical wood framing members shall penetrate not less than $^5/_8$ in. ~~(16~~ (15.9 mm) into the member when the lath ~~see gypsum lath.Subcommittee: C11.91 Standard: C11~~ is installed. For expanded metal ~~lath~~ lath, ~~see gypsum lath.Subcommittee: C11.91 Standard: C11,~~ the screw shall engage not less than three strands of lath. For wire laths, screws shall engage not less than two strands of diamond mesh and flat rib expanded metal lath ~~see gypsum lath.Subcommittee: C11.91 Standard: C11~~ or not less than two strands of wire lath. ~~see gypsum lath.Subcommittee: C11.91 Standard: C11.~~ When installing expanded metal rib lath, the screw shall pass through, but not deform, the rib. When installing wire rib ~~lath~~ lath, ~~see gypsum lath.Subcommittee: C11.91 Standard: C11,~~ the screw may deform the rib.

7.10.3 Attachments for Metal Plaster Bases to Metal Framing Members:

7.10.3.1 Except as described in 7.10.3.2, all metal plaster bases shall be securely attached to metal framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ with 0.0475-in. 18 gauge (1.21 mm) wire ties, clips, or by other means of attachment which afford carrying strength and resistance to corrosion equal to or superior to that of the wire.

7.10.3.2 Rib metal lath shall be attached to open-web steel joists by single ties of galvanized, annealed steel wire, not less than 0.0475 in. (1.21 mm), with the ends the end perpendicular to the paper-bound edge or long edge.Subcommittee: C11.01 Standard: C473 of each tie twisted together $1^1/_2$ times.

7.10.3.3 Screws used to attach metal plaster base to metal framing members shall project not less than $^3/_8$ in. (10 (9.5 mm) through the metal framing member studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787 when the lath is installed and for expanded metal laths shall engage not less than three strands of lath. see gypsum lath.Subcommittee: C11.91 Standard: C11. For wire laths, screws shall engage not less than two strands of diamond mesh and flat rib expanded metal lath see gypsum lath.Subcommittee: C11.91 Standard: C11 or not less than two strands of wire lath. When installing expanded metal rib lath lath, see gypsum lath.Subcommittee: C11.91 Standard: C11, the screw shall pass through, but not deform, the rib. When installing wire rib lath lath, see gypsum lath.Subcommittee: C11.91 Standard: C11, the screw may deform the rib.

*7.10.4 Attachments for Metal Plaster Bases to Concrete Joists—Rib Joists—*Rib metal lath shall be attached to concrete joists by loops of 0.0800-in. (2.03 mm) galvanized, annealed steel wire, with the ends the end perpendicular to the paper-bound edge or long edge.Subcommittee: C11.01 Standard: C473 of each loop twisted together.

7.10.5 Metal plaster bases shall be attached to masonry or concrete with power or powder actuated fasteners, or a combination of power or powder actuated fasteners and hardened concrete stub nails. One power or powder actuated fastener shall be located at each corner and one at the mid point of the long dimension adjacent to the edge of the metal plaster base expanded metal lath, or welded or woven wire lath.Subcommittee: C11.03 Standard: C926 sheet. The balance of the sheet shall be fastened with power or powder actuated fasteners, or hardened concrete stub nails. The fasteners shall be installed in rows not more than 16 in. (406 mm) on center and spaced vertically along each row not more 7 in. (178 mm) on center. Power-actuated All fasteners and shall concrete be stub corrosion nails resistant and shall be be not less than $^3/_4$ in. (19 mm) long, with heads not less than $^3/_8$ in. (10 (9.5 mm) wide. Where the head diameter of the power actuated fastener or concrete stub nail is smaller than 3/8-in. (10 mm), fastener nails, screws, or staples used for the application of the gypsum base or backing board.Subcommittee: C11.03 Standard: C844nails, staples, or screws used for application of the gypsum panel product.Subcommittee: C11.03 Standard: C1280a nail, screw, staple or power actuated fastener.Subcommittee: C11.02 Standard: C1861 shall use a 7/8-in. (22 mm) diameter minimum corrosion resistant metal washer, which shall be perforated when washer diameter exceeds 1 in. (25 mm).

7.11 Installation Application of Lathing Accessories:

7.11.1 Lathing *General—*All Accessory metal General Requirements—The type, location, ground dimension, and orientation of lathing accessories shall be indicated installed in the contract documents a series of several individual items that generally include drawings and specifications. Either or both of these documents may exist for any particular project.Subcommittee: C11.03 Standard: C926. 7.11.2 Install lathing accessories products fabricated for the purpose of forming corners, edges, control joints, or decorative effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints, such as casing beads, bull noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516 before cement plaster application to facilitate lathing installation, cement plaster see gypsum plaster, gypsum neat plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926 application, and functionality of the completed stucco a portland manner cement-aggregate than plaster mix designed for use on exterior surfaces. See portland cement plaster.Subcommittee: C11.91 Standard: C11portland cement-based plaster used on exterior locations.Subcommittee: C11.03 Standard: C926 cladding assembly. 7.11.3 Lathing Accessory Attachment Requirements: 7.11.3.1 Attach lathing accessory attachment flanges to substrate to ensure proper alignment during application of cement plaster. Secure lathing accessory attachment flanges at 7 in. (178 mm) maximum intervals along framing members studs joist, runners (tracks), bridging and bracing clips and provided related accessories.Subcommittee: C11.03 Standard: C1007. 7.11.3.2 Install lathing accessories products fabricated for the their purpose of forming corners, edges, control joints, or decorative effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints, such as casing beads, bull noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516 with key attachment flanges are to completely embed embedded the flanges in cement the plaster. see

7.11.1.1 gypsum Accessories plaster, shall gypsum be neat attached plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926. 7.11.3.3 Alternatively for solid plaster base substrates, adhere lathing accessory key attachment flanges directly to solid substrate plaster bases with adhesive applied in nominal 1 in. (25 mm) dabs at intervals in accordance with 7.11.3.1 or in a semi-continuous bead between the solid plaster base and the solid portion of the key attachment flange the attachment flange element of a lathing accessory that is full of holes or is expanded sheet metal that provides a means for accurate alignment, facilitates complete embedment of the key attachment flange and adjacent lath by cement plaster, and is used to attach the lathing accessory.Subcommittee: C11.02 Standard: C1861. 7.11.4 Lathing Accessory Water Management Requirements: 7.11.4.1 Where a defined drainage space is provided over the water-resistive barrier under lath and cement plaster, the ground dimension of lathing accessories with solid attachment flanges installed behind the water resistive barrier a material that resists the infiltration of liquid moisture through the building enclosure system.Subcommittee: C11.03 Standard: C1063 and defined drainage space to facilitate drainage, such as weep screeds, designated drainage screeds, expansion joints and drainage flashings, shall accommodate the defined drainage space dimension and specified cement plaster see gypsum plaster, gypsum neat plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926 thickness. 7.11.4.2 Install the water-resistive barrier and lathing to entirely cover the vertical solid attachment flange the solid attachment flange element of a lathing manner or furring accessory that provides a means for accurate alignment, facilitates drainage where drainage is required by integration of the solid attachment flange with the water-resistive barrier, and which has no holes except for optional fastener holes used to fasten the lathing accessory.Subcommittee: C11.02 Standard: C1861 of lathing accessories with a drainage function and drainage flashings such as weep screeds, designated drai nage screeds, expansion joints, and drainage flashings. Terminate lathing within 1/2 in. (13 mm) nominal above the lathing accessory drainage surface the sloped or non-sloped, perforated or non-perforated surface element of a lathing accessory that facilitates a drainage function, by directing water from behind the stucco cladding to the ensure exterior proper of alignment the during stucco application cladding.Subcommittee: C11.02 Standard: C1861. 7.11.4.3 At intersections of lathing plaster. accessories Flanges products fabricated for the purpose of forming corners, edges, control joints, or decorative effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints, such as casing beads, bull noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516 exposed at the cement plaster cladding finished surface, install the vertical lathing accessory continuously through the intersection unless the horizontally intersecting lathing accessory performs an expansion or drainage function, or both. Where vertical lathing accessories terminate above a drainage screed synonymous with ground.Subcommittee: C11.02 Standard: C1861 lathing accessory or drainage flashing, the intersection shall be kept secured free of sealant or other materials that will impede drainage. 7.11.4.4 Lathing accessories products fabricated for the purpose of forming corners, edges, control joints, or decorative effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints, such as casing beads, bull noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516 installed over the water-resistive barrier shall not impede drainage. 7.11.5 Foundation Weep Screed—install a weep screed lathing accessory at the bottom of steel or wood framed exterior walls. Locate the bottom edge of the weep screed lathing accessory not less more than 1 7 in. (25 (178 mm) below intervals the along joint supports. formed

7.11.2 by Corner the Beads—Corner foundation beads and shall framing. be Locate installed the weep screed lathing accessory ground the element of a lathing accessory that provides an edge, end, or termination for a cement plaster panel area, with a ground dimension to assist protect in all cement external plaster corners thickness control.Subcommittee: C11.02 Standard: C1861 a of 4 in. (102 mm) minimum above raw earth or 2 in. (51 mm) above paved surfaces. 7.11.6 Designated Drainage Screed—Install a designated drainage screed lathing accessory at locations indicated in the contract documents a series of several individual items that generally include drawings and specifications. Either or both of these documents may exist for any particular project.Subcommittee: C11.03 Standard: C926 and follow specified requirements in the contract documents a series of several individual items that generally include drawings and specifications. Either or both of these documents may exist for any particular project.Subcommittee: C11.03 Standard: C926. 7.11.7 Casing Bead—Install a casing bead lathing accessory or other suitable means, at locations to separate establish cement grounds. plaster

7.11.2.1 see External gypsum plaster, gypsum neat plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926 from dissimilar materials, penetrating elements, load bearing members in screw application of gypsum board, studs, runners (track), hat furring channels, main beams, and cross furring members of grid suspension systems or other items manufactured in accordance with this specification.Subcommittee: C11.02 Standard: C645studs, runners, tracks, bracing, bridging, accessories, or other items manufactured in accordance with this specification.Subcommittee: C11.02 Standard: C955 and to avoid transfer of structural loads. 7.11.8 Internal Corner Reinforcement—Install Reinforcement—External an internal corner reinforcement lathing shall accessory be at internal cement plaster corner locations except where lathing is installed continuously to through reinforce the all internal external corner, corners or where an corner expansion bead joint is lathing not accessory or control joint a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used. for Where designed no or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessory is installed at the internal corner location. 7.11.9 External Corner Reinforcement—Install an external corner reinforcement lathing or accessory at external cement plaster corner locations. bead Alternatively, where no external corner reinforcement lathing accessory is used used, on lath framed, and framed and sheathed construction, lathing shall be furred away out from the substrate and installed carried continuously around external corners for not a less minimum than distance of one framing member studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to on which frame a construction. gypsum

7.11.3 panel *Casing* product, *Beads*—Non-load-bearing or members metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not isolated less from than load-bearing 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not all less penetrating than elements, 6 with in. casing (152 beads mm) wide for gypsum studs. For internal corners or angles, other the suitable bearing means, surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive avoid the transfer gypsum of panel structural product. loads,Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787 beyond the corner. 7.11.10 Expansion Joint—Install an expansion joint lathing accessory at an expansion joint location in the building, the substrate surface to which separate the from DEFS dissimilar is materials. applied.

7.11.4Subcommittee: C11.05 Standard: C1516, or its components. 7.11.11 *Control Joints—Install Joints control (General)*—Control joint joints a shall joint be that formed accommodates by movement using of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063 a formed single product prefabricated used member, for designed or required fabricated separations by between installing adjacent casing surfaces beads of back gypsum to boards back or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessories in conformance with 7.10.1.5. 7.11.11.1 Form control joints by attaching a prefabricated flexible control barrier joint membrane a behind joint the that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessory, or alternatively by attaching a pair of casing beads. with The key attachment flanges, back to back, with a separation spacing shall be not less than $^1/_8$ in. (3 (3.2 mm) or as required pertaining to a mandatory obligation imposed by a force outside this standard, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C840pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C926 by the anticipated thermal exposure range range, and a flexible barrier membrane behind the casing beads. Wall or partition height door frames shall be considered in as conformance control with joints. 7.10.1.5 7.11.11.2. Install

7.11.4.1 control *Control joint Joints*—Control a (expansion joint that accommodates movement of plaster shrinkage and curing contraction) along joints predetermined, shall usually be straight, installed lines. inSubcommittee: walls C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessories at locations to delineate cement areas plaster not see more gypsum than plaster, gypsum neat plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926 panel areas of 144 ft² (13 (13.4 m²) maximum and for to walls delineate and areas not more than 100 ft² (9 (9.30 m²) maximum for all horizontal installations, applications, that is, ceilings, curves, or angle type structures. 7.11.11.3

7.11.4.2 Install The control distance joint between a control joint joints that shall accommodates not movement exceed of 18 plaster ft shrinkage (5.5 and m) curing in along either predetermined, direction usually or straight, lines.Subcommittee: C11.03 Standard: C1063 a formed length-to-width product ratio used for designed or required separations between adjacent surfaces of gypsum 2 boards[1 or] / gypsum 2 veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessories at locations to delineate 1. cement A plaster control see joint gypsum shall plaster, be gypsum installed neat where plaster. theSubcommittee: ceiling C11.91 framing Standard: or C11 furringportland changes cement-based direction. cementitious

7.11.4.3 mixture An (see expansion stucco). jointSubcommittee: shall C11.03 be Standard: installed C926 where panel an areas expansion of joint 18 occurs ft in (5 the m) base maximum exterior dimension, wall. in

7.11.4.4 either Wall direction, or a partition maximum height length-to-width door ratio frames of shall 2 be1 considered/ as2 to 1. 7.11.11.4 Install a control joint joints. a

7.11.5 joint *Foundation that Weep accommodates Screed*—Foundation movement weep of screed plaster shall shrinkage be and installed curing at along the predetermined; bottom usually of straight, all lines. steelSubcommittee: or C11.03 wood Standard: framed C1063 exteriora walls formed to product receive used lath for and designed plaster. or Place required the separations bottom between edge adjacent surfaces of gypsum the boards foundation or weep gypsum screed veneer not base. lessSubcommittee: than C11.02 1 Standard: in. C1047 (25 lathing mm) accessory below at locations where the ceiling joint framing formed or by furring the preparing foundation a and wall or ceiling with framing. or The furring nose members of to the provide screed a shall level be surface placed or not airspace. lessSubcommittee: than C11.03 4 Standard: in. C754 (102spacer mm) strips above fastened raw to earth a wall, ceiling, or planar 2 element in. that (51 create mm) an above even paved surface surfaces. for The the weather application resistive of barrier metal and plaster bases or gypsum lathSubcommittee: shall C11.03 entirely Standard: cover C841 thespacer vertical elements attachment added flange to and a terminate building at structure the to top facilitate edge fastening of gypsum the panel nose products. orSubcommittee: ground C11.03 flange. Standard: C1546 changes direction.

8 KEYWORDS

8.1 ceiling; expansion control joints; lath; plaster; screed; suspended ceiling; walls

ANNEX

(Mandatory Information)

A1 GENERAL INFORMATION

A1.1 All wood-based sheathing shall be installed with a minimum $^1/_8$-in. (3 (3.2 mm) minimum gap around all panel edges and between openings for doors and windows.

NOTE A1.1: This $^1/_8$-in. (3 (3.2 mm) gap is intended to accommodate expansion. Linear expansion that is not accommodated by an expansion gap can cause stress on the stucco a portland cement aggregate plaster mix designed for use on exterior surfaces. See portland cement plaster.Subcommittee: C11.91 Standard: C11portland cement-based plaster used on exterior locations.Subcommittee: C11.03 Standard: C926 membrane resulting in stucco cracks.

APPENDIX

A1.2 (Nonmandatory *Expansion Information) Joints* X1.1 shall The be nominal used lap values specified pertaining to a accommodate mandatory some requirement degree of this movement standard or a referenced requirement (see 3.2.17).Subcommittee: C11.03 Standard: C840pertaining to a mandatory requirement of this specification or a referenced requirement.Subcommittee: C11.03 Standard: C1280 in 7.9.2 do not represent a maximum threshold value. Experience has shown that excessive lapping of expanded metal lath can inhibit proper embedment of the plaster in the underlying layer of lath which, in turn, can result in attendant corrosion and cracking of the stucco a membrane portland caused cement-aggregate by plaster movement mix designed for use on exterior surfaces. See portland cement plaster.Subcommittee: C11.91 Standard: C11portland cement-based plaster used on exterior locations.Subcommittee: C11.03 Standard: C926 finishes. The nominal value provided in

7.9.2 has been shown to perform successfully; lath see gypsum lath.Subcommittee: C11.91 Standard: C11 laps greater than this value may also perform successfully, but represent a heightened risk of embedment and cracking problems. SUMMARY OF CHANGES Committee C11 has identified the location building of or selected its changes components to this minimize standard damage since the last issue (C1063 — 18a) that may impact the use of this standard. (Approved April 1, 2018.) (1) Revised 7.9.2. (2) Added new Appendix X1. Committee C11 has identified the location of selected changes to this standard since the last stucco issue (C1063 — 18) that may impact the use of this standard. (Approved April 1, 2018.) (1) Removed A0641_A0641M, B0069, B0221, C0954, C1002, D1784, and D4216 water from resistive list barrier of

A1.3 referenced Control documents Joints (Section shall 2). be (2) installed Added to Specifications minimize C1280 stress and due C1861 to list stucco of curing referenced documents (Section 2). (3) Added new 3.1.2 and renumbered drying subsequent shrinkage sections accordingly. (4) Removed previous 6.3 — 6.3.2 with new 6 — 6.3.2. (5) Removed previous 6.3.4 — 6.8.3. (6) Revised 7.1, 7.2.1 — 7.2.5, 7.3.4, 7.4 — 7.5.4, 7.6 — 7.6.2, 7.7.1 — 7.7.3. (7) Added new 7.8 and renumbered minor subsequent movement, sections along accordingly. predetermined, (8) usually Revised straight 7.9.2, lines 7.10.1.6, 7.10.1.7, 7.10.2.3, 7.10.3.2, 7.10.4, and 7.10.5. as (9) a Removed screed previous to 7.11 aid in 7.11.5 stucco and thickness replaced control. with

SUMMARY NEW OF 7.11 CHANGES — 7.11.11.4. (10) SWITCHED PREVIOUS TABLES 2 AND 3 (AND UPDATED IN TEXT TABLE REFERENCES ACCORDINGLY). (11) REVISED TABLE 3 AND TITLE OF FIG. 3. (12) REMOVED PREVIOUS A1.2 AND A1.3.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 — 17b) 15) that may impact the use of this standard. (Approved Jan. Aug. 1, 2018.) 2015.)

(1) Revised 7.8.3, definition 7.8.3.1, 7.10.4.1. (2) Replaced previous Table 3 with new Table 3. (3) Added new 2.2. (4) Added new Section 6, renumbered other sections accordingly. (5) Updated titles of Sections "water 4 resistive and barrier 5. system" Committee (formerly C11 "water has barrier identified system") the in location Terminology of (Section selected 3 changes). to this standard since the last issue (C1063 — 17a) that may impact the use of this standard. (Approved Dec. 1, 2017.) (1) Revised 7.9.2.3 and 7.10.4.1. (2) Combined previous Sections 4 and 5, added new Section 6, and renumbered subsequent sections accordingly.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 — 17a) 14d) that may impact the use of this standard. (Approved June 1, 2017.) 2015.)

(1) Added Definition new for 7.10.1.3. "drainage Committee plane" C11 has identified the location of selected changes to this standard since the last issue (C10633.2.4 —) 16c) was that revised. may impact the use of this standard. (Approved April 1, 2017.) (1) Removed previous 3.2.1, 3.2.4 — 3.2.6, , 3.2.14, 7.9, and renumbered subsequent sections accordingly.

(2) Replaced the terms "member" and "support" with " framing member studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787" throughout. (3) Replaced the term "support" with " framing member studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in.

(38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787". (4) Replaced the terms "application" and "applied" with "installation" and "installed" throughout. (5) Removed previous Note 2 and placed its contents in new 5.3.3. (6) Revised 7.10.1.4 7.10.2.2 and, 7.9.2.2. 7.10.2.4 (7), Added 7.10.2.5 new, 5.1 and renumbered 7.10.3.3 subsequent. sections accordingly. (8) Added new 5.8.3.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063— –16b) 14c) that may impact the use of this standard. (Approved Sept. Aug. 15, 2016.) 2014.)

(1) Revised 5.3.2 subsection and 7.10.1.7 7.10.1..

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063— –16a) 14b) that may impact the use of this standard. (Approved Sept. June 1, 2016.) 2014.)

(1) Corrected Definition table for reference water in resistive 7.6.1. barrier (2) was Added revised. 7.10.1.4. Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 — 16) that may impact the use of this standard. (Approved March 1, 2016.) (1) Revised 1.1.

(2) Revised Revisions 7.10.1.2. were Committee made C11 in has 7.7.4, identified 7.8.3.1, the location of selected changes to this standard since the last issue (C1063 — 15a) that may impact the use of this standard. (Approved Jan. 1, 2016.) (1) Revised 3.2.6 and 7.9.2.2. A1.2.

Committee C11 has identified the location of selected changes to this standard specification since the last issue (C1063— –15) 14a) that may impact the use of this standard. specification. (Approved Aug. April 1, 2015.) 2014.)

(1) Revised Addition definition of " the water exception resistive in barrier 7.8.3.1 a for material backing that to resists be the placed infiltration outboard of liquid moisture through the building weep enclosure screed system. flangeSubcommittee: to C11.03 be Standard: consistent C1063 with system" 7.11.5 (formerly. "water barrier system") in Terminology (Section 3).

FOOTNOTES

(1) This specification is under the jurisdiction of ASTM Committee C11 on Gypsum and Related Building Materials and Systems and is the direct responsibility of Subcommittee C11.03 on Specifications for the Application of Gypsum and Other Products in Assemblies.

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(2) For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

Date Submitted	12/7/2018	**Section**	2517	**Proponent**	Robert Koning
Chapter	25	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

The ASTM C926 and C1063 are not specific to Florida's climatic region and Florida's windspeeds.

Rationale

The ASTM C926 and C1063 are not specific to Florida's climatic region and Florida's windspeeds. These International Standards have always contained statements such as "unless otherwise specified" throughout their provisions to allow necessary regional modification to their generic provisions. The HVHZ provisions outlining stucco and metal lath installation in Florida's high wind and damp regions have always (since the 1970's) served as the source for these necessary modifications thereby eliminating the need for individual engineering for wind loads and stucco applications. Since these were removed without cause (post 2010) applicators, builders and specifiers are without prescriptive provisions for application in high wind and high humidity regions of Florida. For this and many other reasons, they must be reinstated to avoid the requirement of individual engineering for each individual building and to provide a provable cladding system for Florida’s unique climate and environment.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

yes

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

yes

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

no

Does not degrade the effectiveness of the code

no

SECTION 2517

HIGH-VELOCITY HURRICANE ZONES — STUCCO

2517.1 General.

2517.1.1 Portland cement-based plaster shall be applied in accordance with ASTM C 926, excluding Table 4 of that standard.

2517.1.2 Stucco base and finish coats, where required to meet fire-resistance requirements, shall be mixed in proportion of at least one part portland cement to a maximum of two and one-half parts sand by volume.

2517.1.3 Approved manufacturing products may be used for base and finish coats.

2517.1.4 Materials. The materials of stucco shall conform to ASTM C 926.

2517.1.5 Admixtures.

2517.1.5.1 Plasticity agents shall be of approved types and amounts and, where added to Portland cement in the manufacturing process, no additions shall be made later.

2517.1.5.2 Color may be added to the finish coat in approved amounts.

2517.1.6 Application.

2517.1.6.1 Stucco applied to concrete or masonry to meet fire-resistance requirements shall consist of at least two coats, and the total thickness shall be not less than 1 /2 inch (12.7 mm).

2517.1.6.2 Masonry surfaces on which all stucco is applied shall be clean, free from efflorescence, damp and sufficiently rough, or coated with an approved bonding agent, to insure proper bond.

2517.1.6.3 All concrete surfaces shall be coated with an approved bonding agent or shall be effectively roughened.

2517.1.6.4 The first coat shall be well forced into the pores of the masonry, shall be brought out to grounds, straightened to a true surface and left rough enough to receive the finish coat.

2517.1.6.5 The first coat shall be rodded and waterfloated to a true surface approximately one-half the total thickness.

2517.1.6.6 The base coat shall be damp cured for a period of not less than 24 hours.

2517.1.6.7 In lieu thereof, the finish coat, where containing appropriate waterproofing or curing admixtures, may be applied as soon as the base coat has attained initial set and is sufficiently firm to receive the finish coat.

2517.1.6.8 The finish coat shall be applied over a uniformly damp but surface-dry base.

2517.1.6.9 Stucco shall be kept damp for a period of not less than 48 hours after application of the finish coat.

2517.1.6.10 In lieu thereof, the finish coat may contain appropriate approved waterproofing or curing agents.

2517,2 Stucco on walls other than concrete or masonry.

2517.2.1 General. Stucco shall be as set forth in Section

2517.1.

2517.2.2 Moisture barrier. Wood shall be covered with 15- pound (7 kg) roofing felt, or other approved equally moisture-resisting layer, and metal reinforcement as set forth herein.

2517.2.3 Metal reinforcement.

2517.2.3.1 Stucco shall be reinforced with galvanized expanded metal weighing no less than 1.8 pounds per square yard (0.98 kg/e), or galvanized welded or woven wire-fabric weighing no less than 1 pound per square yard (0.54 kg/mi.

2517.2.3.2 All metal lathing shall be lapped not less than 1 inch (25 mm).

2517.2,3,3 Metal reinforcement shall be furred out from the backing by an approved method.

2517.2.3.4 Fastenings into wood sheathing or wood framing shall be by galvanized nails, with heads not less than 3/8 inch (9.5 mm) in diameter, driven to full penetration, using a minimum of two nails per square foot (0.093 m2), or by approved staples having equal resistance to withdrawal.

2517.2.3.5 The fastening of rib-lath to metal members shall be by #8 galvanized sheet-metal screws, using a minimum of two screws per square foot (0.093 m2).

2517.2.4 Application.

2517.2.4.1 Stucco applied on metal lath shall be three-coat work applied to a total thickness of not less than 1/2 inch (12.7 mm) thickness except as required to meet fire-resistance requirements.

2517.2.4.2 The first coat shall be forced through all openings in the reinforcement to fill all spaces and scored horizontally.

2517.2.4.3 The second coat shall be applied after the first coat has set sufficiently to provide a rigid backing.

2517.2.4.4 The third coat shall be applied as soon as the second coat has attained initial set.

2517.3 Pneumatically placed stucco.

2517.3.1 Pneumatically-placed stucco shall consist of a mixture of one part Portland cement to not more than five parts sand, conveyed through a pipe or flexible tube and deposited by pressure in its final position.

2517.3.2 Rebound material may be screened and reused as sand in an amount not greater than 25 percent of the total sand in any batch.

2517.33 Plasticity agents may be used as specified in Section 2517.1.5.1.

S8035

Date Submitted	12/14/2018	**Section**	2509.2	**Proponent**	Manuel Hurtado
Chapter	25	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

The proposal is to harmonize Backerboard materials FBC Table 2509.2 with FRC Table R702.4.2.

Rationale

This proposal will harmonize FBC Table 2509.2 to FRC Table R702.4.2 by adding "Fiber-reinforced gypsum panels" and the corresponding ASTM C1278 standard. Fiber-reinforced gypsum panels are currently acceptable per the FRC and has been in the International Residential Code since 2009.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

There is no impact. This proposal adds fourth alternate backerboard material option and not a requirement.

Impact to building and property owners relative to cost of compliance with code

There is no impact. This proposal adds fourth alternate backerboard material option and not a requirement. Owners may choose to use any of the other three existing options.

Impact to industry relative to the cost of compliance with code

There is no impact. This proposal adds fourth alternate backerboard material option and not a requirement. Industry may choose to use any of the other three existing options.

Impact to small business relative to the cost of compliance with code

There is no impact. This proposal adds fourth alternate backerboard material option and not a requirement. Small businesses may choose to use any of the other three existing options.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Gypsum products complying ASTM C1278 have been deemed safe to health and welfare of the general public as they are already part of the Florida Residential Code and have been part of the International Residential Building Code since 2009.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Adding the Fiber-reinforced gypsum panels in accordance with ASTM C1278 option improves the code. These water resistant panels per ASTM C1278 offer equivalency to the gypsum panels per ASTM C1178. Both standards require not more than 5 weight percentage after 2 hour water immersion testing.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal adds to the allowable materials list of backerboards in shower and water closets. Existing backerboard materials are not being removed or discriminated against.

Does not degrade the effectiveness of the code

There is no impact to the effectiveness of the code.

SECTION 2509

SHOWERS AND WATER CLOSETS

2509.1 Wet areas. Showers and public toilet walls shall conform **to Section 1210.2.**

2509.2 Base for tile. Materials used as a base for wall tile in **tub and shower areas and wall and ceiling panels in shower areas shall be of materials listed in Table 2509.2 and installed in accordance with the manufacturer's recommendations. Water-resistant gypsum backing board shall be used as a base for tile in water closet compartment walls when installed in accordance with GA-216 or ASTM C840 and the manufacturer's recommendations. Regular gypsum wallboard is permitted under tile or wall panels in other wall and ceiling areas when installed in accordance with GA-216 or ASTM C840.**

TABLE 2509.2

BACKERBOARD MATERIALS

MATERIAL	STANDARD
Glass mat gypsum backing panel	ASTM C1178
Fiber-reinforced gypsum panels	ASTM C1278
Nonasbestos fiber-cement backer board	ASTM C1288 or ISO 8336, Category C
Nonasbestos fiber-mat reinforced cementitious backer unit	ASTM C1325

2509.3 Limitations. Water-resistant gypsum backing board shall not be used in the following locations:

1. Over a vapor retarder in shower or bathtub compartments.

2. Where there will be direct exposure to water or in areas

subject to continuous high humidity.

S8321

Date Submitted	12/15/2018	**Section**	2510.6	**Proponent**	John Woestman
Chapter	25	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

In some climates, a vapor permeable WRB that is too vapor permeable (i.e., ^ 10 perms) can result in significant solar-driven inward moisture movement. Proposed new exception helps address this.

Rationale

In some climates, a vapor permeable WRB that is too vapor permeable (i.e., ^ 10 perms) can result in significant solar-driven inward moisture movement into and through the exterior sheathing and farther into the wall assembly (e.g., to the interior vapor retarder or interior finishes), causing significantly increased risk of moisture damage and mold. This concern is particularly relevant to Section 2510.6 which deals with conventional stucco -- a moisture storage ("reservoir") cladding. A new exception is proposed to address this problem and is based on consistent findings and recommendations from several studies including Derome (2010), Wilkinson, et al. (2007), BSC (2005), and Lepage and Lstiburek (2013). Key findings and recommendations from these studies are summarized in ABTG (2015). It is also important to note that this proposal does NOT eliminate the use of WRB materials of greater than 10 perms in the stated conditions because an alternative allows for use of a ventilated air space to avoid the 10 perm limitation.

Bibliography:

ABTG (2015). "Assessment of Water Vapor Control Methods for Modern Insulated Light-Frame Wall Assemblies", Research Report No. ABTG-1410-03, Applied Building Technology Group, LLC, http://www.appliedbuildingtech.com/rr/1410-03 BSC (2005).
Derome, D. (2010). The nature, significance and control of solar-driven w ater vapor diffusion in w all systems -- synthesis of Research Project RP-1235, ASHRAE Transactions, January 2010. www.ashrae.org
Lepage, R. and Lstiburek, J. (2013). Moisture Durability with Vapor-Permeable Insulating Sheathing, U.S. DOE, Building Technologies Office, www.osti.gov/bridge
Wilkinson, J. Ueno, K., DeRose, D., Straube, J.F. and Fugler, D. (2007). Understanding Vapour Permeance and Condensation in Wall Assemblies, 11th Canadian Conference on Building Science and Technology, Banff, Alberta

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Adds a new (optional) exception for water management practices in walls clad with stucco. May require some attention to detail when inspecting buildings.

Impact to building and property owners relative to cost of compliance with code

May or may not increase the cost of code compliance.
The proposal provides limitations that may affect some product choices (or cladding detailing) under specified conditions of use, but options remain available for all WRB types and many are unaffected.

Impact to industry relative to the cost of compliance with code

May or may not increase the cost of code compliance.
The proposal provides limitations that may affect some product choices (or cladding detailing) under specified conditions of use, but options remain available for all WRB types and many are unaffected.

Impact to small business relative to the cost of compliance with code

May or may not increase the cost of code compliance.
The proposal provides limitations that may affect some product choices (or cladding detailing) under specified conditions of use, but options remain available for all WRB types and many are unaffected.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Proposed new exception can help reduce moisture management issues in walls.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens and improves the code, provide an alternative effective system of moisture management in walls.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Improves the effectiveness of the code.

Modify as follow:

2510.6 Water-resistive barriers. Water-resistive barriers shall be installed as required in Section 1404.2 and, where applied over wood-based sheathing, shall include a water resistive vapor-permeable barrier with a performance at least equivalent to two layers of water-resistive barrier complying with ASTM E2556, Type I. The individual layers shall be installed independently such that each layer provides a separate continuous plane and any flashing (installed in accordance with Section 1405.4) intended to drain to the water resistive barrier is directed between the layers.

~~Exception:~~Exceptions:

1. Where the water-resistive barrier that is applied over wood-based sheathing has a water resistance equal to or greater than that of a water-resistive barrier complying with ASTM E2556, Type II and is separated from the stucco by an intervening, substantially nonwater-absorbing layer or drainage space.

2. Where the water-resistive barrier is applied over wood-based sheathing in Climate Zone 1A, 2A or 3A, a ventilated air space shall be provided between the stucco and water-resistive barrier.

S7170

Date Submitted	11/2/2018	**Section**	2615.2	**Proponent**	Eduardo Fernandez
Chapter	26	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

To correct scrivener error for this section subtitled

Rationale

This section is actually a technical requirement and not a definition.
The code modification will correct the scrivener error contained in Section 2615.2 and will make the technical content on this section comprehensible to comply.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact as the provision are currently in effect. No new requirements created.

Impact to building and property owners relative to cost of compliance with code

No impact as the provision are currently in effect. No new requirements created.

Impact to industry relative to the cost of compliance with code

No impact as the provision are currently in effect. No new requirements created.

Impact to small business relative to the cost of compliance with code

No impact as the provision are currently in effect. No new requirements created.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This modification improves the safety and welfare of the general public by establishing a clear direction for the durability of approved plastic when used as a component in a product element.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The proposed modification will improved the code by giving clear guidance to the designers and manufactures.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposed does not discriminate.

Does not degrade the effectiveness of the code

Improves the effectiveness of the code by making more clear the application of the technical content contained on this section.

2615.2 ~~Definitions~~. APPROVED PLASTIC

~~APPROVED PLASTIC~~. Approved plastics for outdoor exposure shall be evaluated for outdoor durability in accordance with the Voluntary Standard Uniform Load Test Procedure for Thermoformed Plastic Domed Skylights, of the AAMA/WDMA 101/IS2/NAFS, Voluntary Performance Specification for Windows, Skylights and
Glass Doors, as follows:

S7604

Date Submitted 11/30/2018
Chapter 26
Section 2603.12
Affects HVHZ No
Proponent Bonnie Manley
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

7452, 7454, 7455, 7458, S299-16 (Structural, Structural Chart#1)

Summary of Modification

This proposal is one in a series adopting the latest generation of AISI standards for cold-formed steel.

Rationale

This proposal is one in a series adopting the latest generation of AISI standards for cold-formed steel. This particular proposal focuses on Chapter 26 by incorporating a reference to the new cold-formed steel structural framing standard – AISI S240. The standard is published and available for a free download at: www.aisistandards.org.

The new standard, AISI S240, North American Standard for Cold-Formed Steel Structural Framing, addresses requirements for construction with cold-formed steel structural framing that are common to prescriptive and engineered light frame construction. This comprehensive standard was formed by merging the following AISI standards: AISI S200, AISI S210, AISI S211, AISI S212, AISI S213, and AISI S214. Consequently, AISI S240 supersedes all previous editions of the above mentioned individual AISI standards.

Both Table 2603.12.1 and Table 2603.12.2 previously referenced AISI S200 for cold-formed steel screw requirements. This reference is updated to AISI S240. Additionally, the term "cold-formed steel" is editorially corrected to reflect industry terminology in several locations.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

2603.12 Cladding attachment over foam sheathing to cold-formed steel framing.
Cladding shall be specified and installed in accordance with Chapter 14 and the cladding manufacturer's approved installation instructions, including any limitations for use over foam plastic sheathing, or an approved design. Where used, furring and furring attachments shall be designed to resist design loads determined in accordance with Chapter 16. In addition, the cladding or fur-ring attachments through foam sheathing to cold-formed steel framing shall meet or exceed the minimum fastening requirements of Sections 2603.12.1and 2603.12.2, or an approved design for support of cladding weight.

Exceptions:

1.Where the cladding manufacturer has provided approved installation instructions for application over foam sheathing, those requirements shall apply.

2.For exterior insulation and finish systems, refer to Section 1408.

3.For anchored masonry or stone veneer installed over foam sheathing, refer to Section 1405.

2603.12.1 Direct attachment.
Where cladding is installed directly over foam sheathing without the use of furring, cladding minimum fastening requirements to support the cladding weight shall be as specified in Table 2603.12.1.

TABLE 2603.12.1
CLADDING MINIMUM FASTENING REQUIREMENTS FOR DIRECT ATTACHMENT OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHTa

CLADDING FASTENERTHROUGH FOAMSHEATHING INTO:	CLADDING FASTENERTYPE AND MINIMUM SIZEb	CLADDINGFASTENERVERTICAL SPACING(inches)	MAXIMUM THICKNESS OF FOAM SHEATHINGc(inches)					
			16?o.c. fastener horizontal spacing			24?o.c. fastener horizontal spacing		
			Cladding weight			Cladding weight		
			3 psf	11 psf	25 psf	3 psf	11 psf	25 psf
Cold-formed s~~S~~teel framing(minimum penetration of steel thickness plus3 threads)	#8 screw into 33 milsteel or thicker	6	3	3	1.5	3	2	DR
		8	3	2	0.5	3	1.5	DR
		12	3	1.5	DR	3	0.75	DR

		6	4	3	2	4	3	0.5
	#10 screw into 33 milsteel	8	4	3	1	4	2	DR
		12	4	2	DR	3	1	DR
		6	4	4	3	4	4	2
	#10 screw into 43 milsteel or thicker	8	4	4	2	4	3	1.5
		12	4	3	1.5	4	3	DR

For SI: 1 inch = 25.4 mm; 1 pound per square foot (psf) = 0.0479 kPa, 1 pound per square inch = 0.00689 MPa.

DR = design required; o.c. = on center.

a.Cold-formed s~~S~~teel framing shall be minimum 33 ksi steel for 33 mil and 43 mil steel and 50 ksi steel for 54 mil steel or thicker.

b.Screws shall comply with the requirements of AISI S240~~S200~~.

c.Foam sheathing shall have a minimum compressive strength of 15 pounds per square inch in accordance with ASTM C578or ASTM C1289.

2603.12.2 Furred cladding attachment.
Where steel or wood furring is used to attach cladding over foam sheathing, furring minimum fastening requirements to support the cladding weight shall be as specified in Table 2603.12.2. Where placed horizontally, wood furring shall be preservative-treated wood in accordance with Section 2303.1.9 or naturally durable wood and fasteners shall be corrosion resistant in accordance Section 2304.10.5. Steel furring shall have a minimum G60 galvanized coating.

TABLE 2603.12.2
FURRING MINIMUM FASTENING REQUIREMENTS FOR APPLICATION OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[a]

FURRING MATERIAL	FRAMINGMEMBER	FASTENER TYPEAND MINIMUM SIZE[b]	MINIMUMPENETRATION INTOWALL FRAMING(inches)	FASTENERSPACING INFURRING(inches)	MAXIMUM THICKNESS OF FOAM SHEATHING[4](inches)	
					16? o.c. furring[e]	24? o.c. furring[e]
					Cladding weight	Cladding weight

					3 psf	11 psf	25 psf	3 psf	11 psf	25 psf
Minimum 33 milsteel furring or minimum1x wood furring[c]	33 mil cold-formed steel stud	#8 screw	Steel thickness plus3 threads	12	3	1.5	DR	3	0.5	DR
				16	3	1	DR	2	DR	DR
				24	2	DR	DR	2	DR	DR
		#10 screw	Steel thickness plus3 threads	12	4	2	DR	4	1	DR
				16	4	1.5	DR	3	DR	DR
				24	3	DR	DR	2	DR	DR
	43 mil or thicker cold-formed steel stud	#8 Screw	Steel thickness plus3 threads	12	3	1.5	DR	3	0.5	DR
				16	3	1	DR	2	DR	DR
				24	2	DR	DR	2	DR	DR
		#10 screw	Steel thickness plus3 threads	12	4	3	1.5	4	3	DR
				16	4	3	0.5	4	2	DR
				24	4	2	D	4	0.	D

							R		5	R

For SI: 1 inch = 25.4 mm; 1 pound per square foot (psf) = 0.0479 kPa, 1 pound per square inch = 0.00689 MPa.
DR = design required: o.c. = on center.

a.Wood furring shall be Spruce-Pine fir or any softwood species with a specific gravity of 0.42 or greater. Cold-formed s~~S~~teel furring shall be minimum 33 ksi steel. Steel studs shall be minimum 33 ksi steel for 33 mil and 43 mil thickness and 50 ksi steel for 54 mil steel or thicker.

b.Screws shall comply with the requirements of AISI S240~~S200~~.

c.Where the required cladding fastener penetration into wood material exceeds 3/4 inch and is not more than 11/2 inches, a minimum 2-inch nominal wood furring shall be used or an approved design.

d.Foam sheathing shall have a minimum compressive strength of 15 pounds per square inch in accordance with ASTM C578or ASTM C1289.

e.Furring shall be spaced not more than 24 inches on center, in a vertical or horizontal orientation. In a vertical orientation, furring shall be located over wall studs and attached with the required fastener spacing. In a horizontal orientation, the indicated 8-inch and 12-inch fastener spacing in furring shall be achieved by use of two fasteners into studs at 16 inches and 24 inches on center, respectively.

S8338

Date Submitted	12/15/2018	**Section**	2603.12	**Proponent**	John Woestman
Chapter	26	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

This proposal updates the existing tables by applying a consistent rounding down to the nearest 0.05" for foam sheathing thickness and adds an 18 psf cladding weight category at the request of the brick industry.

Rationale

This proposal updates the existing tables by applying a consistent rounding down to the nearest 0.05" for foam sheathing thickness to better and more efficiently accommodate various foam sheathing products that have actual thickness that may vary from nominal thickness currently in the table. The same rounding is applied to the addition of an 18 psf cladding weight category at the request of the brick industry. All of the values were determined using the same analysis and research basis of the original tables, including limiting foam thicknesses to 3" maximum for #8 screw as was done for the existing tables based on availability of fastener lengths and practicality considerations.

COST IMPACT: This proposal will not increase cost. This proposal will actually decrease cost as a result of more efficient design for foam thickness and fastener sizing.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

The proposal refines the values in the existing table regarding maximum thickness of foam sheathing. There should be no differences in code enforcement.

Impact to building and property owners relative to cost of compliance with code

This proposal will not increase cost. This proposal will actually decrease cost as a result of more efficient design for foam thickness and fastener sizing.

Impact to industry relative to the cost of compliance with code

This proposal will not increase cost. This proposal will actually decrease cost as a result of more efficient design for foam thickness and fastener sizing.

Impact to small business relative to the cost of compliance with code

This proposal will not increase cost. This proposal will actually decrease cost as a result of more efficient design for foam thickness and fastener sizing.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the technical requirements of these two tables - which are related to energy efficiency aspects of a building.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code by improving the technical requirements in these tables.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials.

Does not degrade the effectiveness of the code

Maintains the effectiveness of the code.

Revise Tables 2603.12.1 and 2603.12.2 as follows:

TABLE 2603.12.1 CLADDING MINIMUM FASTENING REQUIREMENTS

FOR DIRECT ATTACHMENT OVER FOAM PLASTIC SHEATHING

TO SUPPORT CLADDING WEIGHT[1]

Cladding Fastener Through Foam Sheathing into:	Cladding Fastener -Type and Minimum Size[2]	Cladding Fastener Vertical Spacing (inches)	Maximum Thickness of Foam Sheathing[3] (inches)							
			16"oc Fastener Horizontal Spacing				24"oc Fastener Horizontal Spacing			
			Cladding Weight:				Cladding Weight:			
			3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Steel Framing (minimum penetration of steel thickness + 3 threads)	#8 screw into 33 mil steel or thicker	6	3.00	2.953	2.20	1.45	3.00	2.35	1.25	DR
		8	3.00	2.55	1.60	0.605	3.00	1.805	DR	DR
		12	3.00	1.805	DR	DR	3.00	0.6575	DR	DR
	#10 screw into 33 mil steel	6	4.00	3.50	2.70	1.952	4.00	2.903	1.70	0.55
		8	4.00	3.10	2.05	1.00	4.00	2.25	0.70	DR
		12	4.00	2.25	0.70	DR	3.70	1.05	DR	DR
	#10 screw into 43 mil steel or thicker	6	4.00	4.00	4.00	3.60	4.00	4.00	3.45	2.70
		8	4.00	4.00	3.70	3.002	4.00	3.85	2.80	1.805
		12	4.00	3.85	2.80	1.805	4.00	3.05	1.50	DR

(Table notes unchanged)

TABLE 2603.12.2 FURRING MINIMUM FASTENING REQUIREMENTS FOR APPLICATION

OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[1]

Furring Material	Framing Member	Fastener Type and Minimum Size[2]	Minimum Penetration into Wall Framing (inches)	Fastener Spacing in Furring (inches)	Maximum Thickness of Foam Sheathing[4] (inches)							
					16"oc FURRING[5]				24"oc FURRING[5]			
					Cladding Weight:				Cladding Weight:			
					3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Minimum 33mil Steel Furring or Minimum 1x Wood Furring[3]	33 mil Steel Stud	#8 screw	Steel thickness + 3 threads	12	3.00	1.805	DR	DR	3.00	0.65	DR	DR
				16	3.00	1.00	DR	DR	2.85	DR	DR	DR
				24	2.85	DR	DR	DR	2.20	DR	DR	DR
		#10 screw	Steel thickness + 3 threads	12	4.00	2.25	0.70	DR	3.704	1.05	DR	DR
				16	3.854	1.45	DR	DR	3.40	DR	DR	DR
				24	3.40	DR	DR	DR	2.70	DR	DR	DR
	43 mil or thicker Steel Stud	#8 Screw	Steel thickness + 3 threads	12	3.00	1.805	DR	DR	3.00	0.65	DR	DR
				16	3.00	1.00	DR	DR	2.85	DR	DR	DR
				24	2.85	DR	DR	DR	2.20	DR	DR	DR

		#10 screw	Steel thickness + 3 threads	12	4.00	3.85	2.80	1.80~~5~~	4.00	3.05	1.50	DR
				16	4.00	3.30	1.95	0.60~~5~~	4.00	2.25	DR	DR
				24	4.00	2.25	DR	DR	4.00	0.65	DR	DR

(Table notes unchanged)

Date Submitted	12/15/2018	**Section**	2603.13	**Proponent**	John Woestman
Chapter	26	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Propose the same requirements for cladding attachment over foam sheathing to wood framing were approved in the 2017 Florida residential code, and similar requirements for steel framing were approved in the 2017 Florida building code and residential code.

Rationale

These same requirements for cladding attachment over foam sheathing to wood framing were included in the 2017 residential code and similar requirements for steel framing were included in the 2017 Florida codes. Similar requirements also have existed in the New York State Energy Code for several years. These requirements fill the only remaining information gap in the Florida code provisions for wood frame exterior wall covering assemblies that include foam plastic insulation. This proposal includes the addition of an 18 psf cladding weight category at the request of the brick industry.

The proposed requirements are based on a project sponsored by the New York State Energy Research and Development Agency (NYSERDA) (Bowles, 2010). The purpose of the NYSERDA project was to develop prescriptive fastening requirements for cladding materials installed over foam sheathing to ensure adequate performance. The project included testing of cladding attachments through various thicknesses of foam sheathing using various fastener types on steel frame wall assemblies, including supplemental test data to address attachments to wood framing sponsored by the FSC. The proposed cladding attachment requirements and foam sheathing thickness limits are based on rational analysis (based on NDS yield equations) verified by the NYSERDA data to control cladding connection movement to no more than 0.015” slip under cladding weight or dead load. This deflection controlled approach resulted in safety factors commonly in the range of 5 to 8 relative to average shear capacity and demonstrated adequate long-term deflection control.

Bibliography:

Bowles, L. (2010). “Fastening Systems for Continuous Insulation” Albany, NY: New York State Energy Research and Development Authority. www.nyserda.ny.gov

Baker, P. (2014). Initial and Long Term Movement of Cladding Installed Over Exterior Rigid Insulation. Building American Report – 1404

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This new section in the Florida building code may add to code enforcement activities - but provides appropriate guidance where the code has previously been silent.

Impact to building and property owners relative to cost of compliance with code

This proposal should not increase cost. The proposal provides additional options for use with wood framing that do not currently exist.

Impact to industry relative to the cost of compliance with code

This proposal should not increase cost. The proposal provides additional options for use with wood framing that do not currently exist.

Impact to small business relative to the cost of compliance with code

This proposal should not increase cost. The proposal provides additional options for use with wood framing that do not currently exist.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Appropriate fastening of cladding through foam sheathing, where installed, is important for the long-term performance of the cladding.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code by providing guidance where the code was previously silent.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials.

Does not degrade the effectiveness of the code

Improves the effectiveness of the code.

Add new text as follows:

2603.13 Cladding attachment over foam sheathing to wood framing. Cladding shall be specified and installed in accordance with Chapter 14 and the cladding manufacturer's installation instructions. Where used, furring and furring attachments shall be designed to resist design loads determined in accordance with Chapter 16. In addition, the cladding or furring attachments through foam sheathing to framing shall meet or exceed the minimum fastening requirements of Section 2603.13.1, Section 2603.13.2, or an approved design for support of cladding weight.

Exceptions:

1. Where the cladding manufacturer has provided approved installation instructions for application over foam sheathing, those requirements shall apply.
2. For exterior insulation and finish systems, refer to Section 1408.
3. For anchored masonry or stone veneer installed over foam sheathing, refer to Section 1405.

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2603.11.1 Direct attachment. Where cladding is installed directly over foam sheathing without the use of furring, cladding minimum fastening requirements to support the cladding weight shall be as specified in Table 2603.13.1.

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2603.11.2 Furred cladding attachment. Where wood furring is used to attach cladding over foam sheathing, furring minimum fastening requirements to support the cladding weight shall be as specified in Table 2603.13.2. Where placed horizontally, wood furring shall be preservative treated wood in accordance with Section 2303.1.9 or naturally durable wood and fasteners shall be corrosion resistant in accordance with Section 2304.10.5.

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TABLE 2603.13.1

CLADDING MINIMUM FASTENING REQUIREMENTS FOR DIRECT ATTACHMENT OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[a]

Cladding Fastener Through Foam Sheathing into:	Cladding Fastener -Type and Minimum Size[b]	Cladding Fastener Vertical Spacing (inches)	Maximum Thickness of Foam Sheathing[c] (inches)							
			16" o.c. Fastener Horizontal Spacing				24" o.c. Fastener Horizontal Spacing			
			Cladding Weight:				Cladding Weight:			
			3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18psf	25 psf
Wood Framing (minimum 1-1/4 inch penetration)	0.113" diameter nail	6	2.00	1.45	0.75	DR	2.00	0.85	DR	DR
		8	2.00	1.00	DR	DR	2.00	0.55	DR	DR
		12	2.00	0.55	DR	DR	1.85	DR	DR	DR
	0.120" diameter nail	6	3.00	1.70	0.90	0.55	3.00	1.05	0.50	DR
		8	3.00	1.20	0.60	DR	3.00	0.70	DR	DR
		12	3.00	0.70	DR	DR	2.15	DR	DR	DR
	0.131" diameter nail	6	4.00	2.15	1.20	0.75	4.00	1.35	0.70	DR
		8	4.00	1.55	0.80	DR	4.00	0.90	DR	DR
		12	4.00	0.90	DR	DR	2.70	0.50	DR	DR
	0.162"	6	4.00	3.55	2.05	1.40	4.00	2.25	1.25	0.80
		8	4.00	2.55	1.45	0.95	4.00	1.60	0.85	0.50

	diameter nail	12	4.00	1.60	0.85	0.50	4.00	0.95	DR	DR

For SI: 1 inch = 25.4 mm; 1 pound per square foot (psf) = 0.0479 kPa

DR = design required

o.c. = on center

a. Wood framing shall be Spruce-Pine-Fir or any wood species with a specific gravity of 0.42 or greater in accordance with AFPA/NDS.

b. Nail fasteners shall comply with ASTM F1667, except nail length shall be permitted to exceed ASTM F1667 standard lengths.

c. Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C 578 or ASTM C 1289.

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TABLE 2603.13.2

FURRING MINIMUM FASTENING REQUIREMENTS FOR APPLICATION

OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[a,b]

Furring Material	Framing Member	Fastener Type and Minimum Size	Minimum Penetration into Wall Framing (inches)	Fastener Spacing in Furring (inches)	Maximum Thickness of Foam Sheathing[d] (inches)							
					16"oc Furring[e]				24"oc Furring[e]			
					Siding Weight:				Siding Weight:			
					3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Minimum 1x Wood Furring[c]	Minimum 2x Wood Stud	0.131" diameter nail	1-1/4	8	4.00	2.45	1.45	0.95	4.00	1.60	0.85	DR
				12	4.00	1.60	0.85	DR	4.00	0.95	DR	DR
				16	4.00	1.10	DR	DR	3.05	0.60	DR	DR
		0.162" diameter nail	1-1/4	8	4.00	4.00	2.45	1.60	4.00	2.75	1.45	0.85
				12	4.00	2.75	1.45	0.85	4.00	1.65	0.75	DR
				16	4.00	1.90	0.95	DR	4.00	1.05	DR	DR
		No. 10 wood screw	1	12	4.00	2.30	1.20	0.70	4.00	1.40	0.60	DR
				16	4.00	1.65	0.75	DR	4.00	0.90	DR	DR
				24	4.00	0.90	DR	DR	2.85	DR	DR	DR
		¼" lag screw	1-1/2	12	4.00	2.65	1.50	0.90	4.00	1.65	0.80	DR
				16	4.00	1.95	0.95	0.50	4.00	1.10	DR	DR
				24	4.00	1.10	DR	DR	3.25	0.50	DR	DR

For SI: 1" = 25.4 mm; 1 pound per square foot (psf) = 0.0479 kPa.

DR = design required

o.c. = on center

a. Wood framing and furring shall be Spruce-Pine-Fir or any wood species with a specific gravity of 0.42 or greater in accordance with AFPA/NDS.

b. Nail fasteners shall comply with ASTM F1667, except nail length shall be permitted to exceed ASTM F1667 standard lengths.

c. Where the required cladding fastener penetration into wood material exceeds ¾ inch (19.1 mm) and is not more than 1-1/2 inches (38.1 mm), a minimum 2x wood furring shall be used or an approved design.

d. Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C 578 or ASTM C 1289.

e. Furring shall be spaced a maximum of 24 inches (610 mm) on center, in a vertical or horizontal orientation. In a vertical orientation, furring shall be located over wall studs and attached with the required fastener spacing. In a horizontal orientation, the indicated 8 inch (203.2 mm) and 12 inch (304.8 mm) fastener spacing in furring shall be achieved by use of two fasteners into studs at 16 inches (406.4 mm) and 24 inches (610 mm) on center, respectively.

S7365

Date Submitted	11/20/2018	**Section**	3111	**Proponent**	Bryan Holland
Chapter	31	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No   **Alternate Language** No

Related Modifications

7345, 7347, 7348

Summary of Modification

This proposed modification updates requirement for solar energy systems in the FBC-B.

Rationale

This proposed modification deletes the current requirements in Section 3111 and replaces them with the updated rules in 3111 of the 2018 IBC that have been correlated and harmonized with current industry standards and other applicable references. This change is similar to those proposed under Mods 7345, 7347, and 7348 for inclusion into the FBC-R. This change will also coordinate the FBC-B with the FFPC.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposed modification will not impact the local entity relative to code enforcement.

Impact to building and property owners relative to cost of compliance with code

This proposed modification will not change the cost of compliance to building and property owners.

Impact to industry relative to the cost of compliance with code

This proposed modification will not change the cost of compliance or impact industry.

Impact to small business relative to the cost of compliance with code

This proposed modification will not change the cost of compliance or impact small business.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposed modification is directly connected to the health, safety, and welfare of the general public by coordinating the FBC-B with the FFPC for life, fire, and property safety related to solar energy system installations.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposed modification improves and strengthens the code by updating the rules for solar energy systems in the FBC-B.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposed modification does not discriminate against materials, products, methods, or systems of construction.

Does not degrade the effectiveness of the code

This proposed modification enhances the effectiveness of the code.

~~SECTION 3111~~

~~PHOTOVOLTAIC PANELS AND MODULES~~

~~3111.1 General. Photovoltaic panels and modules shall comply with the requirements of this code and the Florida Fire Prevention Code.~~

~~3111.1.1 Rooftop-mounted photovoltaic panels and modules. Photovoltaic panels and modules installed on a roof or as an integral part of a roof assembly shall comply with the requirements of Chapter 15 and the Florida Fire Prevention Code.~~

SECTION 3111

SOLAR ENERGY SYSTEMS

3111.1 General. Solar energy systems shall comply with the requirements of this section.

3111.1.1 Wind resistance. Rooftop-mounted photovoltaic panels and modules and solar thermal collectors shall be designed in accordance with Section 1609.

3111.1.2 Roof live load. Roof structures that provide support for solar energy systems shall be designed in accordance with Section 1607.13.5.

3111.2 Solar thermal systems. Solar thermal systems shall be designed and installed in accordance with the Florida Building Code-Plumbing, the Florida Building Code-Mechanical, and the Florida Fire Prevention Code.

3111.2.1 Equipment. Solar thermal systems and components shall be listed and labeled in accordance with ICC 900/SRCC 300 and ICC 901/SRCC 100.

3111.3 Photovoltaic solar energy systems. Photovoltaic solar energy systems shall be designed and installed in accordance with this section, the Florida Fire Prevention Code, NFPA 70 and the manufacturer's installation instructions.

3111.3.1 Equipment. Photovoltaic panels and modules shall be listed and labeled in accordance with UL 1703. Inverters shall be listed and labeled in accordance with UL 1741. Systems connected to the utility grid shall use inverters listed for utility interaction.

3111.3.2 Fire classification. Rooftop-mounted photovoltaic systems shall have a fire classification in accordance with Section 1505.9. Building-integrated photovoltaic systems shall have a fire classification in accordance with Section 1505.8.

3111.3.3 Building-integrated photovoltaic systems. Building-integrated photovoltaic systems that serve as roof coverings shall be designed and installed in accordance with Section 1507.18.

3111.3.4 Access and pathways. Roof access, pathways and spacing requirements shall be provided in accordance with Section 1204 of the Florida Fire Prevention Code.

3111.3.5 Ground-mounted photovoltaic systems. Ground-mounted photovoltaic systems shall be designed and installed in accordance with Chapter 16 and the Florida Fire Prevention Code.

3111.3.5.1 Fire separation distances. Ground-mounted photovoltaic systems shall be subject to the fire separation distance requirements determined by the local jurisdiction.

S7621

Date Submitted	12/4/2018	**Section**	3115	**Proponent**	Steve Martin
Chapter	31	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **Yes** **Alternate Language** **No**

Related Modifications

Summary of Modification

Public use restrooms on publicly owned lands in flood hazard areas shall comply with the requirements of ASCE 24, except for elevation requirements, and shall comply with criteria set forth in the amendment.

Rationale

Under the current requirements of the NFIP and IFBC, restrooms for public use that are located in flood hazard areas must meet the same requirements as residential and commercial buildings. This proposal is intended to meet the intent of all NFIP requirements, except elevation requirements, to minimize flood damage, while acknowledging the special needs and access required or appropriate for public use restrooms. See support file for a complete rationale and photographs.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in costs associated with enforcement.

Impact to building and property owners relative to cost of compliance with code

The proposal will lower initial costs and lower routine and long-term facility maintenance by public entities that provide public use restrooms on publicly owned lands. Construction costs will be less than the cost to elevate and provide and maintain elevators and extensive ramp systems.

Impact to industry relative to the cost of compliance with code

The code change proposal will decrease the cost of construction.

Impact to small business relative to the cost of compliance with code

No impact; the proposal applies only to public use restrooms on publicly owned lands.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Accessible public use restrooms on publicly owned lands have a direct substantial connect to health, safety, and welfare of the public that visits public parks and beaches.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by providing a better method to provide public use restrooms on publicly owned land, while preserving the objective of flood resistant construction.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No specific materials, products, methods or systems are specified.

Does not degrade the effectiveness of the code

Communities that permit public use restrooms on publicly owned lands in accordance with the proposal may have to justify such action to FEMA.

1st Comment Period History

S7621-G1

Proponent Gregory Wilson **Submitted** 2/13/2019 **Attachments** Yes

Comment:

See attached letter from the FEMA Floodplain Management Division Director

3101.1 Scope. The provisions of this chapter shall govern special building construction including membrane structures, temporary structures, *pedestrian walkways* and tunnels, automatic *vehicular gates*, *awnings* and *canopies*, *marquees*, signs, ~~and~~ towers and antennas, and public use restroom buildings on publicly owned lands in flood hazard areas.

3115 PUBLIC USE RESTROOM BUILDINGS IN FLOOD HAZARD AREAS

3115.1 General. - For the purpose of this section, public restroom buildings are located on publicly owned lands in flood hazard areas and intended for public use. Public restroom buildings and portions of other buildings that contain public restrooms, are limited to toilet rooms, bathrooms, showers and changing rooms. Public restroom buildings and portions of buildings that contain public restrooms shall comply with the requirements of this section. Public use restrooms that are not elevated or dry flood proofed in accordance with Section 1612 shall comply with Section 3115.2. Portions of buildings that include uses other than public use toilet rooms, bathrooms, showers and changing rooms shall comply with Section 1612.

3115.2 Flood resistance. Public use restrooms on publicly owned lands in flood hazard areas shall comply with the requirements of ASCE 24, except for elevation requirements, and shall comply with all of the following criteria:

-

1. The building foot print is not more than 1,500 square feet.
2. Located, designed and constructed to resist the effects of flood hazards and flood loads to minimize flood damage from a combination of wind and water loads associated with the base flood.
3. Anchored to prevent flotation, collapse or lateral movement resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy during conditions of the base flood.
4. Constructed of flood damage-resistant materials.
5. Where enclosed by walls, the walls have flood openings.
6. Mechanical and electrical systems are located above the base flood elevation.
7. Plumbing fixtures and plumbing connections are located above the base flood elevation.
8. An emergency plan, approved by the jurisdiction, is submitted to the building official where the building design documents specify implementation of protection measures prior to the onset of flooding conditions.

-

Exceptions:

1. Minimum necessary electric equipment required to address health, life safety and electric code requirements is permitted below the base flood elevation in accordance with ASCE 24 provisions for electric elements installed below the minimum elevations.
2. Plumbing fixtures and connections are permitted below the base flood elevation provided the fixtures and connections are designed and installed to minimize or eliminate infiltration of flood waters into the sanitary sewage system and discharges from sanitary sewage systems into flood waters.

U.S. Department of Homeland Security
500 C Street, SW
Washington, DC 20472

FEMA

2 3 OCT 2018

International Code Council
International Codes Governmental Member Voting Representatives
2018 Public Comment Hearings, Group A
Richmond, Virginia

International Codes Governmental Member Voting Representatives:

FEMA Floodplain Management Division appreciates the opportunity to comment on the proposed code change being offered by the Florida Department of Emergency Management (FDEM) and Building Officials Association of Florida (BOAF) related to public restroom construction in beach areas.

Over 22,300 communities currently participate in the National Flood Insurance Program (NFIP). This number represents over 90 percent of all US communities that have land use authority and identified flood hazards. By law, FEMA can only provide flood insurance via the NFIP to those States or communities that adopt and vigorously enforce floodplain management regulations that meet or exceed minimum NFIP requirements. These minimum requirements are detailed in the Code of Federal Regulations in Title 44, Emergency Management and Assistance, and are primarily within Part 60, Subpart A - Requirements for Flood Plain Management Regulations. The requirements focus on buildings and other development that is occurring in identified Special Flood Hazard Areas (SFHAs) also commonly referred to as the base or regulatory floodplain. A primary tenant of these regulations is to require that all new construction (and substantial improvements) of non-residential structures either be elevated above the elevation associated with the base or regulatory floodplain (BFE or base flood elevation) or be dry floodproofed to this elevation and capable of resisting hydrostatic and hydrodynamic loads and effects of buoyancy. Dry floodproofing is not, however, permissible in coastal flood hazard areas labeled as V zones, nor is it advisable in areas subject to any type of wave action.

The Public Restroom Proposal submitted by FDEM and BOAF is not consistent with floodplain management regulations that communities must adopt and enforce to remain in good standing with the NFIP. The proposal includes provisions to allow the lowest floor of restrooms to be constructed below the BFE. This is in direct conflict with the minimum floodplain management requirements of the NFIP. While the proposal does include additional provisions to address potential flood damage, including the use of flood-resistant materials and the placement of mechanical and electrical systems and plumbing fixtures above the BFE, it is still in direct conflict with current NFIP floodplain management requirements.

Should the International Building Code be changed to incorporate this proposal, it would no longer be consistent with minimum NFIP floodplain management regulations. This change would signify the first time in 15 years that an inconsistency would exist between the International Codes and the NFIP representing a significant departure in our shared goals of community resilience. Furthermore, should states and communities adopt this provision, their floodplain management regulations would no longer meet minimum NFIP floodplain management requirements. If states and communities implement this provision, they will be permitting NFIP violations to occur and it would be incumbent on NFIP State Coordinators and FEMA Staff to identify these violations and hold communities accountable for them. When violations in NFIP-participating communities are identified by the State or FEMA and not addressed by the community, enforcement actions—including community probation and ultimately suspension—are taken against the community.

Communities put on probation are expected to resolve identified noncompliance actions or face suspension. Probation has no effect on the continued availability of flood insurance, but a $50 surcharge is added to premiums for new and renewed policies for each year the community is on probation. Suspension is the removal of a community from the program.

The NFIP is a voluntary program. However, it's worth noting that the NFIP can only provide flood insurance coverage in participating states and communities. Furthermore, when a community is sanctioned (i.e., it has identified flood hazard areas but does not participate in the NFIP), Federal officers and agencies are prohibited from approving any financial assistance for acquisition or construction purposes in an area of special flood hazard in the community. This restriction applies to Federal disaster assistance under the Stafford Act if the assistance is in connection with a flood.

FEMA Floodplain Management recognizes that the State of Florida is interested in identifying alternate means of public restroom construction in Special Flood Hazard Areas. We are willing to continue to explore how to address this interest and are currently working with our Office of Chief Counsel, Office of Environmental and Historic Preservation and Building Science Branch colleagues to identify a potential resolution that could be implemented while still abiding by the laws and regulations that govern our programs.

As you consider whether to approve this code change proposal, we respectfully request that you consider the impact it would have on the States and communities that would adopt and enforce this provision in the future should it become part of the International Building Code.

1. If the State or FEMA identifies community violations, there is a notable burden in terms of time, effort, coordination and stress that is placed on community officials to remedy those violations in order for the community to remain in good standing with the NFIP.

2. There would be significant ramifications in terms of NFIP flood insurance policy availability for communities that either knowingly or unknowingly permit violations, particularly if they are unable to remedy them. Additionally, there is a $50 surcharge placed on all NFIP policy holders within a community when that community is placed on probation.

3. Federal disaster assistance is limited in floodprone areas for those communities that are sanctioned from the NFIP. Many communities rely heavily on federal disaster assistance in the wake of flood disasters to recover and become fully functional again.

FEMA Floodplain Management Division appreciates the opportunity to be heard by the voting representatives and we thank you for your time.

Sincerely,

Rachel Sears
Floodplain Management Division Director
Federal Insurance and Mitigation Administration
Resilience

RATIONALE Support File

Proposal No.: 7621

Proponent: Steve Martin, Florida Division of Emergency Management

Most Florida communities and some state agencies have public open space and parks along rivers and shorelines. Many communities experience economic value from tourism and public access to areas that feature water resources. Under the current requirements of the NFIP and FBC, restrooms for public use that are located in flood hazard areas must meet the same requirements as commercial buildings. In flood hazard areas other than coastal high hazard areas and Coastal A Zones (i.e., in flood zones identified on Federal Emergency Management Agency Flood Insurance Rate Maps with the letter "A"), restroom buildings must either be elevated or dry floodproofed to or above the elevations required by the FBC/ASCE 24. In coastal high hazard areas (flood Zone V) and Coastal A Zones, restroom buildings must be elevated to or above the elevations required by the FBC/ASCE 24.

In Florida, this has resulted in construction of public use restrooms as high as 6 to 18 feet above grade. This poses many challenges, not the least of which is access. Figures 1, 2, 3 and 4 (below) illustrate elevated restrooms with long ramps. While ramps can be built to meet ADA requirements, to reach some heights required in some flood hazard areas the ramps may be as long as 300 feet. In coastal high hazard areas, such ramps likely conflict with the NFIP requirements that elevated buildings be “free of obstruction,” and the presence of such ramps would likely interfere with the ability of walls around enclosures to break away under flood conditions. Those same provisions are required by FBC Section 1612, Flood Loads, which references ASCE 24, Flood Resistant Design and Construction.

Long ramps defeat accessibility when the distance of travel still renders restroom facilities inaccessible to many persons with disabilities or limited mobility. Although the FBC (and FEMA) permits elevators to extend below the base flood elevation, installing elevators to provide access to elevated public use restrooms is expensive and creates many maintenance issues, and a high rate of failure to function, especially in beach areas where blowing sand and windborne salt aerosols create corrosive conditions.

This proposal creates a new section in FBC Chapter 31, Special Construction to limit the scope to public use restrooms that include public use toilet rooms, bathrooms, showers and changing rooms and spaces. Portions of such buildings that include other uses would have to fully comply with the elevation and other flood resistant requirements of FBC Section 1612, Flood Loads, which references ASCE 24, Flood Resistant Design and Construction.

In recognition that most public use restrooms are built on public land using public funds, the proposal is to limit the potential financial losses associated with flooded public facilities in two ways: by limiting the footprint to not more than 1,500 square feet and by specifying design requirements that minimize or eliminate physical damage when flooding occurs. Enabling public use restrooms to be designed to withstand the hydrodynamic and hydrostatic loads below the base flood elevation is an appropriate alternative to the extremely high cost for design, construction and maintenance of highly elevated public restrooms and their required access ramps or elevators.

Although the proposed design requirements are intended to preclude significant damage during flood conditions up to and including conditions of the design flood (e.g., the base or 100-year flood), more severe floods can and do occur. Figure 5 (below) illustrates one modest design option that demonstrates the feasibility of the proposal. It shows a small masonry restroom on a beach after Hurricane Irma pushed onshore. The drawings for the building show below-grade piling support and it appears the masonry units were filled. Despite approximately 6-8 feet of flooding (including waves), there is no evidence of structural damage and the non-structural damage appears readily repairable. The Florida Division of Emergency Management staff participated in FEMA's post-Irma field work and, along with the other team members, observed some below-BFE small public restrooms designed to resist flood loads that sustained superficial damage (finishes and fixtures) and were readily repairable.

FDEM and BOAF submitted this proposal for the 2021 International Building Code (G149-18) and modified it to respond to comments by the ICC committee. The proposal is now in the last stage of online voting by government members of ICC. At a June 2018 meeting between the FDEM and senior management officials with the FEMA Flood Insurance and Mitigation Administration, FEMA indicated the agency would work to achieve consistency across agency programs to develop guidance or procedures based on the proposed amendment. No opposition to the proposal was expressed during that meeting.

The proposal includes requirements for flood resistance similar to those found in ASCE 24-14 for Flood Design Class 1 (which is essentially equivalent to Structure/Risk Category I). Those requirements effectively are the same as the NFIP requirements in 44 Code of Federal Regulations Section 60.3(a)(3)(ii), (iii), and (iv). FEMA deems the flood provisions of the FBC, with reference to ASCE 24, to meet or exceed the requirements of the National Flood Insurance Program (NFIP).

The intent is to allow public use restrooms to be at-grade or above-grade but below the base flood (partially elevated), provided they meet the design requirements listed in 3115.2. FDEM acknowledges that FEMA guidance states that restroom buildings and comfort stations in coastal high hazard areas must be elevated and meet the same design and construction requirements as other buildings.

Despite the indications from the June 2018 meeting between FDEM and FEMA, FEMA is now on record opposing this proposal for the IBC because it does not meet the minimum requirements of the NFIP. In 2015 the FDEM withdrew a similar proposal for the 2018 IBC based on a FEMA commitment to establish a task force to examine and recommend guidance for options to minimize future damage while meeting construction requirements. The task force was expected to develop a workable solution that balances flood resistance, accessibility, costs, and aesthetics to meet the sanitary needs of the public. While the task force initiated work, FEMA did not follow through and the expected guidance was not prepared.

This proposal is intended to meet the intent of all NFIP requirements, except elevation requirements, to minimize flood damage, while acknowledging the special needs and access required or appropriate for public use restrooms. The Florida Floodplain Management Association prepared a white paper on this subject: Policy and Design Options for Public Restrooms in Special Flood Hazard Areas (2014), www.FLfloods.org/ffmawhitepaper.

Figure 1. Florida, flood Zone V. Ramp wraps around entire building. Has composting toilets, battery and solar electric system, emergency plan requires pumping out tank and filling with clean water.

Figure 2. Coastal Mississippi, flood Zone V. This facility cost $1.1 million.

Figure 3. Florida, Gulf Coast, flood Zone V. Ramp built after original elevator determined to be unsustainable due to significant maintenance problems.

Figure 4. Southwest Florida, flood Zone V. Extensive ramp wraps around three sides.

Figure 5. Florida, after Hurricane Irma, flood Zone V. No evidence of structural damage after estimated 5 ft stillwater plus waves. From upper left: facing beach, side, interior, rear.

Date Submitted 12/14/2018	**Section** 3105.3	**Proponent** Paul Coats
Chapter 31	**Affects HVHZ** No	**Attachments** Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No | **Alternate Language** No

Related Modifications

7522, 7553, 7826, 8265, 8267, 8269, 8270, 8271, 8273

Summary of Modification

This is a correlation change with other modifications that reorganize the heavy timber provisions. It does not change requirements but improves terminology to distinguish between the use of the terms "heavy timber" and "Type IV construction."

Rationale

This modification was approved by the ICC committee and membership and appears in the 2018 edition of the International Building Code. This code change is related a reorganization of Type IV provisions in Section 602.4 and the heavy timber provisions in section 2304.11. The goal of this change (and similar changes to heavy timber terminology in other chapters) is to use the term "Type IV" or "Section 602.4" when the provisions are referring to the type of construction for the building, and "heavy timber complying with Section 2304.11" when the provisions are referring to a heavy timber element located in a building of any construction type. This and related changes are not intended to make technical changes to the code but rather to make the current requirements easier to apply.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will make code application easier.

Impact to building and property owners relative to cost of compliance with code

No cost-related impact.

Impact to industry relative to the cost of compliance with code

No cost-related impact.

Impact to small business relative to the cost of compliance with code

No cost-related impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Will make code application easier.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by making its application easier.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

1.

1. 3105.3 Design and construction.

Awnings and *canopies* shall be designed and constructed to withstand wind or other lateral loads and live loads as required by Chapter 16 and in accordance with Section 3105.4 of this code with due allowance for shape, open construction and similar features that relieve the pressures or loads. Structural members shall be protected to prevent deterioration. *Awnings* shall have frames of noncombustible material, *fire-retardant-treated wood*, ~~wood of Type IV size~~heavy timber complying with Section 2304.11, or 1-hour construction with combustible or noncombustible covers and shall be either fixed, retractable, folding or collapsible.

G 180-15

406.7.2, TABLE 601, 603.1, 705.2.3, 803.3, 803.13.3, 1406.3, [BG] 1510.2.5, [BG] 1510.3, 3105.3, D102.2.8, 803.1

Proponent: Dennis Richardson, American Wood Council, representing American Wood Council (drichardson@awc.org)

2015 International Building Code

Revise as follows:

406.7.2 Canopies. Canopies under which fuels are dispensed shall have a clear, unobstructed height of not less than 13 feet 6 inches (4115 mm) to the lowest projecting element in the vehicle drive-through area. Canopies and their supports over pumps shall be of noncombustible materials, *fire-retardant-treated wood* complying with Chapter 23, ~~wood of Type IV sizes~~heavy timber complying with Section 2304.11 or of construction providing 1-hour *fire resistance*. Combustible materials used in or on a *canopy* shall comply with one of the following:

1. Shielded from the pumps by a noncombustible element of the *canopy*, or ~~wood of Type IV sizes~~heavy timber complying with Section 2304.11;
2. Plastics covered by aluminum facing having a thickness of not less than 0.010 inch (0.30 mm) or corrosion-resistant steel having a base metal thickness of not less than 0.016 inch (0.41 mm). The plastic shall have a *flame spread index* of 25 or less and a smokedeveloped index of 450 or less when tested in the form intended for use in accordance with ASTM E 84 or UL 723 and a self-ignition temperature of 650°F (343°C) or greater when tested in accordance with ASTM D 1929; or
3. Panels constructed of light-transmitting plastic materials shall be permitted to be installed in *canopies* erected over motor vehicle fuel-dispensing station fuel dispensers, provided the panels are located not less than 10 feet (3048 mm) from any building on the same *lot* and face *yards* or streets not less than 40 feet (12 192 mm) in width on the other sides. The aggregate areas of plastics shall be not greater than 1,000 square feet (93 m^2). The maximum area of any individual panel shall be not greater than 100 square feet (9.3 m^2).

TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A	B	A	B	HT	A	B
Primary structural frame[f] (see Section 202)	3[a]	2[a]	1	0	1	0	HT	1	0
Bearing walls Exterior[e, f] Interior	3 3[a]	2 2[a]	1 1	0 0	2 1	2 0	2 1/HT	1 1	0 0
Nonbearing walls and partitions Exterior	See Table 602								
Nonbearing walls and partitions Interior[d]	0	0	0	0	0	0	See Section ~~602.4.6~~2304.11.2	0	0
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	1 1/2[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	HT	1[b,c]	0

For SI: 1 foot = 304.8 mm.

a. Roof supports: Fire-resistance ratings of primary structural frame and bearing walls are permitted to be reduced by 1 hour where supporting a roof only.

b. Except in Group F-1, H, M and S-1 occupancies, fire protection of structural members shall not be required, including protection of roof framing and decking where every part of the roof construction is 20 feet or more above any floor immediately below. Fire-retardant-treated wood members shall be allowed to be used for such unprotected members.

c. In all occupancies, heavy timber complying with Section 2304.11 shall be allowed where a 1-hour or less fire-resistance rating is required.

d. Not less than the fire-resistance rating required by other sections of this code.

e. Not less than the fire-resistance rating based on fire separation distance (see Table 602).

f. Not less than the fire-resistance rating as referenced in Section 704.10.

603.1 Allowable materials. Combustible materials shall be permitted in buildings of Type I or II construction in the following applications and in accordance with Sections 603.1.1 through 603.1.3:

1. *Fire-retardant-treated wood* shall be permitted in:
   1.1. Nonbearing partitions where the required *fire-resistance rating* is 2 hours or less.
   1.2. Nonbearing *exterior walls* where fire-resistance-rated construction is not required.
   1.3. Roof construction, including girders, trusses, framing and decking.
   Exception: In buildings of Type IA construction exceeding two *stories abovegrade plane*, *fire-retardant-treated wood* is not permitted in roof construction where the vertical distance from the upper floor to the roof is less than 20 feet (6096 mm).
2. Thermal and acoustical insulation, other than foam plastics, having a *flame spread index* of not more than 25.
   Exceptions:
   1. Insulation placed between two layers of noncombustible materials without an intervening airspace shall be allowed to have a *flame spread index* of not more than 100.
   2. Insulation installed between a finished floor and solid decking without intervening airspace shall be allowed to have a *flame spread index* of not more than 200.
3. Foam plastics in accordance with Chapter 26.
4. Roof coverings that have an A, B or C classification.
5. *Interior floor finish* and floor covering materials installed in accordance with Section 804.
6. Millwork such as doors, door frames, window sashes and frames.
7. *Interior wall and ceiling finishes* installed in accordance with Sections 801 and 803.
8. *Trim* installed in accordance with Section 806.
9. Where not installed greater than 15 feet (4572 mm) above grade, show windows, nailing or furring strips and wooden bulkheads below show windows, including their frames, aprons and show cases.
10. Finish flooring installed in accordance with Section 805.
11. Partitions dividing portions of stores, offices or similar places occupied by one tenant only and that do not establish a *corridor* serving an *occupant load* of 30 or more shall be permitted to be constructed of *fire-retardant-treated wood*, 1-hour fire-resistance-rated construction or of wood panels or similar light construction up to 6 feet (1829 mm) in height.
12. Stages and platforms constructed in accordance with Sections 410.3 and 410.4, respectively.
13. Combustible *exterior wallcoverings*, balconies and similar projections and bay or oriel windows in accordance with Chapter 14.
14. Blocking such as for handrails, millwork, cabinets and window and door frames.
15. Light-transmitting plastics as permitted by Chapter 26.
16. Mastics and caulking materials applied to provide flexible seals between components of *exterior wall* construction.
17. Exterior plastic veneer installed in accordance with Section 2605.2.
18. Nailing or furring strips as permitted by Section 803.11.
19. Heavy timber as permitted by Note c to Table 601 and Sections ~~602.4.7~~602.4.3 and 1406.3.
20. Aggregates, component materials and admixtures as permitted by Section 703.2.2.
21. Sprayed fire-resistant materials and intumescent and mastic fire-resistant coatings, determined on the basis of *fire resistance* tests in accordance with Section 703.2 and installed in accordance with Sections 1705.14 and 1705.15, respectively.
22. Materials used to protect penetrations in fire-resistance-rated assemblies in accordance with Section 714.
23. Materials used to protect joints in fire-resistance-rated assemblies in accordance with Section 715.
24. Materials allowed in the concealed spaces of buildings of Types I and II construction in accordance with Section 718.5.
25. Materials exposed within plenums complying with Section 602 of the *International Mechanical Code*.
26. Wall construction of freezers and coolers of less than 1,000 square feet (92.9 m^2), in size, lined on both sides with noncombustible materials and the building is protected throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

705.2.3 Combustible projections. Combustible projections extending to within 5 feet (1524 mm) of the line used to determine the *fire separation distance* shall be of not less than 1-hour fire-resistance-rated construction, ~~Type IV~~heavy timber construction complying with Section 2304.11, fire-retardant-treated wood or as required by Section 1406.3.

Exception: Type VB construction shall be allowed for combustible projections in Group R-3 and U occupancies with a fire separation distance greater than or equal to 5 feet (1524 mm).

803.3 Heavy timber exemption. Exposed portions of building elements complying with the requirements for buildings of ~~Type IV~~heavy timber construction in Section 602.4 or Section 2304.11 shall not be subject to *interior finish* requirements.

803.13.3 Heavy timber construction. Wall and ceiling finishes of all classes as permitted in this chapter that are installed directly against the wood decking or planking of ~~Type IV~~heavy timber construction in Sections 602.4.2 or 2304.11 or to wood furring strips applied directly to the wood decking or planking shall be fireblocked as specified in Section 803.13.1.1.

1406.3 Balconies and similar projections. Balconies and similar projections of combustible construction other than fire-retardant-treated wood shall be fire-resistance rated where required by Table 601 for floor construction or shall be of ~~Type IV~~heavy timber construction in accordance with Section ~~602.4~~2304.11. The aggregate length of the projections shall not exceed 50 percent of the building's perimeter on each floor.

Exceptions:
1. On buildings of Type I and II construction, three stories or less above *grade plane*, *fire-retardant-treated wood* shall be permitted for balconies, porches, decks and exterior stairways not used as required exits.
2. Untreated wood is permitted for pickets and rails or similar guardrail devices that are limited to 42 inches (1067 mm) in height.
3. Balconies and similar projections on buildings of Type III, IV and V construction shall be permitted to be of Type V construction, and shall not be required to have a *fire-resistance rating* where sprinkler protection is extended to these areas.
4. Where sprinkler protection is extended to the balcony areas, the aggregate length of the balcony on each floor shall not be limited.

[BG] 1510.2.5 Type of construction. Penthouses shall be constructed with walls, floors and roofs as required for the type of construction of the building on which such penthouses are built.

Exceptions:

1. On buildings of Type I construction, the exterior walls and roofs of penthouses with a *fire separation distance* greater than 5 feet (1524 mm) and less than 20 feet (6096 mm) shall be permitted to have not less than a 1-hour fire-resistance rating. The exterior walls and roofs of penthouses with a fire separation distance of 20 feet (6096 mm) or greater shall not be required to have a fire-resistance rating.
2. On buildings of Type I construction two stories or less in height above grade plane or of Type II construction, the exterior walls and roofs of penthouses with a *fire separation distance* greater than 5 feet (1524 mm) and less than 20 feet (6096 mm) shall be permitted to have not less than a 1-hour fire-resistance rating or a lesser fire-resistance rating as required by Table 602 and be constructed of fire-retardant-treated wood. The exterior walls and roofs of penthouses with a *fire separation distance* of 20 feet (6096 mm) or greater shall be permitted to be constructed of fire-retardant-treated wood and shall not be required to have a fire-resistance rating. Interior framing and walls shall be permitted to be constructed of fire-retardant-treated wood.
3. On buildings of Type III, IV or V construction, the exterior walls of penthouses with a fire separation distance greater than 5 feet (1524 mm) and less than 20 feet (6096 mm) shall be permitted to have not less than a 1-hour fire-resistance rating or a lesser fire-resistance rating as required by Table 602. On buildings of Type III, IV or VA construction, the exterior walls of penthouses with a fire separation distance of 20 feet (6096 mm) or greater shall be permitted to be of ~~Type IV~~heavy timber construction complying with Sections 602.4 and 2304.11 or noncombustible construction or fire-retardant-treated wood and shall not be required to have a fire-resistance rating.

[BG] 1510.3 Tanks. Tanks having a capacity of more than 500 gallons (1893 L) located on the roof deck of a building shall be supported on masonry, reinforced concrete, steel or ~~Type IV~~heavy timber construction complying with Section 2304.11 provided that, where such supports are located in the building above the lowest *story*, the support shall be fire-resistance rated as required for Type IA construction.

3105.3 Design and construction. *Awnings* and *canopies* shall be designed and constructed to withstand wind or other lateral loads and live loads as required by Chapter 16 with due allowance for shape, open construction and similar features that relieve the pressures or loads. Structural members shall be protected to prevent deterioration. *Awnings* shall have frames of noncombustible material, *fire-retardant-treated wood*, ~~wood of Type IV size~~heavy timber complying with Section 2304.11, or 1-hour construction with combustible or noncombustible covers and shall be either fixed, retractable, folding or collapsible.

D102.2.8 Permanent canopies. Permanent canopies are permitted to extend over adjacent open spaces provided all of the following are met:

1. The canopy and its supports shall be of noncombustible material, *fire-retardant-treated wood*, ~~Type IV construction~~heavy timber complying with Section 2304.11 or of 1-hour fire-resistance-rated construction.
   Exception: Any textile covering for the canopy shall be flame resistant as determined by tests conducted in accordance with NFPA 701 after both accelerated water leaching and accelerated weathering.
2. Any canopy covering, other than textiles, shall have a *flame spread index* not greater than 25 when tested in accordance with ASTM E 84 or UL 723 in the form intended for use.
3. The canopy shall have at least one long side open.
4. The maximum horizontal width of the canopy shall not exceed 15 feet (4572 mm).
5. The *fire resistance* of *exterior walls* shall not be reduced.

2015 International Fire Code

803.1 General. The provisions of this section shall limit the allowable fire performance and smoke development of interior wall and ceiling finishes and interior wall and ceiling trim in existing buildings based on location and occupancy classification. Interior wall and ceiling finishes shall be classified in accordance with Section 803 of the *International Building Code*. Such materials shall be grouped in accordance with ASTM E 84, as indicated in Section 803.1.1, or in accordance with NFPA 286, as indicated in Section 803.1.2.

Exceptions:

1. Materials having a thickness less than 0.036 inch (0.9 mm) applied directly to the surface of walls and ceilings.
2. Exposed portions of structural members complying with the requirements of ~~buildings of Type IV construction~~heavy timber in accordance with the *International Building Code* shall not be subject to interior finish requirements.

Reason: This code change is part 2 of a proposal to reorganize Type IV Section 602.4 and heavy timber section 2304.11. This part of the change includes references found throughout the IBC to either: Type IV construciton, Section 602.4, Section 2304.11, or "heavy timber". This change should follow directly after the 602.4 change and the reason for the change is included in that reason statement.
The references found in this part are generally changed to Type IV or Section 602.4 when the section of the code is referring to the type of construction associated with a structure. The references are generally changed to "heavy timber complying with Section 2304.11" when the code is referring to a heavy timber element found in a building of another type of construction. This change is a reorganization of two sections and is not intended to change the intent of the code.

Cost Impact: Will not increase the cost of construction
Since this is a reorganization of existing requirements, not the creation of new requirements, this code change will not increase the cost of construction.

G 180-15 : 406.7.2-RICHARDSON5276

G 180-15

Committee Action: Approved as Submitted

Committee Reason: This is a companion piece to G179-15. G179 reorganizes the heavy timber provisions. This change provides corrections to the various new section numbers resulting from G179-15.

S8357

Date Submitted	12/15/2018	**Section**	3115	**Proponent**	Joseph Belcher for Bison
Chapter	31	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Related definitions in Section 202

Summary of Modification

Adds section for exterior elevated flooring systems.

Rationale

Exterior elevated flooring systems are increasingly seen on rooftops and other exterior locations. The systems are used to create space typically used for assembly occupancies such as restaurants, bars, and nightclubs, and gathering places. The code does not adequately address such systems. This proposal is to address that need.

In many cases, the flooring system is treated as a roof, and overly restrictive provisions are applied. The exterior elevated flooring system is not a roof but is a floor created on a rooftop or other supporting structure. The proposal provides for continuing to treat the systems as a roof by attaching the support pedestals to the roof surface. However, considerable research has shown that these systems due to their air-permeability react to wind forces differently than the typical rooftop. The application of current literature and the use of wind tunnel testing coupled with new provisions on air-permeable cladding in ASCE 7-16 will allow more economical construction of these popular systems with no reduction in safety.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact on the cost of enforcement of code.

Impact to building and property owners relative to cost of compliance with code

The provisions will likely result in savings to property owners desiring to turn rooftops and other exterior spaces into useable areas.

Impact to industry relative to the cost of compliance with code

The provisions will allow economical expansion of the conversion of unusable spaces. The provisions will likely result in savings to industry constructing exterior elevated flooring system to turn rooftops and other spaces into useable areas.

Impact to small business relative to the cost of compliance with code

The provisions will allow economical expansion of the conversion of unusable spaces benefitting the owners of small businesses. The provisions will likely result in savings to small businesses seeking to add useable areas to their business by installing exterior elevated flooring systems.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Occupied roofs using elevated flooring systems are becoming more common and the code does not adequately address the systems. This proposal will help to assure the health, safety, and welfare of members of the public using such facilities.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The change to the code will improve the code by addressing a system not adequately addressed by the code and helping to assure the safety of the public.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The change does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The proposed change does not degrade the effectiveness of the code.

202

Exterior Elevated Flooring System. An elevated flooring system installed over roofing systems or other supporting structures. Exterior elevated flooring systems may be attached to the supporting structure or installed independently of the supporting structure or a combination thereof.

Attached systems. Attached systems are those where pedestals are attached to the roof or other supporting structure by mechanical fasteners, adhesives, or both.

Independent systems. Independent systems are those where pedestals are not attached to but rest on the roof or other supporting structure.

Exterior Elevated Flooring System. An assembly installed over a roof assembly and/or exterior supporting structure consisting of pedestrian deck panels/pavers mounted on pedestals using other accessory components, and mechanical fasteners and/or adhesives as required by the manufacturer for attaching deck panels/pavers to pedestals and other accessory components.

Pedestrian Deck Panels/Pavers. Pedestrian deck panels/pavers for the purpose of this section are manufactured from materials such as naturally durable wood, ceramic, stone, or concrete suitable for exterior applications.

Pedestal. A fixed or adjustable-height support column composed of a plastic support base, plastic vertical structural element, and a plastic load bearing top cap/surface.

Accessory Components. These components are used in the installation of pedestals and deck panels/pavers of the exterior elevated flooring system. These components are made of either plastic or metal material. These components may be used to provide lateral bracing of the pedestals, vertical support, leveling the pedestal, and to restrain the deck panel/paver to the top of the pedestal.

3101.1 Scope. The provisions of this chapter shall govern special building construction including membrane structures, temporary structures, pedestrian walkways and tunnels, automatic vehicular gates, awnings and canopies, marquees, signs, ~~and~~ towers and antennas, and exterior elevated flooring systems.

Section 3115

Exterior Elevated Flooring Systems

3115.1 Scope. This section is applicable to exterior elevated flooring systems installed over roof assemblies or other exterior supporting structures. Each exterior elevated flooring system consists of deck panels/pavers supported by pedestals placed directly on roof assemblies or exterior supporting structures, to provide a level walking surface. Pedestals can be adjusted to various heights or installed at a fixed height.
The pedestals need not be mechanically or adhesively attached to the supporting structure. The exterior elevated flooring system comprised of the deck panels/pavers and pedestals must be restrained on all sides against horizontal movement using a perimeter-restraining system and along any ramps and/or walkway areas.

3115.1.1 Attached exterior elevated flooring systems. Attached systems shall be designed and constructed as a roofing system in accordance with Chapter 15 of this code.

3115.1.2 Independent exterior elevated flooring systems. Independent systems shall comply with the provisions of Section 3115.

3115.2 Information Submitted with Permit Application. In addition to other information required to accompany the permit application, product-specific information shall be provided as follows:

3115.2.1 Deck Panels/Pavers. Documentation describing the weight, dimensions, specifications, and the manufacturing process of the materials. Specifications for cementitious materials such as concrete pavers shall include 28-day compressive strength ($f_{c'}$), impact resistance, and density.

3115.2.2 Pedestals. Documentation describing materials, dimensions, specifications, and manufacturer's installation instructions.

3115.2.3 Fasteners. Documentation describing mechanical fasteners and adhesives as applicable. A statement shall be provided regarding whether or not the fasteners are commonly available or are proprietary.

3115.2.4 Packaging and Identification. A description of the method of packaging and identification of deck panel/pavers, pedestals, and accessory components. Identification provisions shall include the manufacturer's name, the product name, and a copy of the installation instructions, as packaged with the product.

3115.3 Product Approval and Manufacturer's Installation Instructions.

3115.3.1 Product approval. Exterior elevated flooring systems shall have Florida Product Approval or local product approval.

3115.3.2 Manufacturer's installation instructions. In addition to the copy of the manufacturer's installation instructions submitted with the permit application, manufacturer's installation instructions shall be kept on the job site and made available to inspection personnel.

3115.4 Structural Requirements for Exterior Elevated Flooring Systems.

3115.4.1 General. Exterior elevated flooring system shall withstand the applicable uniform loads of FBC-B Table 1607, the applicable load combinations and other loads contained in FBC-B Chapter 16.

3115.4.2 Wind resistance. Wind resistance of independent exterior elevated flooring systems shall be determined by wind tunnel testing in accordance with ASCE 7 Chapter 31and Section 30.1.5 where applicable. Testing shall be conducted and the data analyzed by a registered design professional. Exterior elevated flooring systems shall be evaluated by a registered design professional to withstand applicable wind loads as specified in ASCE/SEI 7 Chapters 26 through 30, and the combined load effects of other applicable gravity loads in FBC-B Chapter 16, such as live and dead loads.

S7257

Date Submitted	11/13/2018	**Section**	35	**Proponent**	T Stafford
Chapter	35	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Updates the vinyl siding specification to the 2017 edition.

Rationale

This proposal updates the specification standard for vinyl siding to ASTM D3679-17. One of the key changes in ASTM D3679-17 is an update to the pressure equalization factor (PEF). For determining the design wind pressure rating of vinyl siding, ASTM D 3679 permits test pressures to be adjusted to account for pressure equalization across the vinyl siding due to leakage paths (gaps). Pressure equalization refers to the reduction in net wind forces across cladding layers caused by external pressures being transferred to an interior air space. Previous editions have permitted the PEF to be taken as 0.36. ASTM D3679-17 increases the PEF to 0.5 based on new research.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

Will potentially increase the cost of vinyl siding in some areas of Florida. However, this is a standard update supported by industry.

Impact to industry relative to the cost of compliance with code

Will potentially increase the cost of vinyl siding in some areas of Florida. However, this is a standard update supported by industry.

Impact to small business relative to the cost of compliance with code

Will potentially increase the cost of vinyl siding in some areas of Florida. However, this is a standard update supported by industry.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal will be beneficial to the health, safety, and welfare of the general public by reducing the potential for wind damage to vinyl siding.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal strengthens the code by increasing the wind load resistance of vinyl siding based on new research.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

ASTM D3679—~~13~~17 Specification for Rigid Poly (Vinyl Chloride) (PVC) Siding 1404.9, 1405.14

S7458

Date Submitted	11/26/2018	**Section**	35	**Proponent**	Bonnie Manley
Chapter	35	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

7452, 7454, 7455, S299-16 (Structural, Structural, Chart #1)

Summary of Modification

This proposal is one in a series adopting the latest generation of AISI standards for cold-formed steel.

Rationale

This proposal is one in a series adopting the latest generation of AISI standards for cold-formed steel. This particular proposal focuses on Chapter 35 by updating references to the AISI suite of standards, including the addition of three new cold-formed steel standards -- AISI S240, AISI S400, and AISI S202 – now referenced in Chapters 22 and 25. All AISI standards are published and available for a free download at: www.aisistandards.org.

AISI S240, North American Standard for Cold-Formed Steel Structural Framing, addresses requirements for construction with cold-formed steel structural framing that are common to prescriptive and engineered light frame construction. This comprehensive standard was formed by merging the following AISI standards: AISI S200, AISI S210, AISI S211, AISI S212, AISI S213, and AISI S214. Consequently, AISI S240 supersedes all previous editions of the above mentioned individual AISI standards.

AISI S400, North American Standard for Seismic Design of Cold-Formed Steel Structural Systems, addresses the design and construction of cold-formed steel structural members and connections used in the seismic force-resisting systems in buildings and other structures. AISI S400 supersedes AISI S110 and the seismic design provisions of AISI S213 and is intended to be applied in conjunction with both AISI S100 and AISI S240, as applicable.

AISI S202, Code of Standard Practice for Cold-formed Steel Structural Framing, is intended to service as a state-of-the-art mandatory document for establishing contractual relationships between various parties in a construction project where cold formed steel structural materials, components and assemblies are used. While it is not specifically intended to be a direct reference in the building code, portions of AISI S202 are recommended for adoption in this proposal to establish the minimum requirements for cold-formed steel truss design drawings.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

AISI S100—~~16~~12, *North American Specification for the Design of Cold-formed Steel Structural Members*, 2016~~2012~~

~~AISI S110—07/S1-09 (2012),*Standard for Seismic Design of Cold-Formed Steel Structural Systems—Special Moment Frames*, 2007 with Supplement 1, dated 2009 (Reaffirmed 2012)~~

~~AISI S200—12, *North American Standard for Cold-Formed Steel Framing-General Provisions*, 2012~~

~~AISI S210—07(2012), *North American Standard for Cold-Formed Steel Framing-Floor and Roof System Design*, 2007 (Reaffirmed 2012)~~

~~AISI S211—07/S1-12(2012), *North American Standard for Cold-Formed Steel Framing-Wall Stud Design*, 2007 including Supplement 1, dated 2012 (Reaffirmed 2012)~~

~~AISI S212—07(2012), *North American Standard for Cold-Formed Steel Framing-Header Design*, 2007 (Reaffirmed 2012)~~

~~AISI S213—07/S1-09 (2012), *North American Standard for Cold-Formed Steel Framing-Lateral Design*, 2007 with Supplement 1, dated 2009 (Reaffirmed 2012)~~

~~AISI S214—12,North American Standard for Cold-formed Steel Framing-Truss Design, 2012~~

AISI S220—15~~11~~, *North American Standard for Cold-formed Steel Framing-Nonstructural Members*, 2015

AISI S230—15~~07/S3-12(2012)~~, *Standard for Cold-formed Steel Framing-Prescriptive Method for One- and Two-family Dwellings*, 2015~~2007 with Supplement 3, dated 2012 (Reaffirmed 2012)~~

AISI S240—15, *North American Standard for Cold-Formed Steel Structuring Framing*, 2015

AISI S400—15/S1—16, *North American Standard for Seismic Design of Cold-formed Steel Structural Systems*, 2015, with Supplement 1, dated 2016.

S7704

Date Submitted	12/5/2018	**Section**	102.4	**Proponent**	Dick Wilhelm
Chapter	35	**Affects HVHZ**	Yes	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

This proposed modification updates AAMA, FMA and ASTM reference standards in Chapter 35, 6th Edition, Florida Building Code.

Rationale

Updates reference standards pertaining to the manufacture, testing and quality assurance of fenestration products.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification does not impact the enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This modification does not impact the cost associated with the enforcement of the code.

Impact to industry relative to the cost of compliance with code

This modification does not impact the cost of enforcement of the code.

Impact to small business relative to the cost of compliance with code

This modification does not impact cost associated with compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Reference standards control the manufacture, testing and quality assurance of fenestration products sold throughout Florida.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Updating testing and performance standards provides the consumer with the latest innovation in technology

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code

AAMA

1402—09 Standard Specifications for Aluminum Siding, Soffit and Fascia

~~**101/I.S.2—97 Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors**~~

AAMA/NPEA/NSA 2100—12 Voluntary Specifications for Sunrooms

AAMA/WDMA/CSA101/I.S.2/A440—~~05 or~~ 08, ~~or 11~~ or 17 North American Fenestration Standard/Specifications for Windows, Doors and Skylights

~~**101/I.S.2/NAFS—02 Voluntary Performance Specifications for Windows, Skylights and Glass Doors**~~

~~**1302.5—76 Voluntary Specifications for Forced-Entry Resistant Aluminum Prime Windows**~~

~~**1303.5—76 Voluntary Specifications for Forced-Entry Resistant Aluminum Sliding Glass Doors**~~

AAMA 450—10 Voluntary Performance Rating Method for Mulled Fenestration Assemblies

AAMA 501—~~94 or 05 or~~ 15 Methods of Test for Exterior Walls

AAMA 506-16 Voluntary Specification for Impact and Cycle Testing of Fenestration Products.

711—~~07 or~~ 16 Voluntary Specification for Self-Adhering Flashing Used for Installation of Exterior Wall Fenestration Products

714—~~12 or~~ 15 Voluntary Specification for Liquid Applied Flashing Used to Create a Water-resistive Seal around Exterior Wall Openings in Buildings

FMA/AAMA 100—12 Standard Practice for the Installation of Windows with Flanges or Mounting

FMA/AAMA 200—12 Standard Practice for the Installation of Windows with Frontal Flanges

FMA/WDMA 250—10 Standard Practice for the Installation of Non-Frontal Flange Windows with Mounting Flanges for Surface Barrier Masonry for Extreme Wind/Water Conditions

FMA/AAMA/WDMA300—12 Standard Practice for the Installation of Exterior Doors in Wood Frame Construction for Extreme Wind/Water Exposure

FMA/AAMA/WDMA 400-13 Standard Practice for the Installation of Exterior Doors in Surface Barrier Masonry Construction for Extreme Wind/Weather Exposure

ASTM

E1300—04e01, 07e01, 09e ~~or~~ 12AE1 or -16 Practice for Determining Load Resistance of Glass in Buildings

E1886—~~02 or 05~~ or 12 or 2013a Test Method for Performance of Exterior Windows, Curtain Walls, Doors and Storm Shutters Impacted by Missiles and Exposed to Cyclic Pressure Differentials

E1996—~~05, 06, 09~~-17 or~~,~~2012a or 2014a Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes

F2006—~~00~~ 17 (2005) 10 Standard/Safety Specification for Window Fall Prevention Devices for Nonemergency Escape (Egress) and Rescue (Ingress) Windows

F2090—~~13~~ 17Specification for Window Fall Prevention Devices—with Emergency Escape (Egress) Release Mechanisms http://www.floridabuilding.org/Upload/Modifications/Rendered/Mod_7704_TextOfModification_3.png

Florida Building Code (Building) 2017 Referenced Standards

AAMA

1402—09 Standard Specifications for Aluminum Siding, Soffit and Fascia

~~101/I.S.2—97 Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors~~

AAMA/NPEA/NSA 2100—12 Voluntary Specifications for Sunrooms

AAMA/WDMA/CSA101/I.S.2/A440—~~05 or~~ 08, ~~or~~ 11 or 17 North American Fenestration Standard/Specifications for
Windows, Doors and Skylights

~~101/I.S.2/NAFS—02 Voluntary Performance Specifications for Windows, Skylights and Glass Doors~~

~~1302.5—76 Voluntary Specifications for Forced-Entry Resistant Aluminum Prime Windows~~

~~1303.5—76 Voluntary Specifications for Forced-Entry Resistant Aluminum Sliding Glass Doors~~

AAMA 450—10 Voluntary Performance Rating Method for Mulled Fenestration Assemblies

AAMA 501—~~94 or 05 or~~ 15 Methods of Test for Exterior Walls

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FMA/AAMA/WDMA 400-13 Standard Practice for the Installation of Exterior Doors in Surface Barrier Masonry Construction for Extreme Wind/Weather Exposure

ASTM

E1300—04e01, 07e01, 09e ~~or~~ 12AE1 or -16 Practice for Determining Load Resistance of Glass in Buildings

E1886—~~02 or 05~~ or 12 or 2013a Test Method for Performance of Exterior Windows, Curtain Walls, Doors and Storm Shutters Impacted by Missiles and Exposed to Cyclic Pressure Differentials

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F2006—~~00~~ 17 (2005) 10 Standard/Safety Specification for Window Fall Prevention Devices for

Nonemergency Escape (Egress) and Rescue (Ingress) Windows

F2090—~~10~~ 17 Specification for Window Fall Prevention Devices—with Emergency Escape (Egress) Release Mechanisms

S7880

Date Submitted	12/11/2018	**Section**	3501	**Proponent**	Joseph Hetzel
Chapter	35	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Referencing 2005 and 2017 versions of ANSI/DASMA 108 and ANSI/DASMA 115 in addition to the 2012 versions referenced in the 6th edition.

Rationale

Provided additional references to ANSI/DASMA standards version equivalent to those currently referenced.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact.

Impact to building and property owners relative to cost of compliance with code

No impact.

Impact to industry relative to the cost of compliance with code

No impact.

Impact to small business relative to the cost of compliance with code

No impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Upholds the health, safety and welfare of the general public because the standards are equivalents.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens and improves the code by providing equivalent standards versions.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The standards are all material/product/method/systems neutral.

Does not degrade the effectiveness of the code

The standards are equivalents, upholding the effectiveness of the code.

Mod 7880

108—05
Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference
1709.5.2

108—12
Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference
1709.5.2

108—17
Standard Method for Testing Sectional Garage Doors, Rolling Doors, and Flexible Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference
1709.5.2

115—05
Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure

1609.1.2.3

115—12
Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure
1609.1.2.3

115—17
Standard Method for Testing Sectional Doors, Rolling Doors, and Flexible Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure

ANSI/DASMA 108-2005

AMERICAN NATIONAL STANDARD

STANDARD METHOD FOR TESTING SECTIONAL GARAGE DOORS AND ROLLING DOORS: DETERMINATION OF STRUCTURAL PERFORMANCE UNDER UNIFORM STATIC AIR PRESSURE DIFFERENCE

ANSI/DASMA 108-2005

Door & Access Systems Manufacturers' Association, International

Sponsor:
DASMA
Door & Access Systems Manufacturers Association International
1300 Sumner Ave
Cleveland, Ohio 44115-2851

AMERICAN NATIONAL STANDARD

Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference

Sponsor

Door & Access Systems Manufacturers' Association, International

American National Standard

American National Standard implies a consensus of those substantially concerned with its scope and provisions. An American National Standard is intended as a guide to aid the manufacturer, the consumer, and the general public. The existence of an American National Standard does not in any respect preclude anyone, whether he has approved the standard or not, from manufacturing, marketing, purchasing or using products, processes, or procedures not conforming to the standard. American National Standards are subject to periodic review and users are cautioned to obtain the latest editions.

CAUTION NOTICE:

This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken to reaffirm, revise, or withdraw this standard no later than five years from the date of publication. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute.

Sponsored and published by:
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Suggestions for improvement of this standard will be welcome.
They should be sent to the Door & Access Systems Manufacturers' Association, International.

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Foreword (This foreword is included for information only and is not part of ANSI/DASMA 108-2005, *Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference.)*

This standard was developed concurrently by the Technical Committee of the DASMA Commercial & Residential Garage Door Division and by the DASMA Rolling Door Division. It incorporates years of experience in testing sectional garage doors and rolling doors commonly found in garage type structures. The committees and divisions believe the existence of the standard will provide a uniform basis of testing and rating the structural performance of such doors under uniform static air pressure difference.

The DASMA Rolling Door Division and the DASMA Commercial & Residential Garage Door Division concurrently approved revisions to the standard on April 21, 2006. DASMA employed the canvass method to demonstrate consensus and to gain approval as an American National Standard. The ANSI Board of Standards Review first granted approval of the document as an American National Standard on May 21, 2002, and granted approval of the most recent revisions to the standard on January 29, 2007.

DASMA recognizes the need to periodically review and update this standard. Suggestions for improvement should be forwarded to the Door & Access Systems Manufacturers' Association, International, 1300 Sumner Avenue, Cleveland, Ohio, 44115-2851.

ANSI/DASMA 108-2005
AMERICAN NATIONAL STANDARD

Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference

1.0 SCOPE

1.1 This test method describes the determination of the structural performance of garage door and rolling door assemblies under uniform static air pressure difference, using a test chamber.

1.2 This test method is intended only for evaluating the structural performance associated with the specified test specimen and not the structural performance of adjacent construction.

1.3 The proper use of this test method requires a knowledge of the principles of pressure and deflection measurement.

1.4 This test method describes the apparatus and the procedure to be used for applying uniformly distributed loads to a specimen.

1.5 This test method does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

1.6 This test method shall be considered equivalent to ASTM E 330-02, provided the pass/fail criteria contained in Section 11 of this standard is applied to testing in accordance with ASTM E 330-02.

1.7 For products intended for installation in the Florida High Velocity Hurricane Zone (Miami-Dade and Broward Counties), the testing procedure in Appendix A shall be used.

2. 0 DEFINITIONS

2.1 Design load: the specified difference in static air pressure (positive or negative) for which the specimen is to be tested, expressed in pounds per square foot (or pascals).

2.2 Full Operability: the ability for the door to be fully opened and closed.

2.3 Permanent deformation: the displacement or change in dimension of the specimen after the applied load has been removed and the specimen has relaxed for the specified period of time.

2.4 Preload: 50% of design load

2.5 Test load: the specified difference in static air pressure (positive or negative), equal to 1.5 times the design load, expressed in pounds per square foot (or pascals). (Note: Test load is equivalent to the proof load as defined by 330-02.)

2.6 Test specimen: the complete installed door assembly and mounting hardware as specified on the submitted drawing.

3.0 SUMMARY OF TEST METHOD

3.1 Seal the test specimen against one face as with a normal door assembly.

3.2 Supply air to or exhaust air from the chamber according to a specific test program, at the rate required to maintain the appropriate test pressure difference across the specimen.

3.3 Observe, measure, and record the deflections, deformations, and nature of any distresses or failures of the specimen.

4.0 APPARATUS

4.1 Test Chamber

4.1.1 A chamber shall be used which includes one open side against which the specimen is installed.

4.1.2 Provide a static pressure tap to measure the pressure difference across the test specimen. Locate the tap so that the reading is unaffected by the velocity of air supplied to or from the chamber or by any other air movements.

4.1.3 The air supply opening into the chamber shall be arranged so that the air does not impinge directly on the test specimen with any significant velocity.

4.1.4 A means shall be provided to facilitate test specimen adjustments and observations.

4.1.5 The test chamber and the specimen mounting frame shall not deflect under the test load in such a manner that the performance of the specimen will be affected.

4.2 Air System

4.2.1 A controllable blower, a compressed air supply, an exhaust system, or reversible controllable blower designed to provide the required maximum air pressure difference across the specimen.

4.2.2 The system shall provide an essentially constant air pressure difference for the required test period.

4.3 Pressure-Measuring Apparatus

4.3.1 The pressure-measuring apparatus shall be capable of measuring a test pressure difference within a tolerance of +/- 0.5% or +/- 0.1 inch of water column (+/- 25 Pa), whichever is greater.

4.4 Deflection-Measuring Apparatus

4.4.1 The deflection-measuring apparatus shall be capable of measuring deflections within a tolerance of +/- 1/16 inch (+/- 1.60 mm).

4.4.2 The maximum deflection, located where the door system experiences maximum deflection, shall be measured.

4.4.3 Additional locations for deflection measurements, if required, shall be stated by the specifier.

4.4.4 The deflection gages shall be installed so that the deflection of the test specimen can be measured without being influenced by possible movements of, or movements within, the specimen or member supports.

4.4.5 Deflection-measuring apparatus may also be used to measure permanent deformation.

4.5 Permanent Deformation-Measuring Apparatus

4.5.1 Permanent deformation can be determined by the use of a straight-edge type gage applied to specimen members after pre-loading and again after the test load has been removed.

5.0 HAZARDS

5.1 At the pressure used in this test method, hazardous conditions may result if failure occurs.

5.2 Take proper safety precautions to protect observers in the event that a failure occurs.

5.3 Do not permit personnel in pressure chambers during testing.

6.0 TEST SPECIMENS

6.1 The test specimen shall be as per the manufacturer's detailed drawings and/or written instructions. For sectional garage doors, the horizontal track and hanging brackets may be shortened to fit the test chamber.

6.2 The test specimen shall be anchored as supplied by the manufacturer for installation, or as set forth in a referenced specification, if applicable.

7.0 CALIBRATION

7.1 All pressure and deflection measuring devices shall be calibrated, not more than 6 months prior to testing, in accordance with the device manufacturer's specification.

7.2 All pressure and deflection measuring devices shall be capable of achieving the tolerances provided in Section 4.0.

7.3 Calibration of manometers and mechanical deflection measuring devices are normally not required, provided the instruments are used at a temperature near their design temperature.

8.0 REQUIRED INFORMATION

8.1 Documentation in the form of detailed drawings and/or written instructions indicating complete test specimen.

8.2 The number of incremental loads and the positive and negative test loads at these increments at which deflection measurements are required.

8.3 The duration of incremental and maximum loads.

8.4 The number and location of required deflection measurements.

9.0 PREPARATION FOR TEST

9.1 Remove from the test specimen any shipping or construction material that is not to be used.

9.2 Carefully review the manufacturer's installation instructions, noting any conditions that would alter a normal installation.

9.3 Fit the specimen against the chamber opening, as with a normally installed door assembly. The exterior side of the specimen shall face the higher pressure side for positive loads; the interior side shall face the higher pressure side for negative loads.

9.4 Support and secure the specimen, exactly as shown in the installation documentation.

9.5 Install the door system per the manufacturer's installation instructions; and the door either counterbalanced where no more than the larger of 5% of door weight or ten pounds (44.5 N) applied force is required to open the door manually from the fully closed position, or a simulated counterbalance condition (including locking mechanism) by shimming up the ends of the door.

9.6 If air flow through the test specimen is such that the specified pressure cannot be maintained, cover the entire specimen and mounting frame with a single thickness of polyethylene film no thicker than .002 inches (.050 mm). The technique of application is important to ensure that the maximum load is transferred to the specimen and that the membrane does not prevent movement or failure of the specimen. Apply the film loosely with extra folds of material at each corner and at all offsets and recesses. When the load is applied, there shall be no fillet caused by tightness of plastic film. On negative pressure tests, it is especially important that the film fully contact the door surface and not span between strut, stile or rail members. Tape may be used to protect the film from sharp edges, to attach the film, and to repair holes in the film. Tape shall not provide structural support.

10.0 TEST PROCEDURE

10.1 Check the specimen for proper adjustment, and that the specimen has been assembled in accordance with manufacturer's installation instructions.

10.2 Check that the specimen has been properly prepared for testing in accordance with documentation.

10.3 Install deflection-measuring devices at the predetermined locations, according to Section 4.4.

10.4 Apply pre-load (50% of design load) and hold for 10 seconds.

10.5 Release the pressure difference across the specimen.

10.6 Allow a recovery period for stabilization of the test specimen. The recovery period for stabilization shall not be less than 1 minute nor more than 5 minutes.

10.7 Record initial static pressure and deflection gage readings.

10.8 Begin applying load until the design load is reached. Measure maximum deflection at design load. The design load shall be held for 10 seconds.

10.9 Release the load and measure the permanent deformation, if desired, within 1 to 5 minutes.

10.10 The pressure shall then be reapplied until the test load is reached. The test load shall be held for 10 seconds.

10.11 Release the load.

10.12 If the specimen has sustained the predetermined design load and test load without failure, repeat 10.3 through 10.11 for the opposite loading direction.

11.0 PASS/FAIL CRITERIA

11.1 The door system shall sustain both the design load and the test load for the predetermined amount of time.

11.2 The door system shall remain in the opening throughout the duration of the test.

11.3 The door systems shall be evaluated for full operability at the conclusion of the test. The door shall pass only if the test engineer deems that the door system has full operability.

12.0 TEST REPORT

12.1 Identification of the test

specimen **12.1.1** Manufacturer

12.1.2 Location of manufacturer

12.1.3 Dimensions

12.1.4 Model Type

12.1.5 Material description

12.1.6 Test specimen selection procedure

12.2 Detailed drawings of the test specimen (separate drawings for each test specimen are not required if all test specimen differences are noted on the drawings)

12.2.1 Dimensioned section profiles

12.2.2 Door dimensions and arrangement

12.2.3 Opening framing

12.2.4 Installation and spacing of anchorage

12.2.5 Weather-stripping

12.2.6 Locking arrangement

12.2.7 Hardware

12.2.8 Glazing details

12.2.9 Any other pertinent construction details, including the operator and its attachment if included in the test specimen.

12.3 Type, quantity and location(s) of the locking and operating hardware

12.4 Glazing thickness and type, and method of glazing

12.5 Record ambient temperature

12.6 Tabulation of data:

12.6.1 Pre-load pressure and duration

12.6.2 Design pressure differences exerted on the specimen

12.6.3 Design pressure durations

12.6.4 Pertinent deflections at these design pressure differences

12.6.5 Test pressure differences exerted on specimen

12.6.6 Test pressure durations

12.6.7 Permanent deformations at locations specified for each specimen tested.

12.7 Pass/Fail criteria results

12.8 Visual observations of performance

12.9 State whether or not tape or film were used to seal against air leakage, and whether in the judgment of the test engineer, the tape or film influenced the results of the test.

12.10 Name of the individual that conducted the test

12.11 Name and address of the testing facility

12.12 Names of official observers

12.13 Other data, useful to the understanding of the test report, as determined by the laboratory or specifier, shall either be included within the report or appended to the report.

REFERENCED DOCUMENTS:

ASTM-E 330-02, Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

ANSI/DASMA 108 Test Report Form
Uniform Static Air Pressure Performance

Test Specimen Identification:
Manufacturer ____________________________ Manufacturer Location ___________________________
Model Type/Number _______________ Dimensions ____
Material Description ____

Test Specimen Selection Procedure ____

Applicable Drawing No.'s ____

Operating Hardware (Type, Quantity, Location(s)):

____

____

Glazing Description:
Type: ____________ Thickness: ________________ Method: ___________________

Ambient Temperature: _________

Performance:

	Positive Pressure	Negative Pressure
Pre-load Pressure		
Design Pressure		
Design Pressure Test Duration		
Maximum Deflection at Design Pressure		
Deflection after Release of Design Pressure		
Test Pressure		
Test Pressure Test Duration		

Pass/Fail Criteria: **Positive Negative**

Design Load Sustained? (Yes/No) _______ _______
Test Load Sustained? (Yes/No) _______ _______
Garage/Rolling Door remained in opening during duration of test? (Yes/No) _______ _______
Garage/Rolling Door operable, after evaluation for full operability? (Yes/No) _______ _______

Visual Observations of Performance:

____

____

____

Notes:

Testing Conducted by _________________________ **of** ________________________________

Signature of Tester __________________________ **Date** _________________________________

Test Facility and Location ____

Official Observers ____

6

Appendix A
Testing Procedure for the Florida High Velocity Hurricane Zone

1. Scope

1.1 This Appendix covers procedures for conducting a uniform static air pressure test for garage doors and rolling doors as required in the Florida High Velocity Hurricane Zone per Section 1707.4.3 of the Florida Building Code, Building.

2. Referenced Documents

2.1 2004 Florida Building Code, Building

2.2 ASTM E 330-02

3. Terminology

3.1 *Definitions* – for definitions of terms used in this Appendix, refer to the Florida Building Code, Building

3.2 *Descriptions of Terms Specific to This Protocol*

3.2.1 ***Specimen*** – The entire assembled unit submitted for test, including anchorage devices and structure to which product is to be mounted.

3.2.2 ***Test Chamber*** – An airtight enclosure of sufficient depth to allow unobstructed deflection of the specimen during pressure loading, including ports for air supply and removal, and equipped with a device to measure test pressure differentials.

3.2.3 ***Maximum Deflection*** – The maximum displacement, measured to the nearest 1/8" (3 mm), attained from an original position while a maximum load is being applied.

3.2.4 ***Permanent Deformation*** – The permanent displacement, measured to the nearest 1/8" (3 mm), from an original position that remains after maximum test load has been removed.

3.2.5 ***Design Pressure (Design Wind Load)*** – The uniform static air pressure difference, inward or outward and expressed in pounds per square foot (Newtons per square meter), for which the specimen would be designed under service load conditions using Section 1619 of the Florida Building Code, Building.

3.2.6 ***Test Load*** – One and one-half (1.5) times the design pressure (positive or negative) as determine by Section 1714 of the Florida Building Code, Building, for which the specimen is to be tested, expressed in pounds per square foot (Newtons per square meter.)

3.2.7 ***Specimen Failure*** – A change in condition of the specimen indicative of deterioration under repeated load or incipient failure, such as cracking, fastener loosening, local yielding, or loss of adhesive bond.

4. Significance and Use

4.1 The test procedures outlined in this protocol provide a means of determining whether a garage door or rolling door provides sufficient resistance to wind forces as determine by Section 1619 of the Florida Building Code, Building.

5. Test Specimen and Procedures

5.1 ***Test specimen*** – All parts of the test specimen shall be full size, using the same materials, details, methods of construction and methods of attachment as proposed for actual use. The specimen shall consist of the entire assembled unit attached to a given type of structural framing of the building, and shall contain all devices used to resist wind forces.

A pressure treated nominal 2 x 4 - #3 Southern Pine wood buck shall be used for attachment of the specimen to the test frame/stand/chamber. Such wood buck shall become part of the approval.

5.1.1 Locking mechanisms shall be permanently mounted on the specimen. Such locking mechanism shall require no tools to be latched in the locked position. Devices such as pins shall be permanently secured to the specimen through the use of chains or wires which shall be of corrosion resistant material. This section shall not apply to specimens referenced in Section 2413 of the Florida Building Code, Building.

5.1.2 Products that are not categorized as means of egress/escape, and are provided with more than one single action locking mechanism, shall be provided with permanently posted instructions on latching for high wind pressures.

5.1.3 Doors shall be evaluated for operability after this test.

5.1.4 Specimen and fasteners, when used, shall not become disengaged during test procedure.

5.2 ***Procedure***

5.2.1 *Preparation* – Remove from the test specimen any sealing or construction material that is not normally used when installed in or on a building. Fit the specimen, with its structural framing, into or against the chamber opening. The outdoor side of the specimen shall face the higher pressure side for positive loads; the indoor side shall face the higher pressure side for negative loads. Support and secure the specimen by the same number and type of anchors to be approved for normal installation of the specimen in the building.

5.2.2 ***Single Action Locking/Closing Procedure***

5.2.2.1 All specimens which are required to comply with means of egress/escape, shall be tested for full static loads as required by Section 5.2.3 of this Appendix with only one single action locking mechanism. Additionally, doors that are not required to comply with means of egress/escape requirement shall be tested as described in Sections 5.2.2.2 and 5.2.2.3 of this Appendix.

5.2.2.2 Doors that are not required to comply with the means of egress/escape requirements, which are provided with more than one single action hardware and comply with the test described in this Appendix, shall also be successfully tested with a test load equal to a static air pressure based on wind velocity of 75 mph (33.6 m/s) using only one single action locking mechanism. Apply the corresponding positive test load and hold for 30 seconds. Release this test load across the specimen, and after a recovery period of not less than 1 minute nor more than 5 minutes, apply the corresponding reverse test load and hold for 30 seconds. Release the reverse test load and record observations. Such products shall have all additional locking mechanism permanently attached to the product by means of non-removable and non-corrosive devices, and shall comply with Section 5.1.1 of this Appendix.

5.2.3 ***Uniform Static Air Procedure***

5.2.3.1 Check specimen for adjustment and engage all locks.

5.2.3.2 Install all required measurement devices.

5.2.4 Apply one-half of the test load and hold for 30 seconds. Release the test load across the specimen, and after a recovery period of not less than 1 minute nor more than 5 minutes, apply one-half the reverse test load and hold for 30 seconds. Release reverse test load, and after a recovery period of not less than 1 minute nor more than 5 minutes, record all readings.

5.2.5 Apply full test load and hold for 30 seconds. Release the test load across the specimen, and after a recovery period of not less than 1 minute nor more than 5 minutes, apply full reverse test load and hold for 30 seconds. Release reverse test load, and after a recovery period of not less than 1 minute nor more than 5 minutes, record all readings.

5.3 Specimens successfully tested shall qualify assemblies with material thicker and of the same type and construction provided the anchorage of the product is proportionally changed according to the wind pressure test.

5.4 Specimens successfully tested shall qualify assemblies of a smaller size and of the same type and construction, provided the anchorage of the product remains unchanged.

6. Apparatus

6.1 The description of the apparatus is general in nature. Any equipment, properly certified, calibrated, and approved by the Authority Having Jurisdiction capable of performing this test within the allowable tolerance, shall be permitted.

6.2.1 ***Test Chamber*** – The test chamber, to which the specimen is mounted, shall be provided with pressure taps to measure the pressure difference across the test specimen and shall be so located that the reading is unaffected by the velocity of air supplied to or from the chamber. The specimen mounting frame shall not deflect under test load in such manner that the performance of the specimen will be affected.

6.2.2 ***Pressure-Measuring Apparatus*** – The pressure-measuring apparatus shall measure the test pressure difference within a tolerance of +/-2%

6.2.3 ***Deflection-Measuring System*** – The deflection-measuring system shall measure the deflection within a tolerance of 0.01" (0.25 mm).

6.2.4 ***Air System*** – A controllable blower, a compressed-air supply, an exhaust system, or reversible controllable blower designed to provide the required maximum air pressure difference across the specimen. The system shall provide an essentially constant air-pressure difference for the required test period.

6.3 ***Calibration of Equipment*** – The pressure-measuring apparatus and the deflection-measuring system shall be calibrated and certified by an independent qualified agency approved by the Authority Having Jurisdiction, at two-year intervals.

6.3.1 The calibration report shall include the date of the calibration, the name of the agency conducting the calibration, methods and equipment used in the calibration process, the equipment being calibrated, and any pertinent comments.

7. Hazards

7.1 Testing facilities shall take all necessary precautions to protect observers during the entire test procedure. All observers shall always be at a safe distance away from specimen and apparatus. Safety regulations shall be followed in order to avoid any injuries to any and all observers.

8. Testing Facilities

8.1 Any testing facility wishing to perform this test shall first obtain the approval of the Authority Having Jurisdiction. Such approval shall only be given to those facilities that show they are properly equipped to perform the complete test. Testing facilities shall request, in writing, approval of their facilities. Such request shall contain the ability of the facility to perform all aspects of the test, all equipment used in the performance of the test, name of the independent agency calibrating their equipment, location of facilities, personnel involved in the testing, a quality control program, a safety program and any other pertinent information which shall clearly indicate that such facility is in the business of performing independent testing. A representative of the Authority Having Jurisdiction shall visit the site, and shall reserve the right to order any changes necessary to accept the facility for testing.

8.2 Approval of facilities to perform the test described in this Appendix shall not constitute an approval of such facilities to perform other tests not specifically mentioned in this protocol.

8.3 The testing lab shall be TAS301 certified.

9. Format of Test

The manufacturer shall notify the Authority Having Jurisdiction at least seven (7) working days prior to the performing of the test. The Authority Having Jurisdiction reserves the right to observe the test. The Authority Having Jurisdiction must be notified of the place and time the test will take place. The test must be recorded on video and retained by the laboratory per TAS301.

10. **Test Reports** The following minimum information shall be included in the submitted report:

10.1 Date of the test and the report, and the report number.

10.2 Name and location of facilities performing the test.

10.3 Name and address of requester of the test.

10.4 Identification of the specimen (manufacturer, source of supply, dimension, model types, material, procedure of selection and any other pertinent information).

10.5 Detailed drawings of the specimen showing dimensioned section profiles, type of framing to which specimen was attached, panel arrangement, installation and spacing of anchorage, locking arrangement, sealant, hardware, product markings and their locations, and any other pertinent construction details. Any deviation from the drawings or any modifications made to the specimen to obtain the reported values shall be noted on the drawings and in the report.

10.6 Maximum deflection recorded, and mechanism used to make such determination.

10.7 Permanent deformation (a cross-sectional diagram shall be provided to show where it occurred).

10.8 Name, address, signature and seal of Florida professional engineer, witnessing the test and preparing the report. Engineer shall be part of the laboratory's permanent staff or under laboratory's contract.

10.9 A tabulation of pressure differences exerted across the specimen during the test and their duration.

10.10 Maximum positive and negative pressures used in the test.

10.11 A description of the condition of the test specimens after testing, including details of any damage and any other pertinent observations.

10.12 When the tests are made to check conformity of the specimen to a particular specification, an identification or description of that specification.

10.13 A statement that the tests were conducted in accordance with this test method.

10.14 A statement of whether or not, upon completion of all testing, the specimens meet the requirements of Section 1620 of the 2004 Florida Building Code, Building and this Appendix.

10.15 A statement as to whether or not tape or film, or both were used to seal against air leakage, and whether in the judgment of the test engineer, the tape or film influenced the results of the test.

10.16 Signatures of persons responsible for supervision of the tests, and a list of official observers.

10.17 All data not required herein, but useful to a better understanding of the test results, conclusions or recommendations, may be appended to the report.

11. Recording Deflections

Maximum Deflection

Permanent Deformation

100% recovery is required after half test load, and 80% minimum is required after full load (see Miami-Dade BCCO checklist 0220).

12. Additional Testing

12.1 After successfully completing all parts of the test described in the Appendix, the specimen shall be subjected to the forced entry test as required by the 2004 Florida Building Code, Building. Minimum gauge of materials shall be determined prior to testing per the 2004 Florida Building Code, Building.

12.2 If a product is subjected to weathering that can affect its integrity, the manufacturer shall contact the Authority Having Jurisdiction for additional testing requirements such as but not limited to moisture, U.V., accelerated aging, and other similar tests.

12.3 The Authority Having Jurisdiction shall reserve the right to require any additional testing necessary to assure full compliance with the intent of the 2004 Florida Building Code, Building.

13. Product Marking

13.1 All approved products shall be permanently labeled with the manufacturer's name, city, and state, and the following statement: "Product Control Approved."

13.2 Permanently labeled shall be a metallic label fixed permanently to the frame of the specimen by rivets or permanent adhesive.

13.3 Any instructions for operations shall be permanently mounted on the specimen in an area not subject to be painted or concealed.

DASMA
Door & Access Systems
Manufacturers Association
International

DASMA – the Door & Access Systems Manufacturers Association, International – is North America's leading trade association of manufacturers of garage doors, rolling doors, garage door operators, vehicular gate operators, and access control products. With Association headquarters based in Cleveland, Ohio, our 90 member companies manufacture products sold in virtually every county in America, in every U.S. state, every Canadian province, and in more than 50 countries worldwide. DASMA members' products represent more than 95% of the U.S. market for our industry.

For more information about the Door & Access Systems Manufacturers Association, International, contact:

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Standard Method For Testing Sectional Garage Doors, Rolling Doors and Flexible Doors: Determination Of Structural Performance Under Uniform Static Air Pressure Difference

DASMA 108-2017

Door & Access Systems Manufacturers' Association, International

Sponsor:

DASMA Door & Access Systems Manufacturers Association International

1300 Sumner Ave
Cleveland, Ohio 44115-2851

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Suggestions for improvement of this standard will be welcome. They should be sent to the Door & Access Systems Manufacturers' Association, International.

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Foreword (This foreword is included for information only and is not part of DASMA 108-2015, *Standard Method for Testing Sectional Garage Doors, Rolling Doors and Flexible Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference.)*

This standard was developed concurrently by the DASMA Commercial & Residential Garage Door Division Technical Committee, the DASMA Rolling Door Division, and the DASMA High Performance Door Division. It incorporates years of experience in testing sectional garage doors and rolling doors commonly found in garage type structures. The committees and divisions believe the existence of the standard will provide a uniform basis of testing and rating the structural performance of such doors under uniform static air pressure difference.

The DASMA Commercial & Residential Garage Door Division, The DASMA Rolling Door Division, and the DASMA High Performance Door Division concurrently approved revisions to the standard on October 30, 2015. DASMA employed the canvass method to demonstrate consensus and to gain approval as an American National Standard. The ANSI Board of Standards Review first granted approval of the document as an American National Standard on May 21, 2002. The ANSI Board of Standards Review granted approval of the most recent revisions to the standard as an American National Standard on November 21, 2017.

DASMA recognizes the need to periodically review and update this standard. Suggestions for improvement should be forwarded to the Door & Access Systems Manufacturers' Association, International, 1300 Sumner Avenue, Cleveland, Ohio, 44115-2851.

DASMA – the Door & Access Systems Manufacturers Association, International – is North America's leading trade association of manufacturers of garage doors, rolling doors, garage door operators, vehicular gate operators, and access control products. With Association headquarters based in Cleveland, Ohio, our 90 member companies manufacture products sold in virtually every county in America, in every U.S. state, every Canadian province, and in more than 50 countries worldwide. DASMA members' products represent more than 95% of the U.S. market for our industry.

For more information about the Door & Access Systems Manufacturers Association, International, contact:

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ANSI/DASMA 108-2017

AMERICAN NATIONAL STANDARD

Standard Method for Testing Sectional Garage Doors, Rolling Doors and Flexible Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference

1.0 SCOPE

1.1 This test method describes the determination of the structural performance of garage door, rolling door and flexible door assemblies under uniform static air pressure difference, using a test chamber.

1.2 This test method is intended only for evaluating the structural performance associated with the specified test specimen and not the structural performance of adjacent construction.

1.3 The proper use of this test method requires a knowledge of the principles of pressure and deflection measurement.

1.4 This test method describes the apparatus and the procedure to be used for applying uniformly distributed loads to a specimen.

1.5 This test method does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

1.6 This test method shall be considered equivalent to ASTM E 330-02, provided

the pass/fail criteria contained in Section 11 of this standard is applied to testing in accordance with ASTM E 330-02.

1.7 For products intended for installation in the Florida High Velocity Hurricane Zone

(Miami-Dade and Broward Counties), the testing procedure in Appendix A shall be used.

2.0 DEFINITIONS

2.1 Design Load: The specified difference in static air pressure (positive or negative) for which the specimen is to be tested, expressed in pounds per square foot (or pascals).

2.2 Flexible Door: A door, excluding rolling sheet doors as defined in DASMA 207, in which a flexible fabric or other flexible sheet material forms the panel portion, even though it may have a rigid frame, rigid reinforcements, rigid support means for one or more edges thereof, or combinations of these features.

2.3 Full Operability: The ability for the door to be fully opened and closed.

2.4 Permanent Deformation: The displacement or change in dimension of the specimen after the applied load has been removed and the specimen has relaxed for the specified period of time.

2.5 Preload: 50% of design load.

2.6 Test Load: The specified difference in static air pressure (positive or negative), equal to 1.5 times the design load, expressed in pounds per square foot (or pascals). (Note: Test load is equivalent to the proof load as defined by 330-02.)

2.7 Test Specimen: The complete installed door assembly and mounting hardware as specified on the submitted drawing.

3.0 SUMMARY OF TEST METHOD

3.1 Seal the test specimen against one face as with a normal door assembly.

3.2 Supply air to or exhaust air from the chamber according to a specific test program, at the rate required to maintain the appropriate test pressure difference across the specimen.

3.3 Observe, measure, and record the deflections, deformations, and nature of any distresses or failures of the specimen.

4.0 APPARATUS

4.1 Test Chamber

4.1.1 A chamber shall be used which includes one open side against which the specimen is installed.

4.1.2 Provide a static pressure tap to measure the pressure difference across the test specimen. Locate the tap so that the reading is unaffected by the velocity of air supplied to or from the chamber or by any other air movements.

4.1.3 The air supply opening into the chamber shall be arranged so that the air does not impinge directly on the test specimen with any significant velocity.

4.1.4 A means shall be provided to facilitate test specimen adjustments and observations.

4.1.5 The test chamber and the specimen mounting frame shall not deflect under the test load in such a manner that the performance of the specimen will be affected.

4.2 Air System

4.2.1 A controllable blower, a compressed air supply, an exhaust system, or reversible controllable blower designed to provide the required maximum air pressure difference across the specimen.

4.2.2 The system shall provide an essentially constant air pressure difference for the required test period.

4.3 Pressure-Measuring Apparatus

4.3.1 The pressure-measuring apparatus shall be capable of measuring a test pressure difference within a tolerance of +/- 0.5% or +/- 0.1 inch of water column (+/- 25 Pa), whichever is greater.

4.4 Deflection-Measuring Apparatus

4.4.1 The deflection-measuring apparatus shall be capable of measuring deflections within a tolerance of +/- 1/16 inch (+/- 1.60 mm).

4.4.2 The maximum deflection, located where the door system experiences maximum deflection, shall be measured.

4.4.3 Additional locations for deflection measurements, if required, shall be stated by the specifier.

4.4.4 The deflection gages shall be installed so that the deflection of the test specimen can be measured without being influenced by possible movements of, or movements within, the specimen or member supports.

4.4.5 Deflection-measuring apparatus may also be used to measure permanent deformation.

4.5 Permanent Deformation-Measuring

Apparatus

4.5.1 Permanent deformation can be determined by the use of a straight-edge type gage applied to specimen members after pre-loading and again after the test load has been removed.

5.0 HAZARDS

5.1 At the pressure used in this test method, hazardous conditions may result if failure occurs.

5.2 Take proper safety precautions to protect observers in the event that a failure occurs.

5.3 Do not permit personnel in pressure chambers during testing.

6.0 TEST SPECIMENS

6.1 The test specimen shall be as per the manufacturer's detailed drawings and/or written instructions. Any horizontal track and hanging brackets may be shortened to fit the test chamber.

6.2 The test specimen shall be anchored as supplied by the manufacturer for installation, or as set forth in a referenced specification, if applicable.

7.0 CALIBRATION

7.1 All pressure and deflection measuring devices shall be calibrated, not more than 6 months prior to testing, in accordance with the device manufacturer's specification.

7.2 All pressure and deflection measuring devices shall be capable of achieving the tolerances provided in Section 4.0.

7.3 Calibration of manometers and mechanical deflection measuring devices are normally not required, provided the instruments are used at a temperature near their design temperature.

8.0 REQUIRED INFORMATION

8.1 Documentation in the form of detailed drawings and/or written instructions indicating complete test specimen.

8.2 The number of incremental loads and the positive and negative test loads at these increments at which deflection measurements are required.

8.3 The duration of incremental and maximum loads.

8.4 The number and location of required deflection measurements.

9.0 PREPARATION FOR TEST

9.1 Remove from the test specimen any shipping or construction material that is not to be used.

9.2 Carefully review the manufacturer's installation instructions, noting any conditions that would alter a normal installation.

9.3 Fit the specimen against the chamber opening, as with a normally installed door assembly. For flexible doors, the test report shall include a diagram indicating which side of the door received positive pressure and which side of the door received negative pressure.

9.4 Support and secure the specimen, exactly as shown in the installation documentation.

9.5 Install the door system per the manufacturer's installation instructions.

9.5.1 For garage doors and rolling doors, the door shall be counterbalanced where no more than the larger of 5% of door weight or ten pounds (44.5 N) applied force is required to open the door manually from the fully closed position, or a simulated counterbalance condition (including locking mechanism) shall be achieved by shimming up the ends of the door.

9.6 If air flow through the test specimen is such that the specified pressure cannot be maintained, cover the entire specimen and mounting frame with a single thickness of polyethylene film no thicker than .002 inches (.050 mm). The technique of application is important to ensure that the maximum load is transferred to the specimen and that the membrane does not prevent movement or failure of the specimen. Apply the film loosely with extra folds of material at each corner and at all offsets and recesses. When the load is applied, there shall be no fillet caused by tightness of plastic film. On negative pressure tests, it is especially important that the film fully contact the door surface and not span between door reinforcement or support members. Tape may be used to protect the film from sharp edges, to attach the film, and to repair holes in the film. Tape shall not provide structural support.

10.0 TEST PROCEDURE

10.1 Check the specimen for proper adjustment, and that the specimen has been assembled in accordance with manufacturer's installation instructions.

10.2 Check that the specimen has been properly prepared for testing in accordance with documentation.

10.3 Install deflection-measuring devices at the predetermined locations, according to Section 4.4.

10.4 Apply pre-load (50% of design load) and hold for 10 seconds.

10.5 Release the pressure difference across the specimen.

10.6 Allow a recovery period for stabilization of the test specimen. The recovery period for stabilization shall not be less than 1 minute nor more than 5 minutes.

10.7 Record initial static pressure and deflection gage readings.

10.8 Begin applying load until the design load is reached. Measure maximum deflection at design load. The design load shall be held for 10 seconds.

10.9 Release the load and measure the permanent deformation, if desired, within 1 to 5 minutes.

10.10 The pressure shall then be reapplied until the test load is reached. The test load shall be held for 10 seconds.

10.11 Release the load.

10.12 If the specimen has sustained the pre-determined design load and test load without failure, repeat 10.3 through 10.11 for the opposite loading direction.

11.0 PASS/FAIL CRITERIA

11.1 The door system shall sustain both the design load and the test load for the predetermined amount of time.

11.2 The door system shall remain in the opening throughout the duration of the test.

11.3 The door system shall be evaluated for full operability at the conclusion of the test. The door shall pass only if the test engineer deems that the door system has full operability.

12.0 TEST REPORT

12.1 Identification of the test specimen

12.1.1 Manufacturer

12.1.2 Location of manufacturer

12.1.3 Dimensions

12.1.4 Model Type

12.1.5 Material description

12.1.6 Test specimen selection procedure

12.2 Detailed drawings of the test specimen. For flexible doors, the test report shall include a diagram indicating which side of the door received positive pressure and which side of the door received negative pressure. (separate drawings for each test specimen are not required if all test specimen differences are noted on the drawings)

12.2.1 Dimensioned section profiles

12.2.2 Door dimensions and arrangement

12.2.3 Opening framing

12.2.4 Installation and spacing of Anchorage

12.2.5 Weather-stripping

12.2.6 Locking arrangement

12.2.7 Hardware

12.2.8 Glazing details

12.2.9 Any other pertinent construction details, including the operator and its attachment if included in the test specimen.

12.3 Type, quantity and location(s) of the locking and operating hardware.

12.4 Glazing thickness and type, and method of glazing.

12.5 Record ambient temperature

12.6 Tabulation of data:

12.6.1 Pre-load pressure and duration

12.6.2 Design pressure differences exerted on the specimen

12.6.3 Design pressure durations

12.6.4 Pertinent deflections at these design pressure differences

12.6.5 Test pressure differences exerted on specimen

12.6.6 Test pressure durations

12.6.7 Permanent deformations at locations specified for each specimen tested.

12.7 Pass/Fail criteria results

12.8 Visual observations of performance

12.9 State whether or not tape or film were used to seal against air leakage, and whether in the judgment of the test engineer, the tape or film influenced the results of the test.

12.10 Name of the individual that conducted the test

12.11 Name and address of the testing facility

12.12 Names of official observers

12.13 Other data, useful to the understanding of the test report, as determined by the laboratory or specifier, shall either be included within the report or appended to the report.

REFERENCED DOCUMENTS

1. ASTM-E 330-02, Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

2. DASMA 207, Standard for Rolling Sheet Doors

3. TAS 202-94. Uniform Static Air Pressure Testing, Miami-Dade County Building Code Compliance Office

DASMA 108 Test Report Form
Uniform Static Air Pressure Performance

Test Specimen Identification:

Manufacturer ___________________________Manufacturer Location______________________________
Model Type/Number ______________ Dimensions____
Material Description ____

Test Specimen Selection Procedure____

Applicable Drawing No.'s ____

Operating Hardware (Type, Quantity, Location(s)):

____

____

Glazing Description:

Type: ___________ Thickness: _______________Method: __________________

Ambient Temperature: ________

Performance:

	Positive Pressure	Negative Pressure
Pre-load Pressure		
Design Pressure		
Design Pressure Test Duration		
Maximum Deflection at Design Pressure		
Deflection after Release of Design Pressure		
Test Pressure		
Test Pressure Test Duration		

Pass/Fail Criteria:	**Positive**	**Negative**
Design Load Sustained? (Yes/No)	_______	_____
Test Load Sustained? (Yes/No)	_______	_____
Door remained in opening during duration of test? (Yes/No)	_______	_____
Door operable, after evaluation for full operability? (Yes/No)	_______	_____

Visual Observations of Performance:

____

____

____

Notes:

Testing Conducted by ________________________ **of** ____

Signature of Tester __________________________________ **Date** _________________________________

Test Facility and Location ____

Official Observers ____

7

Appendix A
Testing Procedure for the Florida High Velocity Hurricane Zone
(Uniform Static Air Pressure)

1. **Scope**

1.1 This Appendix covers procedures for conducting a uniform static air pressure test for doors as required in the Florida High Velocity Hurricane Zone per Section 1710.5.2.1 of the Florida Building Code, Building.

1.2 ASCE 7 Design Pressure are permitted to be multiplied by 0.6.

2. **Referenced Documents**

2.1 2014 Florida Building Code, Building
2.2 ASTM E 330-02
2.3 ASCE 7-10
2.4 TAS 301-94

3. **Terminology**

3.1 *Definitions* – For definitions of terms used in this Appendix, refer to the Florida Building Code, Building.

3.2 *Descriptions of Terms Specific to This Appendix.*

3.2.1 ***Specimen*** **–** The entire assembled unit submitted for test, including anchorage devices and structure to which product is to be mounted.

3.2.2 T***est Chamber*** **–** An airtight enclosure of sufficient depth to allow unobstructed deflection of the specimen during pressure loading, including ports for air supply and removal, and equipped with a device to measure test pressure differentials.

3.2.3 ***Maximum Deflection*** **–** The maximum displacement measured to the nearest 1/8" (3 mm) attained from an original position while a maximum load is being applied.

3.2.4 ***Permanent Deformation*** **–** The permanent displacement measured to the nearest 1/8" (3 mm) from an original position that remains after maximum test load has been removed.

3.2.5 ***Design Pressure (Design Wind Load)*** **–** The uniform static air pressure difference, inward or outward and expressed in pounds per square foot (Newtons per square meter), for which the specimen would be designed under service load conditions using Section 1609 of the Florida Building Code, Building.

3.2.6 ***Test Load*** **–** One and one-half (1.5) times the design pressure (positive or negative) as determine by Section 1609 of the Florida Building Code, Building, for which the specimen is to be tested, expressed in pounds per square foot (Newtons per square meter.)

3.2.7 ***Specimen Failure –*** A change in condition of the specimen indicative of deterioration under repeated load or incipient failure, such as cracking, fastener loosening, local yielding, or loss of adhesive bond.

4. **Significance and Use**

4.1 The test procedures outlined in this protocol provide a means of determining whether a door provides sufficient resistance to wind forces as determine by Section 1609 of the Florida Building Code, Building.

5. **Test Specimen and Procedures**

5.1 ***Test Specimen –*** All parts of the test specimen shall be full size, using the same materials, details, methods of construction and methods of attachment as proposed for actual use. The specimen shall consist of the entire assembled unit attached to a given type of structural framing of the building, and shall contain all devices used to resist wind forces.

5.1.1 Locking mechanisms shall be permanently mounted on the specimen. Such locking mechanism shall require no tools to be latched in the locked position. Devices such as pins shall be permanently secured to the specimen through the use of chains or wires which shall be of corrosion resistant material. This section shall not apply to specimens referenced in Section 2413 of the Florida Building Code, Building.

5.1.2 Products that are not categorized as means of egress/escape, and are provided with more than one single action locking mechanism, shall be provided with permanently posted instructions on latching for high wind pressures.

5.1.3. Doors shall be evaluated for operability after this test.

5.1.4. Specimen and fasteners, when used, shall not become disengaged during test procedure.

5.2 **Procedure**

5.2.1 ***Preparation*** – Remove from the test specimen any sealing or construction material that is not normally used when installed in or on a building. Fit the specimen, with its structural framing, into or against the chamber opening. For garage doors and rolling doors, the outdoor side of the specimen shall face the higher pressure side for positive loads; the indoor side shall face the higher pressure side for negative loads. For flexible doors, the test report shall include a diagram indicating which side of the door received positive pressure and which side of the door received negative pressure. Support and secure the specimen by the same number and type of anchors to be approved for normal installation of the specimen in the building.

5.2.2 ***Single Action Locking/Closing Procedure***

5.2.2.1 All specimens which are required to comply with means of egress/escape, shall be tested for full static loads as required by Section 5.2.3 of this Appendix with only one single action locking mechanism. Additionally, doors that are not required to comply with means of egress/escape requirement shall be tested as described in Sections 5.2.2.2 of this Appendix.

5.2.2.2 Doors that are not required to comply with the means of egress/escape requirements, which are provided with more than one single action hardware and comply with the test described in this Appendix, shall also be successfully tested with a test load equal to a static air pressure based on wind velocity of 97 mph (44 m/s) using only one single action locking mechanism. Test pressures are permitted to be multiplied by 0.6 as specified in Section 1.2. Apply the corresponding positive test load and hold for 30 seconds. Release this test load across the specimen and after a recovery period of not less than 1 minute nor more than 5 minutes, apply the corresponding reverse test load and hold for 30 seconds. Release the reverse test load and record observations. Such products shall have all additional locking mechanism permanently attached to the product by means of non-removable and non-corrosive devices, and shall comply with Section 5.1.1 of this Appendix.

5.2.3 **Uniform Static Air Procedure**

5.2.3.1 Check specimen for adjustment and engage all locks. 5.2.3.2 Install all required measurement devices.

5.2.3.2. Install all required measurement devices.

5.2.4 Apply one-half of the test load and hold for 30 seconds. Release the test load across the specimen, and after a recovery period of not less than 1 minute and not more than 5 minutes, apply one-half the reverse test load and hold for 30 seconds. Release reverse test load, and after a recovery period of not less than 1 minute and not more than 5 minutes, record all readings.

5.2.5 Apply full test load and hold for 30 seconds. Release the test load across the specimen, and after a recovery period of not less than 1 minute nor more than 5 minutes, apply full reverse test load and hold for 30 seconds. Release reverse test load, and after a recovery period of not less than 1 minute nor more than 5 minutes, record all readings.

5.2.7 Air Infiltration. Where required, air infiltration shall comply with either ASTM E283 or ANSI/DASMA 105.

5.3 Specimens successfully tested shall qualify assemblies with material thicker and of the same type and construction provided the anchorage of the product is proportionally changed according to the wind pressure test.

5.4 Specimens successfully tested shall qualify assemblies of a smaller size and of the same type and construction, provided the anchorage of the product remains unchanged.

6. Apparatus

6.1 The description of the apparatus is general in nature. Any equipment, properly certified, calibrated, and approved by the Authority Having Jurisdiction capable of performing this test within the allowable tolerance, shall be permitted.

6.2.1 ***Test Chamber –*** The test chamber, to which the specimen is mounted, shall be provided with pressure taps to measure the pressure difference across the test specimen and shall be so located that the reading is unaffected by the velocity of air supplied to or from the chamber. The specimen mounting frame shall not deflect under test load in such manner that the performance of the specimen will be affected.

6.2.2 ***Pressure-Measuring Apparatus –*** The pressure-measuring apparatus shall measure the test pressure difference within a tolerance of +/-2%

6.2.3 ***Deflection-Measuring System –*** The deflection-measuring system shall measure the deflection within a tolerance of 0.01" (0.25 mm).

6.2.4 ***Air System –*** A controllable blower, a compressed-air supply, an exhaust system, or reversible controllable blower designed to provide the required maximum air pressure difference across the specimen. The system shall provide an essentially constant air-pressure difference for the required test period.

6.3 ***Calibration of Equipment –*** The pressure-measuring apparatus and the deflection-measuring system shall be calibrated and certified by an independent qualified agency approved by the Authority Having Jurisdiction, at two-year intervals.

6.3.1 The calibration report shall include the date of the calibration, the name of the agency conducting the calibration, methods and equipment used in the calibration process, the equipment being calibrated, and any pertinent comments.

7. Hazards

7.1 Testing facilities shall take all necessary precautions to protect observers during the entire test procedure. All observers shall always be at a safe distance away from specimen and apparatus. Safety regulations shall be followed in order to avoid any injuries to any and all observers.

8. Testing Facilities - (For a more detailed description see TAS 301-94)

8.1 Any testing facility wishing to perform this test shall first obtain the approval of the

Authority Having Jurisdiction. Such approval shall only be given to those facilities that show they are properly equipped to perform the complete test. Testing facilities shall request, in writing, approval of their facilities. Such request shall contain the ability of the facility to perform all aspects of the test, all equipment used in the performance of the test, name of the independent agency calibrating their equipment, location of facilities, personnel involved in the testing, a quality control program, a safety program and any other pertinent information which shall clearly indicate that such facility is in the business of performing independent testing. A representative of the Authority Having Jurisdiction shall visit the site, and shall reserve the right to order any changes necessary to accept the facility for testing.

8.2 Approval of facilities to perform the test described in this Appendix shall not constitute an approval of such facilities to perform other tests not specifically mentioned in this protocol.

9. Format of Test

The manufacturer shall notify the Authority Having Jurisdiction at least seven (7) working days prior to the performing of the test. The Authority Having Jurisdiction reserves the right to observe the test. The Authority Having Jurisdiction must be notified of the place and time the test will take place. The test must be recorded on video and retained by the laboratory per TAS301.

10. Test Reports

The following minimum information shall be included in the submitted report:

10.1 Date of the test and the report, and the report number.

10.2 Name and location of facilities performing the test.

10.3 Name and address of requester of the test.

10.4 Identification of the specimen (manufacturer, source of supply, dimension, model types, material, procedure of selection and any other pertinent information).

10.5 Detailed drawings of the specimen showing dimensioned section profiles, type of framing to which specimen was attached, panel arrangement, installation and spacing of anchorage, locking arrangement, sealant, hardware, product markings and their locations, and any other pertinent construction details. Any deviation from the drawings or any modifications made to the specimen to obtain the reported values shall be noted on the drawings and in the report. For flexible doors, the test report shall include a diagram indicating which side of the door received positive pressure and which side of the door received negative pressure.

10.6 Maximum deflection recorded, and mechanism used to make such determination.

10.7 Permanent deformation (a cross-sectional diagram shall be provided to show where it occurred).

10.8 Name, address, signature and seal of Florida professional engineer, witnessing the test and preparing the report. Engineer shall be part of the laboratory's permanent staff or under laboratory's contract. (See TAS 301-94)

10.9 A tabulation of pressure differences exerted across the specimen during the test and their duration.

10.10 Maximum positive and negative pressures used in the test.

10.11 A description of the condition of the test specimens after testing, including details of any damage and any other pertinent observations.

10.12 When the tests are made to check conformity of the specimen to a particular specification, an identification or description of that specification.

10.13 A statement that the tests were conducted in accordance with this test method.

10.14 A statement of whether or not, upon completion of all testing, the specimens meet the requirements of Section 1620 of the 2004 Florida Building Code, Building and this Appendix.

10.15 A statement as to whether or not tape or film, or both were used to seal against air leakage, and whether in the judgment of the test engineer, the tape or film influenced the results of the test.

10.16 Signatures of persons responsible for supervision of the tests, and a list of official observers.

10.17 All data not required herein, but useful to a better understanding of the test results, conclusions or recommendations, may be appended to the report.

11. **Recording Deflections**

Maximum Deflection

Permanent Deformation

95% recovery is required after half test load, and 80% minimum is required after full load (see Miami-Dade County RER checklist 0220). An initial datum plane shall be established for this measurement, along with an initial measurement of deflection under a predetermined baseline pressure condition equal to 5% of the test load. Once the initial baseline deflection measurement is taken, it shall be replicated after the pressure test to measure the change in permanent set of the curtain. Operability of door before and after testing shall be reported.

12. **Additional Testing**

12.1 After successfully completing all parts of the test described in the Appendix, the specimen shall be subjected to the forced entry test by applying a 300 lb. (1335 N) load in the upward or opening direction at the door's mid-span, within 6 inches (152 mm) from the bottom. The load shall be held for 30 seconds. The minimum skin thickness for single skin garage doors shall be 24 gauge (.0209 inches) (0.531 mm), and 26 gauge (.0157 inches) (0.399 mm) for double skin (FBC Section 2222.4.3.)

12.2 If a product is subjected to weathering that can affect its integrity, the manufacturer shall contact the Authority Having Jurisdiction for additional testing requirements such as but not limited to moisture, U.V., accelerated aging, and other similar tests.

12.3 The Authority Having Jurisdiction shall reserve the right to require any additional testing necessary to assure full compliance with the intent of the 2014 Florida Building Code, Building.

13. **Product Marking**

13.1 All approved products shall be permanently labeled with the manufacturer's name, city, and state, and the following statement: "Product Control Approved."

13.2 Permanently labeled shall be a metallic label fixed permanently to the frame of the specimen by rivets or permanent adhesive.

13.3 Any instructions for operations shall be permanently mounted on the specimen in an area not subject to be painted or concealed.

DASMA
Door & Access Systems Manufacturers Association International

DASMA – the Door & Access Systems Manufacturers Association, International – is North America's leading trade association of manufacturers of garage doors, rolling doors, garage door operators, vehicular gate operators, and access control products. With Association headquarters based in Cleveland, Ohio, our 90 member companies manufacture products sold in virtually every county in America, in every U.S. state, every Canadian province, and in more than 50 countries worldwide. DASMA members' products represent more than 95% of the U.S. market for our industry.

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Approved American National Standard ANSI

ANSI/DASMA 115-2005

AMERICAN NATIONAL STANDARD

STANDARD METHOD FOR TESTING SECTIONAL GARAGE DOORS AND ROLLING DOORS: DETERMINATION OF STRUCTURAL PERFORMANCE UNDER MISSILE IMPACT AND CYCLIC WIND PRESSURE

ANSI/DASMA 115-2005

Door & Access Systems Manufacturers' Association, International

Sponsor:

DASMA Door & Access Systems Manufacturers Association International

1300 Sumner Ave
Cleveland, Ohio 44115-2851

AMERICAN NATIONAL STANDARD

Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure

Sponsor

Door & Access Systems Manufacturers' Association, International

American National Standard

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Suggestions for improvement of this standard are welcome.
They should be sent to the Door & Access Systems Manufacturers' Association, International.

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Foreword (This foreword is included for information only and is not part of ANSI/DASMA 115, *Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure.*)

This standard was developed concurrently by the Technical Committees of the DASMA Commercial & Residential Garage Door Division and the DASMA Rolling Door Division. It incorporates years of experience in testing sectional garage doors and rolling doors commonly found in garage type structures. The committees and divisions believe the existence of the standard will provide a uniform basis of testing and rating the structural performance of such doors under missile impact and cyclic wind pressure.

The DASMA Rolling Door Division and the DASMA Commercial & Residential Garage Door Division concurrently approved revisions to the standard on April 21, 2006. DASMA employed the canvass method to demonstrate consensus and to gain approval as an American National Standard. The ANSI Board of Standards Review first granted approval of the document as an American National Standard on March 21, 2003, and granted approval of the most recent revisions to the standard on October 19, 2006.

DASMA recognizes the need to periodically review and update this standard. Suggestions for improvement should be forwarded to the Door & Access Systems Manufacturers' Association, International, 1300 Sumner Avenue, Cleveland, Ohio, 44115-2851.

ANSI/DASMA 115-2005

AMERICAN NATIONAL STANDARD

Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure

1.0 SCOPE

1.1 This test method determines the performance of sectional garage doors and rolling doors impacted by missiles and subsequently subjected to cyclic static pressure differentials.

1.2 The performance determined by this test method relates to the ability of the sectional garage door or rolling door to remain unbreached during a windstorm due to windborne debris.

1.3 Water exposure conditions shall not be a part of this standard.

1.4 The proper use of this test method requires a knowledge of the principles of pressure and deflection measurement.

1.5 This test method describes the apparatus and the procedure to be used for applying missile impact and cyclic static pressure loads to a specimen.

1.6 This test method does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

1.7 This test method incorporates applicable provisions from TAS 201, TAS 203, TDS 1-95, SSTD 12-97, ASTM E 1886-02, ASTM E 1996-03 and fatigue load testing referenced in the Florida Building Code, Building.

1.8 For products intended for installation in the Florida High Velocity Hurricane Zone (Miami-Dade and Broward Counties), the testing procedure in Appendix B and Appendix C shall be used.

2.0 DEFINITIONS

2.1 Air Pressure Cycle - beginning at zero air pressure differential, the application of positive (negative) pressure to achieve a specified air pressure differential and returning to zero pressure differential.

2.2 Air Pressure Differential - the specified differential in static air pressure across the specimen, creating a positive (negative) load, expressed in pounds per square foot (or pascals).

2.3 Basic Wind Speed - also known as design wind speed, the wind speed as determined by the specifying authority.

2.4 Design Pressure - also known as design load or design wind load, the specified difference in static air pressure (positive or negative) for which the specimen is to be tested, expressed in pounds per square foot (or pascals).

2.5 Full Operability – the ability for the door to be fully opened and closed.

2.6 Maximum Deflection – the maximum displacement of the specimen measured to the nearest 0.125 inch (3 mm) attained from the original position while the maximum test load is being applied.

2.7 Missile - the object that is propelled toward a test specimen.

2.8 Positive (Negative) Cyclic Test Load - the specified difference in static air pressure, creating an inward (outward) loading, for which the specimen is to be tested under repeated conditions, expressed in pounds per square foot (or pascals).

2.9 Recovery - The ratio of the differential measurement between the test specimen surface at rest (following cyclic test loading in one direction) and the maximum deflection measured (for such cyclic test loading), to the maximum deflection measured.

2.10 Section/Slat Joint - The section to section (slat to slat) interface defined by the longitudinal surfaces that move relative to each other as the door opens and closes.

2.11 Specifying Authority - the entity responsible for determining and furnishing information required to perform this test method.

2.12 Specimen Failure - deterioration under repeated load or incipient failure, as defined in the pass/fail criteria of this standard.

2.13 Test Chamber - an airtight enclosure of sufficient depth to allow unobstructed deflection of the specimen during pressure cycling, including ports for air supply and removal, and equipped with instruments to measure test pressure differentials.

2.14 Test Loading Program - the entire sequence of air pressure cycles to be applied to the test specimen.

2.15 Test Specimen - the complete installed door assembly and mounting hardware as specified on the submitted drawing.

2.16 Windborne Debris - objects carried by the wind in windstorms.

2.17 Windstorm - a weather event, such as a hurricane, with high sustained winds and turbulent gusts capable of generating windborne debris.

3.0 SUMMARY OF TEST METHODS

3.1 A test series shall consist of three identical test specimens.

3.2 Each test specimen shall be subjected to the large missile impact test and then to the cyclic pressure loading test.

3.3 A test specimen is considered to have passed the test if it satisfies the acceptance criteria of this standard.

4.0 TEST APARATUS

4.1 Test Chamber - See Section 2.12 for definition.

4.2 Air System - shall consist of a controllable blower, a compressed-air supply, an exhaust system, a reversible controllable blower, or other air-moving system capable of providing a variable pressure from zero to the required pressures, both positive and negative.

4.3 Large Missile - shall be a nominal 2x4 Southern Pine lumber, minimum Stud grade, with no knots within 12 inches (305 mm) of the impact end. The missile shall have a length of not less than 7 feet (2.13 m) and not more than 9 feet (2.75 m). The end of the missile subjected to impact shall be permitted to be rounded to no less than a 48 inch (1219 mm) diameter sphere, with sharp edges permitted to be rounded to no more than a 1/16 inch (2 mm) radius. The missile may be marked/ticked in dark ink at one inch (25 mm) intervals on center, and congruently numbered every three inches (76 mm). A sabot shall be attached to the trailing edge of the missile to facilitate launching. The weight of the sabot shall not exceed 0.5 lbs. (227 g). The combined weight of the timber and sabot, which constitutes the missile, shall be between 9 lbs. (4.08 kg) and 9.5 lbs. (4.31 kg). The missile shall be propelled through a cannon as described in section 4.4.

4.4 Large Missile Cannon - shall be capable of producing impact at the speed specified in Section 8.2. The missile cannon may use compressed air to propel the large missile, and if using compressed air shall consist of the following major components: a compressed air supply, a pressure release valve, a pressure gauge, a barrel and support frame, and a timing system for determining the missile speed. The barrel of the missile cannon shall consist of either a 4 inch (102 mm) inside diameter pipe or a nominal 2 inch (51 mm) by 4 inch (102 mm) rectangular tube, and shall be at least as long as the missile. The barrel of the large missile cannon shall be mounted on a support frame in a manner to facilitate aiming the large missile so that it impacts the test specimen at the desired location.

4.5 Timing System - shall be capable to measure speeds accurate to +/- 2%. One method shall be comprised of two, through-beam photoelectric sensors spaced at a known distance apart and used to start and stop an electronic clock, and shall be capable to measure speeds accurate to +/-2%. The speed of the missile shall be measured anywhere between the point where 100% of the missile is outside of the cannon, to the point where the missile is 1 ft. (300 mm) away from the test specimen. The missile speed shall not be measured while the missile is accelerating. The speed of the missile shall be determined by dividing the distance between the two through-beam photoelectric sensors by the total time interval counted by the electronic clock.

5.0 HAZARDS

5.1 If failure occurs during testing, hazardous conditions may result.

5.2 Take proper safety precautions to protect observers in the event that a failure occurs.

5.3 All observers shall be isolated from the path of the missile during the missile impact portion of the test.

5.4 Keep observers at a safe distance from the test specimen during the entire procedure.

6.0 TEST SPECIMENS

6.1 Three test specimens shall be supplied. Each test specimen shall be as per the manufacturer's detailed drawings and/or written instructions. For sectional garage doors, the horizontal track and hanging brackets may be shortened to fit the test chamber.

6.2 All parts of the test specimen, including glazing and structural framing, shall be full size.

6.3 The test specimen shall consist of the same materials, details, methods of construction and methods of attachment as proposed for actual use.

6.4 The specimen shall consist of the entire assembled unit attached to a given type of structural framing of the building, and shall contain all devices used to resist wind forces and windborne debris.

6.5 When testing sectional garage doors and rolling doors which include glazed products, the material used to make such glazed products windborne debris resistant (i.e. fillers, film and similar) shall be an integral part, factory applied, of such glazed products.

6.6 The door shall be either counterbalanced where no more than the larger of 5% of door weight or ten pounds applied force is required to open the door manually from the fully closed position, or a simulated counterbalance condition (including locking mechanism) shall be achieved by shimming up the bottom corners of the door.

7.0 CALIBRATION OF TIMING EQUIPMENT

7.1 The timing system shall be calibrated and certified by an independent approved qualified agency, at six-month intervals. See Appendix A for recommended methods.

7.2 The calibration report shall include the following:

7.2.1 The date of the calibration.

7.2.2 The name of the agency conducting the calibration.

7.2.3 The distance between the through-beam photoelectric sensors (if used).

7.2.4 The speed of the missile as measured by the timing system.

7.2.5 The speed of the missile as determined from the calibration system.

7.2.6 The percentage difference in speeds.

7.3 The system shall be determined to be accurate if the speed of the missile measured by the timing system and the speed measured by the calibration system agree within +/- 2%.

8.0 LARGE MISSILE IMPACT TEST

8.1 The test shall be conducted using a large missile cannon.

8.2 The large missile shall be as described in Section 4.3. The speed of the large missile shall be at least 50 ft/s (15.2 m/s). The speed of the large missile shall be measured as described in Section 4.5.

8.3 The large missile shall impact the surface of the test specimen "end on".

8.4 Impacts

8.4.1 For sectional garage doors, impacts shall be defined as follows:

8.4.1.1 Within a 5 inch (127 mm) radius circle having its center on a section joint at a hinge location nearest the midpoint of the test specimen.
8.4.1.2 Within a 5 inch (127 mm) radius circle having its center located in the thinnest section of the test specimen, equidistant between the lower two section joints and centered between vertical stiles.
8.4.1.3 Within a 5 inch (127 mm) radius circle having its center at a point 6 inches (152 mm) horizontally and vertically away from a bottom corner.

8.4.2 For rolling doors, impacts shall be defined as follows:
8.4.2.1 Within a 5 inch (127 mm) radius of the center of the door.
8.4.2.2 Within a 5 inch (127 mm) radius circle having its center at a point 6 inches (152 mm) horizontally and vertically away from a bottom corner.

8.5 Each specimen shall receive at least two (2) impacts from the large missile.

8.5.1 For sectional garage doors, the first specimen shall receive one impact complying with Section 8.4.1.1 and one impact complying with Section 8.4.1.3.

8.5.2 For sectional garage doors, the second specimen shall receive one impact complying with Section 8.4.1.2 and one impact complying with Section 8.4.1.3.

8.5.3 For sectional garage doors, the third specimen shall receive one impact complying with Section 8.4.1.1 and one impact complying with Section 8.4.1.2.

8.5.4 For rolling doors, each specimen shall receive impacts complying with Section 8.4.2.

8.6 For sectional garage doors and rolling doors that contain glazing, the glazing shall be impacted, in addition to the impact locations set forth in Section 8.5.

8.6.1 Glazing panels greater than or equal to 3 square feet (.28 sq m) in area shall receive two impacts. The first impact within a 5 inch (127 mm) radius circle having its center at a point 6 inches horizontally and vertically away from a corner of the glazing. The second impact within a 5 inch (127 mm) radius circle having its center at the midpoint of the glazing panel.

8.6.2 Glazing panels less than 3 square feet (.28 sq m) in area shall receive one impact located within a 5 inch (127 mm) radius circle having its center at the midpoint of the glazing panel.

8.6.3 For sectional garage doors and rolling doors that contain multiple panels of glazing, the innermost panel shall be impacted.

8.6.4 For sectional garage doors and rolling doors that contain different glazing thicknesses and/or glazing types, each different glazing thickness and glazing type shall be impacted.

9.0 TEST PROCEDURES - LARGE MISSILE IMPACT

9.1 Preparation

9.1.1 Remove from the test specimen any sealing or construction material that is not intended to be used when the unit is installed in or on a building. Support and secure the test specimen into the mounting frame in a vertical position using the same number and type of anchors normally used for product installation as defined by the manufacturer or as required for a specific project. If this is impractical, install the test specimen with the same number of equivalent fasteners located in the same manner as the intended installation. The test specimen shall not be removed from the mounting frame at any time during the test sequence. The test shall be recorded using video equipment.

9.1.2 Secure the test specimen mounting frame such that the large missile will impact the exterior side of the test specimen as installed.

9.1.3 Locate the end of the propulsion device from which the large missile will exit at a minimum distance from the specimen equal to 9 feet (2.74 m) plus the length of the large missile.

9.1.4 Weigh each large missile within four hours prior to each impact.

9.1.5 Align the large missile propulsion device such that the large missile will impact the test specimen at the specified location.

9.2 Large Missile Impact.
9.2.1 Propel the large missile at the specified impact speed and location.

9.2.2 Examine damage in light of the pass/fail criteria found in Section 9.3.

9.2.3 Repeat steps 9.2.1 through 9.2.2 at all additional impact locations specified for the test specimen.

9.3 Pass/Fail Criteria.

9.3.1 The test specimen shall be subjected to evaluation for operability, and shall be acceptable by the following:

9.3.1.1 The door system shall remain in the opening throughout the duration of the test.

9.3.1.2 The door shall be evaluated for full operability at the conclusion of the test. The door shall pass only if the test engineer deems that the door system has full operability.

9.3.2 Latches, locks and fasteners shall not become disengaged during the testing.

9.3.3 Excluding section/slat joints, no crack shall form longer than 5 inches (127 mm) and wider than 1/16 inch (1.6 mm) through which air can pass.

9.3.4 No opening shall form through which a 3 inch (76 mm) diameter sphere can pass.

9.3.5 All three test specimens shall be required to pass this testing.

9.4 Post Impact Test Procedure.

9.4.1 If the test specimen passes the acceptance criteria of the large missile impact test, it shall then be subjected to the cyclic pressure loading test specified in Section 10.

10.0 CYCLIC WIND PRESSURE LOADING TEST

10.1 General.

10.1.1 This test shall apply to sectional garage doors and rolling doors that have passed the acceptance criteria of the large missile impact test.

10.1.2 The test specimens tested for impact shall be used for the cyclic pressure loading test.

10.1.3 If air leakage through the test specimen is excessive, tape may be used to cover any joints through which air leakage is occurring.

10.1.4 Cracks due to impact testing shall not be restrained with tape.

10.1.5 Tape shall not be used when there is a probability that it may significantly restrict differential movement between adjoining members.

10.1.6 Both sides of the entire test specimen and mounting panel shall be permitted to be covered with a single thickness of polyethylene film no thicker than 2 mils (.050 mm), in order that the full load is transferred to the test specimen and that the membrane does not prevent movement or failure of the specimen. The film shall be applied loosely with extra folds of material at each corner and at all offsets and recesses. When the load is applied, there shall be no fillet caused by tightness of the plastic film.

10.2 Loading Sequence Alternatives.

10.2.1 Loading Sequence 1 shall be as follows:

#1:	Range of Test: 0 to +0.5p	Cycles: 600
#2:	Range of Test: 0 to +0.6p	Cycles: 70
#3:	Range of Test: 0 to +1.3p	Cycles: 1
#4:	Range of Test: 0 to -0.5p	Cycles: 600
#5:	Range of Test: 0 to -0.6p	Cycles: 70
#6:	Range of Test: 0 to -1.3p	Cycles: 1

10.2.2 Loading Sequence 2 shall be as follows:

#1:	Range of Test: +0.2p to +0.5p	Cycles: 3500
#2:	Range of Test: 0 to +0.6p	Cycles: 300
#3:	Range of Test: +0.5p to +0.8p	Cycles: 600
#4:	Range of Test: +0.3p to +1.0p	Cycles: 100
#5:	Range of Test: -0.3p to -1.0p	Cycles: 50
#6:	Range of Test: -0.5p to -0.8p	Cycles: 1050
#7:	Range of Test: 0 to -0.6p	Cycles: 50
#8:	Range of Test: -0.2p to -0.5p	Cycles: 3350

10.2.3 The parameter “p” shall be defined as sectional garage door or rolling door design wind load pressure, based on where the assembly will be used.

10.3Test Procedure.

10.3.1 For non-glazed sectional garage doors and non-glazed rolling doors, cyclic static pressure differential loading shall be applied in accordance with either Loading Sequence 1 or Loading Sequence 2 as described in Section 10.2.

10.3.2 For glazed sectional garage doors and glazed rolling doors, cyclic static pressure differential loading shall be applied in accordance with either Loading Sequence 1 or Loading Sequence 2 as described in Section 10.2.

10.3.3 Each cycle shall have duration not to exceed 20 seconds, where the cycles shall be applied as rapidly as possible and shall be performed in a continuous manner.

10.3.4 Interruptions for equipment maintenance and repair shall be permitted.

10.3.5 The test specimen shall not contact any portion of the test chamber at any time during the application of the cyclic static pressure differential loading.

10.3.6 Successful testing of a door assembly containing glazing shall qualify a door assembly of the same type that does not contain glazing.

10.4Pass/Fail Criteria.

10.4.1 The test specimen shall be subjected to evaluation for operability, and shall be acceptable by the following:

10.4.1.1 The door system shall remain in the opening throughout the duration of the test.

10.4.1.2 The door system shall be evaluated for full operability at the conclusion of the test. The door shall pass only if the test engineer deems that the door system has full operability.

10.4.2 Latches, locks and fasteners shall not become disengaged during the testing.

10.4.3 Excluding section/slat joints, no crack shall form longer than 5 inches (127 mm) and wider than 1/16 inch (1.6 mm) through which air can pass.

10.4.4 No opening shall form through which a 3 inch (76 mm) diameter sphere can pass.

10.4.5 All three test specimens shall be required to pass this testing.

11.0**TEST REPORTS**

11.1Date of the test.

11.2Date of the report.

11.3 A description of the test specimens, prior to impact and cyclic pressure loading, including all parts and components of a particular system of construction together with manufacturer's model number, if appropriate, or any other identification.

11.4 Detailed drawings of the test specimens, showing dimensioned section profiles, door dimensions and arrangement, framing location, weatherstripping, locking arrangements, hardware, sealants, glazing details, test specimen sealing methods, and any other pertinent construction details.

11.5 Proper identification of each test specimen, particularly with respect to distinguishing features or differing adjustments. A separate drawing for each test specimen shall not be required where all differences between them are noted on the drawings provided.

11.6Design pressure used as the basis for testing.

11.7Information on the large missile Appendix used:

11.7.1 Description of the missile, including dimensions and weight.

11.7.2 Missile speed measured.

11.7.3 Whether or not certification of the calibration equipment was required.

11.7.4 Missile orientation at impact.

11.7.5 Description of the location of each impact.

11.8Information on the cyclic loading Appendix used:

11.8.1 The positive and negative cyclic test load sequence.

11.8.2 The number of cycles applied for each sequence.

11.8.3 The minimum and maximum duration for each cycle.

11.9A description of the condition of the test specimens after testing, including details of any damage and any other pertinent observations.

11.10 When the tests are made to check conformity of the specimen to a particular specification, an identification or description of that specification.

11.11 A statement that the tests were conducted in accordance with the test method.

11.12 A statement of whether or not, upon completion of all testing, the test specimens meet the pass/fail criteria of this standard for both missile impact and cyclic loading.

11.13 A statement as to whether or not tape or film, or both, were used to seal against air leakage, and whether in the judgment of the test engineer, the tape or film influenced the results of the test. The name and author of the report.

11.14 The names and addresses of both the testing agency that conducted the tests and the requester of the tests.

11.15 Signatures of persons responsible for supervision of the tests and a list of official observers.

11.16 Any additional data or information considered to be useful to a better understanding of the test results, conclusions, or recommendations. This additional data/ information shall be appended to the report.

REFERENCED DOCUMENTS:

1. Protocol TAS 201, Impact Test Procedures, Miami-Dade County Building Code Compliance Office
2. Protocol TAS 203, Criteria For Testing Products Subject To Cyclic Wind Pressure Loading, Miami-Dade County Building Code Compliance Office
3. Standard TDI 1-95, Test For Impact and Cyclic Wind Pressure Resistance of Impact Protective Systems and Exterior Opening Systems, Texas Department of Insurance
4. Test Standard for Determining Impact Resistance From Windborne Debris, SSTD 12-97, Southern Building Code Congress International
5. ASTM E 1886-02, Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Storm Shutters Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
6. ASTM E 1996-04, Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Storm Shutters Impacted by Windborne Debris in Hurricanes
7. Fatigue Loading Testing, Section 1625.4, 2004 Florida Building Code, Building

ANSI/DASMA 115 Test Report Form
Missile Impact and Cyclic Loading

Date of Test ______________ Date of Report __________________

Test Specimen Identification:
Manufacturer
____
Manufacturer Location ____
Model Type/Number ______________ Dimensions ______________________
Material Description ____
Test Specimen Selection Procedure __________________________________
____
____
Applicable Drawing No.'s ____
____

Operating Hardware (Type, Quantity, Location(s)):
____
____
____

Glazing Description: ____

Ambient Temperature: __________

Design pressure used as the basis for testing: __________

Large Missile Information:

Missile Dimensions ______________ Missile Weight _________
Missile speed measured _____________
Certification of the calibration equipment required? Yes No
Missile orientation at impact _______________

Impact #1 Location ____
Maximum Crack Length __________ Maximum Crack Width __________
Maximum Diameter Sphere Penetrating the Impact Location __________
Impact #2 Location ____
Maximum Crack Length __________ Maximum Crack Width __________
Maximum Diameter Sphere Penetrating the Impact Location __________
Impact #3 Location ____
Maximum Crack Length __________ Maximum Crack Width __________
Maximum Diameter Sphere Penetrating the Impact Location __________
Glazing Impact Location (if applicable) ____________________________
Maximum Diameter Sphere Penetrating the Impact Location __________
Test Result: Pass Fail

Notes:
____
____
____

ANSI/DASMA 115 Test Report Form

Missile Impact and Cyclic Loading

Cyclic Loading Information:

# Applied Pressure	# Cycles	Min. Duration (sec)	Max. Duration (sec)

Maximum Diameter Sphere Penetrating the Test Specimen _______________

Maximum Length of Crack Formed in Test Specimen ______ Crack Width ______

Test Result: Pass Fail

Notes:

____

____

____

____

Garage/Rolling Door Operable, after Evaluation for Full Operability? (Yes/No) ______

Certification: The signature of the tester attests that the testing was conducted in accordance with the referenced standard.

Testing Conducted by

____**of**______________________________

Signature of Tester ______________________________________ **Date** ____________________________

Test Facility and Location ____

Official Observers

____

____

Appendix A

The following appendix is informative only and is not a normative part of ANSI/DASMA 115.

Recommended Methods of Calibrating Timing Equipment

A.1 Photographically, using a stroboscope.

A.2 Photographically, using a high speed camera with a frame rate exceeding 500 frames per second.

A.3 Photographically, using a high speed video camera with a frame rate exceeding 500 frames per second.

A.4 Any other certified timing system calibration device with an accuracy of +/- 1%.

Appendix B

Impact Testing Procedure for the Florida High Velocity Hurricane Zone

1. Scope

1.1 This Appendix covers procedures for conducting the impact test of sectional garage doors and rolling doors as required by Section 1626 of the Florida Building Code, Building.

2. Referenced Documents

2.1 2004 Florida Building Code, Building

3. Terminology

3.1 *Definitions* – For definitions of terms used in this Appendix, refer to Sections 1625, 1626 and/or Chapter 2 of the Florida Building Code, Building.

3.2 *Description of Terms Specific to This Appendix*

3.2.1 *Specimen* – The entire assembled unit submitted for test, including but not limited to anchorage devices and structure to which product is to be mounted.

3.2.2 *Test Chamber* – An airtight enclosure of sufficient depth to allow unobstructed deflection of the specimen during pressure cycling, including ports for air supply and removal, and equipped with instruments to measure test pressure differentials.

3.2.3 *Maximum Deflection* – The maximum displacement of the specimen, measured to the nearest 1/8" (3 mm), attained from the original position while the maximum test load is being applied.

3.2.4 *Permanent Deformation* – The permanent displacement of the specimen, measured to the nearest 1/8 inch (3 mm), from the original position to final position that remains after maximum test load has been removed.

3.2.5 *Test Load* – As determined by Sections 1606, 1625 and 1626 of the Florida Building Code, Building.

3.2.6 *Specimen Failure* – A change in condition of the specimen indicative of deterioration under repeated load or incipient failure, such as cracking, fastener loosening, local yielding, or loss of adhesive bond.

4. Significance and Use

4.1 The test procedures outlined in this Appendix provide a means of determining whether a sectional garage door or rolling door provides sufficient resistance to windborne debris, as stated in Section 1626 of the Florida Building Code, Building.

5. Test Specimen

5.1 *Test specimen* – All parts of the test specimen shall be full size, using the same materials, details, methods of construction and methods of attachment as proposed for actual use. The specimen shall consist of the entire assembled unit attached to a given type of structural framing of the building, and shall contain all devices used to resist wind forces and windborne debris. When testing glazed products, the material used to make such glazed product windborne debris resistant (i.e. fillers, film and similar), shall be an integral part, factory applied, of such glazed product.

A pressure treated nominal 2 x 4 - #3 Southern Pine wood buck shall be used for attachment of the specimen to the test frame/stand/chamber. Such wood buck shall become part of the approval.

5.1.1 Locking mechanisms shall be permanently mounted on the specimen. Such locking mechanism shall require no tools to be latched in the locked position. Devices such as pins shall be permanently secured to the specimen through the use of chains or wires that shall be of corrosion resistant material. This section shall not apply to specimens referenced in Section 2413 of the Florida Building Code, Building.

5.1.2 Products that are not categorized as means of egress/escape, and are provided with more than one single action locking mechanism, shall be provided with permanently posted instructions on latching for high wind pressures.

5.1.3 Specimen and fasteners, when used, shall not become disengaged during test procedure.

6. Apparatus

6.1 The description of the apparatus is general in nature. Any equipment, properly certified, calibrated, and approved by the Authority Having Jurisdiction capable of performing this test within the allowable tolerance, shall be permitted.

6.2 *Major Components*

6.2.1 *Cyclic Wind Pressure Loading* – Number of cycles and amount of pressure shall be as indicated in Section 1625.4, Table 1625 and Table 1626 of the Florida Building Code, Building. Design wind pressure shall be determined by using Section 1609 of the Florida Building Code, Building.

6.2.1.1 *Test Chamber* – The test chamber, to which the specimen is mounted, shall be provided with pressure taps to measure the pressure difference across the test specimen and shall be so located that the reading is unaffected by the velocity of air supplied to or from the chamber. The specimen mounting frame shall not deflect under test load in such manner that the performance of the specimen will be affected.

6.2.1.2 *Air System* – A controllable blower, a compressed-air supply, an exhaust system, or reversible controllable blower designed to provide the required maximum air pressure difference across the specimen. The system shall provide an essentially constant air-pressure difference for the required test period.

6.3 *Missile Impact*

6.3.1 *Timing System* – The timing system, which is comprised of two, through-beam photoelectric sensors spaced at a known distance apart and used to start and stop an electronic clock, shall be capable to measure speeds accurate to +/- 2%. The speed of the missile shall be measured anywhere between the point where 90% of the missile is outside of the cannon, to the point where the missile is 1 ft. (305 mm) away from the test specimen. The missile speed shall not be measured while the missile is accelerating. The through-beam photoelectric sensors shall be of the same model.

The electronic clock shall be activated when the reference point of the missile passes through the timing system. The electronic clock shall have an operating frequency of no less than 10 kHz with a response time not to exceed 0.15 milliseconds. The speed of the missile shall be determined by dividing the distance between the two through-beam photoelectric sensors by the total time interval counted by the electronic clock.

6.3.1.1 *Calibration of Timing Equipment* – The timing system shall be calibrated and certified by an independent qualified agency approved by the Authority Having Jurisdiction, at six-month intervals using one of the following methods:

1. Photographically, using a stroboscope,
2. Photographically, using a high speed camera with a frame rate exceeding 500 frames per second,
3. Photographically, using a high speed video camera with a frame rate exceeding 500 frames per second, or
4. Any other certified timing system calibration device used by an independent certified agency approved by this office.

The calibration report shall include the date of the calibration, the name of the agency conducting the calibration, the distance between the through-beam photoelectric sensors (if used), the speed of the missile as determined from the calibration system, and the percentage difference in speeds. The system shall be determined to be accurate if the speed of the missile measured by the timing system and the speed measured by the calibration system agree within 2%.

6.3.2.1 *Large Missile* – The large missile shall be a solid S4S nominal 2x4 #2 surface dry Southern Pine. The weight of the missile shall be as specified in Section 1626.2.3 of the Florida Building Code, Building and shall have a length of not less than 7 feet (2.14 m) and not more than 9 feet (2.75 m). The missile shall be marked/ticked in dark ink at one-inch intervals on center, and congruently numbered every three inches. A sabot shall be attached to the trailing edge of the missile to facilitate launching. The weight of the sabot shall not exceed 1/2 lb (.228 kg). The combined weight of the timber and sabot, which constitutes the missile, shall be between 9 lb. (4.1 kg) and 9.5 lb (4.23 kg). The missile shall be propelled through a cannon as described in section 6.3.3 of this Appendix.

6.3.2.2 When testing any specimen with more than one component, in addition to complying with the impacts required by Section 1626.2 of the Florida Building Code, Building, the framing member connecting these components shall be impacted at one-half the span of such member with the large missile at a speed indicated in Section 1626.2.4 of the Florida Building Code, Building.

6.3.2.3 Any specimen that passes the large missile impact test shall not be tested for the small missile impact test if the specimen has no opening through which a 3/16 inch (5 mm) sphere can pass.

6.3.3 *Large Missile Cannon* – The large missile cannon shall be compressed air to propel the large missile. The cannon shall be capable of producing impact at the speed specified in Section 1626.2.4 of the Florida Building Code, Building. The missile cannon shall consist of four major components: a compressed air supply, a pressure release valve, a pressure gauge, a barrel and support frame, and a timing system for determining the missile speed. The barrel of the missile cannon shall consist of a 4-inch (102 mm) inside diameter pipe and shall be at least as long as the missile. The barrel of the large missile cannon shall be mounted on a support frame in a manner to facilitate aiming the missile so that it impacts the specimen at the desired location. The distance from the end of the cannon to the specimen shall be 9 feet (2.75 m) plus the length of the missile.

6.3.4 *Small Missile* –The missiles shall be propelled by the cannon as described in Section 6.3.5 of this Appendix. The small missile shall be launched in such a manner that each specimen shall be impacted simultaneously over an area not to exceed two square feet per impact as described in Section 1626.3.5 of the Florida Building Code, Building.

6.3.5 *Small Missile Cannon* – A compressed air cannon shall be used that is capable of propelling missiles of the size and speed defined in Section 1626.3.3 and 1626.3.4 of the Florida Building Code, Building. The cannon assembly shall be comprised of a compressed air supply and gauge, a remote firing device and valve, a barrel, and a timing system. The small missile cannon shall be mounted to prevent movement of the cannon so that it can propel missiles to impact the test specimen at points defined in Section 1626.3.5 of the Florida Building Code, Building. The timing system shall be positioned to measure missile speed within 5 feet (1.53 m) of the impact point on the test specimen.

7. Hazards

7.1 Testing facilities shall take all necessary precautions to protect observers during the entire test procedure. All observers shall be at a safe distance away from specimen and apparatus. Safety regulations shall be followed in order to avoid any injuries to any and all observers.

8. Testing Facilities

8.1 Any testing facility wishing to perform this test shall first obtain the approval of the Authority Having Jurisdiction. Such approval shall only be given to those facilities that show they are properly equipped to perform the complete test, including the cyclic loading and the small and large missile impact test. Testing facilities shall request, in writing, approval of their facilities. Such request shall contain the ability of the facility to perform all aspects of the test, all equipment used in the performance of the test, name of independent agency calibrating their equipment, location of facilities, personnel involved in the testing, a quality control program, a safety program and any other pertinent information which shall clearly indicate that such facility is in the business of performing independent testing. A representative of the Authority Having Jurisdiction shall visit the site, and shall reserve the right to order any changes necessary to accept the facility for testing.

8.2 Approval of facilities to perform the test described in this Appendix does not constitute an approval of such facilities to perform other tests not specifically mentioned in this Appendix.

8.3 The testing lab shall be TAS301 certified.

9. Format of Test

The manufacturer shall notify the Authority Having Jurisdiction seven (7) working days prior to the performing of the test. The Authority Having Jurisdiction reserves the right to observe the test. The Authority Having Jurisdiction must be notified of the place and time the test will take place. The test must be recorded on video and retained by the laboratory per TAS301.

10. Test Reports

The following minimum information shall be included in the submitted report:

10.1 Date of the test and the report, and report number.

10.2 Name, location, and certification number of facilities performing the test.

10.3 Name and address of requester of the test.

10.4 Identification of the specimen (manufacturer, source of supply, dimension, model types, material, procedure of selection and any other pertinent information).

10.5 Detailed drawings of the specimen showing dimensioned section profiles, type of framing to which specimen was attached, panel arrangement, installation and spacing of anchorage, locking arrangement, sealants, hardware, product markings and their location, and any other pertinent construction details. Any deviation from the drawings or any modifications made to the specimen to obtain the reported values shall be noted on the drawings and in the report.

10.6 Maximum deflection recorded and mechanism used to make such determination.

10.7 Permanent deformation (a cross-sectional diagram shall be provided to show where it occurred).

10.8 Name, address, signature and seal of Florida professional engineer, witnessing the test and preparing the report. Engineer shall be part of the laboratory's permanent staff or under laboratory's contract.

10.9 The results for all three specimens shall be reported, each specimen being properly identified, particularly with respect to distinguishing features or differing adjustments. A separate drawing for each specimen shall not be required if all differences between them are noted on the drawings provided.

10.10 Location of impacts on each test specimen.

10.11 The large and small missile velocities.

10.12 The weight of the missiles.

10.13 Maximum positive and negative pressures used in the cyclic wind pressure loading.

10.14 A description of the condition of the test specimens after testing, including details of any damage and any other pertinent observations.

10.15 When the tests are made to check conformity of the specimen to a particular specification, an identification or description of that specification.

10.16 A statement that the tests were conducted in accordance with this test method.

10.17 A statement of whether or not, upon completion of all testing, the specimens meet the requirements of Section 1626 of the Florida Building Code, Building.

10.18 A statement as to whether or not tape or film, or both were used to seal against air leakage, and whether in the judgment of the test engineer, the tape or film influenced the results of the test.

10.19 Signatures of persons responsible for supervision of the tests, and a list of official observers.

10.20 All data not required herein, but useful to a better understanding of the test results, conclusions or recommendations, may be appended to the report.

11. Recording Deflections

Maximum Deflection

Permanent Deformation

12. Additional Testing

12.1 Following successful completion of this test, all specimens shall then be successfully tested as per Appendix C of this standard.

12.2 If a product is subjected to weathering that can affect its integrity, the manufacturer shall contact the Authority Having Jurisdiction for additional testing requirements such as but not limited to moisture, U.V., accelerated aging, and other similar tests.

12.3 The Authority Having Jurisdiction shall reserve the right to require any additional testing necessary to assure full compliance with the intent of the Florida Building Code, Building.

12.4 Products tested in accordance with this Appendix shall be required to be successfully tested under Appendix A of ANSI/DASMA 108 prior to conducting tests under this Appendix.

13. Product Marketing

13.1 Any and all approved products shall be permanently labeled with the manufacturer's name, city, and state, and the following statement: "Product Control Approved."

13.2 Permanently labeled shall be a metallic label fixed permanently to the frame of the specimen by rivets or permanent adhesive.

13.3 Any instructions for operations shall be permanently mounted on the specimen in an area not subject to be painted or concealed.

Appendix C

Cyclic Wind Pressure Testing Procedure for the Florida High Velocity Hurricane Zone

1. Scope

1.1 This Appendix covers procedures for conducting the cyclic wind pressure loading test required by the Florida Building Code, Building and Appendix B of this standard.

2. Referenced Documents

2.1 2004 Florida Building Code, Building.

3. Terminology

3.1 *Definitions* – For definitions of terms used in this Appendix, refer to the Florida Building Code, Building.

3.2 *Description of Terms Specific to This Appendix*

3.3 *Specimen* – The entire assembled unit submitted for test, including anchorage devices and structure to which product is to be mounted.

3.4 *Positive (negative) Cyclic Load* – The specified differential in static air pressure, creating an inward (outward) loading, for which the specimen is to be tested under repeated conditions, expressed in pounds per square foot.

3.5 *One cycle* – Beginning at the specified static air pressure, the application of positive cyclic test load, and returning to the specified static air pressure, followed by the application of negative cyclic test load.

3.6 *Design Pressure (Design Wind Load)* – The uniform static air pressure difference, inward or outward and expressed in pounds per square foot (Newtons per square meter), for which the specimen would be designed under service load conditions using Section 1606 of the Florida Building Code, Building.

3.7 *Test Chamber* – An airtight enclosure of sufficient depth to allow unobstructed deflection of the specimen during pressure cycling, including ports for air supply and removal, and equipped with a device to measure test pressure differentials.

3.8 *Maximum Deflection* – The maximum displacement, measured to the nearest 1/8 inch (3 mm), attained from an original position while the maximum load is being applied.

3.9 *Permanent Deformation* – The permanent displacement, measured to the nearest 1/8 inch (3 mm), from an original position that remains after the applied test load has been removed.

3.10 *Specimen Failure* – A change in condition of the specimen indicative of deterioration under repeated load or incipient failure, such as cracking, fastener loosening, local yielding, or loss of adhesive bond.

4. Significance and Use

4.1 This test method is a standard procedure for determining compliance with Section 1625, Table 1625.4 and Table 1626 of the Florida Building Code, Building. This test method shall be intended to be used for installations of sectional garage doors and rolling doors. This test method shall consist of supplying air to and exhausting air from the chamber in accordance with a specific test loading program at the rate required to maintain the test pressure differential across the specimen, and observing, measuring, and recording the deflection, deformations, and nature of any distress or failures of the specimen.

5. Test Specimen

5.1 *Test specimen* – All parts of the test specimen shall be full size, using the same materials, details, methods of construction and methods of attachment as proposed for actual use. The specimen shall consist of the entire assembled unit attached to a given type of structural framing of the building, and shall contain all devices used to resist wind forces and windborne debris. When testing glazed products, the material used to make such glazed product windborne debris resistant (i.e. fillers, film and similar) shall be an integral part, factory applied, of such glazed product.

A pressure treated nominal 2 x 4 - #3 Southern Pine wood buck shall be used for attachment of the specimen to the test frame/stand/chamber. Such wood buck shall become part of the approval.

5.1.1 Locking mechanisms shall be permanently mounted on the specimen. Such locking mechanism shall require no tools to be latched in the locked position. Devices such as pins shall be permanently secured to the specimen through the use of chains or wires which shall be of corrosion resistant material. This section shall not apply to shutters.

5.1.2 Products that are not categorized as means of egress/escape, and are provided with more than one single action locking mechanism, shall be provided with permanently posted instructions on latching for high wind pressures.

5.1.3 Specimen and fasteners, when used, shall not become disengaged during test procedure.

5.2 If the impact test is to be performed on the test specimen, such test shall be conducted prior to performing the test described in this Appendix.

5.3 All locking mechanisms shall be in place when performing this test.

5.4 Doors shall be evaluated for operability after this test.

6. Procedure

6.1 *Preparation* – Remove from the test specimen any sealing or construction material that is not normally used when installed in or on a building. Fit the specimen with its structural framing into or against the chamber opening. The outdoor side of the specimen shall face the higher pressure side for positive loads; the indoor side shall face the higher pressure side for negative loads. Support and secure the specimen by the same number and type of anchors to be approved for normal installation of the specimen in the building.

6.2 Support and secure the test specimen by the same number and type of anchors normally used in installing the unit in the building.

6.3 Load the specimen using the cycles specified in Table 1625.4 and/or Table 1626 of the Florida Building Code, Building, whichever of these apply.

6.4 In the case of Table 1625.4 of the Florida Building Code, Building, Section 6.3 of this Appendix shall be repeated for negative pressures.

6.5 Assemblies shall be tested with no resultant failure or distress, and shall have a recovery of at least 90% over maximum deflection.

7. Apparatus

7.1 The description of the apparatus is general in nature. Any equipment, properly certified, calibrated, and approved by the Authority Having Jurisdiction capable of performing this test within the allowable tolerance shall be permitted.

7.2 *Major Components*

7.2.1 *Test Chamber* – The test chamber, to which the specimen is mounted, shall be provided with pressure tabs to measure the pressure difference across the test specimen and shall be so located that the reading is unaffected by the velocity of air supplied to or from the chamber. The specimen mounting frame shall not deflect under test load in such manner that the performance of the specimen will be affected.

7.2.2 *Pressure-Measuring Apparatus* – The pressure-measuring apparatus shall measure the test pressure difference within a tolerance of +/-2%

7.2.3 *Deflection-Measuring System* – The deflection-measuring system shall measure the deflection within a tolerance of 0.01 inch (0.25 mm).

7.2.4 *Air System* – A controllable blower, a compressed-air supply, an exhaust system, or reversible controllable blower designed to provide the required maximum air pressure difference across the specimen. The system shall provide an essentially cyclic static air-pressure difference for the required test period.

7.3 *Calibration of Equipment* – The pressure-measuring apparatus and the deflection-measuring system shall be calibrated and certified by an independent qualified agency approved by the Authority Having Jurisdiction, at two-year intervals.

7.3.1 The calibration report shall include the date of the calibration, the name of the agency conducting the calibration, methods and equipment used in the calibration process, the equipment being calibrated and any pertinent comments.

8. Hazards

8.1 Testing facilities shall take all necessary precautions to protect the observers during the entire test procedure. All observers shall always be at a safe distance away from specimen and apparatus. Safety regulations shall be followed in order to avoid any injuries to any and all observers.

9. Testing Facilities

9.1 Any testing facility wishing to perform testing on such products shall first obtain the approval of the Authority Having Jurisdiction. Such approval shall only be given to those facilities that show they are properly equipped to perform the complete test. Testing facilities shall request, in writing, approval of their facilities. Such request shall contain the ability of the facility to perform all aspects of the test, all equipment used in the performance of the test, name of independent agency calibrating their equipment, location of facilities, personnel involved in the testing, a quality control program, a safety program and any other pertinent information which shall clearly indicated that such facility is in the business of performing independent testing. A representative of the Authority Having Jurisdiction shall visit the site, and shall reserve the right to order any changes necessary to accept the facility for testing.

9.2 Approval of facilities to perform the test described in this Appendix shall not constitute an approval of such facilities to perform other tests not specifically mentioned in this Appendix.

9.3 The testing lab shall be TAS301 certified.

10. Format of Test

The manufacturer shall notify the Authority Having Jurisdiction seven (7) working days prior to the performing of the test. The Authority Having Jurisdiction reserves the right to observe the test. The Authority Having Jurisdiction must be notified of the place and time the test will take place. The test must be recorded on video and retained by the laboratory per TAS301.

11. Test Reports

The following minimum information shall be included in the submitted report:

11.1 Date of the test and the report, and report number.

11.2 Name and location of facilities performing the test.

11.3 Name and address of requester of the test.

11.4 Identification of the specimen (manufacturer, source of supply, dimension, model types, material, procedure of selection and any other pertinent information).

11.5 Detailed drawings of the specimen showing dimensioned section profiles, type of framing to which specimen was attached, panel arrangement, installation and spacing of anchorage, locking arrangement, sealant, hardware, product markings and their location, and any other pertinent construction details. Any deviation from the drawings or any modifications made to the specimen to obtain the reported values shall be noted on the drawings and in the report.

11.6 Maximum deflection recorded, and mechanism used to make such determination.

11.7 Permanent deformation (a cross-sectional diagram shall be provided to show where it occurred).

11.8 Name, address, signature and seal of Florida professional engineer, witnessing the test and preparing the report. Engineer shall be part of the laboratory's permanent staff or under laboratory's contract.

11.9 A tabulation of pressure differences exerted across the specimen during the test and their duration.

11.10 Maximum positive and negative pressures used in the test.

11.11 A description of the condition of the test specimens after testing, including details of any damage and any other pertinent observations.

11.12 When the tests are made to check conformity of the specimen to a particular specification, an identification or description of that specification.

11.13 A statement that the tests were conducted in accordance with this test method.

11.14 A statement of whether or not, upon completion of all testing, the specimens meet the requirements of Section 1609 of the Florida Building Code, Building and this Appendix.

11.15 A statement as to whether or not tape or film or both were used to seal against air leakage, and whether in the judgment of the test engineer, the tape of film influenced the results of the test.

11.16 Signatures of persons responsible for supervision of the tests and a list of official observers.

11.17 All data not required herein, but useful to a better understanding of the test results, conclusions or recommendations, may be appended to the report.

12. Recording Deflections

Maximum Deflection

Permanent Deformation

13. Additional Testing

13.1 Prior to conducting the test described in this Appendix, all specimens shall have successfully completed the test specified in Appendix B.

13.2 If a product is subjected to weathering that can affect its integrity, the manufacturer shall contact the Authority Having Jurisdiction for additional testing requirements such as but not limited to moisture, U.V., accelerated aging, and other similar tests.

13.3 The Authority Having Jurisdiction shall reserve the right to require any additional testing necessary to assure full compliance with the intent of the Florida Building Code, Building.

13.4 Products tested in accordance with this Appendix shall be required to be successfully tested under Appendix A of ANSI/DASMA 108 prior to conducting tests under this Appendix.

14. Product Marking

14.1 Any and all approved products shall be permanently labeled with the manufacturer's name, city, and state, and the following statement: "Product Control Approved."

14.2 Permanent label shall be a metallic label fixed permanently to the frame of the specimen by rivets or permanent adhesive.

14.3 Any instructions for operations shall be permanently mounted on the specimen in an area not subject to be painted or concealed.

Door & Access Systems
Manufacturers Association
International

DASMA – the Door & Access Systems Manufacturers Association, International – is North America's leading trade association of manufacturers of garage doors, rolling doors, garage door operators, vehicular gate operators, and access control products. With Association headquarters based in Cleveland, Ohio, our 90 member companies manufacture products sold in virtually every county in America, in every U.S. state, every Canadian province, and in more than 50 countries worldwide. DASMA members' products represent more than 95% of the U.S. market for our industry.

For more information about the Door & Access Systems Manufacturers Association, International, contact:

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STANDARD METHOD FOR TESTING SECTIONAL DOORS, ROLLING DOORS, AND FLEXIBLE DOORS: DETERMINATION OF STRUCTURAL PERFORMANCE UNDER MISSILE IMPACT AND CYCLIC WIND PRESSURE

DASMA 115-2017

Door & Access Systems Manufacturers' Association, International

Sponsor:

DASMA
Door & Access Systems Manufacturers Association International

1300 Sumner Ave
Cleveland, Ohio 44115-2851

Standard Method for Testing Sectional Doors, Rolling Doors, and Flexible Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure

Sponsor

Door & Access Systems Manufacturers' Association, International

American National Standard

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Suggestions for improvement of this standard are welcome.
They should be sent to the Door & Access Systems Manufacturers' Association, International.

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Foreword (This foreword is included for information only and is not part of DASMA 115, *Standard Method for Testing Sectional Doors, Rolling Doors, and Flexible Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure.*)

This standard was developed by the DASMA Rolling Door Division, the DASMA High Performance Door Division, and the Technical Committee of the DASMA Commercial & Residential Garage Door Division. It incorporates years of experience in testing sectional doors commonly found in garages. The committee and division believe the existence of the standard will provide a uniform basis of testing and rating the structural performance of such doors under missile impact and cyclic wind pressure.

The DASMA Commercial & Residential Garage Door Division originally approved the standard as a DASMA standard on July 7, 1999. DASMA employed the canvass method to demonstrate consensus and to gain approval as an American National Standard. The ANSI Board of Standards Review granted approval as an American National Standard on March 21, 2005. The document was reviewed and revised to expand the scope to include rolling doors and flexible doors in 2010. The revised standard was finalized by the DASMA Commercial & Residential Garage Door, DASMA Rolling Door, and DASMA High Performance Door Divisions in 2012 and the ANSI Board of Standards Review granted recognition of the revised standard as an American National Standard on November 18, 2014. The Divisions approved revisions on October 30, 2015. The ANSI Board of Standards Review reaffirmed approval as an American National Standard on November 21, 2017.

DASMA recognizes the need to periodically review and update this standard. Suggestions for improvement should be forwarded to the Door & Access Systems Manufacturers' Association, International, 1300 Sumner Avenue, Cleveland, Ohio, 44115-2851.

DASMA 115-2017

Standard Method for Testing Sectional Doors, Rolling Doors, and Flexible Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure

1.0 SCOPE

1.1 This test method determines the structural performance of sectional doors, rolling doors, and flexible door assemblies impacted by missiles and subsequently subjected to cyclic static pressure differentials.

1.2 The performance determined by this test method relates to the ability of the sectional door or rolling door to remain unbreached during a windstorm due to windborne debris.

1.3 Water exposure conditions shall not be a part of this standard.

1.4 The proper use of this test method requires a knowledge of the principles of pressure and deflection measurement.

1.5 This test method describes the apparatus and the procedure to be used for applying missile impact and cyclic static pressure loads to a specimen.

1.6 This test method does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

1.7 This test method incorporates applicable provisions from TAS 201, TAS 203, TDS 1-95, SSTD 12-97, ASTM E 1886-02, ASTM E 1996-03 and fatigue load testing referenced in the Florida Building Code, Building.

1.8 For products intended for installation in the Florida High Velocity Hurricane Zone (Miami-Dade and Broward Counties), the testing procedure in Appendix B and Appendix C shall be used.

2.0 DEFINITIONS

2.1 Air Pressure Cycle - beginning at zero air pressure differential, the application of positive (negative) pressure to achieve a specified air pressure differential and returning to zero pressure differential.

2.2 Air Pressure Differential - the specified differential in static air pressure across the specimen, creating a positive (negative) load, expressed in pounds per square foot (or pascals).

2.3 Basic Wind Speed - also known as design wind speed, the wind speed as determined by the specifying authority.

2.4 Design Pressure - also known as design load or design wind load, the specified difference in static air pressure (positive or negative) for which the specimen is to be tested, expressed in pounds per square foot (or pascals).

2.5 Flexible Door: A door, excluding rolling sheet doors as defined in DASMA 207, in which a flexible fabric or other flexible sheet material forms the panel portion, even though it may have a rigid frame, rigid reinforcements, rigid support means for one or more edges thereof, or combinations of these features.

2.6 Full Operability – the ability for the door to be fully opened and closed.

2.7 Maximum Deflection – the maximum displacement of the specimen measured to the nearest 0.125 inch (3 mm) attained from the original position while the maximum test load is being applied.

2.8 Missile - the object that is propelled toward a test specimen.

2.9 Positive (Negative) Cyclic Test Load - the specified difference in static air pressure, creating an inward (outward) loading, for which the specimen is to be tested under repeated conditions, expressed in pounds per square foot (or pascals).

2.10 Recovery - The ratio of the differential measurement between the test specimen surface at rest (following cyclic test loading in one direction) and the maximum deflection measured (for such cyclic test loading), to the maximum deflection measured.

2.11 Rolling Door - A vertically operating, coiling door typically used in commercial or industrial applications.

2.12 Sectional Door - A door made of two or more horizontal sections hinged together so as to provide a door capable of closing the entire opening and which is by means of tracks and track rollers.

2.13 Section/Slat Joint - The section to section (slat to slat) interface defined by the longitudinal surfaces that move relative to each other as the door opens and closes.

2.14 Specifying Authority - the entity responsible for determining and furnishing information required to perform this test method.

2.15 Specimen Failure - deterioration under repeated load or incipient failure, as defined in the pass/fail criteria of this standard.

2.16 Test Chamber - an airtight enclosure of sufficient depth to allow unobstructed deflection of the specimen during pressure cycling, including ports for air supply and removal, and equipped with instruments to measure test pressure differentials.

2.17 Test Loading Program - the entire sequence of air pressure cycles to be applied to the test specimen.

2.18 Test Specimen - the complete installed door assembly and mounting hardware as specified on the submitted drawing.

2.19 Windborne Debris - objects carried by the wind in windstorms.

2.20 Windstorm - a weather event, such as a hurricane, with high sustained winds and turbulent gusts capable of generating windborne debris.

3.0 SUMMARY OF TEST METHODS

3.1 A test series shall consist of three identical test specimens.

3.2 Each test specimen shall be subjected to the large missile impact test and then to the cyclic pressure loading test.

3.3 A test specimen is considered to have passed the test if it satisfies the acceptance criteria of this standard.

4.0 TEST APPARATUS

4.1 Test Chamber - See Section 2.12 for definition.

4.2 Air System - shall consist of a controllable blower, a compressed-air supply, an exhaust system, a reversible controllable blower, or other air-moving system capable of providing a variable pressure from zero to the required pressures, both positive and negative.

4.3 Large Missile - shall be a nominal 2x4 Southern Pine lumber, minimum Stud grade, with no knots within 12 inches (305 mm) of the impact end. The missile shall have a length of not less than 7 feet (2.13 m) and not more than 9 feet (2.75 m). The end of the missile subjected to impact shall be permitted to be rounded to no less than a 48 inch (1219 mm) diameter sphere, with sharp edges permitted to be rounded to no more than a 1/16 inch (2 mm) radius. The missile may be marked/ticked in dark ink at one inch (25 mm) intervals on center, and congruently numbered every three inches (76 mm). A sabot shall be attached to the trailing edge of the missile to facilitate launching. The weight of the sabot shall not exceed 0.5 lbs. (227 g). The combined weight of the timber and sabot, which constitutes the missile, shall be between 9 lbs. (4.08 kg) and 9.5 lbs. (4.31 kg). The missile shall be propelled through a cannon as described in section 4.4.

4.4 Large Missile Cannon - shall be capable of producing impact at the speed specified in Section 8.2. The missile cannon may use compressed air to propel the large missile, and if using compressed air shall consist of the following major components: a compressed air supply, a pressure release valve, a pressure gauge, a barrel and support frame, and a timing system for determining the missile speed. The barrel of the missile cannon shall consist of either a 4 inch (102 mm) inside diameter pipe or a nominal 2 inch (51 mm) by 4 inch (102 mm) rectangular tube, and shall be at least as long as the missile. The barrel of the large missile cannon shall be mounted on a support frame in a manner to facilitate aiming the large missile so that it impacts the test specimen at the desired location.

4.5 Timing System - shall be capable to measure speeds accurate to +/- 2%. One method shall be comprised of two, through-beam photoelectric sensors spaced at a known distance apart and used to start and stop an electronic clock, and shall be capable to measure speeds accurate to +/- 2%. The speed of the missile shall be measured anywhere between the point where 100% of the missile is outside of the cannon, to the point where the missile is 1 ft. (300 mm) away from the test specimen. The missile speed shall not be measured while the missile is accelerating. The speed of the missile shall be determined by dividing the distance between the two through-beam photoelectric sensors by the total time interval counted by the electronic clock.

5.0 HAZARDS

5.1 If failure occurs during testing, hazardous conditions may result.

5.2 Take proper safety precautions to protect observers in the event that a failure occurs.

5.3 All observers shall be isolated from the path of the missile during the missile impact portion of the test.

5.4 Keep observers at a safe distance from the test specimen during the entire procedure.

6.0 TEST SPECIMENS

6.1 Three test specimens shall be supplied. Each test specimen shall be as per the manufacturer's detailed drawings and/or written instructions. Any horizontal track and hanging brackets may be shortened to fit the test chamber.

6.2 All parts of the test specimen, including glazing and structural framing, shall be full size.

6.3 The test specimen shall consist of the same materials, details, methods of construction and methods of attachment as proposed for actual use.

6.4 The specimen shall consist of the entire assembled unit attached to a given type of structural framing of the building, and shall contain all devices used to resist wind forces and windborne debris.

6.5 When testing doors which include glazed products, the material used to make such glazed products windborne debris resistant (i.e. fillers, film and similar) shall be an integral part, factory applied, of such glazed products.

6.6 Install the door system per the manufacturer's installation instructions.

6.7 For doors that contain vents with a gross opening area of 60 square inches or greater, vents shall be tested as a factory applied, integral part of doors.

6.7.1 For sectional doors and rolling doors, the door shall be counterbalanced where no more than the larger of 5% of door weight or ten pounds applied force is required to open the door manually from the fully closed position, or a simulated counterbalance condition (including locking mechanism) shall be achieved by shimming up the bottom corners of the door.

7.0 CALIBRATION OF TIMING EQUIPMENT

7.1 The timing system shall be calibrated and certified by an independent approved qualified agency, at twelve-month intervals. See Appendix A for recommended methods.

7.2 The calibration report shall include the following:

7.2.1 The date of the calibration.

7.2.2 The name of the agency conducting the calibration.

7.2.3 The distance between the through-beam photoelectric sensors (if used).

7.2.4 The speed of the missile as measured by the timing system.

7.2.5 The speed of the missile as determined from the calibration system.

7.2.6 The percentage difference in speeds.

7.3 The system shall be determined to be accurate if the speed of the missile measured by the timing system and the speed measured by the calibration system agree within +/- 2%.

8.0 LARGE MISSILE IMPACT TEST

8.1 The test shall be conducted using a large missile cannon.

8.2 The large missile shall be as described in Section 4.3. The speed of the large missile shall be at least 50 ft/s (15.2 m/s). The speed of the large missile shall be measured as described in Section 4.5.

8.3 The large missile shall impact the surface of the test specimen "end on".

8.4 Impacts

8.4.1 For sectional doors, impacts shall be defined as follows:

8.4.1.1 Within a 5 inch (127 mm) radius circle having its center on a section joint at a hinge location nearest the midpoint of the test specimen.

8.4.1.2 Within a 5 inch (127 mm) radius circle having its center located in the thinnest section of the test specimen, equidistant between the lower two section joints and centered between vertical stiles.

8.4.1.3 Within a 5 inch (127 mm) radius circle having its center at a point 6 inches (152 mm) horizontally and vertically away from a bottom corner.

8.4.2 For rolling doors impacts shall be defined as follows:

8.4.2.1 Within a 5 inch (127 mm) radius of the center of the door.

8.4.2.2 Within a 5 inch (127 mm) radius circle having its center at a point 6 inches (152 mm) horizontally and vertically away from a bottom corner.

8.4.3 For flexible doors, impacts shall be defined as follows:

8.4.3.1 Within a 5 inch (127 mm) radius of the center of the largest unsupported area of the door.

8.4.3.2 Within a 5 inch (127 mm) radius circle having its center at the location of the weakest panel reinforcing member.

8.4.3.3 Within a 5 inch (127 mm) radius circle having its center at a point either 6 inches (152 mm) horizontally and vertically away from a bottom corner or 6 inches (152 mm) above a bottom reinforcing member if present.

8.5 Each specimen shall receive at least two (2) impacts from the large missile.

8.5.1 For sectional doors, the first specimen shall receive one impact complying with Section 8.4.1.1 and one impact complying with Section 8.4.1.3.

8.5.2 For sectional doors, the second specimen shall receive one impact complying with Section 8.4.1.2 and one impact complying with Section 8.4.1.3.

8.5.3 For sectional doors, the third specimen shall receive one impact complying with Section 8.4.1.1 and one impact complying with Section 8.4.1.2.

8.5.4 For rolling doors, each specimen shall receive impacts complying with Section 8.4.2.

8.5.5 For flexible doors, the first specimen shall receive one impact complying with Section 8.4.3.1 and one impact complying with Section 8.4.3.3.

8.5.6 For flexible doors, the second specimen shall receive one impact complying with Section 8.4.3.2 and one impact complying with Section 8.4.3.3.

8.5.7 For flexible doors, the third specimen shall receive one impact complying with Section 8.4.3.1 and one impact complying with Section 8.4.3.2.

8.6 For doors that contain glazing, the glazing shall be impacted, in addition to the impact locations set forth in Section 8.5.

8.6.1 Glazing panels greater than or equal to 3 square feet (.28 sq m) in area shall receive two impacts. The first impact within a 5 inch (127 mm) radius circle having its center at a point 6 inches horizontally and vertically away from a corner of the glazing. The second impact within a 5 inch (127 mm) radius circle having its center at the midpoint of the glazing panel.

8.6.2 Glazing panels less than 3 square feet (.28 sq m) in area shall receive one impact located within a 5 inch (127 mm) radius circle having its center at the midpoint of the glazing panel.

8.6.3 For doors that contain multiple panels of glazing, the innermost panel shall be impacted.

8.6.4 For doors that contain different glazing thicknesses and/or glazing types, each different glazing thickness and glazing type shall be impacted.

8.7 For doors that contain vents with a gross opening area of 60 square inches or greater, vents shall be impacted in addition to the impact locations set forth in Section 8.5.

8.7.1 The vent impact shall be within a 5 inch (127 mm) radius of the center of the vent.

8.7.2 For doors that contain multiple vents, the innermost vent shall be impacted.

9.0 TEST PROCEDURES - LARGE MISSILE IMPACT

9.1 Preparation

9.1.1 Remove from the test specimen any sealing or construction material that is not intended to be used when the unit is installed in or on a building. Support and secure the test specimen into the mounting frame in a vertical position using the same number and type of anchors normally used for product installation as defined by the manufacturer or as required for a specific project. If this is impractical, install the test specimen with the same number of equivalent fasteners located in the same manner as the intended installation. The test specimen shall not be removed from the mounting frame at any time during the test sequence. The test shall be recorded using video equipment.

9.1.2 Secure the test specimen mounting frame such that the large missile will impact the exterior side of the test specimen as installed.

9.1.3 Locate the end of the propulsion device from which the large missile will exit at a minimum distance from the specimen equal to 9 feet (2.74 m) plus the length of the large missile.

9.1.4 Weigh each large missile within four hours prior to each impact.

9.1.5 Align the large missile propulsion device such that the large missile will impact the test specimen at the specified location.

9.2 Large Missile Impact.

9.2.1 Propel the large missile at the specified impact speed and location.

9.2.2 Examine damage in light of the pass/fail criteria found in Section 9.3.

9.2.3 Repeat steps 9.2.1 through 9.2.2 at all additional impact locations specified for the test specimen.

9.3 Pass/Fail Criteria.

9.3.1 The test specimen shall be subjected to evaluation for operability, and shall be acceptable by the following:

9.3.1.1 The door system shall remain in the opening throughout the duration of the test.

9.3.1.2 The door shall be evaluated for full operability at the conclusion of the test. The door shall pass only if the test engineer deems that the door system has full operability.

9.3.2 Latches, locks and fasteners and vents shall not become disengaged during the testing.

9.3.3 Excluding section/slat joints, vents or fabric jamb engagement, no crack or tear shall form longer than 5 inches (127 mm) and wider than 1/16 inch (1.6 mm) through which air can pass.

9.3.4 For sectional doors and rolling door elements excluding vents, no opening shall form through which a 3 inch (76 mm) diameter sphere can pass.

9.3.5 For flexible doors, no opening shall form creating a perimeter greater than 15 9/16 inches (395 mm).

9.3.6 All three test specimens shall be required to pass this testing.

9.4 Post Impact Test Procedure.

9.4.1 If the test specimen passes the acceptance criteria of the large missile impact test, it shall then be subjected to the cyclic pressure loading test specified in Section 10.

10.0 CYCLIC WIND PRESSURE LOADING TEST

10.1 General.

10.1.1 This test shall apply to doors that have passed the acceptance criteria of the large missile impact test.

10.1.2 The test specimens tested for impact shall be used for the cyclic pressure loading test.

10.1.3 If air leakage through the test specimen is excessive, tape may be used to cover any joints through which air leakage is occurring.

10.1.4 Cracks due to impact testing shall not be restrained with tape.

10.1.5 Tape shall not be used when there is a probability that it may significantly restrict differential movement between adjoining members.

10.1.6 Both sides of the entire test specimen and mounting panel shall be permitted to be covered with a single thickness of polyethylene film no thicker than 2 mils (.050 mm), in order that the full load is transferred to the test specimen and that the membrane does not prevent movement or failure of the specimen. The film shall be applied loosely with extra folds of material at each corner and at all offsets and recesses. When the load is applied, there shall be no fillet caused by tightness of the plastic film.

10.2 Loading Sequence Alternatives.

10.2.1 Loading Sequence 1 shall be as follows:

#1: Range of Test: 0 to +0.5p Cycles: 600
#2: Range of Test: 0 to +0.6p Cycles: 70
#3: Range of Test: 0 to +1.3p Cycles: 1
#4: Range of Test: 0 to -0.5p Cycles: 600
#5: Range of Test: 0 to -0.6p Cycles: 70
#6: Range of Test: 0 to -1.3p Cycles: 1

10.2.2 Loading Sequence 2 shall be as follows:

#1: Range of Test: +0.2p to +0.5p Cycles: 3500
#2: Range of Test: 0 to +0.6p Cycles: 300
#3: Range of Test: +0.5p to +0.8p Cycles: 600
#4: Range of Test: +0.3p to +1.0p Cycles: 100

#5: Range of Test: -0.3p to -1.0p Cycles: 50
#6: Range of Test: -0.5p to -0.8p Cycles: 1050
#7: Range of Test: 0 to -0.6p Cycles: 50
#8: Range of Test: -0.2p to -0.5p Cycles: 3350

10.2.3 The parameter "p" shall be defined as door design wind load pressure, based on where the assembly will be used.

10.3 Test Procedure.

10.3.1 For non-glazed doors, cyclic static pressure differential loading shall be applied in accordance with either Loading Sequence 1 or Loading Sequence 2 as described in Section 10.2.

10.3.2 For glazed doors, cyclic static pressure differential loading shall be applied in accordance with either Loading Sequence 1 or Loading Sequence 2 as described in Section 10.2.

10.3.3 Each cycle shall have duration not to exceed 20 seconds, where the cycles shall be applied as rapidly as possible and shall be performed in a continuous manner.

10.3.4 Interruptions for equipment maintenance and repair shall be permitted.

10.3.5 The test specimen shall not contact any portion of the test chamber at any time during the application of the cyclic static pressure differential loading.

10.3.6 Successful testing of a door assembly containing glazing shall qualify a door assembly of the same type that does not contain glazing.

10.4 Post-Test Pass/Fail Criteria.

10.4.1 The test specimen shall be subjected to evaluation for operability, and shall be acceptable by the following:

10.4.1.1 The door system shall remain in the opening throughout the duration of the test.

10.4.1.2 The door system shall be evaluated for full operability at the conclusion of the test. The door shall pass only if the test engineer deems that the door system has full operability.

10.4.2 Latches, locks and fasteners and vents shall not become disengaged during the testing.

10.4.3 Excluding section/slat joints, vents or fabric jamb engagement, no crack or tear shall form longer than 5 inches (127 mm) and wider than 1/16 inch (1.6 mm) through which air can pass.

10.4.4 For sectional doors and rolling door elements excluding vents, no opening shall form through which a 3 inch (76 mm) diameter sphere can pass.

10.4.5 For flexible doors, no opening shall form creating a perimeter greater than 15 9/16 inches (395 mm).

10.4.6 All three test specimens shall be required to pass this testing.

11.0 **TEST REPORTS**

11.1 Date of the test.

11.2 Date of the report.

11.3 A description of the test specimens, prior to impact and cyclic pressure loading, including all parts and components of a particular system of construction together with manufacturer's model number, if appropriate, or any other identification.

11.4 Detailed drawings of the test specimens, showing dimensioned section profiles, door dimensions and arrangement, framing location, weatherstripping, locking arrangements, hardware, sealants, glazing details, test specimen sealing methods, and any other pertinent construction details.

11.5 Proper identification of each test specimen, particularly with respect to distinguishing features or differing adjustments. A separate drawing for each test specimen shall not be required where all differences between them are noted on the drawings provided.

11.6 Design pressure used as the basis for testing.

11.7 Information on the large missile Appendix used:

11.7.1 Description of the missile, including dimensions and weight.

11.7.2 Missile speed measured.

11.7.3 Whether or not certification of the calibration equipment was required.

11.7.4 Missile orientation at impact.

11.7.5 Description of the location of each impact.

11.8 Information on the cyclic loading Appendix used:

11.8.1 The positive and negative cyclic test load sequence.

11.8.2 The number of cycles applied for each sequence.

11.8.3 The minimum and maximum duration for each cycle.

11.9 A description of the condition of the test specimens after testing, including details of any damage and any other pertinent observations.

11.10 When the tests are made to check conformity of the specimen to a particular specification, an identification or description of that specification.

11.11 A statement that the tests were conducted in accordance with the test method.

11.12 A statement of whether or not, upon completion of all testing, the test specimens meet the pass/fail criteria of this standard for both missile impact and cyclic loading.

11.13 A statement as to whether or not tape or film, or both, were used to seal against air leakage, and whether in the judgment of the test engineer, the tape or film influenced the results of the test. The name and author of the report.

11.14 The names and addresses of both the testing agency that conducted the tests and the requester of the tests.

11.15 Signatures of persons responsible for supervision of the tests and a list of official observers.

11.16 Any additional data or information considered to be useful to a better understanding of the test results, conclusions, or recommendations. This additional data/ information shall be appended to the report.

REFERENCED DOCUMENTS:

1. Protocol TAS 201-94, Impact Test Procedures, Miami-Dade County Building Code Compliance Office
2. Protocol TAS 203-94, Criteria For Testing Products Subject To Cyclic Wind Pressure Loading, Miami-Dade County Building Code Compliance Office
3. Standard TDI 1-95, Test For Impact and Cyclic Wind Pressure Resistance of Impact Protective Systems and Exterior Opening Systems, Texas Department of Insurance
4. Test Standard for Determining Impact Resistance From Windborne Debris, SSTD 12-97, Southern Building Code Congress International
5. ASTM E 1886-05, Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Storm Shutters Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
6. ASTM E 1996-05, Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Storm Shutters Impacted by Windborne Debris in Hurricanes
7. Fatigue Loading Testing, Section 1625.4, 2004 Florida Building Code, Building
8. ANSI/DASMA 207, Standard for Rolling Sheet Doors

DASMA 115 Test Report Form
Missile Impact and Cyclic Loading

Date of Test _____________ Date of Report _________________

Test Specimen Identification:
Manufacturer ____
Manufacturer Location ____
Model Type/Number _____________ Dimensions ___________________________________
Material Description ____
Test Specimen Selection Procedure ____
____
____
Applicable Drawing No.'s ____
____
____

Operating Hardware (Type, Quantity, Location(s)):
____
____
____

Glazing Description: ____

Ambient Temperature: _________

Design pressure used as the basis for testing: _________

Large Missile Information:

Missile Dimensions _____________ Missile Weight ________
Missile speed measured ____________
Certification of the calibration equipment required? Yes No
Missile orientation at impact ______________

Impact #1 Location ____
Maximum Crack Length _________ Maximum Crack Width _________
Maximum Diameter Sphere Penetrating the Impact Location _________
Impact #2 Location ____
Maximum Crack Length _________ Maximum Crack Width _________
Maximum Diameter Sphere Penetrating the Impact Location _________
Impact #3 Location ____
Maximum Crack Length _________ Maximum Crack Width _________
Maximum Diameter Sphere Penetrating the Impact Location _________
Glazing Impact Location (if applicable) _______________________________________
Maximum Diameter Sphere Penetrating the Impact Location _________
Test Result: Pass Fail
Notes:
____
____
____
____

DASMA 115 Test Report Form
Missile Impact and Cyclic Loading

Cyclic Loading Information:

Applied Pressure   # Cycles Min. Duration (sec)   Max. Duration (sec)
____
____
____
____
____
____
____
____

Maximum Diameter Sphere Penetrating the Test Specimen _____________
Maximum Length of Crack Formed in Test Specimen _____ Crack Width _____

Test Result: Pass Fail

Notes:
____
____
____
____

Door Operable, after Evaluation for Full Operability? (Yes/No) _____

Certification: The signature of the tester attests that the testing was conducted in accordance with the referenced standard.

Testing Conducted by _________________________________**of**_________________________

Signature of Tester ________________________________ **Date** _________________________

Test Facility and Location ____

Official Observers

____

The following appendices are informative only and are not a normative part of DASMA 115.

Appendix A

Recommended Methods of Calibrating Timing Equipment

A.1 Photographically, using a stroboscope.

A.2 Photographically, using a high speed camera with a frame rate exceeding 500 frames per second.

A.3 Photographically, using a high speed video camera with a frame rate exceeding 500 frames per second.

A.4 Any other certified timing system calibration device with an accuracy of +/- 1%.

Appendix B
Impact Testing Procedure for the Florida High Velocity Hurricane Zone

1. Scope

1.1 This Appendix covers procedures for conducting the impact test of doors as required by Section 1626 of the Florida Building Code, Building.

2. Referenced Documents

2.1 2014 Florida Building Code, Building

3. Terminology

3.1 *Definitions* – For definitions of terms used in this Appendix, refer to Sections 1625, 1626 and/or Chapter 2 of the Florida Building Code, Building.

3.2 *Description of Terms Specific to This Appendix*

3.2.1 *Specimen* – The entire assembled unit submitted for test, including but not limited to anchorage devices and structure to which product is to be mounted.

3.2.2 *Test Chamber* – An airtight enclosure of sufficient depth to allow unobstructed deflection of the specimen during pressure cycling, including ports for air supply and removal, and equipped with instruments to measure test pressure differentials.

3.2.3 *Maximum Deflection* – The maximum displacement of the specimen, measured to the nearest 1/8" (3 mm), attained from the original position while the maximum test load is being applied.

3.2.4 *Permanent Deformation* – The permanent displacement of the specimen, measured to the nearest 1/8 inch (3 mm), from the original position to final position that remains after maximum test load has been removed.

3.2.5 *Test Load* – As determined by Sections 1609, 1625 and 1626 of the Florida Building Code, Building.

3.2.6 *Specimen Failure* – A change in condition of the specimen indicative of deterioration under repeated load or incipient failure, such as cracking, fastener loosening, local yielding, or loss of adhesive bond.

4. Significance and Use

4.1 The test procedures outlined in this Appendix provide a means of determining whether a door provides sufficient resistance to windborne debris, as stated in Section 1626 of the Florida Building Code, Building.

5. Test Specimen

5.1 *Test specimen* – All parts of the test specimen shall be full size, using the same materials, details, methods of construction and methods of attachment as proposed for actual use. The specimen shall consist of the entire assembled unit attached to a given type of structural framing of the building, and shall contain all devices used to resist wind forces and windborne debris. When testing glazed products, the material used to make such glazed product windborne debris resistant (i.e. fillers, film and similar), shall be an integral part, factory applied, of such glazed product.

5.1.1 Locking mechanisms shall be permanently mounted on the specimen. Such locking mechanism shall require no tools to be latched in the locked position. Devices such as pins shall be permanently secured to the specimen through the use of chains or wires that shall be of corrosion resistant material. This section shall not apply to specimens referenced in Section 2413 of the Florida Building Code, Building.

5.1.2 Products that are not categorized as means of egress/escape, and are provided with more than one single action locking mechanism, shall be provided with permanently posted instructions on latching for high wind pressures.

5.1.3 Specimen and fasteners, when used, shall not become disengaged during test procedure.

5.1.4 Specimen with vent(s) with gross opening areas less than 60 square inches each in the bottom section only shall not be required to have the vent(s) missile impact tested.

6. Apparatus

6.1 The description of the apparatus is general in nature. Any equipment, properly certified, calibrated, and approved by the Authority Having Jurisdiction capable of performing this test within the allowable tolerance, shall be permitted.

6.2 *Major Components*

6.2.1 *Cyclic Wind Pressure Loading* – Number of cycles and amount of pressure shall be as indicated in Section 1625.4, Table 1625 and Table 1626 of the Florida Building Code, Building. Design wind pressure shall be determined by using Section 1609 of the Florida Building Code, Building.

6.2.1.1 *Test Chamber* – The test chamber, to which the specimen is mounted, shall be provided with pressure taps to measure the pressure difference across the test specimen and shall be so located that the reading is unaffected by the velocity of air supplied to or from the chamber. The specimen mounting frame shall not deflect under test load in such manner that the performance of the specimen will be affected.

6.2.1.2 *Air System* – A controllable blower, a compressed-air supply, an exhaust system, or reversible controllable blower designed to provide the required maximum air pressure difference across the specimen. The system shall provide an essentially constant air-pressure difference for the required test period.

6.2.1.3 Test Temperature – The test shall be conducted at a test temperature range of 59 to 95°F (15 to 35°C).

6.3 *Missile Impact*

6.3.1 *Timing System* – The timing system, which is comprised of two, through-beam photoelectric sensors spaced at a known distance apart and used to start and stop an electronic clock, shall be capable to measure speeds accurate to +/- 2%. The speed of the missile shall be measured anywhere between the point where 90% of the missile is outside of the cannon, to the point where the missile is 1 ft. (305 mm) away from the test specimen. The missile speed shall not be measured while the missile is accelerating. The through-beam photoelectric sensors shall be of the same model.

The electronic clock shall be activated when the reference point of the missile passes through the timing system. The electronic clock shall have an operating frequency of no less than 10 kHz with a response time not to exceed 0.15 milliseconds. The speed of the missile shall be determined by dividing the distance between the two through-beam photoelectric sensors by the total time interval counted by the electronic clock.

6.3.1.1 *Calibration of Timing Equipment* – The timing system shall be calibrated by an independently calibrated speed measuring system and certified by an independent qualified agency approved by the Authority Having Jurisdiction, at six-month intervals using one of the following methods:

1. Photographically, using a stroboscope,
2. Photographically, using a high speed camera with a frame rate exceeding 500 frames per second,
3. Photographically, using a high speed video camera with a frame rate exceeding 500 frames per second, or
4. Any other certified timing system calibration device used by an independent certified agency approved by this office.

The calibration report shall include the date of the calibration, the name of the agency conducting the calibration, the distance between the through-beam photoelectric sensors (if used), the speed of the missile as determined from the calibration system, and the percentage difference in speeds. The system shall be determined to be accurate if the speed of the missile measured by the timing system and the speed measured by the calibration system agree within 2%.

6.3.2.1 *Large Missile* – The large missile shall be a solid S4S nominal 2x4 #2 surface dry Southern Pine. The weight of the missile shall be as specified in Section 1626.2.3 of the Florida Building Code, Building and shall have a length of not less than 7 feet (2.14 m) and not more than 9 feet (2.75 m). The missile shall be marked/ticked in dark ink at one-inch intervals on center, and congruently numbered every three inches. A sabot shall be attached to the trailing edge of the missile to facilitate launching. The weight of the sabot shall not exceed 1/2 lb (.228 kg). The combined weight of the timber and sabot, which constitutes the missile, shall be between 9 lb. (4.1 kg) and 9.5 lb (4.23 kg). The missile shall be propelled through a cannon as described in section 6.3.3 of this Appendix.

6.3.2.2 When testing any specimen with more than one component, in addition to complying with the impacts required by Section 1626.2 of the Florida Building Code, Building, the framing member connecting these components shall be impacted at one-half the span of such member with the large missile at a speed indicated in Section 1626.2.4 of the Florida Building Code, Building.

6.3.2.3 Any specimen that passes the large missile impact test shall not be tested for the small missile impact test if the specimen has no opening through which a 3/16 inch (5 mm) sphere can pass.

6.3.3 *Large Missile Cannon* – The large missile cannon shall be compressed air to propel the large missile. The cannon shall be capable of producing impact at the speed specified in Section 1626.2.4 of the Florida Building Code, Building. The missile cannon shall consist of four major components: a compressed air supply, a pressure release valve, a pressure gauge, a barrel and support frame, and a timing system for determining the missile speed. The barrel of the missile cannon shall consist of a 4-inch (102 mm) inside diameter pipe and shall be at least as long as the missile. The barrel of the large missile cannon shall be mounted on a support frame in a manner to facilitate aiming the missile so that it impacts the specimen at the desired location. The distance from the end of the cannon to the specimen shall be 9 feet (2.75 m) plus the length of the missile.

6.3.4 *Small Missile* –The missiles shall be propelled by the cannon as described in Section 6.3.5 of this Appendix. The small missile shall be launched in such a manner that each specimen shall be impacted simultaneously over an area not to exceed two square feet per impact as described in Section 1626.3.5 of the Florida Building Code, Building.

6.3.5 *Small Missile Cannon* – A compressed air cannon shall be used that is capable of propelling missiles of the size and speed defined in Section 1626.3.3 and 1626.3.4 of the Florida Building Code, Building. The cannon assembly shall be comprised of a compressed air supply and gauge, a remote firing device and valve, a barrel, and a timing system. The small missile cannon shall be mounted to prevent movement of the cannon so that it can propel missiles to impact the test specimen at points defined in Section 1626.3.5 of the Florida Building Code, Building. The timing system shall be positioned to measure missile speed within 5 feet (1.53 m) of the impact point on the test specimen.

7. Hazards

7.1 Testing facilities shall take all necessary precautions to protect observers during the entire test procedure. All observers shall be at a safe distance away from specimen and apparatus. Safety regulations shall be followed in order to avoid any injuries to any and all observers.

8. Testing Facilities (For a more detailed description see TAS 301-94)

8.1 Any testing facility wishing to perform this test shall first obtain the approval of the Authority Having Jurisdiction. Such approval shall only be given to those facilities that show they are properly equipped to perform the complete test, including the cyclic loading and the small and large missile impact test. Testing facilities shall request, in writing, approval of their facilities. Such request shall contain the ability of the facility to perform all aspects of the test, all equipment used in the performance of the test, name of independent agency calibrating their equipment, location of facilities, personnel involved in the testing, a quality control program, a safety program and any other pertinent information which shall clearly indicate that such facility is in the business of performing independent testing. A representative of the Authority Having Jurisdiction shall visit the site, and shall reserve the right to order any changes necessary to accept the facility for testing.

8.2 Approval of facilities to perform the test described in this Appendix does not constitute an approval of such facilities to perform other tests not specifically mentioned in this Appendix.

9. Format of Test

The manufacturer shall notify the Authority Having Jurisdiction seven (7) working days prior to the performing of the test. The Authority Having Jurisdiction reserves the right to observe the test. The Authority Having Jurisdiction must be notified of the place and time the test will take place. The test must be recorded on video and retained by the laboratory per TAS301.

10. Test Reports

The following minimum information shall be included in the submitted report:

10.1 Date of the test and the report, and report number.

10.2 Name, location, and certification number of facilities performing the test.

10.3 Name and address of requester of the test.

10.4 Identification of the specimen (manufacturer, source of supply, dimension, model types, material, procedure of selection and any other pertinent information).

10.5 Detailed drawings of the specimen showing dimensioned section profiles, type of framing to which specimen was attached, panel arrangement, installation and spacing of anchorage, locking arrangement, sealants, hardware, product markings and their location, and any other pertinent construction details. Any deviation from the drawings or any modifications made to the specimen to obtain the reported values shall be noted on the drawings and in the report.

10.6 Maximum deflection recorded and mechanism used to make such determination.

10.7 Permanent deformation (a cross-sectional diagram shall be provided to show where it occurred).

10.8 Name, address, signature and seal of Florida professional engineer, witnessing the test and preparing the report. Engineer shall be part of the laboratory's permanent staff or under laboratory's contract. (See TAS 301-94)

10.9 The results for all three specimens shall be reported, each specimen being properly identified, particularly with respect to distinguishing features or differing adjustments. A separate drawing for each specimen shall not be required if all differences between them are noted on the drawings provided.

10.10 Location of impacts on each test specimen.

10.11 The large and small missile velocities.

10.12 The weight of the missiles.

10.13 Maximum positive and negative pressures used in the cyclic wind pressure loading.

10.14 A description of the condition of the test specimens after testing, including details of any damage and any other pertinent observations.

10.15 When the tests are made to check conformity of the specimen to a particular specification, an identification or description of that specification.

10.16 A statement that the tests were conducted in accordance with this test method.

10.17 A statement of whether or not, upon completion of all testing, the specimens meet the requirements of Section 1626 of the Florida Building Code, Building.

10.18 A statement as to whether or not tape or film, or both were used to seal against air leakage, and whether in the judgment of the test engineer, the tape or film influenced the results of the test.

10.19 Signatures of persons responsible for supervision of the tests, and a list of official observers.

10.20 All data not required herein, but useful to a better understanding of the test results, conclusions or recommendations, may be appended to the report.

11. Recording Deflections

Maximum Deflection

Permanent Deformation

12. Additional Testing

12.1 Following successful completion of this test, all specimens shall then be successfully tested as per Appendix C of this standard.

12.2 If a product is subjected to weathering that can affect its integrity, the manufacturer shall contact the Authority Having Jurisdiction for additional testing requirements such as but not limited to moisture, U.V., accelerated aging, and other similar tests.

12.3 The Authority Having Jurisdiction shall reserve the right to require any additional testing necessary to assure full compliance with the intent of the Florida Building Code, Building.

12.4 Products tested in accordance with this Appendix shall be required to be successfully tested under Appendix A of ANSI/DASMA 108 prior to conducting tests under this Appendix.

13. Product Marketing

13.1 Any and all approved products shall be permanently labeled with the manufacturer's name, city, and state, and the following statement: "Product Control Approved."

13.2 Permanently labeled shall be a metallic label fixed permanently to the frame of the specimen by rivets or permanent adhesive.

13.3 Any instructions for operations shall be permanently mounted on the specimen in an area not subject to be painted or concealed.

Appendix C
Cyclic Wind Pressure Testing Procedure for the Florida High Velocity Hurricane Zone

1. Scope

1.1 This Appendix covers procedures for conducting the cyclic wind pressure loading test required by the Florida Building Code, Building and Appendix B of this standard.

2. Referenced Documents

2.1 2014 Florida Building Code, Building.

3. Terminology

3.1 *Definitions* – For definitions of terms used in this Appendix, refer to the Florida Building Code, Building.

3.2 *Description of Terms Specific to This Appendix*

3.3 *Specimen* – The entire assembled unit submitted for test, including anchorage devices and structure to which product is to be mounted.

3.4 *Positive (negative) Cyclic Load* – The specified differential in static air pressure, creating an inward (outward) loading, for which the specimen is to be tested under repeated conditions, expressed in pounds per square foot.

3.5 *One cycle* – Beginning at the specified static air pressure, the application of positive cyclic test load, and returning to the specified static air pressure, followed by the application of negative cyclic test load.

3.6 *Design Pressure (Design Wind Load)* – The uniform static air pressure difference, inward or outward and expressed in pounds per square foot (Newtons per square meter), for which the specimen would be designed under service load conditions using Section 1609 of the Florida Building Code, Building.

3.7 *Test Chamber* – An airtight enclosure of sufficient depth to allow unobstructed deflection of the specimen during pressure cycling, including ports for air supply and removal, and equipped with a device to measure test pressure differentials.

3.8 *Maximum Deflection* – The maximum displacement, measured to the nearest 1/8 inch (3 mm), attained from an original position while the maximum load is being applied.

3.9 *Permanent Deformation* – The permanent displacement, measured to the nearest 1/8 inch (3 mm), from an original position that remains after the applied test load has been removed.

3.10 *Specimen Failure* – A change in condition of the specimen indicative of deterioration under repeated load or incipient failure, such as cracking, fastener loosening, local yielding, or loss of adhesive bond.

4. Significance and Use

4.1 This test method is a standard procedure for determining compliance with Section 1625, Table 1625.4 and Table 1626 of the Florida Building Code, Building. This test method shall be intended to be used for installations of sectional doors, rolling doors and flexible doors. This test method shall consist of supplying air to and exhausting air from the chamber in accordance with a specific test loading program at the rate required to maintain the test pressure differential across the specimen, and observing, measuring, and recording the deflection, deformations, and nature of any distress or failures of the specimen.

5. Test Specimen

5.1 *Test specimen* – All parts of the test specimen shall be full size, using the same materials, details, methods of construction and methods of attachment as proposed for actual use. The specimen shall consist of the entire assembled unit attached to a given type of structural framing of the building, and shall contain all devices used to resist wind forces and windborne debris. When testing glazed products, the material used to make such glazed product windborne debris resistant (i.e. fillers, film and similar) shall be an integral part, factory applied, of such glazed product.

5.1.1 Locking mechanisms shall be permanently mounted on the specimen. Such locking mechanism shall require no tools to be latched in the locked position. Devices such as pins shall be permanently secured to the specimen through the use of chains or wires which shall be of corrosion resistant material.

5.1.2 Products that are not categorized as means of egress/escape, and are provided with more than one single action locking mechanism, shall be provided with permanently posted instructions on latching for high wind pressures.

5.1.3 Specimen and fasteners, when used, shall not become disengaged during test procedure.

5.2 If the impact test is to be performed on the test specimen, such test shall be conducted prior to performing the test described in this Appendix.

5.3 All locking mechanisms shall be in place when performing this test.

5.4 Doors shall be evaluated for operability after this test.

6. Procedure

6.1 *Preparation* – Remove from the test specimen any sealing or construction material that is not normally used when installed in or on a building. Fit the specimen with its structural framing into or against the chamber opening. The outdoor side of the specimen shall face the higher pressure side for positive loads; the indoor side shall face the higher pressure side for negative loads. Support and secure the specimen by the same number and type of anchors to be approved for normal installation of the specimen in the building.

6.2 Support and secure the test specimen by the same number and type of anchors normally used in installing the unit in the building.

6.3 Load the specimen using the cycles specified in Table 1625.4 and/or Table 1626 of the Florida Building Code, Building, whichever of these apply.

6.4 In the case of Table 1625.4 of the Florida Building Code, Building, Section 6.3 of this Appendix shall be repeated for negative pressures.

6.5 Assemblies shall be tested with no resultant failure or distress, and shall have a recovery of at least 90% over maximum deflection.

6.6 Test Temperature. The test shall be conducted at a test temperature range of 59 to 95°F (15 to 35°C).

7. Apparatus

7.1 The description of the apparatus is general in nature. Any equipment, properly certified, calibrated, and approved by the Authority Having Jurisdiction capable of performing this test within the allowable tolerance shall be permitted.

7.2 *Major Components*

7.2.1 *Test Chamber* – The test chamber, to which the specimen is mounted, shall be provided with pressure tabs to measure the pressure difference across the test specimen and shall be so located that the reading is unaffected by the velocity of air supplied to or from the chamber. The specimen mounting frame shall not deflect under test load in such manner that the performance of the specimen will be affected.

7.2.2 *Pressure-Measuring Apparatus* – The pressure-measuring apparatus shall measure the test pressure difference within a tolerance of +/-2%

7.2.3 *Deflection-Measuring System* – The deflection-measuring system shall measure the deflection within a tolerance of 0.01 inch (0.25 mm).

7.2.4 *Air System* – A controllable blower, a compressed-air supply, an exhaust system, or reversible controllable blower designed to provide the required maximum air pressure difference across the specimen. The system shall provide an essentially cyclic static air-pressure difference for the required test period.

7.3 *Calibration of Equipment* – The pressure-measuring apparatus and the deflection-measuring system shall be calibrated by an independently calibrated speed measuring system and certified by an independent qualified agency approved by the Authority Having Jurisdiction, at two-year intervals.

7.3.1 The calibration report shall include the date of the calibration, the name of the agency conducting the calibration, methods and equipment used in the calibration process, the equipment being calibrated and any pertinent comments.

8. Hazards

8.1 Testing facilities shall take all necessary precautions to protect the observers during the entire test procedure. All observers shall always be at a safe distance away from specimen and apparatus. Safety regulations shall be followed in order to avoid any injuries to any and all observers.

9. Testing Facilities (For a more detailed description see TAS 301-94)

9.1 Any testing facility wishing to perform testing on such products shall first obtain the approval of the Authority Having Jurisdiction. Such approval shall only be given to those facilities that show they are properly equipped to perform the complete test. Testing facilities shall request, in writing, approval of their facilities. Such request shall contain the ability of the facility to perform all aspects of the test, all equipment used in the performance of the test, name of independent agency calibrating their equipment, location of facilities, personnel involved in the testing, a quality control program, a safety program and any other pertinent information which shall clearly indicated that such facility is in the business of performing independent testing. A representative of the Authority Having Jurisdiction shall visit the site, and shall reserve the right to order any changes necessary to accept the facility for testing.

9.2 Approval of facilities to perform the test described in this Appendix shall not constitute an approval of such facilities to perform other tests not specifically mentioned in this Appendix.

10. Format of Test

The manufacturer shall notify the Authority Having Jurisdiction seven (7) working days prior to the performing of the test. The Authority Having Jurisdiction reserves the right to observe the test. The Authority Having Jurisdiction must be notified of the place and time the test will take place. The test must be recorded on video and retained by the laboratory per TAS301.

11. Test Reports

The following minimum information shall be included in the submitted report:

11.1 Date of the test and the report, and report number.

11.2 Name and location of facilities performing the test.

11.3 Name and address of requester of the test.

11.4 Identification of the specimen (manufacturer, source of supply, dimension, model types, material, procedure of selection and any other pertinent information).

11.5 Detailed drawings of the specimen showing dimensioned section profiles, type of framing to which specimen was attached, panel arrangement, installation and spacing of anchorage, locking arrangement, sealant, hardware, product markings and their location, and any other pertinent construction details. Any deviation from the drawings or any modifications made to the specimen to obtain the reported values shall be noted on the drawings and in the report.

11.6 Maximum deflection recorded, and mechanism used to make such determination.

11.7 Permanent deformation (a cross-sectional diagram shall be provided to show where it occurred).

11.8 Name, address, signature and seal of Florida professional engineer, witnessing the test and preparing the report. Engineer shall be part of the laboratory's permanent staff or under laboratory's contract. (See TAS 301-94)

11.9 A tabulation of pressure differences exerted across the specimen during the test and their duration.

11.10 Maximum positive and negative pressures used in the test.

11.11 A description of the condition of the test specimens after testing, including details of any damage and any other pertinent observations.

11.12 When the tests are made to check conformity of the specimen to a particular specification, an identification or description of that specification.

11.13 A statement that the tests were conducted in accordance with this test method.

11.14 A statement of whether or not, upon completion of all testing, the specimens meet the requirements of Section 1609 of the Florida Building Code, Building and this Appendix.

11.15 A statement as to whether or not tape or film or both were used to seal against air leakage, and whether in the judgment of the test engineer, the tape of film influenced the results of the test.

11.16 Signatures of persons responsible for supervision of the tests and a list of official observers.

11.17 All data not required herein, but useful to a better understanding of the test results, conclusions or recommendations, may be appended to the report.

12. Recording Deflections

Maximum Deflection

Permanent Deformation

13. Additional Testing

13.1 Prior to conducting the test described in this Appendix, all specimens shall have successfully completed the test specified in Appendix B.

13.2 If a product is subjected to weathering that can affect its integrity, the manufacturer shall contact the Authority Having Jurisdiction for additional testing requirements such as but not limited to moisture, U.V., accelerated aging, and other similar tests.

13.3 The Authority Having Jurisdiction shall reserve the right to require any additional testing necessary to assure full compliance with the intent of the Florida Building Code, Building.

13.4 Products tested in accordance with this Appendix shall be required to be successfully tested under Appendix A of ANSI/DASMA 108 prior to conducting tests under this Appendix.

14. Product Marking

14.1 Any and all approved products shall be permanently labeled with the manufacturer's name, city, and state, and the following statement: "Product Control Approved."

14.2 Permanent label shall be a metallic label fixed permanently to the frame of the specimen by rivets or permanent adhesive.

14.3 Any instructions for operations shall be permanently mounted on the specimen in an area not subject to be painted or concealed.

Appendix D
Windborne Debris Protection for Doors Installed in Essential Facilities

1. Scope

D1.1 This Appendix covers procedures for conducting testing in accordance with this standard, for doors to be installed in essential facilities.

2. Referenced Documents

D2.1 ASTM E1886
D2.2 ASTM E1996
D2.3 ASCE 7
D2.4 International Building Code (IBC)
D2.5 International Residential Code (IRC)

3. Terminology

3.1 **Essential facility.** A building or structure including, but not limited to: hospitals; other health care facilities having emergency treatment facilities; jails and detention facilities; fire, rescue and police stations; emergency vehicle garages; designated emergency shelters; communications centers and other facilities required for emergency response; power generating stations; other public utility facilities required in an emergency; and buildings and other structures having critical national defense functions.

3.2 **Wind Zone.** An area defined by maximum and minimum wind speed boundaries, established by the local authority having jurisdiction, and may be based on a specific version of ASCE 7, the IBC, or the IRC.

4. Applicable Missile Type and Speed

4.1 The large missile shall be as described in Section 4.3 of this standard.

4.2 For Wind Zones 1 and 2, the speed of the large missile shall be at least 50 ft/sec (15.25 m/s). For Wind Zones 3 and 4, the speed of the large missile shall be at least 80 ft/sec (24.38 m/s).

4.3 The speed of the large missile shall be measured as described in Section 4.5 of this standard.

DASMA
Door & Access Systems Manufacturers Association International

DASMA – the Door & Access Systems Manufacturers Association, International – is North America's leading trade association of manufacturers of garage doors, rolling doors, garage door operators, vehicular gate operators, and access control products. With Association headquarters based in Cleveland, Ohio, our 90 member companies manufacture products sold in virtually every county in America, in every U.S. state, every Canadian province, and in more than 50 countries worldwide. DASMA members' products represent more than 95% of the U.S. market for our industry.

For more information about the Door & Access Systems Manufacturers Association, International, contact:

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S7952

Date Submitted	12/12/2018	**Section**	35	**Proponent**	Borjen Yeh
Chapter	35	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **Yes**

Related Modifications

Summary of Modification

Update the referenced standards published by APA.

Rationale

This proposal updates the referenced standards published by APA.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal updates the referenced standards published by APA.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

1st Comment Period History

7952-A1

Proponent Borjen Yeh **Submitted** 1/16/2019 **Attachments** Yes

Rationale

As the original proponent for S7952, I just noticed that the date of the current version for these 4 APA PDS Supplements has not been changed (i.e., "-12") and does not need to be updated to "-14". Note that the other changes proposed in S7952 are valid as proposed.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code.

Impact to Small Business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal updates the referenced standards published by APA.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

APA APA - The Engineered Wood Association. 7011 South 19th Street, Tacoma, WA 98466

Standard reference number	Title	Referenced in code section number
ANSI 117-2015	Structural Glued Laminated Timber of Softwood Species	2306.1
ANSI A190.1-2017~~ANSI/A 190.1—12~~	Structural Glued Laminated Timber	2303.1.3 2306.1
ANSI/APA PRP 210—2014~~08~~	Standard for Performance-Rated Engineered Wood Siding	2303.1.5 2304.7 2306.3 Table 2306.3(1)
ANSI/APA PRR 410—2016~~11~~	Standard for Performance-Rated Engineered Wood Rim Boards	2303.1.13
APA PDS—12	Panel Design Specification	2306.1 2314.4.3
APA PDS Supplement 1—14~~12~~	Design and Fabrication of Plywood Curved Panels (revised 2013)	2306.1 2314.4.3
APA PDS Supplement 2—14~~12~~	Design and Fabrication of Plywood-lumber Beams (revised 2013)	

2306.1 2314.4.3

APA PDS Supplement 3—1412

Design and Fabrication of Plywood Stressed-skin Panels (revised 2013)

2306.1 2314.4.3

APA PDS Supplement 4—1412

Design and Fabrication of Plywood Sandwich Panels (revised 2013)

2306.1 2314.4.3

APA PDS Supplement 5—1612

Design and Fabrication of All-plywood Beams (revised 2013)

2306.1 2314.4.3

APA B840

Siding Manufacturing Specifications

2314.4.3

APA L350

Design/Construction Guide Diaphragms and Shearwalls

2314.4.3

APA PRP108

Performance Standards and Policies for Structural-Use Panels

2314.4.3

APA V910

Plywood Folded Plate Laboratory Report 21

2314.4.3

APA PRG 320—201811

Standard for Performance-Rated Cross-Laminated Timber

2303.1.4

APA EWCG

Engineered Wood Construction Guide, Form E30

2314.4.3

APAEWS R540—1312

Builders Tips: Proper Storage and Handling of Glulam Beams

2306.1

APAEWS S475—1607

Glued Laminated Beam Design Tables

2306.1

APAEWS S560—1410

Field Notching and Drilling of Glued Laminated Timber Beams

2306.1

APAEWS T300—1607

Glulam Connection Details

2306.1

APAEWS X440—1708

Product Guide-Glulam

2306.1

APAEWS X450—1801

Glulam in Residential Building Construction Guide-Western Edition

2306.1

APA PDS Supplement 1—12~~14~~ Design and Fabrication of Plywood Curved Panels (revised 2013) 2306.1 2314.4.3
APA PDS Supplement 2—12~~14~~ Design and Fabrication of Plywood lumber Beams (revised 2013) 2306.1 2314.4.3
APA PDS Supplement 3—12~~14~~ Design and Fabrication of Plywood Stressed-skin Panels (revised 2013) 2306.1 2314.4.3
APA PDS Supplement 4—12~~14~~ Design and Fabrication of Plywood Sandwich Panels (revised 2013) 2306.1 2314.4.3

S7997

Date Submitted	12/12/2018	**Section**	35	**Proponent**	Bonnie Manley
Chapter	35	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

This proposal updates the AISI S230 reference to the 2018 edition.

Rationale

The 2018 editions of the IBC and IRC reference the 2015 edition of AISI S230. The 2015 edition of AISI S230 is based upon ASCE 7-10. With the Florida code cycle happening in 2019, there is an opportunity to adopt the 2018 edition of AISI S230, which is based upon ASCE 7-16. If ASCE 7-16 is chosen as a basis for both the Florida Building Code and Florida Residential Code, it would be appropriate to adopt this latest edition of AISI S230 for coordination.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

AISI S230--18—07/S3-12 (2012) *Standard for Cold-formed Steel Framing—Prescriptive Method for One- and Two-family Dwellings*, 20182007 with Supplement 3, dated 2012 (Reaffirmed 2012)

S8070

Date Submitted	12/13/2018	**Section**	35	**Proponent**	Bonnie Manley
Chapter	35	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

7452, 7454, 7455, 7458

Summary of Modification

This proposal is one in a series adopting the latest generation of AISI standards for cold-formed steel.

Rationale

This proposal adopts the latest editions of two of AISI's test standards -- AISI S913 and AISI S914, which are adopted in Section 2210.3.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

AISI S913—17~~13~~, *Test Standard for Hold-Downs Attached to Cold-Formed Steel Structural Framing*, 2017

AISI S914—17~~15~~, *Test Standard for Joist Connectors Attached to Cold-Formed Steel Structural Framing*, 2017

S8105

Date Submitted	12/13/2018	**Section**	35	**Proponent**	Bonnie Manley
Chapter	35	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments	**No**	**Alternate Language**	**No**

Related Modifications

Summary of Modification

Updates AISC reference documents.

Rationale

This proposal updates the structural steel industry reference documents.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

AISC

AISC, DG09, Torsional Analysis of Structural Steel Members, 2003

AISC, Detailing for Steel Construction, 2009

AISC Steel Construction Manual, 2017

AISC DG15, Rehabilitation and Retrofit Guide A Reference for Historic Shapes and Specifications, 20182002

AISC DG03, Serviceability Design Considerations for Steel Buildings, 2003

AISC 341—1610Seismic Provisions for Structural Steel Buildings, 2016

AISC 360—1610Specification for Structural Steel Buildings, 2016

S8106

Date Submitted	12/13/2018	**Section**	35	**Proponent**	Bonnie Manley
Chapter	35	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Corrects ASCE 8 reference.

Rationale

A 2014 edition of ASCE 8 was not published. The 2002 edition remains "current".

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

ASCE

ASCE 8—0214 Standard Specification for the Design of Cold-formed Stainless Steel Structural Members

Date Submitted 12/13/2018
Chapter 35

Section 35
Affects HVHZ No

Proponent Bonnie Manley
Attachments No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No

Alternate Language Yes

Related Modifications

Summary of Modification

Updates AWS reference documents.

Rationale

This proposal updates the AWS documents.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

Alternate Language

1st Comment Period History

S8107-A1

Proponent Jennifer Molin **Submitted** 2/1/2019 **Attachments** Yes

Rationale

The AWS documents have been revised and the current editions are listed above.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in costs is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in costs is anticipated.

Impact to industry relative to the cost of compliance with code

No change in costs is anticipated.

Impact to Small Business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Yes, it does

Does not degrade the effectiveness of the code

No, it does not

AWS

B2.1—B2.1M—2018 ~~2014~~Specification for Welding Procedure and Performance Qualification

D1.1—D1.1M—2015~~2010~~Structural Welding Code—Steel

AWS documents
D9.1—D9.1M—~~2012~~2018; Sheet Metal Welding Code
D1.4—D1.4M—~~2011~~2018; Structural Welding Code—Reinforcing Steel
D1.3—D1.3M—~~2008~~2018; Structural Welding Code—Sheet Steel

S8108

Date Submitted	12/13/2018	**Section**	35	**Proponent**	Bonnie Manley
Chapter	35	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Updates ASTM standards

Rationale

This proposal updates several ASTM standards for the steel industry.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

ASTM

A6/A6M—14~~11~~ Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes and Sheet

~~A325—09 Specification for Structural Bolts, Steel, Heat-Treated, 120/105 Ksi Minimum Tensile Strength~~

~~A490—08b Specification for Heat-Treated, Steel Structural Bolts, Alloy Steel, Heat Treated 150 ksi Minimum Tensile Strength~~

A1003/A1003M—15~~11~~Standard Specification for Sheet Steel, Carbon, Metallic, and Non-metallic Coated for Cold-formed Steel Framing Members

F3125/F3125M-15 Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions

S8110

Date Submitted	12/13/2018	**Section**	35	**Proponent**	Bonnie Manley
Chapter	35	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Updates NAAMM reference document.

Rationale

This proposal updates the NAAMM manual.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

NAAMM

NAAMM MBG 531Metal Grating Manual, 20172009

S8112

Date Submitted	12/13/2018	**Section**	35	**Proponent**	Bonnie Manley
Chapter	35	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Updates RCSC reference document.

Rationale

This proposal updates the RCSC reference document.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

RCSC

RCSC—14~~09~~ Specification for Structural Joints Using High Strength Bolts

S8113

Date Submitted	12/13/2018	**Section**	35	**Proponent**	Bonnie Manley
Chapter	35	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Updates the SJI reference documents.

Rationale

This proposal updates the SJI reference documents.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

SJI

SJI 100-15, Standard Specification for K-Series, LH-Series, and DLH-Series Open Web Steel Joists and for Joist Girders, 2015

SJI 200-15 ~~CJ—10~~ Standard Specification for Composite Steel Joists, CJ-series , 2015

~~JG—10 Standard Specification for Joist Girders~~

~~K—10 Standard Specification for Open Web Steel Joists, K-series~~

~~LH/DLH—10 Standard Specification for Longspan Steel Joists, LH-series and Deep Longspan Steel Joists, DLH-series~~

...

SJI—17~~10~~ ~~43rd~~44th Edition Standard Specifications ~~and~~ Load Tables and Weight Tables for Steel Joists and Joist Girders~~, which includes Errata No. 1 and No. 2~~

SJI—18~~13~~ ~~85~~90 Years of Open Web Steel Joist Construction

...

S8114

Date Submitted	12/13/2018	**Section**	35	**Proponent**	Bonnie Manley
Chapter	35	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **Yes** **Alternate Language** **No**

Related Modifications

Summary of Modification

Updates the STI references.

Rationale

This proposal updates the STI reference documents.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

1st Comment Period History

S8114-G1

Proponent Jaime Gascon **Submitted** 1/22/2019 **Attachments** No

Comment:

This modification for standards update does impact the HVHZ; Chapter 35 refers to section 2214 when identifying where in the code the standard is referenced.

~~W~~STI Steel Tube Institute

~~STI (2015) HSS Design Manual~~

<u>HSS Design Manual, Volume 1: Section Properties & Design Information, 2015</u>

<u>HSS Design Manual, Volume 2: Member Design, 2016</u>

<u>HSS Design Manual, Volume 3: Connections at HSS Members, 2016</u>

<u>HSS Design Manual, Volume 4: Truss & Bracing Connections, 2017</u>

S8116

Date Submitted 12/13/2018
Chapter 35
Section 35
Affects HVHZ No
Proponent Bonnie Manley
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No

Alternate Language No

Related Modifications

Summary of Modification

Deletes AISI reference documents that are not currently referenced.

Rationale

These AISI reference documents were eliminated from Section 2214.3 last cycle; however, they were not deleted from Chapter 35. This proposal simply cleans up Chapter 35.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

AISI

~~AISI Design Manual for Structural Tubing~~

~~AISI Specifications for Design of Light-Gage Cold-Formed Stainless Structural Members~~

~~AISI Specification for the Criteria for Structural Application of Steel Cables for Buildings~~

S8128

Date Submitted	12/14/2018	**Section**	35.1	**Proponent**	Andy Williams
Chapter	35	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments	**No**	**Alternate Language**	**No**

Related Modifications

Section 2306.1

Summary of Modification

Include correct references to standards recognized in Section 2306.1

Rationale

While referenced in Section 2306.1, these standards are inadvertently left out of Chapter 35.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This is a simple reference and should have no impact on enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This is a simple reference and should have no impact on cost of compliance with the code.

Impact to industry relative to the cost of compliance with code

This is a simple reference and should have no impact on cost of compliance with the code.

Impact to small business relative to the cost of compliance with code

This is a simple reference and should have no impact on cost of compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This is a simple reference and should have no impact on the general public

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This is a simple reference and should have no impact on the general public

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This is a simple reference and should have no impact on the general public

Does not degrade the effectiveness of the code

This is a simple reference and should have no impact on the general public

Add the following text

ASABE American Society of Agricultural and Biological Engineers

2950 Niles Road

St. Joseph, MI 49085

ASABE EP 484.3 MON2016: Diaphragm Design of Metal-clad, Wood Frame Rectangular Buildings

ASABE EP 486.3 OCT 2012 ED: Shallow-post and Pier Foundation Design

ASABE EP 559.1 MON2016: Design Requirements and Bending Properties for Mechanically Laminated Wood Assemblies

ANSI/ASAE EP484.3 DEC2017
Diaphragm Design of Metal-Clad, Wood-Frame Rectangular Buildings

American Society of
Agricultural and Biological Engineers

STANDARD

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Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made toward their resolution.

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ASABE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA, phone 269-429-0300, fax 269-429-3852, hq@asabe.org

ANSI/ASAE EP484.3 DEC2017
Revision approved December 2017 as an American National Standard

Diaphragm Design of Metal-Clad, Wood-Frame Rectangular Buildings

Developed by the ASAE Diaphragm Design of Metal-Clad, Post-Frame Rectangular Buildings Subcommittee of the Structures Group; approved by the Structures and Environment Division Standards Committee; adopted by ASAE September 1989; revised December 1990; reaffirmed December 1994, 1995, 1996, 1997; revised June 1998; approved as an American National Standard August 1998; revised editorially February 2000; reaffirmed February 2003; revised editorially August 2003; reaffirmed February 2008, February 2013; revised December 2017.

Keywords: Buildings, Structures, Terminology, Wood-frame

1 Purpose and Scope

1.1 This Engineering Practice is a consensus document for the analysis and design of metal-clad wood-frame buildings using roof and ceiling diaphragms, alone or in combination. The roof (and ceiling) diaphragms, endwalls, intermediate shearwalls, and building frames are the main structural elements of a structural system used to efficiently resist the design lateral (wind, seismic) loads. This Engineering Practice gives acceptable methods for analyzing and designing the elements of the diaphragm system.

1.2 The provisions of this Engineering Practice are limited to the analysis of single-story buildings of rectangular shape.

2 Normative References

The following referenced documents are integral components in the application of this document. For dated references, only the edition cited applies unless noted. For undated references, the latest approved edition of the referenced document (including any amendments) applies.

AWC (American Wood Council) National Design Specification® (NDS®) for Wood Construction. Washington, D.C.)

ASAE EP486, Shallow Post and Pier Foundation Design

ASAE EP558, Load Tests for Metal-Clad, Wood Frame Diaphragms

AISI S310, North American Standard for the Design of Profiled Steel Diaphragm Panels

3 Definitions (see Figures 1 and 2)

3.1 diaphragm: A structural assembly of metal cladding, including the wood or wood product framing, metal cladding, fasteners and fastening patterns, capable of transferring in-plane shear forces through the cladding and framing members.

3.2 diaphragm design: Design of roof (and ceiling) diaphragm(s), sidewall posts, endwalls, shearwalls, component connections, chord splices, and foundation anchorages, for the purpose of transferring lateral (e.g., wind) loads to the foundation structure.

3.3 diaphragm dimensions

3.3.1 diaphragm length, *d*: Length of a building diaphragm in the plane of the diaphragm.

3.3.2 diaphragm span, b_h: Horizontal span of a building diaphragm having length, *d*.

3.3.3 diaphragm width, *s*: Distance between individual building frames; see also 3.10.

3.3.4 model diaphragm length, *b*: Length of a model diaphragm as measured parallel to the direction of applied load.

3.3.5 model diaphragm width, *a*: Length of a model diaphragm as measured perpendicular to the direction of applied load.

3.4 diaphragm fasteners: The various fasteners and fastener patterns used to connect the several components of the endwalls, shearwalls, and diaphragms. These include fasteners between cladding and purlins, between cladding and endwall girts, between diaphragm framing members, and between individual sheets of cladding (stitch fasteners).

3.5 diaphragm shear stiffness

3.5.1 model diaphragm shear stiffness, *c*: The in-plane shear stiffness of a model diaphragm. Defined as the slope of the shear load-deflection curve between zero load and the load corresponding to the diaphragm allowable shear strength.

3.5.2 in-plane shear stiffness, c_p: The in-plane shear stiffness of an individual roof or ceiling diaphragm.

3.5.3 horizontal shear stiffness, c_h: The horizontal shear stiffness of an individual roof or ceiling diaphragm. It is obtained by adjusting diaphragm in-plane shear stiffness, c_p, for slope.

3.5.4 total horizontal diaphragm shear stiffness, C_h: The horizontal shear stiffness of the roof and ceiling assembly is calculated by summing the horizontal shear stiffness values of individual roof and ceiling diaphragms. Alternatively, this stiffness can be obtained from full-scale building tests.

3.6 diaphragm shear strength, V_a: The allowable design shear strength (see ASAE EP558) of a diaphragm in the plane of the cladding.

3.7 eave load, *R*: A concentrated (point) load, horizontally acting, that is located at the eave of each frame, and results in a horizontal eave displacement identical to that caused by application of the controlling combination of design loads. *R* is numerically equal to the horizontal force required to prevent horizontal translation of the eave when the controlling combination of design loads is applied to the frame.

3.8 endwall and shearwall stiffness, k_e: The ratio of a horizontal force applied at the eave to the corresponding deflection of an individual unattached wall. A wall is unattached when it is not connected to components that lie outside the plane of the wall.

3.9 frame stiffness, *k*: The ratio of a horizontal force applied at the eave to the corresponding deflection of the individual unclad post-frames.

3.10 frame spacing, *s*: The distance between frames. In the absence of stiff frames that resist lateral loads, the frame spacing is generally equated to the distance between adjacent trusses (or rafters) or to the model diaphragm width. Frame spacing defines the width (and therefore stiffness properties) of roof/ceiling diaphragm sections. Frame spacing may vary within a building.

3.11 metal cladding: The metal exterior and interior coverings, usually cold-formed aluminum or steel sheet, fastened to the wood framing.

3.12 model diaphragm: A laboratory tested diaphragm or a diaphragm analyzed using a validated structural model that is used to predict the behavior of a building diaphragm. Laboratory tested diaphragms should be sized, constructed, supported and tested in accordance with ASAE EP558. AISI S310 shall be considered to be a validated structural model to calculate the strength and stiffness of a profiled steel panel and its connectors, to a wood support.

3.13 post frame: A structural building frame consisting of a wood roof truss or rafters connected to vertical timber columns, or sidewall posts.

3.14 sidesway restraining force, *Q*: The total force applied to a frame by the roof/ceiling diaphragm.

3.15 shear transfer: The transfer of the resultant shear forces between individual sheets of cladding, between the ends of roof/ceiling diaphragms and frames and shear walls, or between the bottom of the shear walls and the base of the posts or foundation.

3.16 shearwall: An endwall or intermediate wall designed to transfer shear from the roof/ceiling diaphragm into the foundation structure.

3.17 wood frame: A structural building frame consisting of wood or wood-based materials. Wood trusses over studwalls and post and beam are examples of wood frames.

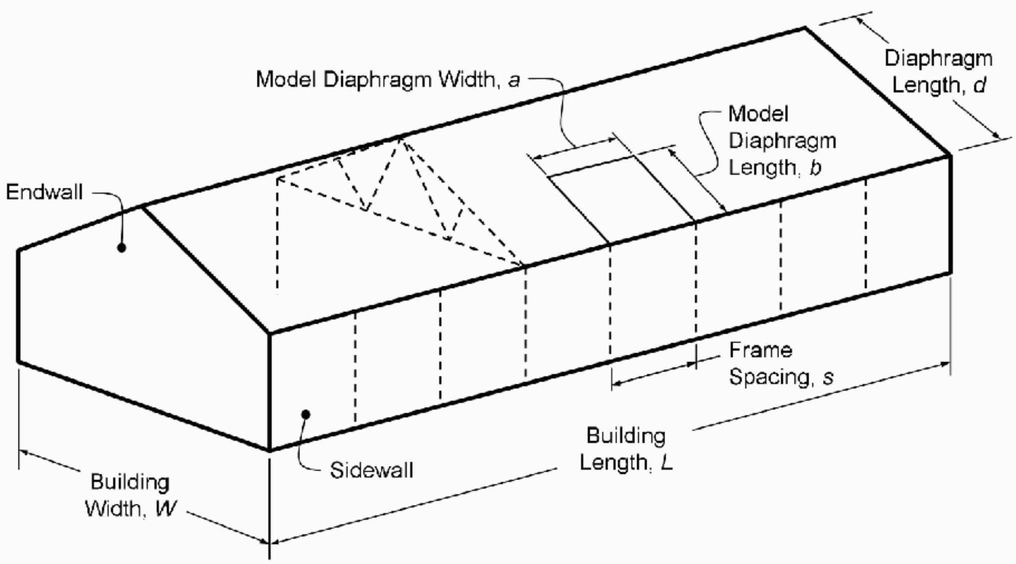

Figure 1 – Definition sketch for terminology

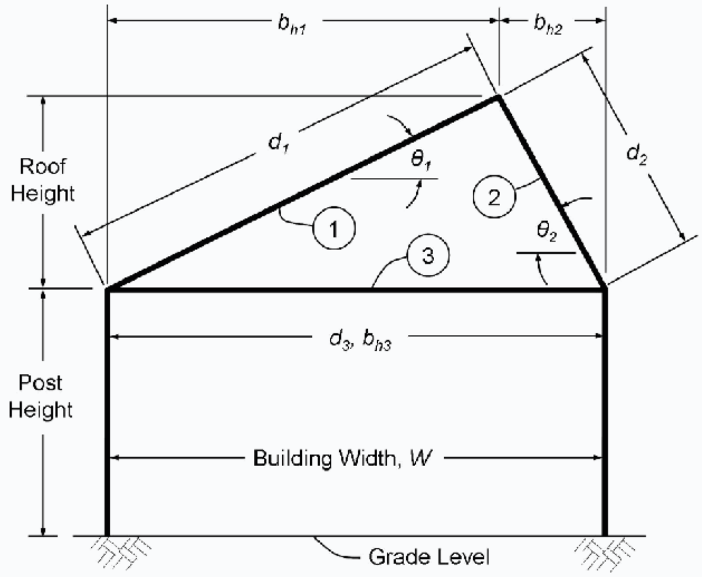

Figure 2 – Building cross section showing roof diaphragms 1 and 2, and ceiling diaphragm 3

4 Diaphragm Stiffness

4.1 General provisions. This section outlines procedures for determining the total horizontal shear stiffness, C_h, of a width, s, of the roof/ceiling assembly. This stiffness is defined as the horizontal load required to cause a horizontal displacement (in a direction parallel to the trusses/rafters) of the roof/ceiling assembly over a spacing, s (Figure 1). This stiffness can be obtained directly from full scale building tests (Gebremedhin *et al.*, 1992), validated structural models, or using procedures outlined in clause 4.2.

4.2 Total horizontal shear stiffness, C_h. The total horizontal diaphragm shear stiffness, C_h, for the frame spacing, s, of the roof / ceiling assembly is defined as:

$$C_h = \sum_{i=1}^{n} c_{h,i} \tag{1}$$

where:

$c_{h,i}$ = horizontal shear stiffness of diaphragm i with a width, s, from clause 4.3, kN/mm (lbf/in.);

n = number of individual roof and ceiling diaphragms in the roof/ceiling assembly (Figure 2).

When the frame spacing, s, or roof/ceiling diaphragm construction varies along the length of a building, C_h may vary, and the building requires special analysis (see clause 7.3).

4.2.1 Excluding diaphragms. Diaphragm analyses may be simplified by excluding from an analysis any diaphragm that is considerably less stiff than others in the roof/ceiling system. For example, where a ceiling diaphragm is much stiffer than the roof diaphragm(s), the stiffness of the roof diaphragm(s) may be excluded from total stiffness calculations (i.e., Equation 1). For diaphragms that are sheathed with dissimilar materials, the combined allowable design unit shear capacity shall be either two times the smaller allowable design unit shear capacity or the larger allowable design unit shear capacity, whichever is greater.

4.3 Horizontal shear stiffness of an individual diaphragm, $c_{h,i}$. The horizontal shear stiffness of an individual diaphragm can be calculated from the diaphragm's in-plane shear stiffness (Equation 2) or from the in-plane stiffness of a model diaphragm (Equation 3) (Anderson and Bundy, 1989). Model diaphragms used to predict the horizontal stiffness of a building diaphragm shall be functionally equivalent to the building diaphragm. ASAE

EP558 gives laboratory test procedures for obtaining model diaphragm shear stiffness.

$$c_{h,i} = c_{p,i}(\cos^2 \theta_i) \quad (2)$$

$$c_{h,i} = G(\cos \theta_i)(b_{h,i}/s) \quad (3)$$

where:

$c_{h,i}$ = horizontal shear stiffness of diaphragm i with width, s, and horizontal span $b_{h,i}$, kN/mm (lbf/in.);

$c_{p,i}$ = in-plane shear stiffness of diaphragm i with width, s, and horizontal span $b_{h,i}$, kN/mm (lbf/in.);

θ_i = slope from the horizontal of diaphragm i;

$G = c\,(a/b)$, effective shear modulus, kN/mm (lbf/in.);

$b_{h,i}$ = horizontal span of diaphragm i as measured parallel to trusses/rafters, m (ft);

s = frame spacing, m (ft);

c = in-plane shear stiffness of the model diaphragm, kN/mm (lbf/in.);

a = length of the model diaphragm as measured perpendicular to the direction of applied load, m (ft);

b = depth of the model diaphragm as measured parallel to the direction of applied load, m (ft).

5 Frame, Endwall, and Shearwall Stiffness

5.1 General provisions. Frames, endwalls, and intermediate shearwalls transfer roof/ceiling loads to the foundation. The amount of load that a frame, endwall, or shearwall attracts is dependent upon its in-plane stiffness.

5.2 Frame stiffness, *k*. A horizontal force, P, applied at the eave of a building frame will result in a horizontal displacement of the eave, Δ. The ratio of the force P to the horizontal displacement Δ is defined as the horizontal frame stiffness, k. Frame stiffness is generally obtained with a plane-frame structural analysis program. Frame stiffness is equal to zero when all posts in the frame are pin connected to both the truss and the base/foundation.

5.2.1 Frame stiffness can be calculated using Equation 4 when: (1) trusses/rafters are assumed to be pin-connected to the posts, and (2) the base of each post is assumed fixed.

$$k = 3\sum_{i=1}^{n}(E_i I_i)/H_i^3 \quad (4)$$

where:

k = frame stiffness, kN/mm (lbf/in.);

n = number of posts in the post-frame (normally 2);

E_i = modulus of elasticity of post i, kN/mm^2 (lbf/in.^{2});

I_i = moment of inertia of post i, mm^4 (in.^{4});

H_i = distance from base to pin connection of post i, mm (in.).

5.3 Endwall and shearwall stiffness, k_e. Endwall and shearwall stiffness, like frame stiffness, is defined as the ratio of a horizontal force, P, applied at the eave of the wall, to the resulting horizontal displacement, Δ. Endwall and shearwall stiffness can be obtained directly from full scale building tests (Gebremedhin et al, 1992), validated structural models, or from tests of functionally equivalent assemblies (Gebremedhin and Jorgensen, 1993). ASAE EP558 gives laboratory test procedures that can be used to determine the stiffness of functionally equivalent walls.

6 Eave Loads

6.1 General provisions. In diaphragm analysis, building loads are replaced by an equivalent set of horizontally acting, concentrated (i.e., point) loads. These loads are located at the eave of each frame, endwall, and shearwall (i.e., they are spaced a distance, *s*, apart), and therefore are referred to as eave loads. Eave loads and applied building loads are equivalent when they horizontally displace the eave an equal amount.

6.2 Eave loads, *R*, by plane-frame structural analysis. A horizontal restraint (vertical roller) is placed at the eave line as shown in Figure 3 and the structural analog is analyzed with all external loads in place. The horizontal reaction at the vertical roller support is numerically equal to the eave load, *R*. Note that the vertical roller should always be placed at the same location that horizontal load *P* was placed when determining frame stiffness (clause 5.2).

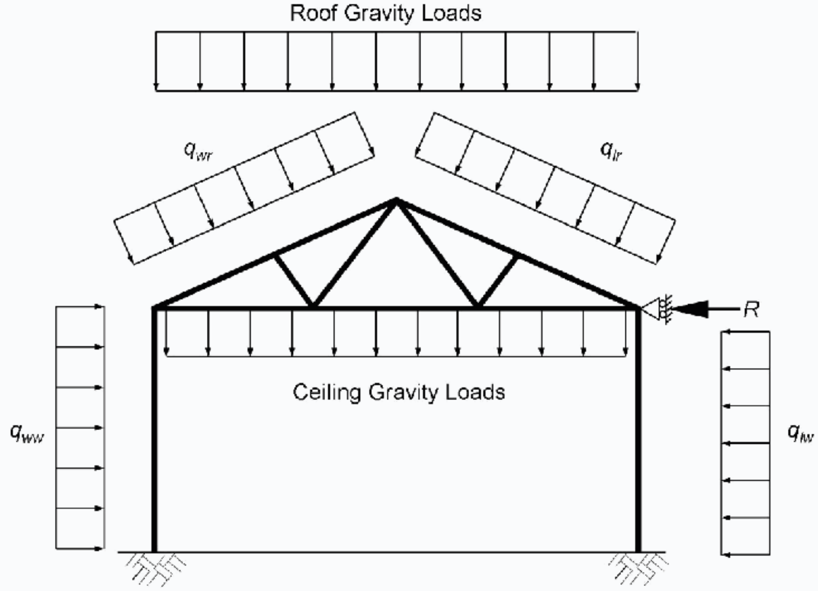

Figure 3 – Structural analog for obtaining eave load, *R*

6.3 Eave load calculation using frame base fixity factors. Eave loads resulting from wind loads can be estimated using Equation 5 (Bohnhoff, 1992b).

$$R = s\,(h_{wr}\,q_{wr} - h_{lr}\,q_{lr} + h_{ww}\,f_w\,q_{ww} - h_{lw}\,f_l\,q_{lw}) \qquad (5)$$

where:

R = eave load, kN (lb);

s = frame spacing for interior frames and shearwalls, m (ft);

= one-half the frame spacing for endwalls, m (ft);

h_{wr} = windward roof height, m (ft);

h_{lr} = leeward roof height, m (ft);

h_{ww} = windward wall height, m (ft);

h_{lw} = leeward wall height, m (ft);

q_{wr} = design windward roof pressure, kN/m^2 (lbf/ft^2);

q_{lr} = design leeward roof pressure, kN/m^2 (lbf/ft^2);

q_{ww} = design windward wall pressure, kN/m^2 (lbf/ft^2);

q_{lw} = design leeward wall pressure, kN/m^2 (lbf/ft^2);

f_w = windward post fixity factor;

f_l = leeward post fixity factor.

Inward acting wind pressures have positive signs, outward acting pressures are negative (see Figure 3). Equation 5 shall be modified for cases where pressures are not uniform over a wall or roof surface. In buildings with variable frame spacings, set *s* equal to the average of the frame spacings on each side of the eave load.

The frame base fixity factor(s), f_w and f_l, will equal 3/8 for a fixed condition at the groundline. The frame base fixity factor(s) will equal 1/2 for all other cases (see ASAE EP486).

For symmetrical base restraint and frame geometry, Equation 5 reduces to:

$$R = s\,[h_r\,(q_{wr} - q_{lr}) + h_w\,f\,(q_{ww} - q_{lw})] \tag{6}$$

where:

h_r = roof height, m (ft);

h_w = wall height, m (ft);

f = leeward and windward post base fixity factor.

6.4 Maximum total diaphragm shear, V_h. A conservative value of maximum total diaphragm shear, V_h, due to wind load may be calculated by multiplying the equations in clause 6.3 by one-half the building length instead of the frame spacing, *s*.

$$V_h = R\,L\,/\,(2s) \tag{7}$$

where:

V_h = maximum total diaphragm shear, kN (lbf);

R = eave load given by either Equation 5 or 6, kN (lbf);

L = building length, m (ft).

For symmetrical base restraint and frame geometry, the maximum diaphragm shear is conservatively estimated by Equation 7 where the eave load, R, is determined with Equation 6.

7 Load Distribution

7.1 General provisions. The distribution of horizontal loads to the various frames, walls, and diaphragms can be determined after diaphragm, frame, shearwall, and endwall stiffness values have been calculated and eave loads have been established. Use the procedure outlined in clause 7.2 to determine load distribution in a building without intermediate shearwalls and with constant values of: diaphragm stiffness, C_h; frame stiffness, k; endwall stiffness, k_e; and eave load, R. When one or more of these variables is not fixed, use methods referenced in clause 7.3. If the number of individual roof and ceiling diaphragms in the roof/ceiling assembly exceeds one, use the equation in clause 7.4 to determine the distribution of roof shear, V_h, to the individual diaphragms, and use the equation in clause 7.5 to determine the horizontal restraining force associated with each diaphragm.

7.2 Load distribution using tables. Tables 1 and 2 are used to determine the maximum total diaphragm shear V_h, and the maximum sidesway restraining force, Q, respectively, in buildings without intermediate shearwalls and with constant values of: diaphragm stiffness, C_h; frame stiffness, k; endwall stiffness, k_e; and eave load, R for interior frames. Input parameters for Tables 1 and 2 include: number of building frames (endwalls are counted as frames); ratio of diaphragm to frame stiffness, C_h/k; and ratio of endwall to frame stiffness, k_e/k. Tables 1 and 2 were developed by Dr. David R. Bohnhoff using a special version of the DAFI Program (Bohnhoff, 1992a). When establishing the values in Tables 1 and 2, it was assumed that the eave load, R, for the endwalls was one-half the load applied to each interior frame.

Table 1 – Shear force modifier (*mS*)

k_e / k	C_h / k	Number of Frames (endwalls are counted as frames) 3	4	5	6	7	8	9	10	11	12	13	14	15	16
5	5	0.88	1.14	1.33	1.45	1.53	1.59	1.62	1.65	1.66	1.67	1.68	1.68	1.68	1.68
5	10	0.89	1.19	1.42	1.59	1.72	1.82	1.89	1.94	1.98	2.00	2.02	2.04	2.05	2.06
5	20	0.90	1.22	1.48	1.68	1.85	1.98	2.08	2.16	2.23	2.29	2.33	2.36	2.39	2.41
5	50	0.91	1.24	1.51	1.74	1.93	2.10	2.23	2.35	2.45	2.53	2.60	2.67	2.72	2.77
5	100	0.91	1.24	1.53	1.76	1.97	2.14	2.29	2.42	2.53	2.63	2.72	2.80	2.87	2.93
5	200	0.91	1.25	1.53	1.77	1.98	2.16	2.32	2.46	2.58	2.69	2.79	2.87	2.95	3.02
5	500	0.91	1.25	1.54	1.78	1.99	2.18	2.34	2.48	2.61	2.73	2.83	2.92	3.01	3.08
5	1000	0.91	1.25	1.54	1.78	2.00	2.18	2.35	2.49	2.62	2.74	2.84	2.94	3.02	3.10
5	10000	0.91	1.25	1.54	1.79	2.00	2.19	2.35	2.50	2.63	2.75	2.86	2.95	3.04	3.12
10	5	0.91	1.23	1.46	1.62	1.73	1.81	1.86	1.89	1.91	1.92	1.93	1.93	1.94	1.94
10	10	0.93	1.29	1.58	1.81	1.99	2.13	2.23	2.31	2.36	2.40	2.44	2.46	2.48	2.49
10	20	0.94	1.33	1.66	1.94	2.17	2.36	2.52	2.66	2.76	2.85	2.92	2.98	3.03	3.06
10	50	0.95	1.35	1.70	2.02	2.30	2.55	2.76	2.96	3.12	3.27	3.40	3.51	3.61	3.70
10	100	0.95	1.36	1.72	2.05	2.35	2.62	2.86	3.08	3.27	3.45	3.61	3.76	3.89	4.01
10	200	0.95	1.36	1.73	2.07	2.37	2.65	2.91	3.14	3.36	3.56	3.74	3.90	4.06	4.20
10	500	0.95	1.36	1.74	2.08	2.39	2.68	2.94	3.19	3.41	3.62	3.82	4.00	4.17	4.32
10	1000	0.95	1.36	1.74	2.08	2.40	2.68	2.95	3.20	3.43	3.64	3.84	4.03	4.20	4.37
10	10000	0.95	1.36	1.74	2.08	2.40	2.69	2.96	3.21	3.45	3.66	3.87	4.06	4.24	4.41
20	5	0.93	1.28	1.54	1.73	1.85	1.94	2.00	2.03	2.06	2.07	2.09	2.09	2.10	2.10
20	10	0.95	1.35	1.68	1.95	2.16	2.33	2.45	2.55	2.62	2.67	2.71	2.74	2.76	2.78
20	20	0.96	1.39	1.76	2.09	2.38	2.62	2.83	3.00	3.14	3.25	3.35	3.43	3.49	3.54
20	50	0.97	1.41	1.82	2.20	2.54	2.85	3.14	3.39	3.62	3.83	4.01	4.17	4.32	4.44
20	100	0.97	1.42	1.84	2.23	2.60	2.95	3.26	3.56	3.83	4.09	4.32	4.54	4.74	4.92
20	200	0.97	1.42	1.85	2.25	2.63	2.99	3.33	3.65	3.95	4.24	4.50	4.75	4.99	5.21
20	500	0.98	1.43	1.86	2.27	2.65	3.02	3.38	3.71	4.03	4.33	4.62	4.90	5.16	5.41
20	1000	0.98	1.43	1.86	2.27	2.66	3.03	3.39	3.73	4.06	4.37	4.66	4.95	5.22	5.48
20	10000	0.98	1.43	1.86	2.27	2.67	3.04	3.40	3.75	4.08	4.40	4.70	5.00	5.28	5.55
50	5	0.95	1.31	1.59	1.79	1.93	2.03	2.09	2.14	2.16	2.18	2.19	2.20	2.20	2.21
50	10	0.97	1.38	1.74	2.04	2.28	2.46	2.61	2.72	2.80	2.86	2.91	2.94	2.97	2.99
50	20	0.98	1.43	1.83	2.20	2.52	2.80	3.04	3.25	3.41	3.55	3.67	3.77	3.84	3.91
50	50	0.99	1.45	1.90	2.32	2.71	3.08	3.42	3.73	4.01	4.26	4.50	4.70	4.89	5.06
50	100	0.99	1.46	1.92	2.36	2.78	3.18	3.57	3.93	4.27	4.60	4.90	5.18	5.45	5.69
50	200	0.99	1.47	1.93	2.38	2.82	3.24	3.65	4.04	4.42	4.79	5.14	5.47	5.79	6.09
50	500	0.99	1.47	1.94	2.40	2.84	3.28	3.70	4.12	4.52	4.91	5.29	5.66	6.02	6.37
50	1000	0.99	1.47	1.94	2.40	2.85	3.29	3.72	4.14	4.55	4.96	5.35	5.73	6.11	6.47
50	10000	0.99	1.47	1.94	2.40	2.86	3.30	3.74	4.16	4.58	5.00	5.40	5.80	6.19	6.57
100	5	0.95	1.32	1.61	1.82	1.96	2.06	2.13	2.17	2.20	2.22	2.23	2.24	2.24	2.25
100	10	0.97	1.40	1.76	2.07	2.32	2.51	2.67	2.78	2.87	2.93	2.98	3.02	3.05	3.06
100	20	0.98	1.44	1.86	2.24	2.58	2.87	3.12	3.34	3.52	3.67	3.79	3.89	3.98	4.05
100	50	0.99	1.47	1.92	2.36	2.77	3.16	3.52	3.85	4.16	4.43	4.69	4.91	5.12	5.30
100	100	0.99	1.48	1.95	2.40	2.85	3.27	3.68	4.07	4.44	4.79	5.13	5.44	5.73	6.01
100	200	0.99	1.48	1.96	2.43	2.89	3.33	3.77	4.19	4.61	5.00	5.39	5.76	6.12	6.46
100	500	1.00	1.48	1.97	2.44	2.91	3.37	3.83	4.27	4.71	5.14	5.56	5.98	6.38	6.78
100	1000	1.00	1.48	1.97	2.45	2.92	3.39	3.85	4.30	4.75	5.19	5.62	6.05	6.48	6.89
100	10000	1.00	1.49	1.97	2.45	2.93	3.40	3.86	4.32	4.78	5.23	5.68	6.12	6.56	7.00
1000	5	0.95	1.33	1.63	1.84	1.99	2.09	2.16	2.20	2.23	2.25	2.27	2.27	2.28	2.28
1000	10	0.98	1.41	1.78	2.10	2.36	2.56	2.72	2.84	2.93	3.00	3.05	3.09	3.12	3.14
1000	20	0.99	1.45	1.88	2.28	2.63	2.93	3.20	3.43	3.62	3.78	3.91	4.02	4.11	4.18
1000	50	1.00	1.48	1.95	2.40	2.83	3.24	3.62	3.97	4.30	4.60	4.87	5.12	5.34	5.54
1000	100	1.00	1.49	1.97	2.45	2.91	3.36	3.79	4.21	4.61	4.99	5.35	5.69	6.02	6.32
1000	200	1.00	1.49	1.99	2.47	2.95	3.42	3.89	4.34	4.78	5.22	5.64	6.05	6.44	6.83
1000	500	1.00	1.50	1.99	2.49	2.98	3.46	3.95	4.42	4.90	5.37	5.83	6.29	6.74	7.18
1000	1000	1.00	1.50	2.00	2.49	2.98	3.48	3.97	4.45	4.94	5.42	5.90	6.37	6.85	7.31
1000	10000	1.00	1.50	2.00	2.50	2.99	3.49	3.98	4.48	4.97	5.47	5.96	6.45	6.94	7.43
10000	5	0.96	1.33	1.63	1.84	1.99	2.09	2.16	2.21	2.24	2.26	2.27	2.28	2.28	2.29
10000	10	0.98	1.41	1.79	2.10	2.36	2.57	2.72	2.85	2.94	3.01	3.06	3.10	3.12	3.14
10000	20	0.99	1.45	1.89	2.28	2.63	2.94	3.21	3.43	3.63	3.79	3.92	4.03	4.12	4.19
10000	50	1.00	1.48	1.95	2.40	2.84	3.25	3.63	3.98	4.31	4.61	4.89	5.14	5.36	5.57
10000	100	1.00	1.49	1.98	2.45	2.92	3.37	3.80	4.22	4.62	5.01	5.37	5.72	6.05	6.35
10000	200	1.00	1.50	1.99	2.48	2.96	3.43	3.90	4.35	4.80	5.24	5.66	6.08	6.48	6.87
10000	500	1.00	1.50	2.00	2.49	2.98	3.47	3.96	4.44	4.92	5.39	5.86	6.32	6.78	7.23
10000	1000	1.00	1.50	2.00	2.50	2.99	3.49	3.98	4.47	4.96	5.44	5.93	6.41	6.88	7.36
10000	10000	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	4.99	5.49	5.99	6.49	6.98	7.48

Table 1 – Shear force modifier (*mS*)

k_e/k	C_h/k	Number of Frames (endwalls are counted as frames)													
		3	4	5	6	7	8	9	10	11	12	13	14	15	16
5	5	0.88	1.14	1.33	1.45	1.53	1.59	1.62	1.65	1.66	1.67	1.68	1.68	1.68	1.68
5	10	0.89	1.19	1.42	1.59	1.72	1.82	1.89	1.94	1.98	2.00	2.02	2.04	2.05	2.06
5	20	0.90	1.22	1.48	1.68	1.85	1.98	2.08	2.16	2.23	2.29	2.33	2.36	2.39	2.41
5	50	0.91	1.24	1.51	1.74	1.93	2.10	2.23	2.35	2.45	2.53	2.60	2.67	2.72	2.77
5	100	0.91	1.24	1.53	1.76	1.97	2.14	2.29	2.42	2.53	2.63	2.72	2.80	2.87	2.93
5	200	0.91	1.25	1.53	1.77	1.98	2.16	2.32	2.46	2.58	2.69	2.79	2.87	2.95	3.02
5	500	0.91	1.25	1.54	1.78	1.99	2.18	2.34	2.48	2.61	2.73	2.83	2.92	3.01	3.08
5	1000	0.91	1.25	1.54	1.78	2.00	2.18	2.35	2.49	2.62	2.74	2.84	2.94	3.02	3.10
5	10000	0.91	1.25	1.54	1.79	2.00	2.19	2.35	2.50	2.63	2.75	2.86	2.95	3.04	3.12
10	5	0.91	1.23	1.46	1.62	1.73	1.81	1.86	1.89	1.91	1.92	1.93	1.93	1.94	1.94
10	10	0.93	1.29	1.58	1.81	1.99	2.13	2.23	2.31	2.36	2.40	2.44	2.46	2.48	2.49
10	20	0.94	1.33	1.66	1.94	2.17	2.36	2.52	2.66	2.76	2.85	2.92	2.98	3.03	3.06
10	50	0.95	1.35	1.70	2.02	2.30	2.55	2.76	2.96	3.12	3.27	3.40	3.51	3.61	3.70
10	100	0.95	1.36	1.72	2.05	2.35	2.62	2.86	3.08	3.27	3.45	3.61	3.76	3.89	4.01
10	200	0.95	1.36	1.73	2.07	2.37	2.65	2.91	3.14	3.36	3.56	3.74	3.90	4.06	4.20
10	500	0.95	1.36	1.74	2.08	2.39	2.68	2.94	3.19	3.41	3.62	3.82	4.00	4.17	4.32
10	1000	0.95	1.36	1.74	2.08	2.40	2.68	2.95	3.20	3.43	3.64	3.84	4.03	4.20	4.37
10	10000	0.95	1.36	1.74	2.08	2.40	2.69	2.96	3.21	3.45	3.66	3.87	4.06	4.24	4.41
20	5	0.93	1.28	1.54	1.73	1.85	1.94	2.00	2.03	2.06	2.07	2.09	2.09	2.10	2.10
20	10	0.95	1.35	1.68	1.95	2.16	2.33	2.45	2.55	2.62	2.67	2.71	2.74	2.76	2.78
20	20	0.96	1.39	1.76	2.09	2.38	2.62	2.83	3.00	3.14	3.25	3.35	3.43	3.49	3.54
20	50	0.97	1.41	1.82	2.20	2.54	2.85	3.14	3.39	3.62	3.83	4.01	4.17	4.32	4.44
20	100	0.97	1.42	1.84	2.23	2.60	2.95	3.26	3.56	3.83	4.09	4.32	4.54	4.74	4.92
20	200	0.97	1.42	1.85	2.25	2.63	2.99	3.33	3.65	3.95	4.24	4.50	4.75	4.99	5.21
20	500	0.98	1.43	1.86	2.27	2.65	3.02	3.38	3.71	4.03	4.33	4.62	4.90	5.16	5.41
20	1000	0.98	1.43	1.86	2.27	2.66	3.03	3.39	3.73	4.06	4.37	4.66	4.95	5.22	5.48
20	10000	0.98	1.43	1.86	2.27	2.67	3.04	3.40	3.75	4.08	4.40	4.70	5.00	5.28	5.55
50	5	0.95	1.31	1.59	1.79	1.93	2.03	2.09	2.14	2.16	2.18	2.19	2.20	2.20	2.21
50	10	0.97	1.38	1.74	2.04	2.28	2.46	2.61	2.72	2.80	2.86	2.91	2.94	2.97	2.99
50	20	0.98	1.43	1.83	2.20	2.52	2.80	3.04	3.25	3.41	3.55	3.67	3.77	3.84	3.91
50	50	0.99	1.45	1.90	2.32	2.71	3.08	3.42	3.73	4.01	4.26	4.50	4.70	4.89	5.06
50	100	0.99	1.46	1.92	2.36	2.78	3.18	3.57	3.93	4.27	4.60	4.90	5.18	5.45	5.69
50	200	0.99	1.47	1.93	2.38	2.82	3.24	3.65	4.04	4.42	4.79	5.14	5.47	5.79	6.09
50	500	0.99	1.47	1.94	2.40	2.84	3.28	3.70	4.12	4.52	4.91	5.29	5.66	6.02	6.37
50	1000	0.99	1.47	1.94	2.40	2.85	3.29	3.72	4.14	4.55	4.96	5.35	5.73	6.11	6.47
50	10000	0.99	1.47	1.94	2.40	2.86	3.30	3.74	4.16	4.58	5.00	5.40	5.80	6.19	6.57
100	5	0.95	1.32	1.61	1.82	1.96	2.06	2.13	2.17	2.20	2.22	2.23	2.24	2.24	2.25
100	10	0.97	1.40	1.76	2.07	2.32	2.51	2.67	2.78	2.87	2.93	2.98	3.02	3.05	3.06
100	20	0.98	1.44	1.86	2.24	2.58	2.87	3.12	3.34	3.52	3.67	3.79	3.89	3.98	4.05
100	50	0.99	1.47	1.92	2.36	2.77	3.16	3.52	3.85	4.16	4.43	4.69	4.91	5.12	5.30
100	100	0.99	1.48	1.95	2.40	2.85	3.27	3.68	4.07	4.44	4.79	5.13	5.44	5.73	6.01
100	200	0.99	1.48	1.96	2.43	2.89	3.33	3.77	4.19	4.61	5.00	5.39	5.76	6.12	6.46
100	500	1.00	1.48	1.97	2.44	2.91	3.37	3.83	4.27	4.71	5.14	5.56	5.98	6.38	6.78
100	1000	1.00	1.48	1.97	2.45	2.92	3.39	3.85	4.30	4.75	5.19	5.62	6.05	6.48	6.89
100	10000	1.00	1.49	1.97	2.45	2.93	3.40	3.86	4.32	4.78	5.23	5.68	6.12	6.56	7.00
1000	5	0.95	1.33	1.63	1.84	1.99	2.09	2.16	2.20	2.23	2.25	2.27	2.27	2.28	2.28
1000	10	0.98	1.41	1.78	2.10	2.36	2.56	2.72	2.84	2.93	3.00	3.05	3.09	3.12	3.14
1000	20	0.99	1.45	1.88	2.28	2.63	2.93	3.20	3.43	3.62	3.78	3.91	4.02	4.11	4.18
1000	50	1.00	1.48	1.95	2.40	2.83	3.24	3.62	3.97	4.30	4.60	4.87	5.12	5.34	5.54
1000	100	1.00	1.49	1.97	2.45	2.91	3.36	3.79	4.21	4.61	4.99	5.35	5.69	6.02	6.32
1000	200	1.00	1.49	1.99	2.47	2.95	3.42	3.89	4.34	4.78	5.22	5.64	6.05	6.44	6.83
1000	500	1.00	1.50	1.99	2.49	2.98	3.46	3.95	4.42	4.90	5.37	5.83	6.29	6.74	7.18
1000	1000	1.00	1.50	2.00	2.49	2.98	3.48	3.97	4.45	4.94	5.42	5.90	6.37	6.85	7.31
1000	10000	1.00	1.50	2.00	2.50	2.99	3.49	3.98	4.48	4.97	5.47	5.96	6.45	6.94	7.43
10000	5	0.96	1.33	1.63	1.84	1.99	2.09	2.16	2.21	2.24	2.26	2.27	2.28	2.28	2.29
10000	10	0.98	1.41	1.79	2.10	2.36	2.57	2.72	2.85	2.94	3.01	3.06	3.10	3.12	3.14
10000	20	0.99	1.45	1.89	2.28	2.63	2.94	3.21	3.43	3.63	3.79	3.92	4.03	4.12	4.19
10000	50	1.00	1.48	1.95	2.40	2.84	3.25	3.63	3.98	4.31	4.61	4.89	5.14	5.36	5.57
10000	100	1.00	1.49	1.98	2.45	2.92	3.37	3.80	4.22	4.62	5.01	5.37	5.72	6.05	6.35
10000	200	1.00	1.50	1.99	2.48	2.96	3.43	3.90	4.35	4.80	5.24	5.66	6.08	6.48	6.87
10000	500	1.00	1.50	2.00	2.49	2.98	3.47	3.96	4.44	4.92	5.39	5.86	6.32	6.78	7.23
10000	1000	1.00	1.50	2.00	2.50	2.99	3.49	3.98	4.47	4.96	5.44	5.93	6.41	6.88	7.36
10000	10000	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	4.99	5.49	5.99	6.49	6.98	7.48

Table 1 *(continued)* – Shear force modifier (*mS*)

k_e/k	C_h/k	17	18	19	20	21	22	23	24	25	26	27	28	29	30
		Number of Frames (endwalls are counted as frames)													
5	5	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69
5	10	2.06	2.07	2.07	2.07	2.07	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08
5	20	2.43	2.44	2.46	2.46	2.47	2.48	2.48	2.49	2.49	2.49	2.49	2.49	2.50	2.50
5	50	2.81	2.84	2.87	2.89	2.92	2.94	2.95	2.97	2.98	2.99	3.00	3.01	3.01	3.02
5	100	2.98	3.03	3.07	3.11	3.14	3.18	3.20	3.23	3.25	3.27	3.29	3.30	3.32	3.33
5	200	3.09	3.14	3.19	3.24	3.28	3.32	3.36	3.39	3.42	3.45	3.48	3.50	3.52	3.54
5	500	3.15	3.22	3.28	3.33	3.38	3.43	3.47	3.51	3.55	3.58	3.61	3.64	3.67	3.70
5	1000	3.18	3.24	3.30	3.36	3.41	3.46	3.51	3.55	3.59	3.63	3.66	3.70	3.73	3.75
5	10000	3.20	3.27	3.33	3.39	3.45	3.50	3.54	3.59	3.63	3.67	3.71	3.74	3.78	3.81
10	5	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94
10	10	2.50	2.50	2.51	2.51	2.51	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52
10	20	3.09	3.12	3.14	3.15	3.16	3.17	3.18	3.19	3.19	3.20	3.20	3.20	3.21	3.21
10	50	3.77	3.84	3.89	3.94	3.99	4.02	4.06	4.09	4.11	4.13	4.15	4.17	4.18	4.19
10	100	4.12	4.21	4.30	4.38	4.45	4.52	4.58	4.63	4.68	4.72	4.76	4.80	4.83	4.86
10	200	4.33	4.45	4.56	4.66	4.76	4.84	4.92	5.00	5.07	5.13	5.19	5.25	5.30	5.35
10	500	4.47	4.61	4.74	4.86	4.97	5.08	5.18	5.27	5.36	5.44	5.52	5.60	5.67	5.73
10	1000	4.52	4.66	4.80	4.93	5.05	5.16	5.27	5.37	5.47	5.56	5.65	5.73	5.81	5.88
10	10000	4.57	4.72	4.86	4.99	5.12	5.24	5.36	5.47	5.57	5.67	5.76	5.86	5.94	6.03
20	5	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10
20	10	2.79	2.80	2.80	2.81	2.81	2.81	2.82	2.82	2.82	2.82	2.82	2.82	2.82	2.82
20	20	3.58	3.62	3.64	3.66	3.68	3.69	3.71	3.71	3.72	3.73	3.73	3.74	3.74	3.74
20	50	4.56	4.65	4.74	4.82	4.88	4.94	4.99	5.03	5.07	5.11	5.14	5.16	5.18	5.20
20	100	5.08	5.24	5.38	5.51	5.62	5.73	5.83	5.91	5.99	6.07	6.13	6.20	6.25	6.30
20	200	5.42	5.61	5.80	5.97	6.13	6.28	6.42	6.55	6.67	6.79	6.90	7.00	7.09	7.18
20	500	5.65	5.88	6.09	6.30	6.50	6.69	6.87	7.04	7.20	7.36	7.51	7.65	7.78	7.91
20	1000	5.73	5.97	6.20	6.42	6.64	6.84	7.03	7.22	7.40	7.58	7.74	7.90	8.06	8.21
20	10000	5.81	6.06	6.30	6.54	6.77	6.98	7.20	7.40	7.60	7.79	7.97	8.15	8.33	8.50
50	5	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21
50	10	3.00	3.01	3.02	3.02	3.03	3.03	3.03	3.03	3.03	3.04	3.04	3.04	3.04	3.04
50	20	3.96	4.00	4.03	4.06	4.08	4.10	4.11	4.12	4.13	4.14	4.14	4.15	4.15	4.16
50	50	5.20	5.33	5.45	5.55	5.64	5.72	5.79	5.85	5.90	5.95	5.99	6.03	6.06	6.08
50	100	5.92	6.13	6.33	6.51	6.67	6.83	6.97	7.10	7.21	7.32	7.42	7.51	7.59	7.67
50	200	6.39	6.66	6.93	7.18	7.41	7.64	7.85	8.05	8.24	8.42	8.59	8.75	8.90	9.04
50	500	6.71	7.04	7.36	7.67	7.97	8.26	8.54	8.81	9.07	9.32	9.57	9.80	10.03	10.25
50	1000	6.83	7.18	7.52	7.85	8.18	8.50	8.80	9.10	9.40	9.68	9.96	10.23	10.50	10.75
50	10000	6.94	7.31	7.68	8.03	8.38	8.72	9.06	9.39	9.72	10.04	10.35	10.66	10.97	11.27
100	5	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25
100	10	3.08	3.09	3.10	3.10	3.11	3.11	3.11	3.11	3.11	3.12	3.12	3.12	3.12	3.12
100	20	4.10	4.14	4.18	4.21	4.23	4.25	4.27	4.28	4.29	4.30	4.30	4.31	4.31	4.31
100	50	5.46	5.61	5.74	5.85	5.95	6.04	6.12	6.19	6.24	6.30	6.34	6.38	6.42	6.45
100	100	6.26	6.50	6.72	6.93	7.12	7.29	7.45	7.60	7.74	7.86	7.98	8.08	8.18	8.27
100	200	6.79	7.10	7.41	7.69	7.97	8.23	8.48	8.72	8.94	9.15	9.35	9.54	9.72	9.89
100	500	7.16	7.54	7.91	8.27	8.62	8.96	9.29	9.62	9.93	10.24	10.53	10.82	11.10	11.37
100	1000	7.30	7.70	8.10	8.49	8.87	9.24	9.61	9.97	10.33	10.67	11.01	11.35	11.68	12.00
100	10000	7.43	7.85	8.28	8.69	9.11	9.51	9.92	10.32	10.72	11.11	11.50	11.88	12.27	12.64
1000	5	2.28	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29
1000	10	3.15	3.16	3.17	3.18	3.18	3.18	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19
1000	20	4.24	4.29	4.32	4.36	4.38	4.40	4.42	4.43	4.44	4.45	4.46	4.46	4.47	4.47
1000	50	5.72	5.88	6.02	6.15	6.26	6.36	6.44	6.52	6.59	6.65	6.70	6.74	6.78	6.81
1000	100	6.61	6.87	7.12	7.35	7.57	7.77	7.95	8.12	8.28	8.43	8.56	8.68	8.79	8.89
1000	200	7.20	7.56	7.90	8.23	8.55	8.85	9.14	9.41	9.68	9.93	10.17	10.39	10.61	10.81
1000	500	7.62	8.05	8.48	8.89	9.30	9.70	10.10	10.48	10.86	11.22	11.58	11.93	12.27	12.61
1000	1000	7.78	8.24	8.69	9.15	9.59	10.04	10.47	10.91	11.33	11.75	12.17	12.58	12.99	13.39
1000	10000	7.92	8.41	8.90	9.39	9.87	10.36	10.84	11.33	11.81	12.29	12.77	13.25	13.73	14.20
10000	5	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29
10000	10	3.16	3.17	3.18	3.19	3.19	3.19	3.19	3.20	3.20	3.20	3.20	3.20	3.20	3.20
10000	20	4.25	4.30	4.34	4.37	4.40	4.42	4.43	4.45	4.46	4.46	4.47	4.48	4.48	4.48
10000	50	5.75	5.91	6.05	6.18	6.29	6.39	6.48	6.56	6.62	6.68	6.73	6.78	6.82	6.85
10000	100	6.64	6.91	7.17	7.40	7.62	7.82	8.01	8.18	8.34	8.49	8.62	8.74	8.86	8.96
10000	200	7.24	7.60	7.95	8.29	8.61	8.92	9.21	9.49	9.76	10.01	10.26	10.49	10.71	10.91
10000	500	7.67	8.11	8.54	8.96	9.38	9.78	10.18	10.57	10.96	11.33	11.70	12.06	12.41	12.75
10000	1000	7.83	8.30	8.76	9.22	9.67	10.12	10.57	11.01	11.44	11.88	12.30	12.72	13.14	13.55
10000	10000	7.98	8.47	8.97	9.46	9.96	10.45	10.94	11.44	11.93	12.42	12.91	13.40	13.89	14.38

Table 2 – Sidesway restraining force modifier (*mD*)

k_e/k	C_h/k	Number of Frames (endwalls counted as frames)													
		3	4	5	6	7	8	9	10	11	12	13	14	15	16
5	5	0.75	0.64	0.52	0.43	0.34	0.28	0.22	0.18	0.14	0.12	0.09	0.08	0.06	0.05
5	10	0.78	0.69	0.59	0.52	0.44	0.39	0.33	0.28	0.24	0.21	0.18	0.15	0.13	0.11
5	20	0.80	0.72	0.64	0.58	0.51	0.46	0.41	0.37	0.33	0.30	0.26	0.24	0.21	0.19
5	50	0.81	0.74	0.67	0.62	0.56	0.52	0.48	0.44	0.41	0.38	0.35	0.32	0.30	0.28
5	100	0.81	0.74	0.68	0.63	0.58	0.54	0.50	0.47	0.44	0.41	0.38	0.36	0.34	0.32
5	200	0.82	0.75	0.69	0.64	0.59	0.55	0.52	0.48	0.46	0.43	0.41	0.38	0.36	0.35
5	500	0.82	0.75	0.69	0.64	0.60	0.56	0.52	0.49	0.47	0.44	0.42	0.40	0.38	0.36
5	1000	0.82	0.75	0.69	0.64	0.60	0.56	0.53	0.50	0.47	0.45	0.42	0.40	0.39	0.37
5	10000	0.82	0.75	0.69	0.64	0.60	0.56	0.53	0.50	0.47	0.45	0.43	0.41	0.39	0.37
10	5	0.83	0.73	0.60	0.51	0.41	0.34	0.27	0.22	0.17	0.14	0.11	0.09	0.07	0.06
10	10	0.86	0.79	0.70	0.63	0.54	0.48	0.41	0.36	0.30	0.26	0.22	0.19	0.16	0.14
10	20	0.88	0.83	0.76	0.70	0.64	0.58	0.52	0.48	0.43	0.39	0.35	0.31	0.28	0.25
10	50	0.90	0.85	0.80	0.75	0.71	0.66	0.62	0.58	0.55	0.51	0.48	0.45	0.42	0.39
10	100	0.90	0.86	0.81	0.77	0.73	0.70	0.66	0.63	0.60	0.57	0.54	0.51	0.49	0.46
10	200	0.90	0.86	0.82	0.78	0.75	0.71	0.68	0.65	0.63	0.60	0.57	0.55	0.53	0.51
10	500	0.90	0.86	0.82	0.79	0.75	0.72	0.70	0.67	0.64	0.62	0.60	0.58	0.56	0.54
10	1000	0.90	0.86	0.83	0.79	0.76	0.73	0.70	0.67	0.65	0.63	0.61	0.59	0.57	0.55
10	10000	0.91	0.86	0.83	0.79	0.76	0.73	0.70	0.68	0.66	0.63	0.61	0.59	0.58	0.56
20	5	0.87	0.78	0.65	0.56	0.45	0.38	0.30	0.25	0.19	0.16	0.13	0.10	0.08	0.07
20	10	0.91	0.85	0.76	0.69	0.60	0.54	0.46	0.41	0.35	0.30	0.26	0.22	0.19	0.16
20	20	0.93	0.89	0.83	0.78	0.72	0.66	0.60	0.55	0.50	0.46	0.41	0.37	0.33	0.30
20	50	0.94	0.91	0.87	0.84	0.80	0.76	0.72	0.69	0.65	0.62	0.58	0.55	0.51	0.48
20	100	0.95	0.92	0.89	0.86	0.83	0.80	0.77	0.75	0.72	0.69	0.66	0.64	0.61	0.58
20	200	0.95	0.92	0.90	0.87	0.85	0.83	0.80	0.78	0.76	0.73	0.71	0.69	0.67	0.65
20	500	0.95	0.93	0.90	0.88	0.86	0.84	0.82	0.80	0.78	0.76	0.74	0.72	0.71	0.69
20	1000	0.95	0.93	0.91	0.88	0.86	0.84	0.82	0.81	0.79	0.77	0.75	0.74	0.72	0.71
20	10000	0.95	0.93	0.91	0.89	0.87	0.85	0.83	0.81	0.80	0.78	0.76	0.75	0.73	0.72
50	5	0.89	0.81	0.68	0.59	0.48	0.40	0.32	0.26	0.21	0.17	0.13	0.11	0.09	0.07
50	10	0.93	0.88	0.80	0.73	0.65	0.58	0.50	0.44	0.38	0.33	0.28	0.24	0.21	0.18
50	20	0.96	0.93	0.88	0.83	0.77	0.72	0.66	0.61	0.55	0.51	0.46	0.41	0.37	0.34
50	50	0.97	0.95	0.93	0.90	0.87	0.84	0.80	0.77	0.73	0.70	0.66	0.63	0.59	0.56
50	100	0.98	0.96	0.94	0.93	0.90	0.88	0.86	0.84	0.81	0.79	0.76	0.74	0.71	0.69
50	200	0.98	0.97	0.95	0.94	0.92	0.91	0.89	0.88	0.86	0.84	0.82	0.81	0.79	0.77
50	500	0.98	0.97	0.96	0.95	0.94	0.92	0.91	0.90	0.89	0.88	0.86	0.85	0.84	0.83
50	1000	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.88	0.87	0.86	0.85
50	10000	0.98	0.97	0.96	0.95	0.94	0.93	0.93	0.92	0.91	0.90	0.89	0.88	0.87	0.87
100	5	0.90	0.82	0.69	0.60	0.48	0.41	0.32	0.27	0.21	0.17	0.14	0.11	0.09	0.07
100	10	0.94	0.90	0.82	0.75	0.66	0.59	0.51	0.45	0.39	0.34	0.29	0.25	0.21	0.18
100	20	0.97	0.94	0.89	0.85	0.79	0.74	0.68	0.63	0.57	0.52	0.47	0.43	0.39	0.35
100	50	0.98	0.97	0.94	0.92	0.89	0.86	0.83	0.80	0.76	0.73	0.69	0.66	0.62	0.59
100	100	0.99	0.98	0.96	0.95	0.93	0.91	0.89	0.87	0.85	0.83	0.80	0.78	0.75	0.73
100	200	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.91	0.90	0.88	0.87	0.85	0.84	0.82
100	500	0.99	0.98	0.98	0.97	0.96	0.96	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.88
100	1000	0.99	0.98	0.98	0.97	0.97	0.96	0.95	0.95	0.94	0.93	0.93	0.92	0.91	0.91
100	10000	0.99	0.99	0.98	0.98	0.97	0.97	0.96	0.96	0.95	0.95	0.94	0.94	0.93	0.93
1000	5	0.91	0.83	0.70	0.61	0.49	0.41	0.33	0.27	0.22	0.18	0.14	0.11	0.09	0.07
1000	10	0.95	0.91	0.83	0.76	0.67	0.60	0.52	0.46	0.40	0.35	0.30	0.26	0.22	0.19
1000	20	0.98	0.95	0.91	0.87	0.81	0.76	0.70	0.65	0.59	0.54	0.49	0.45	0.40	0.36
1000	50	0.99	0.98	0.96	0.94	0.91	0.89	0.86	0.83	0.79	0.76	0.72	0.69	0.65	0.62
1000	100	0.99	0.99	0.98	0.97	0.95	0.94	0.92	0.90	0.88	0.86	0.84	0.82	0.79	0.77
1000	200	1.00	0.99	0.99	0.98	0.98	0.97	0.96	0.95	0.94	0.93	0.91	0.90	0.88	0.87
1000	500	1.00	1.00	0.99	0.99	0.99	0.99	0.98	0.98	0.97	0.97	0.96	0.95	0.95	0.94
1000	1000	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.97	0.97	0.97
1000	10000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99
10000	5	0.91	0.83	0.70	0.61	0.49	0.42	0.33	0.27	0.22	0.18	0.14	0.11	0.09	0.07
10000	10	0.95	0.91	0.83	0.76	0.68	0.61	0.53	0.46	0.40	0.35	0.30	0.26	0.22	0.19
10000	20	0.98	0.95	0.91	0.87	0.81	0.76	0.70	0.65	0.59	0.54	0.49	0.45	0.40	0.37
10000	50	0.99	0.98	0.96	0.94	0.92	0.89	0.86	0.83	0.79	0.76	0.72	0.69	0.65	0.62
10000	100	1.00	0.99	0.98	0.97	0.96	0.94	0.93	0.91	0.89	0.87	0.84	0.82	0.80	0.77
10000	200	1.00	1.00	0.99	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.90	0.89	0.87
10000	500	1.00	1.00	1.00	0.99	0.99	0.99	0.98	0.98	0.98	0.97	0.96	0.96	0.95	0.95
10000	1000	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.97
10000	10000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 2 *(continued)* – Sidesway restraining force modifier (*mD*)

k_e/k	C_h/k	Number of Frames (endwalls counted as frames)													
		17	18	19	20	21	22	23	24	25	26	27	28	29	30
5	5	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
5	10	0.09	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01
5	20	0.17	0.15	0.13	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.06	0.05	0.04	0.04
5	50	0.26	0.24	0.22	0.21	0.19	0.18	0.17	0.16	0.14	0.13	0.12	0.12	0.11	0.10
5	100	0.30	0.29	0.27	0.26	0.24	0.23	0.22	0.20	0.19	0.18	0.17	0.17	0.16	0.15
5	200	0.33	0.31	0.30	0.29	0.27	0.26	0.25	0.24	0.23	0.22	0.21	0.20	0.19	0.19
5	500	0.35	0.33	0.32	0.31	0.29	0.28	0.27	0.26	0.25	0.25	0.24	0.23	0.22	0.21
5	1000	0.35	0.34	0.33	0.31	0.30	0.29	0.28	0.27	0.26	0.25	0.25	0.24	0.23	0.23
5	10000	0.36	0.35	0.33	0.32	0.31	0.30	0.29	0.28	0.27	0.26	0.26	0.25	0.24	0.24
10	5	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
10	10	0.12	0.10	0.09	0.08	0.06	0.06	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.02
10	20	0.23	0.20	0.18	0.16	0.15	0.13	0.12	0.11	0.09	0.08	0.08	0.07	0.06	0.05
10	50	0.36	0.34	0.32	0.30	0.28	0.26	0.24	0.23	0.21	0.20	0.18	0.17	0.16	0.15
10	100	0.44	0.42	0.40	0.38	0.36	0.34	0.33	0.31	0.29	0.28	0.27	0.25	0.24	0.23
10	200	0.49	0.47	0.45	0.43	0.42	0.40	0.39	0.37	0.36	0.34	0.33	0.32	0.31	0.30
10	500	0.52	0.50	0.49	0.47	0.46	0.44	0.43	0.42	0.40	0.39	0.38	0.37	0.36	0.35
10	1000	0.53	0.52	0.50	0.49	0.47	0.46	0.45	0.43	0.42	0.41	0.40	0.39	0.38	0.37
10	10000	0.54	0.53	0.51	0.50	0.49	0.47	0.46	0.45	0.44	0.43	0.42	0.41	0.40	0.39
20	5	0.05	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00
20	10	0.14	0.12	0.10	0.09	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.03	0.02	0.02
20	20	0.27	0.24	0.22	0.20	0.17	0.16	0.14	0.13	0.11	0.10	0.09	0.08	0.07	0.06
20	50	0.45	0.42	0.40	0.37	0.35	0.33	0.30	0.28	0.27	0.25	0.23	0.22	0.20	0.19
20	100	0.56	0.53	0.51	0.49	0.47	0.45	0.43	0.41	0.39	0.37	0.35	0.34	0.32	0.31
20	200	0.63	0.61	0.59	0.57	0.55	0.53	0.52	0.50	0.48	0.47	0.45	0.44	0.42	0.41
20	500	0.67	0.66	0.64	0.63	0.61	0.60	0.59	0.57	0.56	0.55	0.53	0.52	0.51	0.50
20	1000	0.69	0.68	0.66	0.65	0.64	0.62	0.61	0.60	0.59	0.58	0.57	0.55	0.54	0.53
20	10000	0.71	0.69	0.68	0.67	0.66	0.65	0.64	0.63	0.62	0.61	0.60	0.59	0.58	0.57
50	5	0.06	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00
50	10	0.15	0.13	0.11	0.10	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02
50	20	0.30	0.27	0.24	0.22	0.20	0.18	0.16	0.14	0.13	0.11	0.10	0.09	0.08	0.07
50	50	0.52	0.49	0.46	0.44	0.41	0.38	0.36	0.34	0.31	0.29	0.27	0.26	0.24	0.22
50	100	0.66	0.64	0.61	0.59	0.56	0.54	0.52	0.50	0.47	0.45	0.43	0.41	0.40	0.38
50	200	0.75	0.73	0.71	0.69	0.68	0.66	0.64	0.62	0.60	0.59	0.57	0.55	0.54	0.52
50	500	0.81	0.80	0.79	0.78	0.76	0.75	0.74	0.73	0.71	0.70	0.69	0.68	0.67	0.65
50	1000	0.84	0.83	0.82	0.81	0.80	0.79	0.78	0.77	0.76	0.75	0.74	0.73	0.72	0.71
50	10000	0.86	0.85	0.84	0.84	0.83	0.82	0.81	0.81	0.80	0.79	0.79	0.78	0.77	0.77
100	5	0.06	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00
100	10	0.16	0.13	0.11	0.10	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02
100	20	0.31	0.28	0.25	0.23	0.20	0.18	0.16	0.15	0.13	0.12	0.11	0.09	0.08	0.08
100	50	0.55	0.52	0.49	0.46	0.43	0.41	0.38	0.36	0.33	0.31	0.29	0.27	0.25	0.24
100	100	0.70	0.68	0.65	0.63	0.60	0.58	0.56	0.53	0.51	0.49	0.47	0.45	0.43	0.41
100	200	0.80	0.78	0.77	0.75	0.73	0.71	0.69	0.68	0.66	0.64	0.62	0.61	0.59	0.57
100	500	0.87	0.86	0.85	0.84	0.83	0.82	0.81	0.80	0.79	0.77	0.76	0.75	0.74	0.73
100	1000	0.90	0.89	0.88	0.88	0.87	0.86	0.85	0.84	0.84	0.83	0.82	0.81	0.80	0.80
100	10000	0.92	0.92	0.91	0.91	0.90	0.90	0.90	0.89	0.89	0.88	0.88	0.87	0.87	0.86
1000	5	0.06	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00
1000	10	0.16	0.14	0.12	0.10	0.09	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.02	0.02
1000	20	0.33	0.29	0.26	0.24	0.21	0.19	0.17	0.15	0.14	0.12	0.11	0.10	0.09	0.08
1000	50	0.58	0.55	0.52	0.49	0.46	0.43	0.40	0.38	0.35	0.33	0.31	0.29	0.27	0.25
1000	100	0.74	0.72	0.69	0.67	0.64	0.62	0.60	0.57	0.55	0.53	0.50	0.48	0.46	0.44
1000	200	0.85	0.84	0.82	0.80	0.79	0.77	0.75	0.74	0.72	0.70	0.68	0.66	0.65	0.63
1000	500	0.93	0.93	0.92	0.91	0.90	0.89	0.88	0.87	0.86	0.85	0.84	0.83	0.82	0.81
1000	1000	0.96	0.96	0.95	0.95	0.94	0.94	0.93	0.93	0.92	0.92	0.91	0.90	0.90	0.89
1000	10000	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
10000	5	0.06	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00
10000	10	0.16	0.14	0.12	0.10	0.09	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.02	0.02
10000	20	0.33	0.30	0.26	0.24	0.21	0.19	0.17	0.15	0.14	0.12	0.11	0.10	0.09	0.08
10000	50	0.58	0.55	0.52	0.49	0.46	0.43	0.40	0.38	0.36	0.33	0.31	0.29	0.27	0.25
10000	100	0.75	0.72	0.70	0.67	0.65	0.62	0.60	0.58	0.55	0.53	0.51	0.49	0.47	0.45
10000	200	0.86	0.84	0.83	0.81	0.79	0.78	0.76	0.74	0.72	0.71	0.69	0.67	0.65	0.64
10000	500	0.94	0.93	0.92	0.92	0.91	0.90	0.89	0.88	0.87	0.86	0.85	0.84	0.83	0.82
10000	1000	0.97	0.96	0.96	0.96	0.95	0.95	0.94	0.94	0.93	0.93	0.92	0.91	0.91	0.90
10000	10000	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99

7.2.1 Maximum total diaphragm shear, V_h. Table 1 contains shear force modifiers or *mS* values. Multiply the appropriate *mS* value by eave load *R* from clause 6.2 or 6.3 to obtain maximum total diaphragm shear. This value is the total shear, V_h, in the endwalls and in the diaphragm sections adjacent to the endwalls. This value will be less than the conservative estimate calculated using the equations in clause 6.4.

7.2.2 Sidesway restraining force, *Q*. Table 2 contains sidesway restraining force factors or *mD* values. Multiply the appropriate *mD* value by eave load *R* from clause 6.2 or 6.3 to obtain the sidesway restraining force, *Q*. The sidesway restraining force is the total force applied to the critical frame by the roof/ceiling assembly. The critical frame in a symmetric building without interior shearwalls is always the one closest to the building midlength.

7.3 Load distribution — detailed analyses. The force distribution method (Anderson et al, 1989) and computer program DAFI (Bohnhoff, 1992) are two methods that can be used to determine load distribution in a building in which the stiffness of individual frames differ, endwalls differ in stiffness, intermediate shearwalls are present, and eave loads and diaphragm stiffness values vary from frame to frame. The force distribution method is an iterative method for hand-calculating load distribution that is procedurally identical to the classical method of moment distribution. The computer program DAFI automatically formulates and solves a set of equations to obtain eave deflections. Both methods output individual frame, shearwall, endwall, and diaphragm forces. Another specialized structural analysis software package to account for diaphragm action is METCLAD (Gebremedhin, 1987).

7.4 In-plane shear force in individual diaphragms, $V_{p,i}$. The maximum in-plane shear force in an individual diaphragm, $V_{p,i}$, is given as

$$V_{p,i} = (c_{h,i} / C_h)\ V_h / (\cos \theta_i) \quad (8)$$

where:

$V_{p,i}$ = maximum in-plane shear force in diaphragm *i*, kN (lbf);

$c_{h,i}$ = horizontal shear stiffness of diaphragm *i* with spacing s from clause 4.3, kN/mm (lbf/in.);

C_h = total horizontal diaphragm shear stiffness, C_h, for a spacing *s* of the roof/ceiling assembly, kN/mm (lbf/in.);

V_h = maximum total diaphragm shear from clause 6.4, 7.2.1, or 7.3, kN (lbf);

θ_i = slope from the horizontal of diaphragm *i*.

7.5 Sidesway restraining force — individual diaphragms, Q_i. The total sidesway force applied to the critical frame by an individual diaphragm is given as

$$Q_i = (c_{h,i} / C_h)\ Q \quad (9)$$

where:

Q_i = sidesway restraining force for diaphragm *i*, kN (lbf);

c_{hi} = horizontal shear stiffness of diaphragm *i* with spacing *s* from clause 4.3, kN/mm (lbf/in.);

C_h = total horizontal diaphragm shear stiffness, C_h, for a spacing *s* of the roof/ceiling assembly, kN/mm (lbf/in.);

Q = sidesway restraining force for the roof/ceiling assembly from clause 7.2.2 or 7.3, kN/mm (lbf/in.).

8 Building Diaphragm and Shearwall Design

8.1 General. All building components shall be checked to ensure that actual loads do not exceed allowable design values for all applicable load combinations.

8.2 Diaphragms. The maximum in-plane shear in a diaphragm, $V_{p,i}$, cannot exceed the allowable shear strength, $V_{a,i}$, multiplied by the diaphragm length:

$$V_{p,i} \leq V_{a,i}\ d_i \quad (10)$$

where:

$V_{p,i}$ = maximum in-plane shear force in diaphragm i from clause 7.4, kN (lbf);

$V_{a,i}$ =allowable in-plane shear strength of diaphragm i, kN/m (lbf/ft);

d_i = length of diaphragm i as measured parallel to trusses/ rafters (see Figure 2), m (ft);

= $b_{h,i}$ /cos θ_i;

$b_{h,i}$ = horizontal span of diaphragm i as measured parallel to trusses/rafters, m (ft).

The allowable in-plane shear strength, $V_{a,i}$, is obtained from tests (ASAE EP558) or from validated structural models as given in Section 9.

8.3 Diaphragm chords. The diaphragm chords shall be designed to resist axial forces caused by bending moments induced in the diaphragm by the applied loads. A conservative estimate of chord force is

$$P_{c,i} = (R/s)(c_{h,i}/C_h)\, L^2/(8\, b_{h,i}) \quad (11)$$

where:

$P_{c,i}$ = maximum chord force in diaphragm i, kN (lbf);

R = eave load from clause 6.2 or 6.3, kN (lbf);

s = frame spacing, m (ft);

$c_{h,i}$ = horizontal shear stiffness of diaphragm i with width s from clause 4.3, kN/mm (lbf/in.);

C_h = total horizontal diaphragm shear stiffness, C_h, for a width s of the roof/ceiling assembly, kN/mm (lbf/in.);

L = building length, m (ft);

$b_{h,i}$ = horizontal span of diaphragm i as measured parallel to trusses/rafters, m (ft).

More accurate chord forces may be used when estimated by full-scale tests or structural engineering analysis.

8.4 Diaphragm-to-wall connections. Provisions shall be made for the transfer of shear from roof and ceiling diaphragms to endwalls and intermediate shearwalls. The design strength of these connections may be proven by tests of a typical connection detail. Where applicable, the building designer may use the National Design Specifications (NDS) for Wood Construction to design this connection.

8.5 Shearwalls. Endwalls and intermediate shearwalls shall have sufficient shear strength to transmit the induced loads from roof and ceiling diaphragms to the foundation system. The allowable shear capacity of endwalls and intermediate shearwalls, V_e, is obtained from Section 9 of this standard, or from tests (ASAE EP558) or from validated structural models. For buildings without intermediate shearwalls, the allowable shear strength of the endwalls shall be greater than the maximum total diaphragm shear force, V_h, or

$$V_h \le V_e W \quad (12)$$

where:

V_h = maximum total diaphragm shear force, kN (lbf);

V_e = allowable unit shear capacity of the endwall, kN/m (lbf/ft);

W = building width, m (ft).

8.5.1 Doors and openings reduce the total shear capacity of walls. When doors or openings are present in an endwall, the following equation applies for the segmented shear wall approach:

$$V_h \le V_e(W - D_T) \quad (13)$$

where:

D_T = total width of doors and openings in the endwall, m (ft).

Note that this approach requires hold-downs at the ends of each shear wall segment.

8.5.2 The structural framing over doors or openings in walls acts as a drag strut transferring shear force across the opening. The header over the opening shall be designed to carry the force in tension and/or compression across the opening.

8.6 Shearwall-to-foundation connections. The connection system between endwalls and intermediate shearwalls and the foundation system shall be designed to resist the shear carried by the walls. The design of these connections may be proved by tests of a typical connection detail or by a calculation method appropriate for the foundation system.

8.7 Shearwall overturning. Diaphragm loading produces overturning moments in intermediate shearwalls and endwalls. These forces may be calculated using structural analyses that include the resisting action of sidewalls when they are present. ASAE EP486 is recommended for designing uplift resistance of embedded post foundations. For wall framing members attached to a slab, the connection between the members and slab should be designed by the provisions of the NDS.

8.8 Sidewall posts. Sidewall members (and frames) resist the lateral loads not transmitted to the foundation by endwalls and shearwalls. The post shall be designed for combined axial and bending moment according to the NDS. The moment and axial force are calculated by any method of frame analysis, using the design loads applied to a post-frame and the sidesway resisting forces from clause 7.5. Figure 4 gives a structural analog for a post-frame with the sidesway resisting forces distributed to the truss top and bottom chords as uniform loads, q_i.

8.9 Endwall members. Endwall members shall be designed to meet wind pressure loads normal to the endwall surface as well as other design loads.

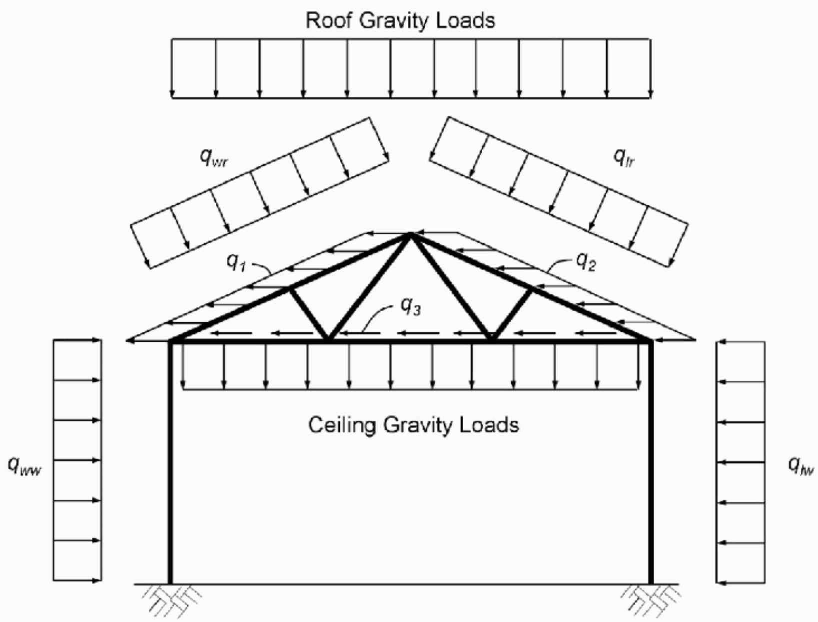

Figure 4 – Structural analog for a building with roof and ceiling diaphragms; sidesway restraining forces, Q_{is}, converted to distributed loads, q_{is}

9 Diaphragm Unit Shear Strength and Stiffness

9.1 General provisions. This section contains a procedure for determining the unit shear strength (clause 9.3), and the effective shear modulus (clause 9.4) of steel-clad, wood-framed diaphragms. The basis for the design values is the MCA procedure as originally developed by Luttrell (1992) and modified by Leflar (2008) and Aguilera (2014).

9.2 Construction specifications. Use of the values in Tables 3, 4, and 5 is restricted to diaphragms that meet the following specifications.

9.2.1. Purlins. Purlins shall be spaced 0.61 m (24 in.), be no less than three in number, have a specific gravity of at least 0.42, be oriented on-edge, and nailed to the top of rafters with 60d post-frame nails. A 60d post-frame nail is a hardened ring-shank nail with a diameter of 5.3 mm (0.207 in.) and a length 152 mm (6.0 in.).

9.2.2. Cladding major ribs. Major ribs shall have an on-center spacing of either 0.23 m (9 in.) or 0.30 (12 in.). Major rib height shall be between 19 and 25 mm (0.75 and 1.0 in.). Major rib bottom width shall be between 35 and 64 mm (1.4 and 2.5 in.), and major rib top width shall be between 13 and 19 mm (0.5 and 0.75 in.).

9.2.3. Field screw location. Screws located in the field of the cladding shall be placed in the flats at locations adjacent to the major rib as shown in Figure 5. Diaphragms *with* stitch screws into the cladding overlaps shall have field screws placed adjacent to, and on only *one* side of each major rib at purlin locations. Diaphragms *without* stitch screws into the cladding overlaps shall have field screws placed adjacent to, and on *both* sides of the major rib *at the cladding overlaps* at purlin locations. At end purlins, screws shall be placed adjacent to and on both sides of each major rib.

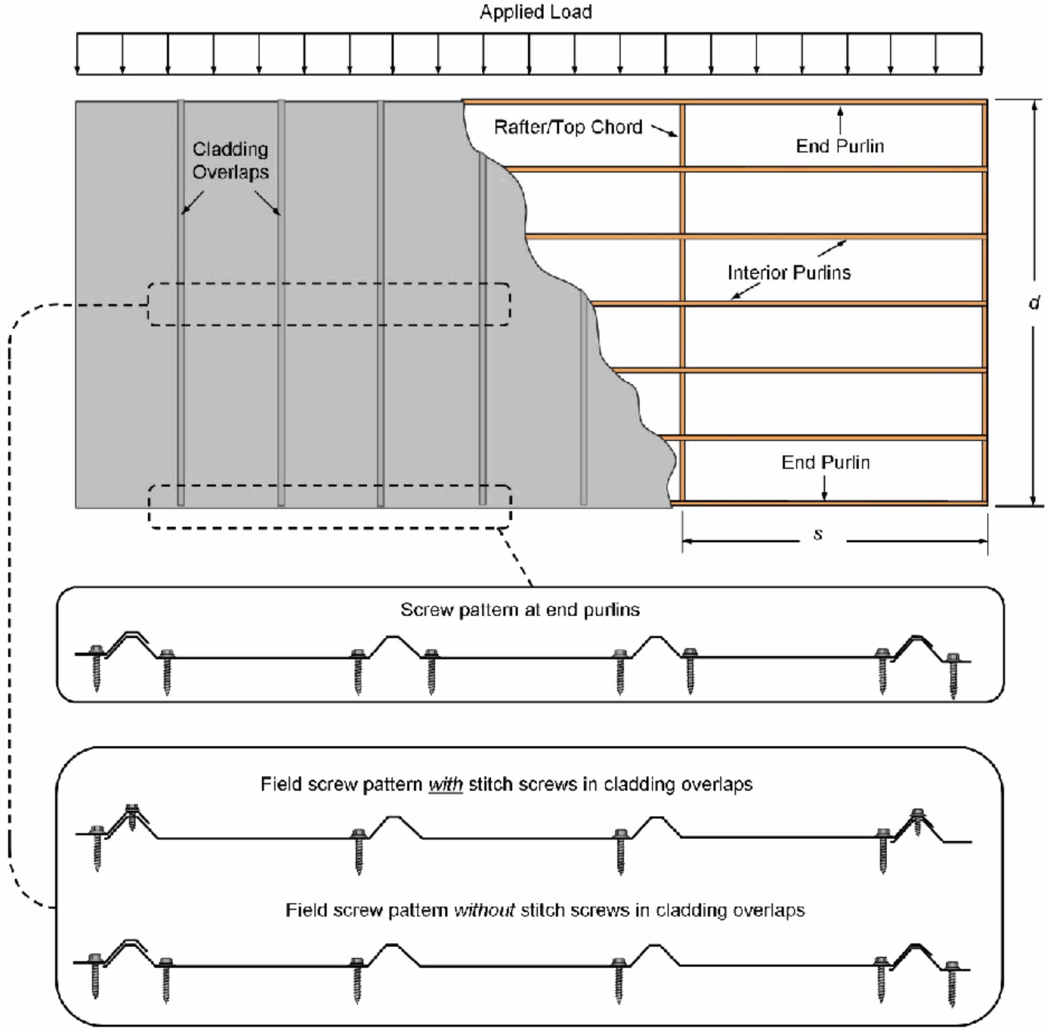

Figure 5 – Required field fastener locations for application of values in Tables 3, 4, 5 and 6. See clause 9.2.3.

Table 3 – ASD allowable diaphragm unit shear strength as governed by cladding fastener failure [a]

Field Screws (in Flats) Size and Length [c]	Stitch Screw Size [c]	Stitch Screw Spacing	0.23 m (9.0 in.) Major Rib Spacing			0.30 m (12.0 in.) Major Rib Spacing		
			V_{10} [b]	V_{50} [b]	G'	V_{10} [b]	V_{50} [b]	G'
mm (in.)	Size [c]	m (in.)	kN/m (lbf/ft)	kN/m (lbf/ft)	kN/mm (lbf/in)	kN/m (lbf/ft)	kN/m (lbf/ft)	kN/mm (lbf/in)
26 Gage Steel, 0.475 mm (0.0187 in.) thick, 345 MPa (50000 lbf/in²) minimum yield strength, 359 MPa (52000 lbf/in²) minimum ultimate strength								
No. 9 25 mm (1.0 in.)	No. 10	0.20 (8)	3.27 (224)	2.99 (205)	7.0 (4.0E4)	2.84 (194)	2.65 (181)	6.8 (3.9E4)
		0.30 (12)	2.73 (187)	2.38 (163)	5.7 (3.2E4)	2.40 (164)	2.14 (147)	5.6 (3.2E4)
		0.61 (24)	2.07 (142)	1.66 (114)	3.7 (2.1E4)	1.81 (124)	1.48 (101)	3.7 (2.1E4)
	No. 12	0.20 (8)	3.46 (237)	3.19 (219)	7.0 (4.0E4)	2.98 (204)	2.81 (192)	6.8 (3.9E4)
		0.30 (12)	2.89 (198)	2.55 (175)	5.7 (3.2E4)	2.53 (174)	2.29 (157)	5.6 (3.2E4)
		0.61 (24)	2.18 (149)	1.76 (121)	3.7 (2.1E4)	1.91 (131)	1.58 (108)	3.7 (2.1E4)
	None	NA	1.46 (100)	1.21 (83)	0.5 (2.8E3)	1.22 (84)	1.04 (71)	0.4 (2.4E3)
No. 10 25 mm (1.0 in.)	No. 10	0.20 (8)	3.37 (231)	3.06 (210)	7.0 (4.0E4)	2.93 (201)	2.72 (186)	6.8 (3.9E4)
		0.30 (12)	2.81 (192)	2.44 (167)	5.7 (32.E4)	2.47 (169)	2.20 (150)	5.6 (3.2E4)
		0.61 (24)	2.14 (147)	1.71 (117)	3.7 (2.1E4)	1.87 (128)	1.52 (104)	3.7 (2.1E4)
	No. 12	0.20 (8)	3.56 (244)	3.27 (224)	7.0 (4.0E4)	3.08 (211)	2.89 (198)	6.8 (3.9E4)
		0.30 (12)	2.98 (204)	2.61 (179)	5.7 (3.2E4)	2.61 (179)	2.35 (161)	5.6 (3.2E4)
		0.61 (24)	2.25 (154)	1.81 (124)	3.7 (2.1E4)	1.97 (135)	1.62 (111)	3.7 (2.1E4)
	None	NA	1.54 (106)	1.28 (88)	0.5 (2.8E3)	1.29 (89)	1.10 (75)	0.4 (2.4E3)
No. 10 38 mm (1.5 in.)	No. 10	0.20 (8)	3.37 (231)	3.06 (210)	7.0 (4.0E4)	2.93 (201)	2.72 (186)	6.8 (3.9E4)
		0.30 (12)	2.81 (192)	2.44 (167)	5.7 (3.2E4)	2.47 (169)	2.20 (150)	5.6 (3.2E4)
		0.61 (24)	2.14 (147)	1.71 (117)	3.7 (2.1E4)	1.87 (128)	1.52 (104)	3.7 (2.1E4)
	No. 12	0.20 (8)	3.56 (244)	3.27 (224)	7.0 (4.0E4)	3.08 (211)	2.89 (198)	6.8 (3.9E4)
		0.30 (12)	2.98 (204)	2.61 (179)	5.7 (3.2E4)	2.61 (179)	2.35 (161)	5.6 (3.2E4)
		0.61 (24)	2.25 (154)	1.81 (124)	3.7 (2.1E4)	1.97 (135)	1.62 (111)	3.7 (2.1E4)
	None	NA	1.54 (106)	1.28 (88)	0.5 (2.8E3)	1.29 (89)	1.10 (75)	0.4 (2.4E3)
No. 12 38 mm (1.5 in.)	No. 10	0.20 (8)	4.23 (290)	3.71 (254)	7.0 (4.0E4)	3.71 (254)	3.33 (228)	6.8 (3.9E4)
		0.30 (12)	3.57 (244)	2.98 (204)	5.7 (3.2E4)	3.12 (213)	2.67 (183)	5.6 (3.2E4)
		0.61 (24)	2.83 (194)	2.19 (150)	3.7 (2.1E4)	2.42 (166)	1.91 (131)	3.7 (2.1E4)
	No. 12	0.20 (8)	4.49 (307)	3.97 (272)	7.0 (4.0E4)	3.93 (269)	3.56 (244)	6.8 (3.9E4)
		0.30 (12)	3.76 (258)	3.18 (218)	5.7 (3.2E4)	3.29 (226)	2.85 (195)	5.6 (3.2E4)
		0.61 (24)	2.95 (202)	2.30 (158)	3.7 (2.1E4)	2.53 (174)	2.02 (138)	3.7 (2.1E4)
	None	NA	2.40 (165)	1.99 (136)	0.5 (2.8E3)	2.00 (137)	1.70 (117)	0.4 (2.4E3)
28 Gage Steel, 0.399 mm (0.0157 in.) thick, 552 MPa (80000 lbf/in²) minimum yield strength, 565 MPa (82000 lbf/in²) minimum ultimate strength								
No. 9 25 mm (1.0 in.)	No. 10	0.20 (8)	2.91 (199)	2.59 (178)	5.6 (3.2E4)	2.53 (173)	2.31 (158)	5.7 (3.3E4)
		0.30 (12)	2.43 (167)	2.07 (142)	4.8 (2.7E4)	2.12 (146)	1.85 (127)	4.8 (2.8E4)
		0.61 (24)	1.89 (130)	1.49 (102)	3.3 (1.9E4)	1.63 (111)	1.30 (89)	3.3 (1.9E4)
	No. 12	0.20 (8)	3.08 (211)	2.78 (190)	5.6 (3.2E4)	2.68 (183)	2.46 (169)	5.7 (3.3E4)
		0.30 (12)	2.57 (176)	2.21 (152)	4.8 (2.7E4)	2.25 (154)	1.98 (136)	4.8 (2.8E4)
		0.61 (24)	1.98 (136)	1.57 (107)	3.3 (1.9E4)	1.71 (117)	1.38 (95)	3.3 (1.9E4)
	None	NA	1.49 (102)	1.24 (85)	0.5 (2.8E3)	1.24 (85)	1.06 (73)	0.4 (2.4E3)
No. 10 25 mm (1.0 in.)	No. 10	0.20 (8)	2.99 (205)	2.66 (182)	5.6 (3.2E4)	2.61 (179)	2.37 (162)	4.8 (2.8E4)
		0.30 (12)	2.51 (172)	2.12 (146)	4.8 (2.7E4)	2.19 (150)	1.90 (130)	3.3 (1.9E4)
		0.61 (24)	1.96 (134)	1.53 (105)	3.3 (1.9E4)	1.68 (115)	1.34 (92)	5.7 (3.3E4)
	No. 12	0.20 (8)	3.17 (217)	2.84 (195)	5.6 (3.2E4)	2.76 (189)	2.53 (173)	4.8 (2.8E4)
		0.30 (12)	2.65 (182)	2.27 (156)	4.8 (2.7E4)	2.31 (159)	2.03 (139)	3.3 (1.9E4)
		0.61 (24)	2.05 (140)	1.61 (111)	3.3 (1.9E4)	1.76 (121)	1.42 (97)	0.4 (2.4E3)
	None	NA	1.58 (108)	1.31 (89)	0.5 (2.8E3)	1.31 (90)	1.12 (77)	4.8 (2.8E4)
No. 10 38 mm (1.5 in.)	No. 10	0.20 (8)	3.29 (225)	2.87 (197)	5.6 (3.2E4)	2.87 (197)	2.56 (176)	4.8 (2.8E4)
		0.30 (12)	2.77 (190)	2.31 (158)	4.8 (2.7E4)	2.41 (165)	2.06 (141)	3.3 (1.9E4)
		0.61 (24)	2.20 (151)	1.71 (117)	3.3 (1.9E4)	1.88 (129)	1.48 (101)	5.7 (3.3E4)
	No. 12	0.20 (8)	3.48 (238)	3.07 (211)	5.6 (3.2E4)	3.04 (208)	2.74 (188)	4.8 (2.8E4)
		0.30 (12)	2.92 (200)	2.46 (169)	4.8 (2.7E4)	2.55 (174)	2.20 (151)	3.3 (1.9E4)
		0.61 (24)	2.30 (157)	1.79 (123)	3.3 (1.0E4)	1.97 (135)	1.56 (107)	0.4 (2.4E3)
	None	NA	1.89 (129)	1.56 (107)	0.5 (2.8E3)	1.57 (108)	1.34 (92)	4.8 (2.8E4)
No. 12 38 mm (1.5 in.)	No. 10	0.20 (8)	3.74 (256)	3.20 (219)	5.6 (3.2E4)	3.26 (223)	2.85 (196)	4.8 (2.8E4)
		0.30 (12)	3.20 (219)	2.61 (179)	4.8 (2.7E4)	2.76 (189)	2.31 (158)	3.3 (1.9E4)
		0.61 (24)	2.61 (179)	1.99 (137)	3.3 (1.9E4)	2.20 (151)	1.71 (117)	5.7 (3.3E4)
	No. 12	0.20 (8)	3.95 (271)	3.42 (234)	5.6 (3.2E4)	3.45 (236)	3.05 (209)	4.8 (2.8E4)
		0.30 (12)	3.35 (230)	2.77 (190)	4.8 (2.7E4)	2.91 (199)	2.46 (168)	3.3 (1.9E4)
		0.61 (24)	2.70 (185)	2.08 (142)	3.3 (1.9E4)	2.29 (157)	1.79 (123)	0.4 (2.4E3)
	None	NA	2.40 (165)	1.99 (136)	0.5 (2.8E3)	2.00 (137)	1.70 (117)	4.8 (2.8E4)

a Diaphragms must be constructed in accordance with clause 9.2.
b An ASD safety factor of 2.5 has been applied to V_{10} and V_{50} values.
c Screw sizes correspond to the following crest diameters: No. 9 = 4.50 mm (0.177 in.), No. 10 = 4.75 mm (0.187 in.), and No. 12 = 5.40 mm (0.211 in.)

Table 3 *(continued)* – ASD allowable diaphragm unit shear strength as governed by cladding fastener failure [a]

Field Screws (in Flats) Size and Length [c]	Stitch Screw Size [c]	Stitch Screw Spacing	0.23 m (9.0 in.) Major Rib Spacing			0.30 m (12.0 in.) Major Rib Spacing		
			V_{10} [b]	V_{50} [b]	G'	V_{10} [b]	V_{50} [b]	G'
mm (in.)	Size [c]	m (in.)	kN/m (lbf/ft)	kN/m (lbf/ft)	kN/mm (lbf/in)	kN/m (lbf/ft)	kN/m (lbf/ft)	kN/mm (lbf/in)
29 Gage Steel, 0.361 mm (0.0142 in.) thick, 552 MPa (80000 lbf/in^2) minimum yield strength, 565 MPa (82000 lbf/in^2) minimum ultimate strength								
No. 9 25 mm (1.0 in.)	No. 10	0.20 (8)	2.71 (186)	2.38 (163)	5.1 (2.9E4)	2.36 (162)	2.13 (146)	5.2 (3.0E4)
		0.30 (12)	2.28 (156)	1.91 (131)	4.4 (2.5E4)	1.98 (136)	1.71 (117)	4.4 (2.5E4)
		0.61 (24)	1.79 (123)	1.40 (96)	3.1 (1.8E4)	1.53 (105)	1.22 (83)	3.1 (1.8E4)
	No. 12	0.20 (8)	2.87 (197)	2.55 (175)	5.1 (2.9E4)	2.50 (171)	2.28 (156)	5.2 (3.0E4)
		0.30 (12)	2.40 (165)	2.04 (140)	4.4 (2.5E4)	2.10 (144)	1.82 (125)	4.4 (2.5E4)
		0.61 (24)	1.87 (128)	1.47 (101)	3.1 (1.8E4)	1.61 (110)	1.28 (88)	3.1 (1.8E4)
	None	NA	1.49 (102)	1.24 (85)	0.5 (2.8E3)	1.24 (85)	1.06 (73)	0.4 (2.4E3)
No. 10 25 mm (1.0 in.)	No. 10	0.20 (8)	2.79 (191)	2.44 (167)	5.1 (2.9E4)	2.43 (167)	2.18 (149)	5.2 (3.0E4)
		0.30 (12)	2.35 (161)	1.96 (135)	4.4 (2.5E4)	2.04 (140)	1.75 (120)	4.4 (2.5E4)
		0.61 (24)	1.86 (128)	1.44 (99)	3.1 (1.8E4)	1.59 (109)	1.25 (86)	3.1 (1.8E4)
	No. 12	0.20 (8)	2.95 (202)	2.61 (179)	5.1 (2.9E4)	2.57 (176)	2.33 (160)	5.2 (3.0E4)
		0.30 (12)	2.48 (170)	2.09 (143)	4.4 (2.5E4)	2.16 (148)	1.87 (128)	4.4 (2.5E4)
		0.61 (24)	1.94 (133)	1.52 (104)	3.1 (1.8E4)	1.66 (114)	1.32 (91)	3.1 (1.8E4)
	None	NA	1.58 (108)	1.31 (89)	0.5 (2.8E3)	1.31 (90)	1.12 (77)	0.4 (2.4E3)
No. 10 38 mm (1.5 in.)	No. 10	0.20 (8)	3.03 (208)	2.62 (179)	5.1 (2.9E4)	2.64 (181)	2.34 (160)	5.2 (3.0E4)
		0.30 (12)	2.57 (176)	2.12 (145)	4.4 (2.5E4)	2.23 (153)	1.88 (129)	4.4 (2.5E4)
		0.61 (24)	2.07 (142)	1.59 (109)	3.1 (1.8E4)	1.76 (120)	1.37 (94)	3.1 (1.8E4)
	No. 12	0.20 (8)	3.21 (220)	2.80 (192)	5.1 (2.9E4)	2.80 (192)	2.50 (171)	5.2 (3.0E4)
		0.30 (12)	2.70 (185)	2.26 (155)	4.4 (2.5E4)	2.35 (161)	2.01 (137)	4.4 (2.5E4)
		0.61 (24)	2.15 (148)	1.67 (114)	3.1 (1.8E4)	1.83 (126)	1.44 (99)	3.1 (1.8E4)
	None	NA	1.85 (127)	1.53 (105)	0.5 (2.8E3)	1.54 (105)	1.31 (90)	0.4 (2.4E3)
No. 12 38 mm (1.5 in.)	No. 10	0.20 (8)	3.38 (232)	2.87 (197)	5.1 (2.9E4)	2.95 (202)	2.56 (175)	5.2 (3.0E4)
		0.30 (12)	2.91 (199)	2.36 (162)	4.4 (2.5E4)	2.50 (172)	2.08 (142)	4.4 (2.5E4)
		0.61 (24)	2.40 (164)	1.82 (125)	3.1 (1.8E4)	2.02 (138)	1.56 (107)	3.1 (1.8E4)
	No. 12	0.20 (8)	3.57 (245)	3.06 (210)	5.1 (2.9E4)	3.11 (213)	2.73 (187)	5.2 (3.0E4)
		0.30 (12)	3.05 (209)	2.50 (171)	4.4 (2.5E4)	2.63 (180)	2.21 (151)	4.4 (2.5E4)
		0.61 (24)	2.48 (170)	1.90 (130)	3.1 (1.8E4)	2.09 (144)	1.63 (112)	3.1 (1.8E4)
	None	NA	2.26 (155)	1.87 (128)	0.5 (2.8E3)	1.88 (129)	1.60 (110)	0.4 (2.4E3)
30 Gage Steel, 0.323 mm (0.0127 in.) thick, 552 MPa (80000 lbf/in^2) minimum yield strength, 565 MPa (82000 lbf/in^2) minimum ultimate strength								
No. 9 25 mm (1.0 in.)	No. 10	0.20 (8)	2.49 (171)	2.16 (148)	4.5 (2.6E4)	2.17 (149)	1.93 (132)	4.6 (2.6E4)
		0.30 (12)	2.11 (145)	1.75 (120)	3.9 (2.2E4)	1.83 (125)	1.55 (106)	3.9 (2.2E4)
		0.61 (24)	1.70 (116)	1.31 (89)	2.9 (1.6E4)	1.44 (99)	1.13 (77)	2.9 (1.6E4)
	No. 12	0.20 (8)	2.64 (181)	2.31 (158)	4.5 (2.6E4)	2.30 (158)	2.06 (141)	4.6 (2.6E4)
		0.30 (12)	2.22 (152)	1.86 (127)	3.9 (2.2E4)	1.93 (132)	1.65 (113)	3.9 (2.2E4)
		0.61 (24)	1.76 (121)	1.37 (94)	2.9 (1.6E4)	1.50 (103)	1.19 (81)	2.9 (1.6E4)
	None	NA	1.49 (102)	1.24 (85)	0.5 (2.8E3)	1.24 (85)	1.06 (73)	0.4 (2.4E3)
No. 10 25 mm (1.0 in.)	No. 10	0.20 (8)	2.57 (176)	2.21 (152)	4.5 (2.6E4)	2.24 (153)	1.98 (135)	4.6 (2.6E4)
		0.30 (12)	2.18 (149)	1.80 (123)	3.9 (2.2E4)	1.89 (129)	1.59 (109)	3.9 (2.2E4)
		0.61 (24)	1.76 (121)	1.35 (93)	2.9 (1.6E4)	1.49 (102)	1.16 (80)	2.9 (1.6E4)
	No. 12	0.20 (8)	2.71 (186)	2.37 (162)	4.5 (2.6E4)	2.37 (162)	2.11 (145)	4.6 (2.6E4)
		0.30 (12)	2.29 (157)	1.91 (131)	3.9 (2.2E4)	1.99 (136)	1.70 (116)	3.9 (2.2E4)
		0.61 (24)	1.83 (125)	1.41 (97)	2.9 (1.6E4)	1.56 (107)	1.22 (84)	2.9 (1.6E4)
	None	NA	1.58 (108)	1.31 (89)	0.5 (2.8E3)	1.31 (90)	1.12 (77)	0.4 (2.4E3)
No. 10 38 mm (1.5 in.)	No. 10	0.20 (8)	2.62 (180)	2.25 (154)	4.5 (2.6E4)	2.29 (157)	2.01 (138)	4.6 (2.6E4)
		0.30 (12)	2.23 (153)	1.83 (126)	3.9 (2.2E4)	1.93 (132)	1.62 (111)	3.9 (2.2E4)
		0.61 (24)	1.81 (124)	1.39 (95)	2.9 (1.6E4)	1.53 (105)	1.19 (82)	2.9 (1.6E4)
	No. 12	0.20 (8)	2.77 (190)	2.41 (165)	4.5 (2.6E4)	2.42 (166)	2.15 (147)	4.6 (2.6E4)
		0.30 (12)	2.34 (161)	1.95 (133)	3.9 (2.2E4)	2.04 (139)	1.73 (118)	3.9 (2.2E4)
		0.61 (24)	1.88 (129)	1.45 (99)	2.9 (1.6E4)	1.60 (109)	1.25 (86)	2.9 (1.6E4)
	None	NA	1.64 (112)	1.36 (93)	0.5 (2.8E3)	1.37 (94)	1.16 (80)	0.4 (2.4E3)
No. 12 38 mm (1.5 in.)	No. 10	0.20 (8)	2.84 (194)	2.41 (165)	4.5 (2.6E4)	2.47 (169)	2.14 (147)	4.6 (2.6E4)
		0.30 (12)	2.44 (167)	1.98 (136)	3.9 (2.2 E4)	2.10 (144)	1.74 (119)	3.9 (2.2E4)
		0.61 (24)	2.01 (138)	1.53 (105)	2.9 (1.6E4)	1.69 (116)	1.30 (89)	2.9 (1.6E4)
	No. 12	0.20 (8)	2.99 (205)	2.57 (176)	4.5 (2.6E4)	2.61 (179)	2.29 (157)	4.6 (2.6E4)
		0.30 (12)	2.55 (175)	2.09 (143)	3.9 (2.2E4)	2.21 (151)	1.85 (127)	3.9 (2.2E4)
		0.61 (24)	2.08 (142)	1.59 (109)	2.9 (1.6E4)	1.76 (120)	1.36 (93)	2.9 (1.6E4)
	None	NA	1.89 (130)	1.57 (107	0.5 (2.8E3)	1.58 (108)	1.34 (92)	0.4 (2.4E3)

a Diaphragms must be constructed in accordance with clause 9.2.
b An ASD safety factor of 2.5 has been applied to V_{10} and V_{50} values.
c Screw sizes correspond to the following crest diameters: No. 9 = 4.50 mm (0.177 in.), No. 10 = 4.75 mm (0.187 in.), and No. 12 = 5.40 mm (0.211 in.)

Table 4 – Adjustment factor for diaphragm length, F_L*

Length m (ft)	F_L*	Length m (ft)	F_L*	Length m (ft)	F_L*	Length m (ft)	F_L*
3.0 (10)	1.00	6.1 (20)	0.38	9.1 (30)	0.17	12.2 (40)	0.06
3.3 (11)	0.89	6.4 (21)	0.35	9.4 (31)	0.15	12.5 (41)	0.05
3.7 (12)	0.79	6.7 (22)	0.32	9.7 (32)	0.14	12.8 (42)	0.05
4.0 (13)	0.71	7.0 (23)	0.29	10.1 (33)	0.13	13.1 (43)	0.04
4.3 (14)	0.64	7.3 (24)	0.27	10.4 (34)	0.12	13.4 (44)	0.03
4.6 (15)	0.58	7.6 (25)	0.25	10.7 (35)	0.11	13.7 (45)	0.03
4.9 (16)	0.53	7.9 (26)	0.23	11.0 (36)	0.10	14.0 (46)	0.02
5.2 (17)	0.49	8.2 (27)	0.21	11.3 (37)	0.09	14.3 (47)	0.02
5.5 (18)	0.44	8.5 (28)	0.20	11.6 (38)	0.08	14.6 (48)	0.01
5.8 (19)	0.41	8.8 (29)	0.18	11.9 (39)	0.07	14.9 (49)	0.01
						15.2 (50)	0.00

* Adjustment factor equation: F_L = (3.81 m) /d_i – 0.25 = (12.5 ft) /d_i – 0.25

9.2.4. Blocking. Blocking shall be placed between purlins at locations where diaphragm loads transfer to shear walls. Diaphragms with stitch screws spaced 0.20, 0.30 and 0.61 m (8, 12 and 24 in.) on center require structural screws into the blocking at a spacing of 0.20, 0.30 and 0.30 m (8, 12 and 12 in.) on center, respectively, at locations where diaphragm loads transfer to shear walls.

9.3 Allowable diaphragm unit shear strength. Allowable diaphragm unit shear strength, $V_{a,i}$, is governed by either cladding fastener failure (clause 9.3.1) or cladding buckling (clause 9.3.2). The lowest of the unit shear strengths calculated using clauses 9.3.1 and 9.3.2 governs. Calculated values are for allowable stress design (ASD).

9.3.1 Allowable diaphragm unit shear strength as governed by cladding fastener failure. Table 3 provides ASD unit shear strength values as governed by cladding fastener failure. Values V_{10} and V_{50} in Table 3 are applicable to 3.0 m (10 ft) and 15.2 m (50 ft) length diaphragms, respectively. For diaphragms with lengths between 3.0 and 15.2 m, use Equation 14 to calculate unit shear strength. An ASD safety factor of 2.5 is included in all unit shear strength values in Table 3.

$$V_{a,i} = F_L\,(V_{10} - V_{50}) + V_{50} \tag{14}$$

where:

$V_{a,i}$ = allowable in-plane shear strength of diaphragm i, kN/m (lbf/ft);

F_L = adjustment factor for diaphragm length from Table 4, dimensionless;

= 3.81 m / d_i – 0.25

= 12.5 ft /d_i – 0.25

d_i = length of the building diaphragm in the plane of the diaphragm, m (ft);

V_{10} = allowable design unit shear strength for 3.0 m (10 ft) long diaphragm, kN/m (lbf/ft);

V_{50} = allowable design unit shear strength for 15.2 m (50 ft) long diaphragm, kN/m (lbf/ft).

9.3.2 Allowable diaphragm unit shear strength as governed by cladding buckling. Table 5 provides diaphragm unit shear strength values as governed by cladding buckling. The buckling unit shear strength is dependent on the dimensions of the major rib (height, top width, and bottom width of the major rib). Linear interpolation may be used for intermediate major rib dimensions. An ASD safety factor of 2.5 is included in all Table 5 values.

9.4 Effective shear modulus, G. The effective shear modulus, G, used in Equation 3 is the in-plane stiffness of a building diaphragm with a width s and an in-plane length d_i. G is a function of the stiffness modulus G' of the cladding and cladding fasteners (see clause 9.4.1) and the stiffness K_R of the rafter-purlin and rafter-shear block connections (see clause 9.4.2) and is calculated as:

$$G = s\,/\,[(s/G') + (2d_i/K_R)] \tag{15}$$

where:

G = effective shear modulus of the steel-clad, wood-framed diaphragm, kN/mm (lbf/in.);

G' = stiffness modulus of cladding and cladding fasteners from Table 3 kN/mm (lbf/in.);

s = frame spacing (width between rafters) m (ft);

d_i = length of diaphragm *i* as measured parallel to trusses/rafters (see Figure 2), m (ft);

K_R = total stiffness of all rafter-purlin and rafter-shear block connections on a single rafter, kN/mm (lbf/in.)

Table 5 – ASD allowable diaphragm unit shear strength as governed by cladding buckling [a]

Major Rib Spacing	Major Rib Height [c]	Top Width of Major Rib[c] mm (in.)	Bottom Width of Major Rib [c]: 36 mm (1.4 in.)	38 mm (1.5 in.)	44 mm (1.75 in.)	51 mm (2.0 in.)	57 mm (2.25 in.)	63.5 mm (2.5 in.)
			ASD Shear Strength, $V_{a,i}$,[b] kN/m (lbf/ft)					
26 Gage Steel, 0.475 mm (0.0187 in.) thick								
0.23 m (9.0 in.)	19 mm (0.75 in.)	13 (0.50)	4.97 (341)	5.02 (344)	5.13 (352)	5.26 (360)	5.39 (369)	5.52 (379)
		19 (0.75)	5.43 (372)	5.47 (375)	5.56 (381)	5.67 (389)	5.79 (397)	5.92 (406)
	22 mm (0.87 in.)	13 (0.50)	6.42 (440)	6.47 (443)	6.60 (452)	6.75 (462)	6.90 (473)	7.06 (484)
		19 (0.75)	6.99 (479)	7.03 (482)	7.15 (490)	7.27 (498)	7.41 (508)	7.56 (518)
	25 mm (1.0 in.)	13 (0.50)	8.03 (551)	8.09 (554)	8.24 (564)	8.40 (576)	8.58 (588)	8.77 (601)
		19 (0.75)	8.73 (598)	8.77 (601)	8.90 (610)	9.04 (620)	9.20 (631)	9.37 (642)
0.30 m (12.0 in.)	19 mm (0.75 in.)	13 (0.50)	4.08 (280)	4.11 (282)	4.21 (288)	4.31 (295)	4.41 (302)	4.52 (310)
		19 (0.75)	4.46 (306)	4.49 (308)	4.57(313)	4.65 (319)	4.75 (325)	4.85 (332)
	22 mm (0.87 in.)	13 (0.50)	5.27 (361)	5.31 (364)	5.42(371)	5.53 (379)	5.66 (388)	5.79 (397)
		19 (0.75)	5.75 (394)	5.78 (396)	5.87 (402)	5.97 (409)	6.08 (417)	6.20 (425)
	25 mm (1.0 in.)	13 (0.50)	6.61 (453)	6.65 (456)	6.77 (464)	6.90 (473)	7.04 (482)	7.19 (493)
		19 (0.75)	7.18 (492)	7.22 (495)	7.32 (501)	7.43 (509)	7.56 (518)	7.69 (527)
28 Gage Steel, 0.399 mm (0.0157 in.) thick								
0.23 m (9.0 in.)	19 mm (0.75 in.)	13 (0.50)	3.44 (236)	3.47 (238)	3.56 (244)	3.65 (250)	3.75 (257)	3.86 (265)
		19 (0.75)	3.73 (256)	3.76 (258)	3.84 (263)	3.92 (269)	4.02 (275)	4.12 (282)
	22 mm (0.87 in.)	13 (0.50)	4.45 (305)	4.49 (308)	4.59 (315)	4.70 (322)	4.82 (330)	4.95 (339)
		19 (0.75)	4.83 (331)	4.86 (333)	4.95 (339)	5.05 (346)	5.16 (353)	5.28 (362)
	25 mm (1.0 in.)	13 (0.50)	5.59 (383)	5.63 (386)	5.74 (394)	5.87 (402)	6.01 (412)	6.15 (422)
		19 (0.75)	6.05 (415)	6.09 (417)	6.18 (424)	6.30 (432)	6.42 (440)	6.56 (449)
0.30 m (12.0 in.)	19 mm (0.75 in.)	13 (0.50)	2.79 (191)	2.82 (193)	2.89 (198)	2.96 (203)	3.04 (209)	3.13 (214)
		19 (0.75)	3.03 (208)	3.05 (209)	3.11 (213)	3.18 (218)	3.26 (223)	3.34 (229)
	22 mm (0.87 in.)	13 (0.50)	3.62 (248)	3.65 (250)	3.73 (255)	3.82 (262)	3.91 (268)	4.01 (275)
		19 (0.75)	3.93 (269)	3.95 (271)	4.02 (276)	4.10 (281)	4.19 (287)	4.28 (293)
	25 mm (1.0 in.)	13 (0.50)	4.55 (312)	4.58 (314)	4.67 (320)	4.77 (327)	4.88 (334)	4.99 (342)
		19 (0.75)	4.93 (338)	4.95 (340)	5.03 (345)	5.12 (351)	5.22 (358)	5.33 (365)
29 Gage Steel, 0.361 mm (0.0142 in.) thick								
0.23 m (9.0 in.)	19 mm (0.75 in.)	13 (0.50)	2.90 (198)	2.92 (200)	3.00 (206)	3.08 (211)	3.17 (217)	3.26 (224)
		19 (0.75)	3.14 (215)	3.17 (217)	3.23 (222)	3.31 (227)	3.39 (232)	3.48 (238)
	22 mm (0.87 in.)	13 (0.50)	3.76 (257)	3.79 (260)	3.88 (266)	3.97 (272)	4.08 (279)	4.18 (287)
		19 (0.75)	4.07 (279)	4.10 (281)	4.17 (286)	4.26 (292)	4.36 (299)	4.46 (306)
	25 mm (1.0 in.)	13 (0.50)	4.72 (323)	4.76 (326)	4.85 (333)	4.96 (340)	5.08 (348)	5.21 (357)
		19 (0.75)	5.10 (350)	5.14 (352)	5.22 (358)	5.32 (364)	5.43 (372)	5.55 (380)
0.30 m (12.0 in.)	19 mm (0.75 in.)	13 (0.50)	2.35 (161)	2.37 (163)	2.43 (167)	2.50 (171)	2.57 (176)	2.64 (181)
		19 (0.75)	2.55 (175)	2.57 (176)	2.62 (180)	2.68 (184)	2.75 (188)	2.82 (193)
	22 mm (0.87 in.)	13 (0.50)	3.07 (210)	3.10 (212)	3.17 (217)	3.25 (223)	3.34 (229)	3.43 (235)
		19 (0.75)	3.31 (227)	3.33 (228)	3.39 (232)	3.46 (237)	3.54 (242)	3.62 (248)
	25 mm (1.0 in.)	13 (0.50)	3.86 (265)	3.89 (267)	3.97 (272)	4.07 (279)	4.17 (285)	4.27 (293)
		19 (0.75)	4.16 (285)	4.18 (286)	4.25 (291)	4.32 (296)	4.41 (302)	4.50 (309)
30 Gage Steel, 0.323 mm (0.0127 in.) thick								
0.23 m (9.0 in.)	19 mm (0.75 in.)	13 (0.50)	2.36 (162)	2.39 (164)	2.45 (168)	2.52 (173)	2.60 (178)	2.67 (183)
		19 (0.75)	2.56 (175)	2.58 (177)	2.64 (181)	2.70 (185)	2.77 (190)	2.85 (195)
	22 mm (0.87 in.)	13 (0.50)	3.07 (210)	3.10 (212)	3.17 (217)	3.25 (223)	3.34 (229)	3.43 (235)
		19 (0.75)	3.32 (228)	3.34 (229)	3.41 (234)	3.48 (239)	3.56 (244)	3.65 (250)
	25 mm (1.0 in.)	13 (0.50)	3.86 (265)	3.89 (267)	3.97 (272)	4.07 (279)	4.17 (285)	4.27 (293)
		19 (0.75)	4.17 (286)	4.20 (288)	4.27 (293)	4.35 (298)	4.45 (305)	4.55 (311)
0.30 m (12.0 in.)	19 mm (0.75 in.)	13 (0.50)	1.92 (131)	1.94 (133)	1.99 (136)	2.04 (140)	2.10 (144)	2.17 (148)
		19 (0.75)	2.08 (142)	2.09 (144)	2.14 (147)	2.19 (150)	2.25 (154)	2.31 (158)
	22 mm (0.87 in.)	13 (0.50)	2.49 (171)	2.51 (172)	2.57 (176)	2.64 (181)	2.71 (186)	2.78 (191)
		19 (0.75)	2.70 (185)	2.72 (186)	2.77 (190)	2.83 (194)	2.89 (198)	2.96 (203)
	25 mm (1.0 in.)	13 (0.50)	3.14 (215)	3.16 (217)	3.23 (221)	3.30 (226)	3.38 (232)	3.47 (237)
		19 (0.75)	3.40 (233)	3.42 (234)	3.47 (238)	3.54 (242)	3.61 (247)	3.69 (253)

a Diaphragms must be constructed in accordance with clause 9.2.
b An ASD safety factor of 2.5 has been applied to $V_{a,i}$ values.
c Linear interpolation may be used for intermediate major rib dimensions.

9.4.1 Stiffness modulus of cladding and cladding fasteners, *G'*. Table 3 provides stiffness modulus values attributable to the cladding and cladding fasteners for diaphragms that meet the construction specification in clause 9.2. Stiffness modulus *G'* accounts for deformations from shear strain of the steel, panel warping, and cladding-to-framing fastener slip.

9.4.2 Stiffness of rafter-purlin and rafter-shear blocking connections, K_R. Diaphragm stiffness associated with rafter-purlin connector slip and rafter-shear blocking connector slip is calculated as:

$$K_R = N_P K_P + N_{sb} K_{sb} \quad (16)$$

where:

K_R = total stiffness of purlin and shear block connectors for a single rafter, kN/mm (lbf/in.)

N_p = number of purlins attached to a single rafter

K_p = stiffness of one rafter-purlin connection, kN/mm (lbf/in.)

N_{sb} = number of shear blocks attached to a single rafter

K_{sb} = stiffness of one shear block connection, kN/mm (lbf/in.)

Table 6 provides stiffness values for rafter-purlin and rafter-shear block connections. If purlins or blocking of different size, connection type, or significantly different specific gravity are used, the connection stiffness can be determined through testing using methods similar to those established by Leflar (2008).

Table 6 – Stiffness of rafter-purlin and rafter-shear block connections

Member	Connection	Size	Orientation	Location	Specific Gravity	Stiffness kN/m (lbf/in.)
Purlin	1-60d post-frame ring shank nail (ASTM F1667 NL PF - 19B	38 × 89 mm	on-edge	on top of rafter	0.42	0.175 (1.0E3)
Shear block	2-60d post-frame ring shank nails (ASTM F1667 NL PF – 19B	38 × 89 mm	on-edge	on top of rafter	0.42	1.75 (1.0E4)

Annex A
(informative)
Bibliography

The following documents are cited as reference sources used in the development of this Engineering Practice:

Aguilera, D. 2014. Development of strength and stiffness design values for steel-clad, wood-framed diaphragms. M.S. thesis, Department of Civil and Environmental Engineering, Washington State University, Pullman, WA.

Anderson, G. A., D. S. Bundy, and N. F. Meador. 1989. The force distribution method: Procedure and application to the analysis of buildings with diaphragm action. *Transactions of the ASAE* 32(5):1791-1796.

Anderson, G. A. and D. S. Bundy. 1989b. Characterizing diaphragm shear stiffness and diaphragm-frame interaction analysis. *Transactions of the ASAE* 32(5): 1785-1790.

Bohnhoff, D. R. 1992. Expanding diaphragm analysis for post-frame buildings. *Applied Engineering in Agriculture* 35(4):509-517.

Bohnhoff, D. R. 1992b. Estimating frame stiffness and eave loads for diaphragm analysis of post-frame buildings. *Transactions of the ASAE* 35(3): 1043-1054.

Gebremedhin, K.G., E.L. Bahler and S.R. Humphreys. 1986. A modified approach to post-frame design using diaphragm theory. *Transactions of the ASAE* 29(5):1364-1372.

Gebremedhin, K. G. 1987b. *Diaphragm design of metal-clad post-frame buildings using microcomputers*. Ithaca, NY: Northeast Regional Agricultural Engineering Service, Cornell University.

Gebremedhin, K. G., J. A. Bartscwh, and M. C. Jorgensen. 1992. Full-scale test of post-frame buildings. In *Post-Frame Building Design*. ASAE Monograph No. 11. ASAE, St. Joseph, MI 49085.

Gebremedhin, K. G., and M. C. Jorgensen. 1993. Stiffness of post-frame building endwalls. *Transactions of the ASAE* 36(3):905-913.

Gebremedhin, K. G., H. B. Manbeck, and E. L. Bahler. 1992. Diaphragm analysis and design of post-frame buildings. In *Post-Frame Building Design*. ASAE Monograph No. 11. ASAE, St. Joseph, MI 49085.

Leflar, J.A. 2008. A Mathematical Model of Steel-Clad Wood-Frame Shear Diaphragms. Unpublished M.S. thesis, Department of Civil and Environmental Engineering, Colorado State University, Fort Collins, CO.

Luttrell, L. D. 1992. *Diaphragm Design Manual*. Steel Deck Institute, Second Edition, Fox River Grove, IL.

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Shallow Post and Pier Foundation Design

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1 Purpose and scope

1.1 Purpose. The purpose of this Engineering Practice is to present a procedure for determining the adequacy of shallow, isolated post and pier foundations in resisting applied structural loads. This Engineering Practice will help ensure that soil and backfill are not overloaded, foundation elements have adequate strength, frost heave is minimized, and lateral movements are not excessive.

1.2 Scope. This engineering practice contains safety factors and other provisions for allowable stress design (ASD) which is also known as working stress design, and for load and resistance factor design (LRFD) which is also known as strength design. It also contains properties and procedures for modeling soil deformation for use in structural building frame analyses.

1.2.1 Limitations. Application of this Engineering Practice is limited to post and pier foundations with the following characteristics:

- vertically installed in relatively level terrain;
- concentrically-loaded footings;
- minimum post or pier foundation spacing equal to the greater of 4.5 times the maximum dimension of the post/pier cross-section, or three times the maximum dimension of a footing or attached collar.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies unless noted. For undated references, the latest approved edition of the referenced document (including any amendments) applies.

2.1 Structural design specifications

ACI 318, Building Code Requirements for Structural Concrete and Commentary

ANSI/AWC NDS, National Design Specification (NDS) for Wood Construction with Commentary

ANSI/ASAE EP484, Diaphragm Design of Metal-Clad, Wood-Frame Rectangular Buildings

ANSI/ASAE EP559, Design Requirements and Bending Properties for Mechanically Laminated-Wood Assemblies

ASCE/SEI 7-10, Minimum Design Loads for Buildings and Other Structures

SEI/ASCE 32, Design and Construction of Frost-Protected Shallow Foundations

2.2 Laboratory soil testing standards

ASTM D422, Standard Test Method for Particle-Size Analysis of Soils

ASTM D854, Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer

ASTM D2166, Standard Test Method for Unconfined Compressive Strength of Cohesive Soil

ASTM D2435, Standard Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading

ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D2850, Standard Test Method for Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D3080, Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions

ASTM D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D4643, Test Method for Determination of Water (Moisture) Content of Soil by Microwave Oven Heating

ASTM D4767, Standard Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils

ASTM D7181, Standard Test Method for Consolidated Drained Triaxial Compression Test for Soils

2.3. In-situ soil testing standards

ASTM D1586, Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

ASTM D2573, Standard Test Method for Field Vane Shear Test in Cohesive Soil

ASTM D3441, Standard Test Method for Mechanical Cone Penetration Tests of Soil

ASTM D4719, Standard Test Method for Prebored Pressuremeter Testing in Soils

ASTM D1194, Standard Test Method for Bearing Capacity of Soil for Static Load and Spread Footings (withdrawn 2003)

ASTM D4750, Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)

ASTM D5778, Standard Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils

2.4 Preservative-treated wood standard

AWPA U1, Use Category System: User Specification for Treated Wood

2.5 Nomenclature standard

ANSI/ASABE S618, Post-Frame Building System Nomenclature

3 Definitions

3.1 Foundation types and components

3.1.1 backfill: Material filling the excavation around a post or pier foundation. See Figure 5.

3.1.2 collar: Foundation component attached to a post or pier, and that moves with it to resist lateral and vertical loads. See Figure 5.

3.1.3 driven pier or post: A pier or post that is pounded or turned into the ground. A pier or post foundation not requiring prior soil excavation. Also referred to as a displacement pier or post. See Figure 2.

3.1.4 footing: Foundation component at the base of a post or pier that provides resistance to vertical downward forces. When properly attached to the post/pier, a footing aids in the resistance of lateral and vertical uplift forces, and embedment depth is measured to the base of the footing instead of to the top of the footing. See Figures 1 through 5.

3.1.5 helical pier: A pier comprised of a steel pipe or tubing with an attached helix or helices. See Figure 2. Helices are also known as auger flighting. A helical pier is a type of driven pier that is turned into the soil in a manner that minimizes soil movement/displacement.

3.1.6 pedestal: A relatively short column that can support vertical forces, but is not designed to transmit horizontal shear, and bending moments. This engineering practice is not applicable to the design of pedestals.

3.1.7 pier: A relatively short column partly embedded in the soil to provide lateral and vertical support for a building or other structure. Piers include members of any material with assigned structural properties such as solid or laminated wood, steel, or concrete. Piers differ from embedded posts in that they seldom extend above the lowest horizontal framing element in a structure, and when they do, it is often only a few centimeters. See Figures 2 through 4.

3.1.8 pier foundation: An assembly consisting of a pier and all below-grade elements, which may include a footing, uplift resistance system, and collar. See Figure 3.

3.1.9 pile: A relatively long and slender column driven, screwed, jacked, vibrated, drilled or otherwise installed into soil to provide lateral and vertical support for a structure. Generally used to carry loads through weak layers of soil to those capable of supporting such loads. This engineering practice is not applicable to the design of piles.

3.1.10 pole: A round post.

3.1.11 post: A structural column that functions as a major foundation element by providing lateral and vertical support for a structure when it is embedded in the soil. Posts include members of any material with assigned structural properties such as solid or laminated wood, steel, or concrete. See Figures 1 and 5.

3.1.12 post foundation: An assembly consisting of an embedded post and all below-grade elements, which may include a footing, uplift resistance system, and collar. See Figure 1.

3.1.13 screw anchor: A helical pier primarily designed to handle uplift or tension forces.

3.1.14 shallow foundation: A foundation for which deformation under load is small, so foundation movement approximates rigid body motion. Foundation deformation is kept small by selection of foundation depth, d, and post/pier bending stiffness, $E_p I_p$.

3.1.15 uplift resistance system: Elements attached to an embedded post or pier, generally near the base, to increase the uplift resistance of a foundation system. See Figures 1 through 5.

3.2 Foundation geometry and constraints

3.2.1 constrained post (or pier): A post or pier foundation that is restrained from significant horizontal movement at the ground surface, typically by a concrete slab.

3.2.2 foundation depth, d_F: Vertical distance from the ground surface to the bottom of a post or pier foundation. Typically the vertical distance from the ground surface to the base of the footing.

3.2.3 non-constrained post (or pier): A post or pier foundation that is not restrained from moving horizontally at or above the ground surface.

3.2.4 post (or pier) embedment depth, *d*: Vertical distance from the ground surface to the bottom of the embedded post or pier. Includes the thickness of the footing when the footing is rigidly attached to the post/pier or is cast integrally with the post/pier.

3.2.5 post (or pier) width, *B*: The cross-sectional dimension that is perpendicular to the direction of lateral post/pier movement. This width defines the area of contact between the foundation and soil that resists lateral post/pier movement. The width of a round post or pier is its diameter.

3.3 Material properties and characteristics

3.3.1 cohesion of soil, *c*: Component of soil shear strength due to cementation or bonding at particle contacts resulting from ionic bonds, hydrogen bonds, and gravitational attraction.

3.3.2 controlled low-strength material (CLSM): A self-leveling and self-compacting, cementitious material with an unconfined compressive strength of 8 MPa (1200 psi) or less. Other terms used to describe controlled low-strength material (CLSM) include flowable fill, unshrinkable fill, controlled density fill, flowable mortar, flowable fly ash, fly ash slurry, plastic soil-cement and soil-cement slurry.

3.3.3 constant of horizontal subgrade reaction, n_h: Soil property used in the calculation of horizontal soil stiffness. When divided by post/pier width *b*, the constant of horizontal subgrade reaction establishes the rate at which the modulus of horizontal subgrade reaction increases with depth.

3.3.4 dry bulk density of soil, ρ_D: Oven-dried mass of a soil divided by its in-situ volume. Also known as dry unit weight.

3.3.5 effective stress: Net stress across points of contact of soil particles, generally considered as equivalent to the total stress minus the pore water pressure.

3.3.6 frost heave: Surface distortion caused by volume expansion within the soil when water freezes and ice lenses form.

3.3.7 moist bulk density of soil, ρ: Mass of a soil divided by its in-situ volume. Also known as wet unit weight.

3.3.8 Poisson's ratio, v: Transverse (lateral) strain divided by the corresponding axial (longitudinal) strain that occurs when a uniformly distributed axial load is applied to a soil sample whose transverse expansion is not restricted during load application.

3.3.9 soil friction angle, ϕ: Slope angle of Mohr-Coulomb shear strength criterion for soils, where shear strength = $\sigma \tan \phi + c$.

3.3.10 swelling soil: A soil material, particularly clays, that exhibit expansion with increasing moisture content, and shrinkage with decreasing moisture content. Also referred to as an expansive soil.

3.3.11 total stress: Total pressure exerted in any direction by both soil and water.

3.3.12 undrained shear strength, S_U: Shear strength of soil sheared such that pore water pressure is not allowed to dissipate (i.e., undrained condition). Shear strength criterion typically used for short-term loading of soil with significant clay content.

3.3.13 Young's modulus for soil, E_S: Uniaxial compressive stress divided by the corresponding uniaxial strain of a soil sample whose transverse (lateral) expansion is not restricted during load application.

3.4 Structural loads and analysis

3.4.1 allowable stress design: A method of proportioning structural members such that elastically computed stresses produced in the members by nominal loads do not exceed specified allowable stresses. Also called "working stress design".

3.4.2 bearing pressure, *q*: Pressure applied normal to the base of the foundation by the soil in response to all downward forces acting on the foundation.

3.4.3 modulus of horizontal subgrade reaction, *k*: Ratio of the load per unit area on a vertical soil surface to the corresponding lateral displacement of the surface. Also known as the coefficient of horizontal subgrade reaction. It is a function of soil properties, surface area over which the pressure is applied, depth below grade at which the pressure is applied, and the magnitude of the lateral displacement.

3.4.4 modulus of vertical subgrade reaction, k_v: Ratio of the load per unit area on a horizontal soil surface to the corresponding vertical displacement of the surface. Also known as the coefficient of subgrade reaction or subgrade modulus.

3.4.5 lateral loading: Any horizontally-directed forces applied to the foundation.

3.4.6 lateral soil pressure, *p*: Net soil pressure acting normal to the sides of the foundation in response to horizontal displacements of the foundation.

3.4.7 load combination: A combination of nominal loads that can reasonably be expected to act on a structure. Loads in a particular combination will be reduced by load factors where there is a low probability of them simultaneously acting at their full value. Load factors in load combinations for strength design also account for uncertainties in structural analyses, and uncertainties surrounding nominal load calculations.

3.4.8 load factor: A factor that accounts for deviations of the actual load from the nominal loads, for uncertainties in the analysis that transforms the load into a load effect, and for the probability that more than one extreme load will simultaneously occur.

3.4.9 nominal loads: The magnitudes of loads specified in ASCE 7 for dead, live, wind, snow, rain, earthquake, etc.

3.4.10 required soil strength: Equal to the product of the nominal load and a load factor.

3.4.11 resistance factor: A factor that accounts for deviations of the actual strength from the nominal strength and the manner and consequences of failure. Also called “strength reduction factor”.

3.4.12 spring constant, K_H: A value assigned to the stiffness of a spring used to model the resistance provided by a soil layer with thickness, *t*, to the lateral movement of a foundation element with thickness, *b*. Numerically equal to the product of *t, b* and the modulus of horizontal subgrade reaction *k*.

3.4.13 strength design: A method of proportioning structural members such that the computed forces produced in the members by the factored loads do not exceed the member design strength. Also called “load and resistance factor design”.

3.4.14 structural analysis: Any analysis used to determine the distribution of applied structural loads to various structural elements.

3.4.15 vertical loading: Any upward or downward force applied to the foundation.

3.4.16 uplift resistance: Resistance provided by the soil to the vertical force acting to withdraw the foundation.

4 Nomenclature (Symbols)

4.1 Abbreviations

ASD	allowable stress design
CPT	Cone Penetration Test
LRFD	load and resistance factor design
SPT	Standard Penetration Test

4.2 Variables and Constants. The units shown after the description of each term are suggested units. Other units that are consistent with expressions being evaluated may be used.

A	footing bearing area, m^2 (in^2)
A_E	linear increase in Young's modulus with depth z below grade, kPa/m (lbf/in^2/in). When A_E is multiplied by depth z, Young's modulus E_S at depth z (or $E_{S,Z}$) is obtained
A_P	cross-sectional area of post/pier, m^2 (in^2). For helical piers, A_P is the cross-sectional area of the shaft (it does not include the area of the attached helix)
b	width of the face of the post/pier, footing, or collar that applies load to the soil when the foundation moves laterally, m (in)
b_G	post/pier face width at the ground surface, m (in)
B	diameter of a round footing or side length of a square footing, m (in)
B_U	diameter of a circular uplift resisting system or the smaller of the two dimensions characterizing a rectangular uplift resisting system, m (in)
c	cohesion of soil, kPa (lbf/in^2)
C_{CPT}	constant relating CPT blow counts to bearing resistance, kPa (lbf/in^2)
C_{PB}	empirical bearing capacity coefficient for adjustment of pressuremeter readings, dimensionless
C_{SPT}	constant relating SPT blow counts to bearing resistance, kPa (lbf/in^2)
C_{w1}	correction factor for effect of ground water location on the ultimate bearing strength of cohesionless soils, dimensionless
C_{w2}	correction factor for effect of ground water location on the ultimate bearing strength of cohesionless soils, dimensionless
d	post/pier embedment depth, m (in)
d_c	depth factor for ultimate bearing strength of a cohesive soil based on the general bearing capacity equation, dimensionless
d_q	depth factor for ultimate bearing strength of a cohesionless soil based on the general bearing capacity equation, dimensionless
d_R	depth from ground surface to point of post/pier rotation, m (in)
d_{RU}	depth from ground surface to point of post/pier rotation at ultimate load, m (in)
d_F	foundation or footing depth, m (ft)
d_U	distance between soil surface and top of the foundation uplift resisting system, m (in)
d_W	distance between soil surface and top of the water table, m (in)
E_P	Young's modulus for the post/pier material, kPa (lbf/in^2)
E_S	Young's modulus for soil which may or may not vary with depth z, kPa (lbf/in^2)
$E_{S,B}$	Young's modulus for backfill soil which may or may not vary with depth z, kPa (lbf/in^2)
$E_{S,U}$	Young's modulus for unexcavated soil which may or may not vary with depth z, kPa (lbf/in^2)
$E_{S,Z}$	Young's modulus for unexcavated soil that is assumed equal to zero at grade and increases linearly with increasing depth z below grade, kPa (lbf/in^2)
f_B	ASD factor of safety for bearing strength assessment, dimensionless
f_L	ASD factor of safety for lateral strength assessment, dimensionless
f_U	ASD factor of safety for uplift strength assessment, dimensionless
F_C	breakout factor for soil uplift, dimensionless
F_S	force in a horizontal spring used to model lateral soil resistance, kN (lbf)

F_{ASD} — F_S induced by an ASD load combination, kN (lbf)

F_{LRFD} — F_S induced by an LRFD load combination, kN (lbf)

F_{ult} — soil spring ultimate strength, kN (lbf)

g — gravitation acceleration constant, 9.81x10^{-3} kN/kg (1.0 lbf/lbm)

h — vertical extent of the uplift soil failure surface, m (in)

I_P — moment of inertia of post/pier around axis of rotation, m^4 (in^4). Equal to $w\,^3b/12$ for a solid rectangular post/pier

I_S — strain influence factor, dimensionless

k — modulus of horizontal subgrade reaction which may or may not vary with depth z, kN/m^3 (lbf/in^3)

k_c — modulus of horizontal subgrade reaction that is constant with depth z, kN/m^3 (lbf/in^3)

k_B — modulus of horizontal subgrade for backfill soil which may or may not vary with depth z, kN/m^3 (lbf/in^3)

k_U — modulus of horizontal subgrade reaction for unexcavated soil which may or may not vary with depth z, kN/m^3 (lbf/in^3)

k_V — modulus of vertical subgrade reaction, kN/m^3 (lbf/in^3)

K_H — stiffness of a horizontal spring used to model the resistance to lateral post/pier movement provided by a soil layer with thickness t in contact with a foundation element of width b, kN/m (lbf/in)

K_P — coefficient of passive earth pressure, dimensionless

K_U — nominal uplift coefficient of earth pressure on a vertical plane, dimensionless

L_U — length of a rectangular uplift resisting system with a width B_U, m (in)

M — bending moment in post/pier, kN-m (lbf- in)

M_F — foundation mass, kg (lbm)

M_G — bending moment in post/pier at the ground surface (at grade), kN-m (lbf- in)

M_{ASD} — M_G due to a ASD load combination, kN-m (lbf-in)

M_{LRFD} — M_G due to a LRFD load combination, kN-m (lbf-in)

M_U — ultimate groundline bending moment capacity of the foundation as limited by soil strength, kN-m (lbf-in)

n_h — constant of horizontal subgrade reaction, kN/m^3 (lbf/in^3)

N_C — bearing capacity factor that accounts for cohesion in the general bearing capacity equation, dimensionless

N_γ — bearing capacity factor that accounts for soil unit weight in the general bearing capacity equation, dimensionless

N_q — bearing capacity factor that accounts for surcharge pressures in the general bearing capacity equation, dimensionless

N_{SPT} — SPT blow count as recorded during test, Blows per 300 mm (Blows per 12 in.)

N_{60} — N_{SPT} blow count corrected for field procedures and equipment, Blows per 300 mm (Blows per 12 in.)

$(N_1)_{60}$ — N_{60} blow count normalized with respect to vertical effective stress, Blows per 300 mm (Blows per 12 in.)

p — lateral soil resistance, kPa (lbf/in^2)

p_A — atmospheric pressure, 100 kPa (2090 lbf/in^2)

p_L	limit pressure from a prebored pressuremeter, kPa (lbf/in^2)
p_U	ultimate lateral soil resistance, kPa (lbf/in^2)
$p_{U,z}$	ultimate lateral soil resistance at depth z, kPa (lbf/in^2)
p_z	lateral soil resistance at a depth z, kPa (lbf/in^2)
P	axial load in post/pier, kN (lbf)
P_{LRFD}	P due to a load and resistance factor load combination, kN (lbf)
P_{ASD}	P due to an allowable stress design load combination, kN (lbf)
q_B	ultimate soil bearing capacity, kPa (lbf/ in^2)
q_{cr}	average cone penetration resistance measured over a specified depth during a CPT test. Cone penetration resistance is equal to the vertical force applied to the cone divided by its horizontally projected area, kPa (lbf/in^2)
q_0	total overburden pressure at footing depth d_F, kPa (lbf/in^2)
r	radius of uplift resisting system (e.g. concrete collar), m (in)
R_B	LRFD resistance factor for bearing strength assessment, dimensionless
R_L	LRFD resistance factor for lateral strength assessment, dimensionless
R_U	LRFD resistance factor for uplift strength assessment, dimensionless
s_c	shape factor for ultimate bearing strength of a cohesive soil based on the general bearing capacity equation, dimensionless
s_q	shape factor for ultimate bearing strength of a cohesionless soil based on the general bearing capacity equation, dimensionless
s_γ	shape factor for ultimate bearing strength of a cohesionless soil based on the general bearing capacity equation, dimensionless
s_F	shape factor for uplift resistance in cohesionless soils, dimensionless
S_{LU}	increase per unit depth in the ultimate lateral force per unit depth that is applied to a foundation by a cohesionless soil, kPa (lbf/in^2)
S_u	undrained shear strength, kPa (lbf/in^2). Numerically equal to cohesion, c, for a saturated clay soil
t	thickness of a soil layer that is represented with a soil spring with stiffness K_S, m (in)
u_z	pore water pressure at depth z, kPa (lbf/in^2)
U	ultimate uplift resistance due to soil mass, kN (lbf)
V	shear force in post/pier, kN (lbf)
V_G	V at the ground surface (at grade), kN (lbf)
V_{ASD}	V_G due to a ASD load combination, kN (lbf)
V_{LRFD}	V_G due to a LRFD load combination, kN (lbf)
V_U	ultimate groundline shear capacity of the foundation as limited by soil strength, kN (lbf)
y	lateral deflection of post/pier, m (in)
w	dimension of a post/pier measured parallel to the direction of applied lateral load. Equal to width b for a round pier/pole; m (in)
z	depth below the ground surface, m, (in)
γ	moist unit weight of soil = $\rho\ g$, kN/m^3 (lbf/ in^3)
γ_D	dry unit weight of soil = $\rho_D\ g$, kN/m^3 (lbf/ in^3)
Δ	lateral deflection of post/pier at ground surface, m (in)

ε strain, mm/mm (in /in)

θ below grade rotation of post/pier with infinite flexural rigidity, radians

v Poisson's ratio, dimensionless

ρ moist bulk density of soil, kg/m^3 (lbm/in^3)

ρ_D dry bulk density of soil, kg/m^3 (lbm/in^3)

σ stress, kPa (lbf/in^2)

σ_v total vertical stress, kPa (lbf/in^2)

σ'_v effective vertical stress, kPa (lbf/in^2)

σ_{0h} total horizontal stress at rest, kPa (lbf/in^2)

σ'_{0h} effective horizontal stress at rest, kPa (lbf/in^2)

ϕ effective friction angle of soil, degrees

5 Soil and backfill properties

5.1 General. This clause addresses soils that should be avoided during post/pier construction (clause 5.2) and appropriate backfill materials (clause 5.3). It also contains provisions for establishing Young's modulus (clause 5.5), undrained shear strength (clause 5.6), and friction angle (clause 5.7) of soils from applicable soil tests. Clause 5.8 addresses presumptive soil properties.

5.1.1 Drained versus undrained. When establishing soil properties, assume that all cohesive soils will be loaded undrained, even under long-term static loadings, and that all cohesionless soils will be loaded drained, even under rapid loadings such as those resulting from earthquakes and wind forces.

5.2 Poor soils. Building in organic silts, soft clays and peat soils is never recommended as these soils are either weak or inherently unstable. Extra caution should be taken when evaluating strength properties of soils with variable characteristics, composition, and moisture content.

5.2.1 Expansive soils. A soil with an expansion index greater than 20, as determined in accordance with ASTM D482, is considered expansive and should be avoided. A soil is also considered expansive if it meets both of the following criteria:

1. Plasticity index (PI) of 15 or greater, determined in accordance with ASTM D4318;
2. More than 10% of the soil particles are less than 5 micrometers in size, determined in accordance with ASTM D422.

5.3 Backfill materials. Backfill properties can have a significant impact on post/pier foundation behavior. Appropriate backfill materials include:

5.3.1 Excavated soil. Except as excluded in clause 5.2, excavated soil can generally be used for backfill. In the special case where holes are drilled in clay, it may be preferable to backfill with the excavated clay instead of a coarse-grained material (clause 5.3.2) for reasons explained in clause 13.2.3. In all cases, excavated material used as backfill should be compacted to at least its pre-excavation density and should be free of organic material and construction debris.

5.3.2 Coarse-grained soils. Replacing excavated material with a gravel or well-graded sand may be necessary where greater soil strength and stiffness are needed. Compact all backfill by tamping layers that do not exceed a thickness of 0.2 m (8 in.).

5.3.3 Concrete and CLSM. Cast-in-place concrete and controlled low-strength material (CLSM) can significantly enhance the lateral strength and stiffness of a post/pier foundation. This is because the width, *b*, of the pier/post foundation for lateral strength analysis is equated to the diameter of the concrete or CLSM backfill. Concrete and CLSM placed against soil may affect frost heaving; see clause 13 on frost heaving.

5.4 Soil tests. Obtaining soil properties by laboratory or in-situ testing reduces uncertainty and enables the application of lower factors of safety relative to those associated with ultimate strength values based on presumptive soil properties.

5.4.1 Sampling locations. For uplift and lateral strength assessments, soil sampling and in-situ soil tests should cover the distance between one-third and 100% of the anticipated foundation depth. For bearing strength assessment, in-situ soil tests should be taken at a location between the anticipated footing base and a distance *B* below the anticipated footing depth.

5.5 Young's modulus for soil, E_S. Young's modulus is used to calculate modulus of horizontal subgrade reaction (clause 8.2) for backfill and the surrounding soil. In order to use the Simplified Method *for determination of foundation and soil forces* (clause 8.4), E_S must increase linearly with depth or be constant with depth.

5.5.1 E_S from laboratory tests. Young's modulus can be determined for any soil using a triaxial compression test in accordance with ASTM D2850. E_s for most cohesive soils can also be determined using an unconfined compression test in accordance with ASTM D2166. E_s can also be determined from a one-dimensional consolidation test in accordance with ASTM D2435. Where horizontally applied loads are primarily due to forces that fluctuate with time (e.g., wind, stored materials), define E_S as the secant modulus associated with a major principle stress of approximately one-fourth of the soil's ultimate strength at the location being modeled.

5.5.2 E_S from prebored pressuremeter test (PMT) results. For all soils:

$$E_S = (E_O + E_R)\,/\,2$$

where E_O is the pressuremeter first load modulus and E_R is the pressuremeter reload modulus calculated in accordance ASTM D4719.

5.5.3 E_S from cone penetration test (CPT) results. For sandy soils:

$E_S = 1.5\ q_{cr}$ for silts, sands and silty sands;

$E_S = 2\ q_{cr}$ for young, normally consolidated sands;

$E_S = 3\ q_{cr}$ for aged, normally consolidated sands;

$E_S = 4\ q_{cr}$ for sand and gravel.

where q_{cr} is average cone resistance in kPa (lbf/in.^{2}) determined in accordance with ASTM D3441.

5.5.4 E_S from standard penetration test (SPT) results.

For silts, sandy silts, slightly cohesive soils:

$$E_S\ (\text{kPa}) = 380\ (N_1)_{60}$$

$$E_S\ (\text{lbf/in}^2) = 56\ (N_1)_{60}$$

For clean fine to medium sands and slightly silty sands:

$$E_S\ (\text{kPa}) = 670\ (N_1)_{60}$$

$$E_S\ (\text{lbf/in}^2) = 97\ (N_1)_{60}$$

For coarse sands and sands with little gravel:

$$E_S\ (\text{kPa}) = 960\ (N_1)_{60}$$

$$E_S\ (\text{lbf/in}^2) = 140\ (N_1)_{60}$$

For sandy gravel and gravels:

$$E_S\ (\text{kPa}) = 1150\ (N_1)_{60}$$

$$E_S\ (\text{lbf/in}^2) = 170\ (N_1)_{60}$$

and $(N_1)_{60} = N_{60}\,(p_A/\sigma'_v)^{0.5}$

where:

$(N_1)_{60}$ is the N_{60} blow count normalized with respect to vertical effective stress;

N_{60} is the N_{SPT} blow count corrected for field procedures and equipment;

p_A is atmospheric pressure (100 kPa or 2090 lbf/ft^2 or 14.5 lbf/in^2); and

σ'_V is vertical effective stress.

5.5.5 E_S from undrained shear strength, S_U

For soft sensitive clay: E_S ranges from 400 S_U to 1000 S_U

For medium stiff to stiff clay: E_S ranges from 1500 S_U to 2400 S_U

For very stiff clay: E_S ranges from 3000 S_U to 4000 S_U

where S_U is undrained shear strength, kPa (lbf/in^2).

5.6 Constant of horizontal subgrade reaction, n_h

$$n_h = 2.0\, E_{S,Z} / z = 2.0\, A_E$$

and

$$E_{S,Z} = A_E\, z$$

where:

n_h is the modulus of horizontal subgrade reaction, kN/m^3 (lbf/in^3);

z is depth below grade, m (in);

$E_{S,Z}$ is a Young's modulus for soil that is assumed equal to zero at grade and to increase linearly with increasing depth z below grade (e.g., a cohesionless soil), kN/m^2 (lbf/in^2); and

A_E is the increase in Young's modulus per unit increase in depth z below grade, kN/m^3 (lbf/in^3).

5.7 Undrained shear strength, S_U. Is used to calculate bearing capacity, uplift resistance and lateral strength in cohesive soils.

5.7.1 S_U from laboratory tests. Determine S_U for a cohesive soil using an unconfined compressive strength test in accordance with ASTM D2166 or an unconsolidated-undrained triaxial compression test in accordance with ASTM D2850.

5.7.2 S_U from prebored pressuremeter (PBPMT) test results

$$S_U = 0.67\, p_L^{0.75} \quad \text{for } S_U \text{ and } p_L \text{ in kPa}$$

$$S_U = 0.41\, p_L^{0.75} \quad \text{for } S_U \text{ and } p_L \text{ in lbf/in}^2$$

where p_L is limit pressure determined in accordance with ASTM D4719.

5.7.3 S_U from cone penetration test (CPT) results

$$S_U = 0.037\, q_{cr}$$

where q_{cr} is average cone resistance determined in accordance with ASTM D3441.

5.7.4 S_U from field vane tests. Determine S_U of cohesive soils directly from the torque applied to a four-bladed vane shear device in accordance with ASTM D2573.

5.8 Soil friction angle, ϕ. Is required in clause 12.5.1 to calculate the uplift resistance, U, provided by a cohesionless soil. When ultimate bearing capacity, q_B, is not determined via in-situ tests, ϕ is used in the general bearing capacity equation (clause 10.4.1) to determine q_B of cohesionless soils. Likewise, ϕ is used to calculate the ultimate lateral resistance pressure, p_U, where p_U has not been determined by in-situ testing.

5.8.1 Friction angle ϕ from laboratory tests. For cohesionless soils determine the friction angle ϕ using a direct shear test in accordance with ASTM D3080 or a consolidated-drained (CD) triaxial compression test in accordance with ASTM D7181.

5.8.2 Friction angle ϕ from standard penetration test (SPT) results. For sandy soils:

$$\phi = [20\ (N_1)_{60}]^{0.5} + 20$$

and

$$(N_1)_{60} = N_{60}\ (p_A / \sigma'_v)^{0.5}$$

where:

$(N_1)_{60}$ is the N_{60} blow count normalized with respect to vertical effective stress;

N_{60} is the N_{SPT} blow count corrected for field procedures and equipment;

p_A is atmospheric pressure (100 kPa or 2090 lbf/ft^2 or 14.5 lbf/in^2); and

σ'_v is vertical effective stress.

5.8.3 Friction angle ϕ from cone penetration test (CPT) results. For sandy soils:

$$\phi = 17.6 + 11.0 \log [q_{cr} / (p_A\ \sigma'_v)^{0.5}]$$

where:

q_{cr} is average cone resistance;

p_A is atmospheric pressure (100 kPa or 2090 lbf/ft^2 or 14.5 lbf/in^2); and

σ'_v is vertical effective stress.

5.9 Presumptive values. In the absence of satisfactory soil test data or specific building code requirements, presumptive soil characteristics in Table 1 may be used.

6 Foundation material properties

6.1 General. This clause contains material requirements for post and pier foundation elements. Elements not specifically addressed by the following requirements shall be designed in accordance with applicable normative references, building codes, standards, and good engineering judgment.

6.2 Minimum concrete compressive strength. All concrete used in footings, posts and piers must have a minimum 28-day compressive strength of 3000 lbf/in^2.

6.3 Cast-in-place concrete footings

6.3.1 Minimum nominal thickness. The minimum nominal thickness of an unreinforced (plain) footing that is cast-in-place on a compacted base shall be 20 cm (8 in). The minimum thickness of a reinforced cast-in-place footing shall be such that the concrete provides a minimum cover of 7.5 cm (3 in) above and below the reinforcement. Load-induced forces may dictate a thicker footing.

6.3.2 Reinforcement. Cast-in-place concrete footings do not require steel reinforcement when the actual maximum distance from a footing edge to the nearest post/pier edge is less than the nominal thickness of the footing. Where this requirement is not met, the need for reinforcement shall be determined in accordance with ACI 318 Chapter 15.

6.4 Precast concrete footings

6.4.1 Minimum actual thickness. The minimum actual thickness of unreinforced (plain) precast footing that is placed on a flat, compacted base shall be 10 cm (4 in). The minimum thickness of a reinforced precast footing shall be such that the concrete provides a minimum cover of 4 cm (1.5 in) above and below the reinforcement. Load-induced forces may dictate a thicker footing.

6.4.2 Reinforcement. Precast concrete footings do not require steel reinforcement when the actual maximum distance from a precast footing edge to the nearest post/pier edge is less than 1.25 times the actual thickness of the footing. Where this requirement is not met, the need for reinforcement shall be determined in accordance with ACI 318 Chapter 15.

6.5 Concrete piers

6.5.1 Longitudinal reinforcement. The location and size of longitudinal reinforcement shall be determined in accordance with ACI 318 Chapter 10. The cross-sectional area of longitudinal reinforcement shall not be less than 1.0% of the gross cross-sectional area of the concrete. The minimum number of longitudinal bars shall be 4 for bars within rectangular or circular ties, 3 for bars with triangular ties and 6 for bars enclosed with spirals.

6.5.2 Shear reinforcement. The location and size of shear reinforcement shall be determined in accordance with ACI 318 Chapter 11. Shear reinforcement is not required where tests show that the required bending strength and shear strengths can be developed when shear reinforcement is omitted.

6.5.3 Cover on reinforcement. When a concrete pier is formed by casting concrete directly against earth, a minimum concrete cover of 7.5 cm (3 in) shall be provided on all steel reinforcement. When concrete is cast on site but not directly against the earth (e.g., the concrete is cast into cardboard forming tubes), the minimum concrete cover on steel reinforcement can be reduced to 5 cm (2 in) for bars 19 mm or greater in diameter (No. 6 or larger bars) and 3.8 cm (1.5 in) for bars 13 mm or smaller in diameter (No. 5 or smaller bars). Minimum concrete cover on reinforcement in precast concrete piers (i.e., piers manufactured under plant control conditions) shall be 3.8 cm (1.5 in) for bars 19 mm or greater in diameter (No. 6 or larger bars) and 3.2 cm (1.25 in) for bars 13 mm or smaller in diameter (No. 5 or smaller bars).

6.6 Embedded wood posts and piers

6.6.1 Preservative treatment. Wood used for embedded posts and piers shall be preservative treated in accordance with AWPA U1 Use Category UC4B.

6.6.2 Size. Mechanically-laminated wood posts and piers shall be sized in accordance with ASAE EP 559. All other wood posts and piers shall be sized in accordance with ANSI/AWC NDS.

6.6.3 Mechanical Fasteners. Fasteners used below grade in mechanically-laminated wood posts and piers shall meet the requirements of ASAE EP 559.

6.7 Anchor attachments. Fasteners used below grade to attach collars, footings and other devices to resist uplift forces shall have a durability equal to the service life of the structure.

6.8 CLSM base for precast concrete and wood footings. A controlled low-strength material (CLSM) placed between the bottom of a precast concrete or wood footing and the underlying soil can be used to increase the effective bearing area of the footing when its unconfined compressive strength exceeds the ultimate bearing capacity of the underlying soil.

7 Structural load combinations

7.1 General. Loads applied to the above-grade portion of a structure, shall be considered to act in the combinations specified in clause 7.2 for allowable stress design, and in clause 7.3 for strength design. More than one combination may control the design of the same structural element. Consideration shall be given to one or more loads in the same combination not acting.

7.1.1 Nominal loads. The following nominal loads shall be calculated in accordance with ASCE 7.

- D nominal dead load
- E nominal earthquake load
- F nominal load due to fluids with well-defined pressures and maximum heights
- H nominal pressure of bulk materials

L	nominal live load
L_r	nominal roof live load
R	nominal rain load
S	nominal snow load
T	self-straining force
W	nominal wind load

7.1.2 Combinations including wind and earthquake loads. The most unfavorable effects from both wind and earthquake loads shall be considered, where appropriate, but need not be assumed to act simultaneously.

7.1.3 Ice, wind-on-ice, flood, and self-straining loads. Ice, wind-on-ice, flood and self-straining loads shall be calculated in accordance with ASCE 7, and shall be used in load combinations as specified in ASCE 7.

7.1.4 Snow loads. In load combinations in which the full force of companion load S is not assumed to be acting (i.e., combinations 4 and 6 in clause 7.2 and combinations 2, 4 and 5 in clause 7.3), S shall be taken as either the flat roof snow load (p_f) or the sloped roof snow load (p_s). In combinations in which the full force of companion load S is assumed to be acting (i.e., combination 3 in clause 7.2 and combination 3 in clause 7.3), S shall account for adverse effects of partial, unbalanced, drift and sliding loads where applicable.

7.1.5 Loads due to lateral earth pressure, ground water pressure, or pressure of bulk materials. Load H shall be included with an ASD load factor of 1.0 (clause 7.2 combinations) and an LRFD load factor of 1.6 (clause 7.3 combinations) when the effect of H adds to the primary variable load effect. Where H is a permanent load and its effect resists the primary variable load effect, include H with an ASD load factor of 0.6 in clause 7.2 combinations and with a LRFD load factor of 0.9 in clause 7.3 combinations. Use a load factor of 0 when H resists the primary load variable but is not a permanent load.

7.1.6 Fluid loads. Where fluid loads F are present, they shall be included in ASD (clause 7.2) combinations 1 through 6 and 8 and in LRFD (clause 7.3) combinations 1 through 5 and 7. Assign fluid loads the same factors as used in the combination for dead load.

7.2 Load combinations for allowable stress design (a.k.a. working stress design)

1. D
2. $D + L$
3. $D + (L_r \text{ or } S \text{ or } R)$
4. $D + 0.75L + 0.75(L_r \text{ or } S \text{ or } R)$
5. $D + (0.6W \text{ or } 0.7E)$

6a. $D + 0.75L + 0.75(0.6W) + 0.75(L_r \text{ or } S \text{ or } R)$

6b. $D + 0.75L + 0.75(0.7E) + 0.75S$

7. $0.6D + 0.6W$
8. $0.6D + 0.7E$

7.3 Load combinations for load and resistance factor design (a.k.a. strength design)

1. $1.4D$
2. $1.2D + 1.6L + 0.5(L_r \text{ or } S \text{ or } R)$
3. $1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (L \text{ or } 0.5W)$
4. $1.2D + W + L + 0.5(L_r \text{ or } S \text{ or } R)$
5. $1.2D + E + L + 0.2S$
6. $0.9D + W$
7. $0.9D + E$

7.3.1 The load factor on L in LRFD load combinations 3, 4, and 5 is permitted to equal 0.5 for all occupants in which the uniformly distributed live load is less than or equal to 100 psf, which the exception of garages or areas occupied as places of public assembly.

8 Structural analysis

8.1 General. Structural analysis is the determination of the forces induced in a post/pier foundation by applied structural loads. Two methods are outlined in this clause. The Universal Method (clause 8.3) can be used to analyze any post/pier foundation. Application of the Simplified Method (clause 8.4) is limited by assumptions inherent in its development which are outlined in clause 8.4. In order to complete the calculations in clauses 8.3 and 8.4, the modulus of horizontal subgrade reaction must be established in accordance with clause 8.2.

8.1.1 Alternative analyses. Structural analyses of post and pier foundations are not restricted to the procedures outlined here. Other analytical procedures along with laboratory and field testing are available that can provide more accurate analyses. In all cases, sound engineering judgment should guide selection and application of the design procedure.

8.2 Modulus of horizontal subgrade reaction, *k*. The modulus of horizontal subgrade reaction k is the ratio of average contact pressure (between the foundation and soil) to horizontal foundation movement, and is equated to twice the effective Young's modulus for the soil divided by foundation face width. In equation form:

$$k = p_Z / \Delta_Z = 2.0\ E_{SE} / b$$

where:

k is modulus of horizontal subgrade reaction at depth z;

p_z is average contact pressure between the foundation and soil at depth z;

Δ_Z is horizontal movement of the foundation at depth z;

E_{SE} is effective Young's modulus for the soil at depth z from clause 8.2.1 or 8.2.2; and

b is face width of foundation at depth z.

8.2.1 Effective Young's modulus of soil, E_{SE}, for portions of the foundation backfilled with soil.

$$E_{SE} = \frac{1}{I_S / E_{S,B} + (1 - I_S) / E_{S,U}} \quad \text{for } 0 < J < 3b$$

$$E_{SE} = E_{S,B} \quad \text{for } J \geq 3b$$

$$E_{SE} = E_{S,U} \quad \text{for } J = 0$$

where $$I_S = [\ln(1 + J/b)] / 1.386 \quad \text{for } 0 < J < 3b$$

and:

$E_{S,B}$ is E_S for backfill at depth z;

$E_{S,U}$ is E_S for the unexcavated soil surrounding the backfill at depth z;

I_S is strain influence factor, dimensionless;

b is width of the face of the foundation component (post/pier, footing, or collar) at depth z; and

J is distance (measured in the direction of lateral foundation movement) between the edge of the backfill and the face of the foundation component at depth z (see Figure 9).

The condition of $J = 0$ would apply to a driven pier/post for which the foundation is entirely surrounded by unexcavated soil.

8.2.2 Effective Young's modulus of soil, E_{SE}, for portions of the foundation backfilled with concrete or CLSM

At any depth below grade where concrete or CLSM backfill is present, face width *b* is equal to the width of the concrete backfill or CLSM backfill, respectively, and effective Young's modulus of the soil at that depth is equal to E_S for the unexcavated soil surrounding the concrete or CLSM backfill.

8.3 Universal Method for determination of foundation and soil forces. The Universal Method refers to any structural analysis utilizing a 2-dimensional structural analog that uses conventional frame elements to model the below grade portions of a post/pier foundation, and horizontal spring elements to model the resistance to lateral movement provided by backfill and soil (Figures 6, 7 and 8). Soil spring stiffness values are calculated in accordance with clause 8.3.1. Recommendations for soil spring and support placements are given in clauses 8.3.2 and 8.3.3, respectively. Soil spring forces provided by the subsequent structural analysis are converted to soil pressures in accordance with clause 8.3.4.

8.3.1 Soil spring stiffness. The stiffness of a horizontal soil spring, K_H, located at depth, *z*, is given as:

$$K_H = t\,k\,b = 2.0\,t\,E_{SE}$$

where:

t is thickness of the soil layer represented by the spring;

b is width of the post/pier, footing, or collar upon which soil represented by the spring is acting; and

k is modulus of horizontal subgrade reaction at depth *z* from clause 8.2.

E_{SE} is effective Young's modulus for soil at depth *z* from clause 8.2.1 or 8.2.2

8.3.2 Soil spring placement. A closer spring spacing enables more accurate estimation of post/pier forces and soil pressures and is most important where such forces and pressures change rapidly. In general, soil spring spacing, *t*, should not exceed 2*w* where *w* is the face width of a rectangular post/pier and diameter of a round post/pier.

8.3.3 Support placement. Where a post is constrained from moving laterally by a concrete slab or other rigid structure, place a vertical roller support at the point of likely contact between the post and constraining component (Figure 8a). Do not constrain post/pier movement with a roller support if the post/pier is not directly connected to the structure and will move away from it when loaded (Figure 8b). Model the interface between the base of the foundation and the soil with a horizontal roller support (Figure 8).

8.3.4 Lateral soil pressures. Lateral soil pressure at a depth *z* below the ground surface, p_z, is given as:

$$p_z = F_S / (t\,b)$$

where F_S is the force in a horizontal spring located at depth *z* that represents a soil layer with thickness *t* and width *b*. In this case, *b* is the width of the post/pier, footing, or collar upon which the soil represented by the spring is acting.

8.4 Simplified method for determination of foundation and soil forces. The Simplified Method assumes the following:

1. At-grade pier/post forces are not dependent on below-grade deformations.
2. The below-grade portion of the foundation has an infinite flexural rigidity ($E_P I_P$).
3. Unexcavated soil and backfill are each homogeneous for the entire embedment depth.
4. Young's modulus for soil is either constant for all depths below grade or is zero at grade and then linearly increases with depth below grade.
5. Width *b* of the below-grade portion of the foundation is constant. This generally means that there are no attached collars or footings that are effective in resisting lateral soil forces.

The Simplified Method can be used if the condition in clause 8.4.1 is met. The procedure uses a fixed-based structural analog described in clause 8.4.2 to determine the bending moment, axial, and shear forces induced in the post/pier near the ground surface. These forces are then substituted in the appropriate equations in clause 8.4.3 to determine lateral soil pressures as well as the ground surface displacement and rotation of the post/pier.

Equations in clause 8.4.3 utilize the sign convention shown in Figure 10. Note: V_G and M_G have the same sign if they independently rotate the foundation in the same direction.

8.4.1 Depth requirements. For soils whose modulus of horizontal subgrade reaction k increases linearly with depth, the Simplified Method can be used if:

$$d \leq 2(E_P I_P / n_h)^{0.20} = 2[E_P I_P / (2A_E)]^{0.20}$$

For soils whose modulus of horizontal subgrade reaction k is constant with depth, the Simplified Method can be used if:

$$d \leq 2[E_P I_P / (k_c b)]^{0.25} = 2[E_P I_P / (2E_{SE})]^{0.25}$$

8.4.2 Fixed base analog. The fixed base analog refers to any 2-dimensional structural analog that replaces an embedded post/pier foundation with fixed supports. For a constrained foundation (i.e., a post/pier constrained from moving laterally by a concrete slab or other rigid structure located at grade), place a vertical roller support at the point of likely contact between the post/pier and constraining component, and place a fixed support at the ground surface. For a non-constrained post/pier, place the fixed support a distance w below the ground surface, where w is the face width of a rectangular post/pier and diameter of a round post/pier (Figure 11a). The shear force, V, and bending moment, M, resisted by the fixed support shall be used in the equations of clause 8.4.3. for V_G and M_G, respectively. Note that:

$V_{LRFD} = V_G$ for LRFD

$M_{LRFD} = M_G$ for LRFD

$V_{ASD} = V_G$ for ASD

$M_{ASD} = M_G$ for ASD

8.4.3 Lateral soil pressures. For calculation of lateral soil pressures use clauses 8.4.3.1 and 8.4.3.3 for *non-constrained* posts/piers and clauses 8.4.3.2 and 8.4.3.4 for *constrained* posts/piers. The effective Young's modulus for soil E_{SE} is not required in this clause to calculate lateral soil pressures, which is one advantage of using the Simplified Method. However, the effective Young's modulus for soil is required in the following clauses for calculation of post/pier displacement parameters θ and Δ.

8.4.3.1 Non-constrained posts/piers with linearly increasing soil stiffness. The following equations for non-constrained post/pier foundations assume the effective Young's modulus for soil E_{SE} increases linearly with soil depth, and is numerically equal to $A_E z$ (Figure 12).

$$d_R = \frac{d(3\ V_G d + 4\ M_G)}{4\ V_G d + 6\ M_G} \quad \text{for } 0 \leq d_R \leq d$$

$$\theta = \frac{12\ V_G d + 18\ M_G)}{d^4 A_E}$$

$$\Delta = \frac{9\ V_G d + 12\ M_G)}{d^3 A_E}$$

$$p_z = 6z(6M_G z/d + 4V_G z - 3dV_G - 4M_G)/(d^3 b)$$

8.4.3.2 Constrained posts/piers with linearly increasing soil stiffness. The following equations for post/pier foundations constrained at grade assume the effective Young's modulus for soil E_{SE} increases linearly with soil depth, and is numerically equal to $A_E z$ (Figure 13).

$$\theta = \frac{2\ M_G}{d^4 A_E}$$

$$p_z = 4z^2 M_G/(d^4 b)$$

8.4.3.3 Non-constrained posts/piers with constant soil stiffness. The following equations for non-constrained post/pier foundations assume the effective Young's modulus for soil E_{SE} remains constant with depth (Figure 14).

$$d_R = \frac{d(2\ V_G d + 3\ M_G)}{3\ V_G d + 6\ M_G}$$

$$\theta = \frac{3\ V_G d + 6\ M_G}{d^3 E_{SE}}$$

$$\Delta = \frac{2\ V_G d + 3\ M_G}{d^2 E_{SE}}$$

$$p_z = (12M_G z/d + 6V_G z - 4dV_G - 6M_G)/(d^2 b)$$

8.4.3.4 Constrained posts/piers with constant soil stiffness. The following equations for post/pier foundations constrained at grade assume the effective Young's modulus for soil E_{SE} remains constant with depth (Figure 15).

$$\theta = \frac{1.5\ M_G}{d^3 E_{SE}}$$

$$p_z = 3zM_G/(d^3 b)$$

9 Resistance and safety factors

9.1 Tabulated values. Tables 2, 3, 4 and 5 contain resistance factors for LRFD design and corresponding safety factors for ASD design. Table 2 values apply to bearing strength assessment, Table 3 values apply to lateral strength assessment involving the Universal Method of analysis, Table 4 values apply to lateral strength assessment involving the Simplified Method of analysis, and Table 5 values apply to uplift strength assessment.

9.2 Adjustments. For buildings and other structures that represent a low risk to human life in the event of a failure, Tables 2, 3, 4, and 5 resistance factors may be increased 25% (multiplied by 1.25), and Tables 2, 3, 4, and 5 safety factors may be reduced 20% (multiplied by 0.80). In all cases, the adjusted resistance factor is limited to a maximum value of 0.93 and the adjusted safety factor is limited to a minimum value of 1.50.

10 Bearing strength assessment

10.1 General. Clauses 10.2 and 10.3 contain equations for checking adequacy of the foundation's bearing capacity under ASD and LRFD load combinations, respectively. Clause 10.4 contains equations for calculating ultimate soil bearing capacity, q_B, a variable in the equations of clauses 10.2 and 10.3. The quantity q_0 in clauses 10.2 and 10.3 is the pressure applied by the soil overburden at the foundation base (i.e., at a depth, d_F) and is equal to γd_F for soils with a uniform unit weight γ between the soil surface and depth d_F.

Assuming that the difference is negligible between the moist unit weight γ of the soil and the average unit weight of the foundation elements, the net ultimate bearing capacity can be approximated as the difference between q_B and q_0. When the net ultimate bearing capacity is calculated in this fashion, the values of P_{ASD} and P_{LRFD} should not include the weight of foundation elements located below grade.

10.2 Allowable stress design. Bearing area is sufficient if the following inequality is met.

$$(q_B - q_0)/f_B \geq P_{ASD}/A$$

or

$$A \geq f_B\ P_{ASD}/(q_B - q_0)$$

where f_B is the allowable stress design factor of safety for bearing strength assessment from Table 2.

10.3 Load and resistance factor design. Bearing area is sufficient if the following inequality is met.

$$(q_B - q_0)\ R_B \geq P_{LRFD} / A$$

or

$$A \geq P_{LRFD} / [R_B\ (q_B - q_0)]$$

where R_B is the LRFD resistance factor for bearing strength assessment from Table 2.

10.4 Ultimate soil bearing capacity, q_B. Different methods for calculating ultimate soil bearing capacity are given in clauses 10.4.1, 10.4.2, 10.4.3, and 10.4.4. Equations in these clauses assume that the ground surrounding the location of the installed footing is level. If it is not, adjustments to calculated values must be made in accordance with common engineering practice. Correction factors C_{W1} and C_{W2} are included in equations for cohesionless soils to account for water table depth, d_W relative to foundation depth, d_F. In equation form:

$$C_{W1} = 0.5 \quad \text{when } d_W \leq d_F$$

$$= 1.0 \quad \text{when } d_W \geq 1.5\ B + d_F$$

$$= 0.5 + (d_W - d_F) / (3B) \quad \text{when } d_F < d_W < 1.5\ B + d_F$$

$$C_{W2} = 0.5 + 0.5\ d_W / d_F \quad \text{when } d_W < d_F$$

$$= 1.0 \quad \text{when } d_W \geq d_F$$

10.4.1 q_B from the general bearing capacity equation. For saturated clay soils:

$$q_B = S_u\ N_C\ d_C\ s_C + \gamma d_F$$

$$q_B = S_u\ (6.19 + 1.23\ d_F / B) + \gamma d_F \quad \text{for } d_F / B < 2.5$$

$$q_B = S_u\ 9.25 + \gamma d_F \quad \text{for } d_F / B \geq 2.5$$

where:

$N_C = 5.14$ for $\phi = 0$

$s_C = 1.2$ for square and round footings

$d_C = 1 + 0.2\ d_F / B$ for $d_F / B < 2.5$

$d_C = 1.5$ for $d_F / B \geq 2.5$

For cohesionless soils:

$$q_B = \gamma(0.5\ B\ C_{w1}\ N_\gamma\ s_\gamma + d_F\ C_{w2}\ N_q\ d_q\ s_q)$$

where:

$N_\gamma = 2\ (N_q + 1) \tan \phi$

$N_q = \exp(\pi \tan\phi) \tan^2(45 + \phi/2)$

$s_\gamma = 0.6$ for square and round footings

$s_q = 1 + \tan \phi$ for square and round footings

$d_q = 1 + 2 \tan \phi\ (1 - \sin\phi)^2 \tan^{-1}(d_F / B)$

Obtain values for C_{W1} and C_{W2} from clause 10.4. Values of N_γ, N_q, s_q and d_q for different values of ϕ are given in Table 6.

10.4.2 q_B from standard penetration test (SPT) results. Bearing resistance for foundations in sands can be taken as:

$$q_B = N_1\ C_{SPT}\ B(C_{w1} + C_{w2}\ d_F / B)$$

where:

C_{SPT} is a constant equal to 31.4 kPa/m (200 lbf/ft^3 or 0.116 lbf/in^3);

C_{w1} and C_{w2} are given in clause 10.4; and

N_1 is the SPT blow count, N_{SPT}, normalized with respect to vertical effective stress as given in clause 5.5.4. For calculations of q_B, the SPT blow count, N_{SPT}, shall be obtained within the range of depth from footing base to 1.5 B below the footing.

10.4.3 q_B from cone penetration test (CPT) results. For saturated clay soils:

$$q_B = C_{CPT1} + q_{cr} / 3$$

For cohesionless soils:

$$q_B = q_{cr} B \left(C_{w1} + C_{w2} d_F / B\right) / C_{CPT2}$$

where:

q_{cr} is average cone resistance within a depth B below the bottom of the footing;

C_{CPT1} is a constant equal to 546 kPa (11,400 lbf/ft^2 or 79.2 lbf/in^2);

C_{CPT2} is a constant equal to 12 m (40 ft or 480 in); and

C_{w1} and C_{w2} are given in clause 10.4.

10.4.4 q_B from pressuremeter test (PMT) results

$$q_B = q_o + C_{PB} \left(p_L - \sigma_{0h}\right)$$

where:

q_o is the initial total vertical pressure at the base of the footing;

p_L is the average value of limiting pressures obtained from pressuremeter tests within a zone of $\pm$1.5 B above and below the footing depth d_F;

σ_{0h} is the horizontal total stress at rest for the depth where the pressuremeter test is performed; and

C_{PB} is an empirical bearing capacity coefficient given as:

$C_{PB} = 0.80 + 0.642(d_F / B) - 0.0839(d_F / B)^2$ for sands

$C_{PB} = 0.80 + 0.384(d_F / B) - 0.0572(d_F / B)^2$ for silts

$C_{PB} = 0.80 + 0.223(d_F / B) - 0.0395(d_F / B)^2$ for clays

where d_F is footing depth; and B is diameter of a round footing or side length of a square footing.

11 Lateral strength assessment

11.1 General. Where the Universal Method has been used to determine foundation and soil forces, conduct lateral stress checks in accordance with clause 11.3. This will require that ultimate lateral soil resistance first be determined in accordance with clause 11.2

For foundations that meet the following two criteria, lateral strength can be assessed using equations in clause 11.4.

1. Soil is homogeneous for the entire embedment depth.
2. Width b of the below-grade portion of the foundation is constant. This generally means that there are no attached collars or footings that are effective in resisting lateral soil forces.

All checks in this section ignore resistance to lateral movement provided by friction between the base of the post/pier foundation and the soil.

11.2 Ultimate lateral soil resistance, p_U

11.2.1 p_U based on soil properties. At a given depth z the ultimate lateral soil resistance p_U can be calculated as:

$$p_{U,z} = 3\sigma'_{v,z} K_P + (2 + z / b)\, c\, K_P^{0.5} \quad \text{for } 0 \leq z < 4b_G$$

$$p_{U,z} = 3\,(\sigma'_{v,z}\,K_P + 2\,c\,K_P^{0.5}) \quad \text{for } z \geq 4b_G$$

$$K_P = (1 + \sin\phi)\,/\,(1 - \sin\phi)$$

where:

$p_{U,z}$ is the ultimate lateral resistance at depth z;

$\sigma'_{v,z}$ is the effective vertical stress at depth z;

K_P is the coefficient of passive earth pressure;

b_G is foundation width at the ground surface;

c is soil cohesion at depth z; and

ϕ is soil friction angle.

For cohesionless soils the preceding equation reduces to:

$$p_{U,z} = 3\,\sigma'_{v,z}\,K_P$$

For cohesive soils the preceding equation reduces to:

$$p_{U,z} = 3\,S_U\,[1 + z\,/\,(2b)] \quad \text{for } 0 \leq z < 4b_G$$

$$p_{U,z} = 9\,S_U \quad \text{for } z \geq 4b_G$$

where S_U is undrained soil shear strength as depth z.

11.2.1.1 Effective vertical stress, $\sigma'_{v,z}$. The difference between the total vertical stress and pore water pressure at a given depth z is defined as the effective vertical stress at depth z, or:

$$\sigma'_{v,z} = \sigma_{v,z} - u_z$$

where:

$\sigma'_{v,z}$ is effective vertical stress at depth z;

$\sigma_{v,z}$ is total vertical stress at depth z; and

u_z is pore water pressure at depth, z.

11.2.2 p_U from in-situ soil tests

11.2.2.1 p_U for cohesionless soils from CPT tests. At a given depth z, ultimate lateral soil resistance p_u for cohesionless soils can be determined from CPT cone penetration resistance q_{cr} at depth z using the following correlation from Lee et al. (2010).

$$p_{U,z} = (1.959\,p_A^{-0.10}\,q_{cr}^{0.47})\,/\,(\sigma'_{m,z}{}^{-0.63})$$

where:

$p_{U,z}$ is ultimate lateral resistance at depth z;

p_A is atmospheric pressure; and

$\sigma'_{m,z}$ is mean effective stress at depth z and is given as:

$$\sigma'_{m,z} = (\sigma'_{v,z} + 2\,\sigma'_{0h,z})\,/\,3$$

where:

$\sigma'_{v,z}$ is effective vertical stress at depth z; and

$\sigma'_{0h,z}$ is at rest effective horizontal stress at depth z.

To maintain dimensional homogeneity, input p_A, q_{cr}, and $\sigma'_{m,z}$ in identical units. Pressure $p_{U,z}$ will then have the same units as these three input variables.

11.2.2.2 p_U from pressuremeter tests. p_U for a given depth can be determined from a pressuremeter reading in accordance with procedures outlined by Briaud (1992).

11.3 Lateral strength checks for Universal Method

When soil springs are used to model soil behavior, there are two different methods that can be used to check the adequacy of the soil in resisting applied lateral loads. The first method is presented in clause 11.3.2 and requires establishment of a $V_U - M_U$ envelope. The second method is presented in clause 11.3.3 and involves a check on the force induced in each soil spring when ASD (or LRFD) loads are applied to the structure. Both methods require calculation of soil spring ultimate strength, F_{ult} (clause 11.3.1).

11.3.1 Soil spring ultimate strength, F_{ult}. The maximum force that an individual soil spring can sustain is given as:

$$F_{ult} = p_{U,z}\ t\ b$$

where:

F_{ult} is soil spring ultimate strength

$p_{U,z}$ is ultimate lateral resistance p_U at soil spring location from clause 11.2

t is thickness of the soil layer represented by soil spring

b is width of foundation at soil spring location

11.3.2 Lateral strength check using $V_U - M_U$ envelope

A foundation is adequate if on a plot of groundline shear versus groundline bending moment, the point $V_{ASD}\ f_L$, $M_{ASD}\ f_L$ (for ASD load combinations) or the point V_{LRFD}/R_L, M_{LRFD}/R_L (for LRFD load combinations) is located within the $V_U - M_U$ envelope,

where:

V_{ASD} is the shear force in the foundation at the ground surface due to an ASD load combination

M_{ASD} is the bending moment in the foundation at the ground surface due to an ASD load combination

f_L is the ASD factor of safety for lateral strength assessment from Table 3

V_{LRFD} is the shear force in the foundation at the ground surface due to an LRFD load combination

M_{LRFD} is the bending moment in the foundation at the ground surface due to an LRFD load combination

R_L is the LRFD resistance factor for lateral strength assessment from Table 3

The $V_U - M_U$ envelope is established by using the following equations to calculate V_U and M_U for different ultimate pivot point locations.

$$V_U = -\sum_{i=1}^{n} F_{ult,i}$$

$$M_U = -\sum_{i}^{n} F_{ult,i}$$

where:

M_U is ultimate groundline bending moment capacity of the foundation (as limited by soil strength). Positive when acting clockwise.

V_U is ultimate groundline shear capacity (as limited by soil strength) of the foundation. Positive when acting to the right.

n is number of springs used to model the soil surrounding the foundation.

$F_{ult,i}$ is ultimate strength of soil spring i from clause 11.3.1. For clockwise foundation rotation, $F_{ult,i}$ is negative for any soil spring located above the selected ultimate pivot point and positive for any soil spring located below the selected ultimate pivot point. For counterclockwise foundation rotation, $F_{ult,i}$ is positive for any soil spring located above the selected ultimate pivot point and negative for any soil spring located below the selected ultimate pivot point.

z_i is absolute distance between groundline and spring i.

To establish a complete $V_U - M_U$ envelope, locate the ultimate pivot point at the ground surface and at the bottom of each of the n soil layers. Conduct two sets of calculations, one assuming the foundation rotates clockwise; the other assuming the foundation rotates counter clockwise.

Shown in Figure 16 is a foundation model utilizing five soil springs. To the right of the model is the free body diagram associated with each of the n + 1 ultimate pivot point locations. The direction of the spring forces in Figure 16 assumes clockwise foundation rotation. Reversing the direction of the spring forces from those shown in Figure 16 provides the six free body diagrams associated with counterclockwise foundation rotation. The resulting $V_U - M_U$ envelope is shown in Figure 17.

11.3.3 Lateral strength check of individual soil spring forces. The capacity of the soil to resist lateral forces is sufficient if the following inequality is met for all soil springs.

$$F_{ASD} \leq F_{ult} / f_L \quad \text{for ASD load combinations}$$

or

$$F_{LRFD} \leq F_{ult}\, R_L \quad \text{for LRFD load combinations}$$

where:

F_{ASD} is force induced in soil spring by ASD load combination

F_{LRFD} is force induced in soil spring by LRFD load combination

F_{ult} is soil spring ultimate strength from clause 11.3.1

f_L is the allowable stress design factor of safety for lateral strength assessment from Table 3

R_L is the LRFD resistance factor for lateral strength assessment from Table 3

If F_{ASD} exceeds F_{ult} / f_L for a soil spring, replace that spring with a horizontal force equal to F_{ult} / f_L and rerun the structural analysis. Repeat this process as often as needed and/or until only one soil spring remains that has not been converted to a horizontal force. If F_{ASD} for the last remaining soil spring exceeds F_{ult} / f_L then the soil can not adequately resist the forces applied to the foundation.

If F_{LRFD} exceeds $F_{ult}\, R_L$ for a soil spring, replace that spring with a horizontal force equal to $F_{ult}\, R_L$ and rerun the structural analysis. Repeat this process as often as needed and/or until only one soil spring remains that has not been converted to a horizontal force. If F_{LRFD} for the last remaining spring exceeds $F_{ult}\, R_L$ then the soil can not adequately resist the forces applied to the foundation.

11.4 Lateral strength checks for Simplified Method. For foundations meeting the two requirements in clause 11.1, the ultimate groundline bending moment capacity of the foundation, M_U, is obtained using clause 11.4.1, 11.4.2 or 11.4.3 when the foundation is non-constrained and clause 11.4.4, 11.4.5 or 11.4.6 when the foundation is constrained.

A constrained foundation is adequate if the following inequality is met.

$$M_U \geq M_{LRFD} / R_L \quad \text{for LRFD}$$

and

$$M_U \geq f_L\, M_{ASD} \quad \text{for ASD}$$

where:

f_L and R_L are obtained from clause 9; and

M_{LRFD} and M_{ASD} are determined in accordance with clause 8.4.2.

A non-constrained foundation is adequate if the previous inequality for M_U is met when V_U and M_U are both positive. If M_U and V_U have opposite signs, construct a $V_U - M_U$ envelope as described in clause C11.4 to determine the adequacy of the foundation.

11.4.1 Non-constrained pier/post in cohesionless soils. The ultimate moment M_U that can be applied at the groundline to a post/pier foundation that is not constrained at the groundline and is embedded in cohesionless soil (Figure 18) is given as:

$$M_U = S_{LU}\,(d^3 - 2\, d_{RU}^3) / 3 \text{ for } 0 \leq d_{RU} \leq d$$

where:

$d_{RU} = (V_U / S_{LU} + d^2 / 2)^{0.5}$

$S_{LU} = 3\, b\, K_P\, \gamma$

$K_P = (1 + \sin \phi) / (1 - \sin \phi)$

$V_U = V_{LRFD} / R_L$ for LRFD

$V_U = f_L\, V_{ASD}$ for ASD

11.4.2 Non-constrained pier/post in cohesive soils. The ultimate moment M_U that can be applied at the groundline to a post/pier foundation that is not constrained at the groundline and is embedded in cohesive soil is given as:

$$M_U = b\, S_U\, [4.5\, d^2 - 6\, d_{RU}^2 - d_{RU}^3 / (2b)] \text{ for } 0 \le d_{RU} \le d$$

where $d_{RU} = [64\, b^2 + 4 V_U / (3 S_U) + 12\, b\, d]^{0.5} - 8\, b$

The preceding equations apply when d_{RU} is less than $4 b_G$ and the force distribution shown in Figure 19a applies. If d_{RU} from the preceding equation is greater or equal to $4 b_G$ (in which case the force distribution shown in Figure 19b applies) then d_{RU} is calculated as:

$$d_{RU} = V_U / (18\, b\, S_U) + d / 2 + 2\, b / 3$$

and $M_U = 9\, b\, S_U\, (d^2 / 2 - d_{RU}^2 + 16\, b^2 / 9)$ for $0 \le d_{RU} \le d$

In both cases: $V_U = V_{LRFD} / R_L$ for LRFD

$V_U = f_L\, V_{ASD}$ for ASD

11.4.3 Non-constrained pier/post in any soil. The ultimate moment M_U that can be applied at the groundline to a post/pier foundation that is not constrained at the groundline and for which d_{RU} is greater than $4 b_G$ (Figure 20) is given as:

$$M_U = S_{LU}\, (d^3 - 2\, d_{RU}^3) / 3 + 6\, b\, c\, K_P^{0.5}\, (d^2 / 2 - d_{RU}^2 + b^2 / 4) \text{ for } 0 \le d_{RU} \le d$$

where:

$d_{RU} = [X^2 + V_U / S_{LU} + X d + d^2 / 2 + X b / 2]^{0.5} - X$

$X = 2c / (K_P^{0.5} \gamma)$

$S_{LU} = 3\, b\, K_P\, \gamma$

$K_P = (1 + \sin \phi) / (1 - \sin \phi)$

$V_U = V_{LRFD} / R_L$ for LRFD

$V_U = f_L\, V_{ASD}$ for ASD

11.4.4 Constrained pier/post in cohesionless soils. The ultimate moment M_U that can be applied at the groundline to a post/pier foundation that is constrained at the groundline (d_{RU} = 0) and is embedded in cohesionless soil (Figure 21) is given as:

$$M_U = d^3 b\, K_P\, \gamma$$

$$K_P = (1 + \sin \phi) / (1 - \sin \phi)$$

11.4.5 Constrained pier/post in cohesive soils. The ultimate moment M_U that can be applied at the groundline to a post/pier foundation that is constrained at the groundline (d_{RU} = 0) and is embedded in cohesive soil (Figure 22) is given as:

$$M_U = b\, S_U\, (4.5\, d^2 - 16\, b^2) \quad \text{for } d \ge 4 b_G$$

and $M_U = b\, d^2\, S_U\, [3 / 2 + d / (2b)]$ for $d \le 4 b_G$

11.4.6 Constrained pier/post in any soil. The ultimate moment M_U that can be applied at the groundline to a post/pier foundation that is constrained at the groundline (d_{RU} = 0) in any soil (Figure 23) is given as:

$$M_U = d^3 b\, K_P \gamma + b c K_P^{0.5}\, (3 d^2 - 32 b^2 / 3) \quad \text{for } d \ge 4 b_G$$

and $M_U = d^3\, b\, K_P\, \gamma + b\, d^2 c\, K_P^{0.5}\, [1 + d / (3b)]$ for $d \le 4 b_G$

$$K_P = (1 + \sin \phi) / (1 - \sin \phi)$$

12 Uplift strength assessment

12.1 General. Foundation uplift strength is due to the combination of foundation mass M_F and resistance to uplift provided by soil mass *U*. Clauses 12.3 and 12.4 contain equations for checking adequacy of the foundation's uplift strength under ASD and LRFD load combinations. These equations are only applicable when the requirements in clause 12.2 are met.

12.2 Uplift design requirements and considerations

12.2.1 Anchorage system design. The anchorage system must be designed with capacity to adequately handle and transfer load between the soil mass and the pier/post. Use the applicable structural design specification(s) to make these determinations. For example, use the ANSI/AWC *National Design Specification (NDS) for Wood Construction* to determine the adequacy of mechanical fasteners used to connect wood uplift blocking to a wood post.

12.2.2 Backfill compaction. Backfill must be compacted to at least 85% of the density of the surrounding soil. Where this compaction requirement is not met, soil uplift resistance *U* shall not exceed the product of the gravitational constant *g* and the mass of backfill material located directly above the anchorage system.

12.2.3 Concrete paving. When adequately mechanically fastened to posts/piers, paving adds vertical resistance equal to the mass of concrete that remains connected to the post/pier. It also increases effective soil stress and thus increases shear strength along the soil failure plane. See clause 13 for frost heaving considerations to be included in the concrete pavement design.

12.3 Allowable stress design. Resistance to foundation uplift is sufficient if the following inequality is met.

$$g\, M_F + U / f_U \geq P_{ASD}$$

where:

M_F is the mass of the foundation;

U is resistance to uplift provided by the soil from clause 12.5;

f_U is the ASD factor of safety for uplift strength assessment from Table 5 in accordance with clause 9; and

P_{ASD} is the maximum axial uplift force due to the ASD load combinations.

12.4 Load and resistance factor design. Resistance to foundation uplift is sufficient if the following inequality is met.

$$gM_F + UR_U \geq P_{LRFD}$$

where:

M_F is the mass of the foundation;

U is resistance to uplift provided by the soil from clause 12.5;

R_U is the LRFD resistance factor for uplift strength assessment from Table 5 in accordance with clause 9; and

P_{LRFD} is the maximum axial uplift force due to the LRFD load combinations.

12.5 Uplift resistance provided by soil. This clause is used to determine the resistance to foundation uplift provided by soil acting on a pier/post anchorage system. An anchorage system may be an attached footing, collar, uplift blocking, or any other devices that enlarges the base of a foundation. Use equations in clause 12.5.1 for foundations in cohesionless soils and those in clause 12.5.2 for cohesive soils.

12.5.1 Foundation in cohesionless soils. Use the following equations to determine the vertical extent of the uplift soil failure surface, *h,* as shown in Figure 24.

For $\phi \leq 20$: $h = 2.5\, B_U$

For $\phi > 20$: $h = B_U (5.78 - 0.350\ \phi + 0.00947\ \phi^2)$

where ϕ is in degrees.

If $h \geq d_U$ the foundation is classified as a *shallow foundation under uplift* and ultimate uplift resistance is determined in accordance with clause 12.5.1.1.

If $h < d_U$ the foundation is a *deep foundation under uplift* and ultimate uplift resistance is determined in accordance with clause 12.5.1.2.

12.5.1.1 Shallow foundation in cohesionless soils. For circular anchorage systems when $h \geq d_U$:

$$U = \gamma d_U (\pi\ d_U\ s_F\ B_U\ K_U \tan\phi / 2 + B_U^2 \pi / 4 - A_p)$$

For rectangular anchorage systems when $h \geq d_U$:

$$U = \gamma d_U [d_U (2 s_F B_U + L_U - B_U)\ K_U \tan\phi + B_U L_U - A_p]$$

where:

$K_U = 0.95$

$s_F = 1 + 1.105(10^{-5})\ \phi^{2.815} d_U / B_U$

where ϕ is in degrees.

12.5.1.2 Deep foundation in cohesionless soils. For circular anchorage systems when $h < d_U$:

$$U = \gamma\ [\pi\ h\ (d_U - h / 2)\ s_F\ B_U\ K_U \tan\phi + d_U\ B_U^2 \pi / 4 - d_U\ A_p]$$

For rectangular anchorage systems when $h < d_U$:

$$U = \gamma\ [h\ (2d_U - h)\ (2 s_F\ B_U + L_U - B_U)\ K_U \tan\phi + d_U\ B_U\ L_U - d_U\ A_p]$$

where:

$K_U = 0.95$

h = vertical extent of the uplift soil failure surface from clause 12.5.1

$s_F = 1 + 1.105\ (10^{-5})\ \phi^{2.815} h / B_U$

where ϕ is in degrees.

12.5.2 Uplift resistance for foundation in cohesive soils. For circular anchorage systems:

$$U = \gamma d_U (B_U^2 \pi / 4 - A_p) + F_C\ S_u\ B_U^2 \pi / 4$$

For rectangular anchorage systems:

$$U = \gamma d_U (B_U L_U - A_p) + F_C\ S_u\ B_U\ L_U$$

where $F_C = 1.2\ d_U / B_U \leq 9$

13 Frost heave considerations

13.1 General. Freezing temperatures in the soil result in the formation of ice lenses in the spaces between soil particles. Under the right conditions, these ice lenses will continue to attract water and increase in size. This expansion of ice lenses increases soil volume. If this expansion occurs under a footing, or alongside a foundation element with a rough surface, that portion of the foundation will be forced upward. This action is called frost heave, and can induce large differential movements in a structure. Differential movement can crack building finishes, and induce significant stress in structural connections and components. When ice lenses thaw, soil moisture content increases dramatically. The soil is generally in a saturated state with reduced strength. As soil water drains from the soil, effective soil stresses increase and the foundation will generally settle.

13.2 Minimizing frost heave. Frost heave can be minimized by building on soils with a low likelihood of freezing, providing good water drainage, and using fine-grained soils with caution.

13.2.1 Footing location. The best way to avoid foundation frost heave is to minimize the freezing potential of underlying soils. This is accomplished by extending footings below the local frost line or by using a foundation system designed and constructed in accordance with SEI/ASCE 32.

13.2.2 Water drainage. Proper surface and subsurface drainage can reduce frost heave. Drainage of surface waters from a structure is enhanced by installing rain gutters, adequately sloping the finish grade away from the structure, and raising the building elevation to a level above that of the surrounding area. Subsurface drainage is achieved with the placement of drain tile or coarse granular material below the maximum frost depth, with drainage to an outlet. Such drainage lowers the water table and interrupts the flow of water moving both vertically and horizontally through the soil.

13.2.3 Fine-grained soils. Fine-grained soils such as clays and silts are more susceptible to frost heave than sands and gravels because (1) water is drawn up further in the smaller capillaries of fine-grained soils, and (2) there is much more surface area in a unit volume of fine-grained soil, and therefore more surface area for water adsorption. One factor that limits frost heave in fine-grained soils is that water is less mobile (moves slower) as capillaries decrease in size, a factor which explains why frost heave is more of a problem in silts than it is in the more finer-grained clay soils. While it is often recommended to backfill with coarse granular backfill to reduce frost heave, this is not recommended when holes are dug in clay soils. Drilling holes in clay soils and backfilling with a coarse-grained soil turns every post-hole into a sump pit that traps and holds water. This leaves the backfill in a saturated, and thus prolonged low-strength state and very prone to significant frost heave when freezing conditions occur. Consequently, as a general rule, backfill holes in silts and clays with clay soils.

13.3 Concrete floors. If the ground beneath a concrete floor can freeze, the floor should be installed such that its vertical movement is not restricted by embedded posts or by structural elements attached to embedded posts. While concrete shrinkage may break bonds between a floor and surrounding components, more proactive measures will ensure independent vertical behavior. For example, roofing felt or plastic film can be placed against surrounding surfaces prior to placing the floor.

13.4 Concrete backfill. The use of cast-in-place concrete as a backfill material may actually increase the likelihood of frost heave. The rough soil-to-concrete backfill interface provides the potential for significant vertical uplift forces due to frost heave. Also, the placement of concrete in holes that decrease in diameter with depth provide additional risk for frost heave.

14 Installation requirements

14.1 General. This section covers two construction-related factors that can significantly affect structural performance: soil compaction and component placement.

14.2 Compaction under footings. Compact all disturbed soil at the base of a hole to a level consistent with the soil bearing capacity assumed in design. Soil upon which a precast concrete footing will be placed must be flat and level. A non-flat surface results in uneven soil-to-footing contact, and this increases bending moments and shear stresses within the footing. If the compacted base is not level, the top surface of any precast concrete footing will not be level, resulting in only line or point contact between the footing and post/pier it supports.

14.3 Backfill compaction. Compact all backfill by tamping all soil in layers (a.k.a. lifts) that do not exceed a thickness of 0.2 m (8 in.) so as to achieve lateral stiffness and strength properties consistent with those used in design.

14.4 Embedment depth. Installed depth of a post/pier foundation shall not be less than 90% of the specified depth. A post foundation can be installed deeper than specified without adversely affecting foundation behavior. However, installing a post or pier deeper than specified can leave the top too short to meet specified structural needs. In the case of spliced, laminated wood posts (i.e., posts with preservative-treated lumber spliced to non-treated lumber), deeper embedment will bring the non-treated portion of the post closer to grade, making it more difficult to meet the ANSI/ASAE EP559 requirement that preservative wood treatment extend a minimum of 16 in above the ground surface.

14.5 Footing placement. The lateral location and plumbness of drilled holes can be adversely affected by: stones and roots struck during drilling, rough/sloping terrain, drilling equipment characteristics, limited site access for drilling equipment, etc. This frequently requires that the base of a hole be manually enlarged to facilitate more accurate footing placement. Unless otherwise permitted by engineering design, a precast concrete footing shall be placed so that the center of the footing is within a distance *b*/2 of the center of the post/pier it supports, where *b* is the width of the post/pier. Cast-in-place concrete footings shall be placed so that distance from the center of the post/pier to the nearest edge of the footing is not less than half the specified diameter/width of the footing.

Commentary

C1.1 Purpose. Post and pier foundations are embedded structural columns that provide lateral and vertical support for buildings and or other structures. A "post foundation" is a phrase generally used to define the embedded portion of structural column that runs continuously from below the soil surface to roof/ceiling framing. A "pier foundation" typically refers to any embedded column that supports an above grade structural column or floor support (and thus does not extend to roof/ceiling framing). As defined in this Engineering Practice, there is no "below-grade" behavioral difference between a post foundation and a pier foundation when subjected to equal loads.

Post and pier foundations tend to be the most economical option for applications that don't require a continuous foundation wall. This includes buildings without basements and foundations for towers and similar structures. Post and pier foundations are used to support structures located above water or above a strata of expansive, collapsible, or frost-heave susceptible soil. They are considered a more environmentally-friendly option to concrete frost walls because they use considerably less concrete, they can be quickly and easily removed, and many types (e.g. precast concrete, wood, steel) can be reused.

In many respects, this engineering practice is a blend of commonly published procedures for determining allowable vertical loads on shallow spread footings, and commonly published procedures for determining allowable lateral loads on short piles. It is for this reason that the term "shallow" is included in the title of this engineering practice. As is common with shallow foundation design, this EP ignores any foundation-soil friction that would help a pier/post foundation transfer gravity loads into the soil.

C1.2 Scope. One of the primary features of this engineering practice is the inclusion of comprehensive factors of safety for both ASD and LRFD. These factors are a function of (1) the method used to obtain soil properties, (2) load direction (uplift, bearing or lateral), and (3) importance of the structure.

Several areas of this engineering practice contain alternative testing and analysis procedures. Some of these procedures are more accurate, some easier-to-apply, some less restrictive in applicability. More accurate testing and analysis procedures are associated with reduced factors of safety, and thus their use will generally produce higher design values.

C1.2.1 Limitations. One of the primary objectives during the development of this engineering practice was to avoid placing numerous restrictions on its applicability. To this end, only three limitations are listed in clause 1.2.1. The first of these limits the EP to posts and piers that are vertically installed in relatively level terrain. This follows from the fact that equations for calculating soil bearing and lateral load capacities as well as pier/post uplift resistance assume a relatively level terrain. In general, these equations should be applicable when the ground around the post/pier within a distance of two times the depth of embedment does not drop more than 10% of the depth of embedment (i.e., ground slopes downward less than 5%). Where the terrain slopes away from the post/pier more than this, the depth of embedment should be increased accordingly. In the absence of a more detailed analysis, one approach may be to increase the depth of embedment *d* (calculated using the equations of this EP which assume a level terrain) by the amount that the soil elevation drops in excess of 0.1*d* at a distance 2*d* from the post/pier. For example, if a minimum depth of embedment *d* of 1.2 m is calculated using the equations of this EP and the ground slope away and in a downward direction from the pier/post is 15%, the soil elevation drop at a distance 2*d* (i.e. 2.4 m) from the post/pier will be 0.36 m. This exceeds the

0.1*d* (i.e., 0.12 m) by 0.24 m and thus the actual depth of embedment to account for ground slope should be increased from 1.2 m to 1.44 m.

The second limitation in clause 1.2.1 restricts use of the EP to concentrically loaded footings. This provision is generally only of concern where a footing is not attached to the pier/post and is thus much freer to rotate separately of the pier/post. Post/piers that are rigidly attached to a footing will help restrict footing rotation and thus help maintain a more uniform bearing pressures and settlements.

The third limitation in clause 1.2.1 restricts post or pier foundation spacing to a minimum value equal to the greater of 4.5 times the maximum dimension of the post/pier cross-section or three times the maximum dimension of a footing or attached collar. For a foundation consisting of a 12 cm x 20 cm post resting on a 50 cm diameter footing, this equates to a minimum spacing between individual posts of 150 cm (i.e. the greater of 4.5 x 20 cm and 3 x 50 cm). This limitation addresses the fact that the shorter the distance between isolated pier/post foundations, the greater the overlap between the “pressure bulbs” surrounding the foundations, and the less applicable will be the equations contained in this engineering practice for estimating maximum uplift, bearing and lateral capacities for isolated pier/post foundations.

This engineering practice can be used to establish the design capacities of post/pier foundations spaced closer than the minimum allowed in clause 1.2.1. In such cases, the design capacities for the isolated foundation shall be taken as the minimum of the design capacities calculated (1) using this engineering practice for isolated foundations and (2) using similar design procedures for a continuous wall and footing with a length equal to the spacing of the isolated foundation. This requirement recognizes that as a string of isolated foundations are moved closer and closer together, the distribution of soil stresses they induce more closely mirrors those of continuous wall and footing.

Although the EP does not limit foundation depth, the Simplified Method for calculating lateral soil forces in clause 8.4 assumes the post/pier is infinitely rigid, and sets a limit on post/pier depth that is a function of post/pier and soil stiffness. If this depth is exceeded, the Universal Method (clause 8.3) must be used to calculate lateral soil pressures and foundation forces.

This EP applies to piers and posts that are driven into soil, as well as those that are placed into pre-excavated holes and then backfilled. Driven (or displacement) piers consists primarily of steel helical piers (e.g. screw anchors) which are turned into the ground. Driven (or displacement) posts include the short, wood posts used to support highway guardrails. Interestingly, helical piers are primarily used to resist bearing and uplift forces, and driven wood posts are primarily used to resist lateral forces.

C5.3.3 Concrete and CLSM. Where CLSM is used to increase the effective width of a post/pier for lateral strength and stiffness of a post/pier foundation, a CLSM unconfined compressive strength between 1 and 2 MPa (150 and 300 lbf/in.^{2}) is recommended. CLSM with an unconfined compressive strength less than 1 MPa can generally be excavated (broken up) using hand tools (e.g. shovels, picks) and machinery (e.g. excavators, backhoes) fitted with conventional buckets. Percussive devices such as jackhammers, impact hammers and rotary drills are generally required to break up CLSM with unconfined compressive strengths greater than 1 MPa.

C5.4 Soil tests. Either laboratory or in-situ testing or a combination of laboratory and in-situ testing can be used to obtain all necessary information needed for post/pier foundation design.

Soil tests remove uncertainty associated with the use of presumptive soil properties, and thus lower factors of safety are associated with calculations where soil characteristics have been ascertained through test. Since certain soil tests are more accurate than others for obtaining a specific soil property, factors of safety are a function of soil test method. Test procedures deemed the most accurate for obtaining various soil properties can be determined by a comparison of factor of safety values in Table 2.

C5.4.1 Sampling locations. A minimum site investigation generally includes at least three borings, usually combined with standard penetration testing. For a rectangular structure, a boring at each corner and one in the center of the structure is recommended, with more required depending on soil complexity and variability, and the size and importance of the structure.

C5.5 Young’s modulus for soil, E_S. In addition to soil particle shape and size, Young’s modulus E_S for a soil depends on factors that change as the soil is loaded. This includes the relative spacing and organization of particles, cementation between particles, and water content. Additionally, the stress-strain relationship of a soil is highly dependent on stress history (e.g. degree of overconsolidation) which means it will behave differently as it is reloaded. Of the several factors controlling E_S, the ones having the largest influence on granular soils are prestress, which can increase E_S by more than a factor of six, and extreme differences in relative density, which can make a fivefold difference in E_S (Lambrechts and Leonards, 1978).

The variation of E_S with stress level means that it is important to first define the level and type of loading to which the soil in question will be subjected. In this case, E_S is only used to predict lateral foundation displacements. Such displacements are largely due to horizontally-applied structural loads (e.g., wind, equipment impact, stored materials) which are highly cyclical in nature. This means that the soil will be repeatedly loaded and unloaded by forces that will seldom approach, and likely never exceed, those induced by nominal (i.e., unfactored) loads (see clause 7.1.1). It is for this reason that clause 5.5.1 recommends that E_S be defined as the secant modulus associated with a major principle stress approximately one-fourth of the soil's ultimate strength at the location being modeled. As a rule of thumb, the secant modulus at one-fourth of the soils ultimate strength is approximately 75% of the initial tangent modulus (Pyke and Beikae, 1984).

When piers/posts are backfilled with soil (as opposed to concrete or CLSM), the modulus of horizontal subgrade reaction will be largely dictated by the elastic modulus of the backfill. Given that soil backfills are highly disturbed materials without a stress history, their in-situ elastic modulus can be accurately predicted with laboratory tests given that laboratory specimens are prepared to mirror field compaction procedures. It is important to note that because of mixing that occurs when handling, backfills tend to be more isotropic and homogeneous than the surrounding, undisturbed soils.

E_S for non-backfill materials is generally best estimated using field (in-situ) tests because of the significance of stress history on E_S and the difficultly of obtaining undisturbed soil samples for laboratory testing.

Although in-situ soil is assumed to be isotropic, it is not. Anisotropy of both stiffness and strength has been observed in many soils (particularly for undrained loadings) but it is usually ignored in practice. For normally consolidated soils, the stiffness in the horizontal direction will normally be less than that in the vertical direction, but the reverse may be true for overconsolidated soils.

C5.5.1 E_S from laboratory tests. Determination of Young's modulus from laboratory compression tests requires simultaneous measurement of applied load and deflection. When the confining stress in a triaxial compression stress is not zero (as with tests according to ASTM D2850), the stresses applied in both directions as well as the strains induced in both directions must be measured (lateral strains are typically calculated from axial strains and total volume changes). Poisson's ratio and Young's modulus are then calculated as:

$$\nu = \frac{\sigma_3\varepsilon_1 - \sigma_1\varepsilon_3}{\sigma_1\varepsilon_1 + \sigma_3\varepsilon_1 - 2\sigma_3\varepsilon_3}$$

$$E_S = \frac{\sigma_1 - 2\nu\sigma_3}{\varepsilon_1}$$

where:

σ_1 and σ_3 are major and minor principle stresses, respectively, and
ε_1 and ε_3 are the associated strains.

In tests in which the lateral confining stress σ_3 is zero (as with tests according to ASTM D2166):

$$\nu = -\varepsilon_3 / \varepsilon_1$$

$$E_S = \sigma_1 / \varepsilon_1$$

In tests in which the specimen is restrained from moving laterally (i.e., $\varepsilon_3 = 0$) (as with tests according to ASTM D2435)

$$\nu = \sigma_3 / (\sigma_1 + \sigma_3)$$

$$E_S = \frac{\sigma_1(1+\nu)(1-2\nu)}{\varepsilon_1(1-\nu)}$$

$$M_S = \frac{\sigma_1}{\varepsilon_1} = \frac{E_S(1-\nu)}{(1+\nu)(1-2\nu)}$$

where:

M_S is the constrained modulus (a.k.a. oedometer modulus).

C5.5.2 E_S from prebored pressuremeter test (PMT) results. Pressuremeters measure Young's modulus in the horizontal direction which is desirable for application of E_S to the prediction of lateral foundation displacements.

C5.5.3 E_S from cone penetration test (CPT) results. Equations in clause 5.5.3 are from Canadian Foundation Engineering Manual and based on work by Schmertmann (1970).

C5.5.4 E_S from standard penetration test (SPT) results. The SPT equations in clause 5.5.4 for Young's modulus were adopted from the AASHTO LRFD Bridge Design Specifications. The SPT blow count, N_{SPT} is determined for clayey soils in accordance with ASTM D1586 and for sandy soils in accordance with ASTM D6066. The SPT blow count value designated as N_{60} is obtained by multiplying N_{SPT} (i.e., the raw SPT blow count recorded in the field) by factors that adjust for hammer efficiency, sample barrel size, borehole diameter and rod length. The symbol $(N_1)_{60}$ is used to identify an N_{60}, value that has been further adjusted to account for overburden pressure. The overburden correction factor is from Liao and Whitman (1986). A detailed discussion of how to calculate $(N_1)_{60}$, including correction factor values was published by the NCEER (1997).

C5.5.5 E_S from undrained shear strength, S_U. Ranges for E_S listed in clause 5.5.5 are from the AASHTO LRFD Bridge Design Specifications.

C5.6 Constant of horizontal subgrade reaction, n_h.

The constant of horizontal subgrade reaction n_h is multiplied by depth z and divided by width b to obtain the modulus of horizontal subgrade reaction k for the special case where modulus k is assumed to increase linearly with depth when b is fixed ($k = n_h\ z/b$). Derivation of the 2.0 factor appearing in the modulus of horizontal subgrade reaction equation is overviewed in clause C8.2.

C5.7.1 S_U from laboratory tests. The primary result of ASTM D2166 is the unconfined compressive strength of the soil, q_u. The undrained shear strength, S_U, as determined using ASTM D2166 is equal to one-half the unconfined compressive strength q_u.

ASTM D2850 does not directly produce the value for undrained shear strength S_U. To determine S_U using ASTM D2850, several (typically three) tests are required at different confining pressures, and S_U is equal to the cohesion intercept of the failure envelope drawn tangent to the Mohr's circle for all individual tests.

C5.7.2 S_U from prebored pressuremeter (PBPMT) test results. Equations in clause 5.7.2 are from Baguelin et al. (1978) as published in Briaud (1992).

C5.7.3 S_U from cone penetration test (CPT) results. The equation in clause 5.7.3 is from Briaud (1992).

C5.8.1 Friction angle ϕ from laboratory tests. Soil loadings associated with bearing, uplift and lateral forces acting on a pier/post foundation are not plane strain in nature like those associated with continuous foundations. The three-dimensional soil strain and stress fields associated with pier/post foundations make the CD triaxial compression test the more appropriate laboratory test for determining the soil friction angle (Salgado, 2008 page 444). The ASTM CD triaxial compression test method is ASTM D7181 *Standard Test Method for Consolidated Drained Triaxial Compression Test for Soils.*

C5.8.2 Friction angle ϕ from standard penetration test (SPT) results. The relationship between soil friction angle and $(N_1)_{60}$ is from Hatanaka and Uchida (1996).

C5.8.3 Friction angle ϕ from cone penetration test (CPT) results. The equation in clause 5.8.3 is from Kulhawy and Mayne (1990).

C5.9 Presumptive values. Data tabulated in Table 1 are unfactored values for use with the resistance and safety factors in Tables 2 through 5. Because the values in Table 1 have not been pre-adjusted to account for a margin of safety in design, they will appear to be less conservative than data appearing in many presumptive soil property tables.

Since the range of possible void ratios in silts (types ML and MH soils) and gravels (types GW and GP soils) is relatively small, the unit weights for these soils do not largely change with variations in consistency, and thus have been assigned constant values in Table 1.

C6.2 Minimum concrete compressive strength. Requiring a minimum compressive concrete strength is consistent with ACI 318 and important for application of the prescriptive minimum plain concrete footings sizes allowed in this EP.

C6.3.1 Minimum nominal thickness. The minimum thickness of plain concrete cast-in-place footings is in accordance with ACI 318 clause 22.7.4.

Cover on reinforcement in cast-in-place footings is in accordance with ACI 318 clause 7.7.1 requirements for concrete cast against and permanently exposed to earth.

C6.3.2 Reinforcement. The requirement that reinforcement need not be provided when "the actual maximum distance from a footing edge to the nearest post/pier edge is less than the nominal thickness of the footing" is based on the assumption that in such footings, arch action provides concrete compression under all conditions of loading.

Under this requirement, if a post with actual dimensions of 12 cm by 14 cm is centered on a footing with a diameter of 36 cm, reinforcement would not be required as long as the footing had a nominal thickness of at least 18 cm – 12 cm / 2 = 12 cm (i.e., the footing radius minus half the narrow dimension of the post). In this case, the 12 cm is guaranteed by the required minimum nominal thickness of 20 cm (8 in.) for plain cast-in-place footings.

C6.4.1 Minimum actual thickness. The post-frame building industry has a long history of using precast concrete footings. Far and away the most commonly used precast concrete footing is 10 cm (4 in.) thick and 35.5 cm (14 in.) in diameter. Footings of this size have been successfully used for several years in agricultural applications with design service loads per footing approaching 33.3 kN (7500 lbf).

When precast footings are used, it is important that they be placed on a flat, well-compacted surface so that the footing is not required to bridge low-spots in the compacted base.

Cover on reinforcement in precast footings is in accordance with ACI 318 clause 7.7.3 for precast concrete exposed to earth with reinforcement less than 4 cm (1.5 in.) in diameter.

C6.4.2 Reinforcement. The requirement that reinforcement need not be provided when "the actual maximum distance from a precast footing edge to the nearest post/pier edge is less than the 1.25 times the actual thickness of the footing" is based on the assumption that in such footings, arch action provides concrete compression under all conditions of loading.

Under this requirement, if a post with actual dimensions of 12 cm by 14 cm is centered on a precast footing with a diameter of 36 cm, reinforcement would not be required as long as the footing had a nominal thickness greater than (18 cm – 12 cm / 2) / 1.25 = 9.6 cm. In this case, the 9.6 cm is guaranteed by the required minimum actual thickness of 10 cm (4 in.) established for precast footings.

The 1.25 factor is used to compensate for the fact that the *maximum* distance from a footing edge to the nearest post/pier edge is used in the calculation, and this maximum distance is generally measurably greater than the *average* distance between the edge of the footing and the nearest post/pier edge. The 1.25 factor is not allowed in the design of cast-in-place footings because of greater variation in the actual size of cast-in-place footings, and because once they have been cast, cast-in-place footings cannot be shifted to improve alignment with the posts/piers they support.

When sizing reinforcement for larger precast footings, consideration should be given to the fact that the larger the footing, the less likely is there to be full contact between the base of the placed footing and the underlying compacted base.

C6.5.1 Longitudinal reinforcement. Axial, shear and bending forces in most concrete piers are such that the assemblies must be treated as structural columns. ACI 318 clause 22.2.2 requires that all structural columns contain reinforcement and thus be designed in accordance with Chapters 10, 11 and 12 of the code. The minimum cross-sectional area requirement is from ACI 318 clause 10.9.1. The minimum number of longitudinal bars is from ACI 318 clause 10.9.2.

C6.5.2 Shear reinforcement. ACI 318 clause 11.5.6.2 allows shear reinforcement to be omitted where tests show that the required nominal bending strength and nominal shear strength can be developed without it.

C6.5.3 Cover on reinforcement. The outer dimensions of a concrete pier are largely dependent on minimum requirements for concrete cover on the reinforcement. The specified minimum concrete cover requirements for reinforcement are from ACI 318 clause 7.7.1 and 7.7.3. These values represent the minimum distance between the surface of the pier and the surface of any steel reinforcement.

C6.9 CLSM base for precast concrete and wood footings. In lieu of using a CLSM base for footings, some builders have compacted a non-hydrated (i.e., dry) concrete mix in the base of holes drilled for pier/post foundation placement. Tests conducted by Bohnhoff et al. (2003) have shown that non-hydrated concrete mixes that are compacted within a soil mass and allowed to self-hydrate, will obtain unconfined compressive strengths that more than double the 8 MPa limit for classification as a controlled low-strength material.

C7.1 General. Structural load combinations from ASCE-7 are included here primarily to ensure consistency between soil resistance factors introduced in this document and the ASCE 7 load factors.

C7.1.1 Nominal loads. All ASCE-7 nominal loads are included in this EP with the exception that loads due to lateral earth pressure or ground water pressure have not been included. In this particular engineering practice, soil is treated and modeled as a structural element and not as an applied load (i.e., it is on the resistance side of the equation). In addition, it is assumed that ground water pressure acts equally on all sides of an embedded post or pier foundation and thus has no net effect on the behavior of embedded elements.

C8.1 General. The application of a lateral load to a pier or post causes a lateral deflection of the pier or post. The reactions that are generated in the soil must be such that the equations of static equilibrium are satisfied, and the reactions must be consistent with the deflections. Also, because no post or pier is completely rigid, the amount of pier/post bending must be consistent with soil properties and pier stiffness. Thus the problem of a laterally loaded pier/post is a “soil-structure-interaction” problem. The solution of the problem requires that numerical relationships between pier/post deflection and soil reactions be known and that these relationships be considered in obtaining the deflection shape of the pier/post.

C8.2 Modulus of horizontal subgrade reaction, *k*. The modulus of horizontal subgrade reaction k is the ratio of average contact pressure (between foundation and soil) and the horizontal movement of the foundation. In this engineering practice, modulus of subgrade reaction is equated to 2 times Young’s modulus divided by width b, where b is the face width of the foundation component (post/pier, footing, or collar) at the location where k is being determined. This general equation for k is based on elastic theory and recommended by Pyke and Beikae (1984). It is similar in form to the standard equation for the modulus of *vertical* subgrade reaction k_V, which from elastic theory is given as:

$$k_V = q / S_i = E_s / [C_S\, b\, (1 - v^2)]$$

where:

q is the equivalent uniform load on the footing;

S_i is the immediate settlement of a point on the footing surface;

E_S is Young’s modulus;

C_S is a combined footing shape and rigidity factor;

b is the characteristic width of the footing; and

v is Poisson’s ratio.

C_S is equated to 0.79 for rigid circular footings and to 0.82 for rigid square footings. For rigid rectangular footings with length/width ratios of 2, 5 and 10, C_S is equal to 1.12, 1.6 and 2.0, respectively (NFEC, 1986a, Table 1 page 7.1-212).

Although Pyke and Beikae (1984) found the modulus of horizontal subgrade reaction to be equal to 2.3, 2.0, and 1.8 times E_S / b for Poisson's ratios of zero, 0.33, and 0.5, respectively, they recommend equating k to 2.0 E_S / b for all Poisson ratio values for practical purposes. Pyke and Beikae point out that this equation neglects friction between the foundation and soil, and also neglects the decrease in pressure on the back side of the foundation as it undergoes lateral movement. They note that a value of the order of 2.0 E_S / b is not unreasonable as it is about twice the value obtained by considering a strip footing acting on the surface of a half space.

Overall it is important to note that elastic theory shows that a coefficient of subgrade reaction is directly related to Young's modulus and inversely related to the characteristic width, b of the surface in contact with the soil. Given that soil deformation-related equations in this engineering practice are based on this theory and have not been experimentally validated, it would be prudent to investigate factors influencing the coefficient of subgrade reaction by conducting extensive field and laboratory tests using foundations with widths and depths that fall under the scope of this engineering practice,

C8.2.1 Effective Young's modulus of soil, E_{SE}, for portions of the foundation backfilled with soil. Laboratory testing and finite element analyses by many researchers have shown that the vast majority of soil deformation resulting from applied foundation forces will occur within a very short distance of the foundation. For continuous (strip) footings (i.e., situations for which conditions of plane strain apply) there is little deformation below a vertical distance 4b of the footing where b is the footing width (Schmertmann et al., 1978). For square and circular footings, this distance reduces to 2b where b is the diameter/width of the footing. These differences between continuous and square footings are consistent with the differences in stress distributions under continuous and square footings as predicted via elastic theory (see Figure 22).

For this engineering practice, it is assumed that all soil deformation occurs within a horizontal distance 3b of the foundation. Terzaghi (1955) states that "the displacements beyond a distance of 3b have practically no influence on the local bending moments", and this distance is midway between the aforementioned vertical distances of 4b and 2b associated with continuous and square footings, respectively. It is important to recognize that the use of a fixed value of 3b ignores the reality that the actual horizontal distance of "strain influence" varies. More specifically, the horizontal distance of "strain influence" decreases as vertical soil movement is less restrained, this increasingly occurs as you move away from horizontal soil layers characterized by plane strain behavior. Regions of reduced vertical restraint include locations near the ground surface, at the base of the foundation, and at depths where an unrestrained post rotates below grade.

Developed by Bohnhoff (2015), the strain influence factor I_S is the fraction of total lateral displacement that is due to soil straining within a distance J of the face of the foundation. When J is equal to 3b, the strain influence factor is equal to 1.0, which is consistent with the assumption that all displacement is due to soil straining occuring within a distance 3b of the foundation. When J is equal to b and 2b, I_S is equal to 0.500 and 0.792, respectively. Although the natural log function used to calculate I_S has some theoretical basis, it was primarily selected for its simplicity. Realize that the actual percentage of total foundation movement that is due to soil straining within a distance J of the foundation is dependent on numerous factors including: foundation shape, foundation flexibility, soil elastic properties, friction between soil and the foundation, magnitude of lateral displacement, foundation restraint conditions, and location relative to both the ground surface and the foundation base.

The strain influence factor is not needed when there is no backfill soil (in which case E_{SE} is equal to $E_{S,U}$) or when the distance from the face of the foundation to the edge of the backfill J exceeds 3b (in which case E_{SE} is equal to $E_{S,B}$). Use of the strain influence factor is only required when the distance J is less than 3b in which case the modulus of horizontal subgrade reaction is dependent on elastic properties of the backfill soil as well as the unexcavated soil that surrounds it.

The equation used to calculate E_{SE} for values of J less than 3b assumes distribution of *stress* around the foundation is not influenced by the difference between elastic properties of the backfill and the unexcavated soil surrounding the backfill. This means that deformation of the backfill between the face of the foundation and a distance J from the foundation is the same regardless of the properties of the surrounding soil. Likewise, the deformation of unexcavated soil beyond a distance J from the face of the foundation is the same regardless of backfill properties. To calculate the deformation of the backfill (i.e., soil within a distance J of the foundation), one only need assume that everything within a distance 3b of the foundation has the properties of the backfill material, in which case the deformation of everything within a distance J is equal to $I_S\,\Delta$ where I_S is the strain influence factor and Δ is the total soil deformation assuming all soil within a distance 3b has the elastic properties of the backfill (in which case Δ is equal to $p_z\ b/(2.0\ E_{S,B})$). In a similar fashion, it can be shown that the deformation of the unexcavated soil beyond a distance J is equal to $(1 - I_S)\ p_z\ b/(2.0\ E_{S,U})$. Adding the deformation of the backfill to that of the surrounding soil yields the total soil deformation $\Delta = I_S\ p_z\ b/(2.0\ E_{S,B}) + (1 - I_S)\ p_z\ b/(2.0\ E_{S,U})$. Substituting $p_z\ b/(2.0\ E_{SE})$ for Δ and solving for E_{SE} yields the first equation in clause 8.2.1.

C8.2.2 Effective Young's modulus of soil, E_{SE}, for portions of the foundation backfilled with concrete or CLSM. The equations in clause 8.2.1 are applicable for foundations that are backfilled with soil. They are not applicable to foundations that are backfilled with concrete or compacted low strength material (CLSM). This is because the measurable difference in elastic properties of soil and concrete/CLSM produces stress and strain distributions around the foundation that depart significantly from those assumed in the derivation of the equations in clause 8.2.1.

Where a foundation or portion of a foundation is backfilled with concrete or CLSM, it is appropriate to treat the concrete/CSLM backfill as part of the post/pier foundation. The effective Young's modulus of the soil E_{SE} is taken as the Young's modulus of the surrounding unexcavated soil, $E_{S,U}$, and the horizontal modulus of subgrade reaction is then equal to $2.0\ E_{S,U} / b$ where b is the width of the concrete/CSLM backfill.

C8.4 Simplified method for determination of foundation and soil forces. The Simplified Method is the method that has traditionally been used to size pier and post foundations. The procedure is made possible with four major assumptions which turn a highly indeterminate structural analysis problem into a determinate analysis. These assumptions are:

1. The axial load, shear and bending moment in the post or pier are not dependent on below-grade deformation.
2. The flexural rigidity ($E_P I_P$) of the below grade portion of the foundation is infinite.
3. The soil is homogeneous for the entire embedment depth.
4. Coefficient of horizontal subgrade reaction k increases linearly with depth for cohesionless soils, and is constant for cohesive soils.

The Simplified Method has the advantage that it does not require estimates of soil stiffness or post/pier bending stiffness to determine lateral soil pressure p_z.

The Simplified Method can be used to estimate post/pier embedment depth for use in the more detailed Universal Method.

C8.4.1 Depth requirements. Depth limitations placed on use of the simplified methods are based on work by Broms (1964a, 1964b).

C8.4.2 Fixed base analog. The fixed base analog is less accurate then the soil-spring analog and is really only used to approximate shear and bending forces induced in a post/pier at the ground surface.

For non-constrained posts/piers, fixed supports are placed at a distance w below the ground surface (Figure 11a). This is done for two reasons. First, this location is close to the location of maximum post/pier bending moment, a fact confirmed by more detailed computer-based analyses and by observation of actual post-frame building failures. Secondly, fixing the support at a location below the ground surface yields a higher, and thus more conservative estimate of the at-grade bending moment. Such a conservative estimate helps offset the many assumptions inherent in the development of the Simplified Method, assumptions that may artificially reduce at-grade bending moment estimates.

Traditionally, engineers have modeled structures with non-constrained embedded piers/posts using an analog that fixes the pier/post at grade (Figure 11b) or that uses two pin supports located as shown in Figure 11c. The analog that fixes piers/posts at grade is obviously too rigid as it does not account for any soil deformation. The analog in Figure 11c not only requires an estimate of depth d, but it also predicts greater ground surface movement as depth d is increased. In reality, the deeper a post/pier is placed in the soil, the less will be the ground surface movement of the post/pier (assuming the post/pier has a fixed cross-sectional area and all other variables remain unchanged), and at some point, a further increase in embedment depth will have no influence on ground surface movement.

C9.1 Tabulated values. Resistance and safety factors for bearing capacity assessment (Table 2) are based on work by Foye, et al., (2006a, 2006b) and on similar factors compiled in the AASHTO LRFD Bridge Design Specifications.

Table 3 and 4 factors for lateral strength assessment are approximately 10% less conservative than those for bearing strength assessment in Table 2. This adjustment recognizes slightly greater confidence in ultimate lateral strength predictions due to comparisons with laboratory and field test data.

Table 5 factors for uplift strength assessment in cohesionless soils were obtained by increasing the resistance factors for bearing strength in Table 2 by 50% (or reducing the safety factors for bearing strength by 33%). Even with this adjustment, design uplift capacities in cohesionless soils calculated in accordance with Version 1 of ASAE EP 486 are at least twice those calculated in accordance with clause 12 of this version of the EP. Table 5 factors for uplift strength assessment in cohesive soils were obtained by reducing the safety factors for bearing strength by 15%.

Bearing, lateral and uplift capacities in cohesionless soils increase exponentially with friction angle, and thus small variances in estimated friction angle have an amplified effect on these capacities as friction angle increases (Foye, et al., 2006a). For this reason, a smaller (more conservative) resistance factor is required for greater friction angles.

C9.2 Adjustments. Buildings and other structures that represent a low risk to human life in the event of a failure are those that identified under ASCE 7 Risk Category I. Common to this category are agricultural buildings and storage shelters.

C10.4.1 q_B from the general bearing capacity equation. General bearing capacity equations are for vertically-loaded, horizontally-orientated, square or circular footings placed under a level surface. This means that in addition to depth factors, the equations incorporate shape factors for round and square footings, but exclude load-inclination factors, base inclination factors and ground inclination factors. Load-inclination factors are excluded because the depth of post/pier foundations is based on calculations that assume all horizontally applied loads are resisted by lateral forces applied to the foundation. To this end, the ratio of horizontal to vertical load applied at the top of the footing is likely to be relatively low and yield an inclination factor near 1.0. The shape and depth factors used in this EP are the same as those adopted in the AASHTO LRFD Bridge Design Specifications manual, as are the C_{W1} and C_{W2} values used to adjust bearing capacity for water table location.

C10.4.3 q_B from cone penetration test (CPT) results. The equation for clays was regressed from data reported in the National Cooperative Highway Research Program Report 343: Manual for the Design of Bridge Foundations (1991) and is from Awkati (1970) but reported by Schmertmann (1978). The equation for cohesionless soils was adopted from the AASHTO LRFD Bridge Design Specifications. Introduction of the constant C_{CPT2} with dimensions of length provides dimensional homogeneity. Average cone resistance, q_{cr}, is determined in accordance with ASTM D3441.

C10.4.4 q_B from pressuremeter test (PMT) results. The equation in clause 10.4.4 is from Briaud (1992) and is applicable for vertical loadings only. See Briaud (1992) for adjustments to account for inclined loadings. Equations for C_{PB} were regressed from curves in Figure 66 of Briaud (1992).

C11.2 Ultimate lateral soil resistance, p_U. Ultimate lateral soil pressure p_U is assumed to act on the entire vertical profile of the foundation, and is assumed to be fully mobilized wherever there is lateral foundation movement.

C11.2.1 p_U based on soil properties. Ultimate lateral soil resisting pressure p_U based on soil properties is taken as three times the Rankine passive pressure. Although basing resisting pressure solely on passive pressure would appear to neglect the active earth-pressure acting on the back of the foundation and side friction, the factor of three by which the passive pressure is increased is based on observed ultimate loads – ultimate loads which were most likely influenced by forces acting on all sides of the foundation system.

Passive pressure due to soil cohesion is assumed to increase from one-third its full value at the ground surface to its full value at a depth of $4b_G$. This partially accounts for the reduced soil containment at the soil surface and less than full mobilization of the soil due to the likelihood of foundation-soil detachment near the surface.

The value of 9 S_U is approximately equal to three times $2S_UK_P^{0.5}$ when ϕ is equal to 32 degrees. The quantity $2cK_P^{0.5}$ is the Rankine passive pressure due to soil cohesion.

C11.2.1.1 Effective vertical stress, $\sigma'_{v,z}$. Total vertical stress at depth *z* is equal to the weight of all soil above a given area located at depth *z* divided by the given area. Pore water pressure at depth *z* is equal to the product of water density and the vertical distance between the water table and depth *z*.

C11.2.2.1 p_U for cohesionless soils from CPT tests. The equation appearing in clause 11.2.2.1 is a corrected version of the original equation published by Lee et al. (2010).

Mean effective stress is the average stress acting on the six faces of a soil cube located below the soil surface. At rest effective horizontal stress at depth *z*, $\sigma'_{0h,z}$, can be estimated by multiplying the effective vertical stress by the quantity 1 – sin ϕ.

C11.3.2 Lateral strength check using V_U – M_U envelope. The concept of a V_U – M_U envelope for post/pier foundations along with techniques for its development and use were established by Bohnhoff (2015) and are presented here to enhance understanding of clause 11.3.2.

Each soil spring is assumed to exhibit linear-elastic behavior until its ultimate strength capacity, F_{ult}, is reached, at which point the spring is assumed to undergo a plastic state of strain with the force in the soil spring remaining at F_{ult}. The lateral strength capacity of a foundation (as limited by soil strength) is reached when *all* springs acting on the foundation have reached their maximum ultimate strength capacity. In other words, the lateral strength of a foundation (as limited by soil strength) is reached when there is not a single remaining soil spring that can take additional load.

The groundline shear V_G and groundline bending moment M_G that will result in a plastic state of strain in all soil springs are defined respectively as the ultimate groundline shear capacity V_U and ultimate groundline moment capacity M_U for the foundation. A V_U – M_U envelope is a plot of all combinations of V_U and M_U that will produce a plastic state of strain in ALL soil springs. In this respect, the V_U – M_U envelope is a *failure* envelope.

The term "pivot point" is used to define any point below the surface associated with zero lateral foundation displacement. At loads less than a foundation's ultimate capacity (i.e., prior to the yielding of all soil springs) there can be multiple pivot points; that is, there can be more than one location below grade where the foundation does not move laterally as shear and bending forces are applied above grade to the foundation (see Figure 26). At applied forces less than V_U and M_U the location of a pivot point is a function of the bending stiffness of the foundation relative to the stiffness of the surrounding soil, and this location changes as the magnitude of the applied groundline shear and bending forces change.

Once all soil being pushed on by the foundation has yielded, the foundation will pivot about a single point defined as the *ultimate* pivot point (Figure 26). Note that:

1. The ultimate pivot point's location is not a function of the foundation's bending stiffness, nor is it a function of soil stiffness. Its location is only a function of foundation dimensions and ultimate soil strength.

2. At failure, soil in contact with the foundation is pushed in one direction above the ultimate pivot point and in the opposite direction below the ultimate pivot point.

3. For each combination of (1) foundation rotation (i.e., clockwise or counter clockwise) and (2) ultimate pivot point depth d_{RU}, there is a unique combination of V_U and M_U as calculated using the equations in clause 11.3.2. The equation for V_U is obtained by summing soil spring forces in the horizontal direction on a free body diagram of the below-grade portion of a foundation. The equation for M_U is obtained by summing moments about the groundline on the same free body diagram.

Each soil spring represents a soil layer. Application of the equations in clause 11.3.2 requires the ultimate pivot point to be located at the interface between soil layers, at the soil surface, or at the base of the foundation. Thus, for an 8 soil spring model, the equations in clause 11.3.2 can be used to calculate 18 V_U – M_U combinations as shown in Figure 27 (data for this V_U – M_U envelope is in Table 7). This includes 9 each for clockwise and for counter clockwise foundation rotation. Not all 18 combinations are different. As shown in

Figure 27, a clockwise rotation of the foundation about the ground surface produces the same V_U and M_U values as a counter clockwise rotation about the base of the foundation. Likewise, a clockwise rotation of the foundation about the base of the foundation produces the same V_U and M_U values as a counter clockwise rotation about the ground surface. "Boxed" values in Figure 27 identify ultimate pivot point locations as a function of total foundation depth d_F.

The requirement that the ultimate pivot point be located between soil layers ensures that each soil spring is representing soil being pushed in the same direction. If the ultimate pivot point is located within a soil layer, then the spring associated with that soil layer must represent soil pushed in one direction above the pivot point, and in the opposite direction below the pivot point. Any soil spring modeling a layer of soil in which the ultimate pivot point is located is called a *pivot spring* (Bohnhoff, 2015). Note that the points on the plot in Figure 27 separate the $V_U - M_U$ envelope into segments, and each of these segments is associated with a different pivot spring. Segments identified with pivot springs 6 and 7 are identified in Figure 27. Because a pivot spring represents soil that is pushed in opposite directions by the foundation, the force in a pivot spring will always be less than the F_{ult} value calculated using the equation in clause 11.3.1.

For design purposes, the entire $V_U - M_U$ envelope need not be constructed. Calculating M_U and V_U for three or so ultimate pivot points in the ½ d_F to $^7/_8$ d_F range, enables construction of a $V_U - M_U$ envelope line that would cover most loadings associated with a non-constrained foundation. The deeper value of $^7/_8$ d_F is associated with foundations that have an attached footing, bottom collar, and/or some other mechanism that results in the base of the foundation having a much greater effective width than the rest of the foundation. Typically, the only way to move the ultimate pivot point outside of the ½ d_F to $^7/_8$ d_F range is for groundline shear and groundline bending moment to have opposite signs as shown in Figure 10.

The first sentence in clause 11.3.2 states that a foundation is adequate if on a plot of groundline shear versus groundline bending moment, the point $V_{ASD}\, f_L$, $M_{ASD}\, f_L$ (for ASD load combinations) or the point V_{LRFD}/R_L, M_{LRFD}/R_L (for LRFD load combinations) is located within the $V_U - M_U$ envelope. A mathematical way to check this for an ASD loading is to ensure that:

$$(M_U^2 + V_U^2)^{0.5} \geq [(M_{ASD}\, f_L)^2 + (V_{ASD}\, f_L)^2]^{0.5} \qquad \text{when } M_U / V_U = M_{ASD} / V_{ASD}$$

or for an LRFD loading:

$$(M_U^2 + V_U^2)^{0.5} \geq [(M_{LRFD} / R_L)^2 + (V_{LRFD} / R_L)^2]^{0.5} \qquad \text{when } M_U / V_U = M_{LRFD} / V_{LRFD}$$

These inequalities simply check that the distance from the origin to point V_U, M_U is greater or equal to the distance from the origin to point $V_{ASD}\, f_L$, $M_{ASD}\, f_L$ (or V_{LRFD} / R_L, M_{LRFD} / R_L) when *both points lie on the same line drawn through the origin*. On a plot of groundline shear force V_G versus groundline bending moment M_G, points are on the same line when they have the same M_G/V_G ratio (hence the requirement that M_U / V_U equal M_{ASD} / V_{ASD} for an ASD loading or M_{LRFD} / V_{LRFD} for an LRFD loading). Figure 28 shows the results of two structural analyses involving two completely different loadings on the same foundation; one ASD and the other LRFD. A quick scan of this plot reveals that the foundation is adequate for the LRFD loading but not for the ASD loading.

As is evident from Figure 28, there is a unique combination of V_U and M_U for each M_G / V_G ratio. To find this combination, the pivot spring associated with the specified M_G / V_G ratio must first be identified. This is accomplished with the use of a plot like that in Figure 27 and/or the corresponding data as given in Table 7. For example, examination of Figure 27 and Table 7 show that a line with a slope of 30 in (i.e., an M_G / V_G ratio of 30 in) crosses the $V_U - M_U$ envelope in the segment associated with spring 7 as the pivot spring. Once the pivot spring is identified, and ultimate groundline bending moment is equated to the product of V_U and the specified M_G / V_G ratio, a summation of moment about the location of the pivot spring will yield an equation with V_U as the only unknown (see Figure 29b). Solving for V_U and multiplying by the specified M_G / V_G ratio yields M_U. Once V_U is established, the force in the pivot spring can also be obtained by summing forces in the horizontal direction (Figure 29c). If the absolute value of the pivot spring force exceeds F_{ult} for that spring, then the wrong spring was selected as the pivot spring or a calculation error was made.

C11.3.3 Spring replacement. Maximum movement of an unrestrained post/pier occurs at grade where ultimate lateral resistance is the lowest. Depending on spring placement/spacing, this can result in the top spring(s) being overloaded in accordance with clause 11.3.1. Replacement of the springs with a force of magnitude F_{ult} recognizes the fact that the soil offers a fixed amount of resistance once a state of plastic strain is reached. To this end, if one or more springs near the surface are overloaded, it does not necessarily mean that the foundation is inadequate. The foundation is only inadequate when the inequality in clause 11.3.3 is not met for any of the modeling springs.

When replacing a spring with a fixed force, the force must act toward (push on) the foundation when the spring is in compression, and must act away from (pull on) the foundation when the spring is in tension.

C11.4 Lateral strength checks for Simplified Method. Relative to the Universal Method described in clause 11.3, the equations in clause 11.4 provide more exact V_U and M_U values for pier/post foundations that have (1) a fixed width, and (2) are embedded in soil considered homogeneous for their entire depth.

Equations for non-constrained foundations in clauses 11.4.1, 11.4.2 and 11.4.3 were obtained using the free body diagrams in Figures 18, 19 and 20, respectively. For each case, forces were summed in the horizontal direction to obtain an equation that was arranged with d_{RU} (ultimate pivot point depth) as the dependent variable and V_U as one of the independent variables. Moments where summed about the surface to obtain an equation for M_U.

The unconstrained foundation equations in clauses 11.4.1, 11.4.2 and 11.4.3 can be used to construct V_U – M_U envelopes. This is accomplished by selecting V_U values (both positive and negative) that produce a range of d_{RU} values between the ground surface (d = 0) and the depth of the foundation (d = d_F), The unconstrained foundation equations provide the d_{RU} values and then the corresponding M_U values for each of the selected V_U values. Use of the equations in clauses 11.4.1, 11.4.2 and 11.4.3 will produce only half the points needed for a complete V_U – M_U envelope; this since the equations only apply when soil forces act in the direction shown in Figures 18, 19, and 20. The other half of the V_U – M_U envelope is associated with soil forces applied in the opposite direction. The combination of V_U and M_U values associated with this reverse in soil forces are simply obtained by changing the signs on each set of V_U and M_U values obtained with the equations in clauses 11.4,1, 11.4.2 and 11.4.3.

Once a V_U – M_U envelope has been established, it can be used as described in clause C11.3.2 to determine the adequacy of the soil to resist the groundline shear and bending moment applied to the foundation.

Construction of a V_U – M_U envelope is not needed when V_G and M_G are both positive. In such cases, the inequality for M_U in clause 11.4 is the only check needed. Figure 30 illustrates how the checking process for the Simplified Method of analysis works. In this case, groundline shear and bending moment are due to an ASD load combination. The first step in the checking process is to multiply the ASD load-induced groundline shear by safety factor f_L. This yields the minimum required ultimate groundline shear capacity, V_U. Second, d_{RU} is calculated from V_U using the appropriate unconstrained foundation equation. Third, M_U is calculated from the d_{RU} value using the appropriate unconstrained foundation equation. In this case, the resulting M_U is exceeded by the combination of M_{ASD} and f_L, so design requirements are not met.

M_U equations for surface constrained foundations in clauses 11.4.4, 11.4.5, and 11.4.6 can be obtained by setting d_{RU} equal to zero in the equations in clauses 11.4.1, 11.4.2, and 11.4.3, respectively.

C11.4.1 Non-constrained pier/post in cohesionless soils. If shear force V_U is zero and there is a nonzero bending moment acting on the foundation, the foundation will rotate at a point below the surface equal to 0.707 d when Rankine soil pressures for cohesionless soils are acting. As V_U is increased, the point of rotation will lower (i.e., the ratio of d_{RU} to d will increase).

If shear V_G and moment M_G rotate the top of the foundation in opposite directions, a negative value must be input for V_{LRFD} (or V_{ASD}). This will move the point of rotation closer to the surface and d_{RU} will be less than 0.707 d.

C11.4.2 Non-constrained pier/post in cohesive soils. For calculation of the ultimate bending moment that can be applied to a non-constrained pier/post in cohesive soil, the force applied by the soil to the foundation per unit depth is assumed to equal 9 S_U b below the point of post/pier rotation. Above the point of rotation, a force of 3 S_U b is applied at the soil surface. This force increases at a rate of 1.5 S_U z. If 4b is less than d_{RU} the maximum applied soil force 9 S_U b will be reached above the point of post/pier rotation as shown in Figure 16b. If 4b is greater than d_{RU} the soil force above the point of rotation reaches a maximum value at the point of rotation of S_U (3b + 1.5d_{RU}) as shown in Figure 19a.

C11.4.3 Non-constrained pier/post in any soil. Equations for calculating the ultimate lateral load capacity of a pier/post in mixed soils requires tests to obtain both soil cohesion and friction angle under identical conditions (e.g. both drained). It is important that these conditions accurately reflect field conditions and do not overestimate soil strength as soil moisture content changes.

C11.4.5 Constrained pier/post in cohesive soils. For calculation of the ultimate bending moment that can be applied to a constrained pier/post in cohesive soil, the force applied by the soil is assumed to equal 3 $S_U\, b$ at the soil surface and increase at a rate of 1.5 $S_U\, z$ until a maximum of 9 $S_U\, b$ is reached at which point the force applied by the soil per unit depth remains at 9 $S_U\, b$. Where 4b exceeds d, the force acting on the foundation per unit depth will not reach 9 $S_U\, b$; instead it will reach a maximum at depth d of $S_U(3b + 1.5d)$.

C11.4.6 Constrained pier/post in any soil. Equations for calculating the ultimate lateral load capacity of a pier/post in mixed soils requires tests to obtain both soil cohesion and friction angle under identical conditions (e.g. both drained). It is important that these conditions accurately reflect field conditions and do not overestimate soil strength as soil moisture content changes.

C12.2.1 Anchorage system design. By design, the uplift strength of a post/pier foundation may be limited by the strength of the anchorage system or the method used to attach the anchorage system to the post/pier.

C12.2.2 Backfill compaction. The requirement in clause 12.2.2 is based on work by Kulhawy et al., (1987), which showed that the degree of backfill compaction had a significant impact on the actual ultimate uplift capacity of a foundation.

C12.5 Uplift resistance provided by soil. The force required to withdraw a post/pier foundation is largely dependent on the presence and size of an anchorage system. Without an anchorage system the only resistance to uplift is that provided by friction between the soil and vertical surfaces of the post/pier foundation.

Attaching a footing, collar, uplift blocking or any other device that effectively enlarges the foundation's base can significantly increase resistance to upward foundation displacement. This resistance is provided by the weight of the soil mass located above the anchorage system plus the resistance to movement of this soil mass.

To move the soil mass located above the anchorage systems requires that a failure plane form in the soil. This failure plane extends upward and outward from the edges of the anchorage system. It may or may not reach the ground surface depending on soil properties and the depth d_U and width B_U of the anchorage system. A shallow foundation under uplift is a foundation associated with a failure plane that reaches the ground surface as shown in Figure 24. Conversely, a deep foundation under uplift is a foundation associated with a failure plane that does not reach the ground surface as shown in Figure 24.

C12.5.1 Foundations in cohesionless soils. Soil uplift resistance values for foundations in cohesionless soils are based on work by Meyerhof and Adams (1968). The first step in these calculations is determining the *vertical extent of the uplift soil failure surface* for deep foundations, h which is a function of the angle of internal soil friction ϕ, and the anchorage system width B_U. The latter is the diameter of a circular anchorage system, or the smallest dimension of a rectangular anchorage system. The equation used to determine h for soil friction values greater than 20 degrees was regressed from data tabulated by Meyerhof and Adams (1968).

C12.5.1.1 Shallow foundation in cohesionless soils. Equations for calculating uplift resistance of foundations in cohesionless soils account for the soil mass that must be displaced as the anchorage system moves upward, and the internal friction (but not cohesion) between the upward moving soil mass and surrounding soil. The volume of soil displaced by that portion of the pier/post located above the anchorage systems is not included in the weight calculations.

K_U, which is the nominal uplift coefficient of earth pressure on a vertical plane through the edges of the anchorage systems, has been fixed at 0.95 for all calculations as suggested by Meyerhof and Adams (1968).

Shape factor s_F accounts for the shape of the failure plane. The equation for s_F was regressed from data tabulated by Meyerhof and Adams (1968).

C12.5.2 Uplift resistance for foundations in cohesive soils. Equations in clause 12.5.2 are from Meyerhof (1973). The quantity 1.2 d_U / B_U is referred to as the breakout factor, F_C, and is limited to a maximum value of 9.

References

AASHTO. 2008. *AASHTO LRFD Bridge Design Specifications*. Washington, D.C.: American Association of State Highway and Transportation Officials.

ACI. 2002a. Guide for Design of Jointed Concrete Pavements for Streets and Local Roads. ACI 325.12R. Farmington Hills, Mich.: American Concrete Institute.

ACI. 2002b. Suggested Analysis and Design Procedures for Combined Footings and Mats. ACI 336.2R. Farmington Hills, Mich.: American Concrete Institute.

Awkati. 1970. Unpublished, reported by Schmertmann, 1978.

Baguelin F., J. F. Jezequel, and D. H. Shields. 1978. *The Pressuremeter and Foundation Engineering*. Clausthal-Zellerfield, W. Germany.: Trans Tech Publications.

Bohnhoff, D. R., Z. D. Hartjes, D. W. Kammel, and N. P. Ryan. 2003. In-Situ Hydration of a Dry Concrete Mix. ASAE Paper No. 034003. St. Joseph, Mich.: American Society of Agricultural Engineers.

Bohnhoff, D. R. 2015. Lateral Strength and Stiffness of Post and Pier Foundations. ASABE Paper No. 152190408. St. Joseph, Mich.: American Society of Agricultural Engineers.

Briaud, Jean-Louis. 1992. *The Pressuremeter*. Brookfield, Vt.: A. A. Balkema Publishers.

Briaud, Jean-Louis. 2001. Introduction to Soil Moduli. *Geotechnical News* June, 2001.

Broms, B. B. 1964a. Lateral Resistance of Piles in Cohesive Soils. *ASCE Journal of the Soil Mechanics and Foundation Division*. 96(SM3): 27-63.

Broms, B. B. 1964b. Lateral Resistance of Piles in Cohesionless Soils. *ASCE Journal of the Soil Mechanics and Foundation Division*. 96(SM3): 123-158.

Canadian Geotechnical Society. 1992. *Canadian Foundation Engineering Manual*. Richmond, B.C., Canada: BiTech Publishers.

Davisson, M. T. 1970. Lateral Load Capacity of Piles. Highway Research Record No. 333. Washington, D.C.

Fellenius, Bengt H. 2003. Foundations. In *The Civil Engineering Handbook*. Chapter 23. Edited by W. F. Chen and J. Y. Richard Liew. New York, N.Y.: CRC Press.

Foye, K. C., R. Salgado, and B. Scott. 2006a. Resistance Factors for Use in Shallow Foundation LRFD. *ASCE Journal of Geotechnical and Geoenvironmental Engineering*. 132(9): 1208-1218.

Foye, K. C., R. Salgado, and B. Scott. 2006b. Assessment of Variable Uncertainties for Reliability-Based Design of Foundations. *ASCE Journal of Geotechnical and Geoenvironmental Engineering*. 132(9): 1197-1207.

Hatanaka, M. and A. Uchida. 1996. Empirical Correlation between Penetration Resistance and Internal Friction Angle of Sandy Soils. *Soils and Foundation* 36(4): 1-10.

Humphrey, Dana N. 2003. Strength and Deformation. In *The Civil Engineering Handbook*. Chapter 17. Edited by W. F. Chen and J. Y. Richard Liew. New York, N.Y.: CRC Press.

Kulhawy, F. H., and P. H. Mayne. 1990. *Manual on Estimating Soil Properties for Foundation Design*. Report EL-6800. Electric Power Research Institute (EPRI).

Kulhawy, F. H., C. H. Trautman, and C. N. Nicolaides. 1987. Spread foundations in uplift: Experimental study. In *Foundations for Transmission Line Towers*, 96-109. Edited by J. L. Briaud. New York, N.Y.: American Society of Civil Engineers.

Lambrechts, J. R., and G. A. Leonards. 1978. Effects of stress history on deformations of sands. *Journal of the Geotechnical Engineering Division, ASCE* 104)GT11): 1371-1387.

Lee, J., M. Kim, and D. Kyung. 2010. Estimation of Lateral Load Capacity of Rigid Short Piles in Sands Using CPT Results. *Journal of Geotechnical and Geoenvironmental Engineering* 136(1): 48-56.

Liao, S. S. C. and R. V. Whitman. 1986. Overburden Correction Factor for SPT in Sand. *ASCE Journal of Geotechnical Engineering* 112(3): 373-377.

Meyerhof, G. G. 1973. Uplift resistance of inclined anchors and piles. *Proceedings, 8th International Conference on Soil Mechanics and Foundation Engineering, Moscow* 2:167-172.

Meyerhof, G. G., and J. I. Adams. 1968. The uplift capacity of foundations. *Canadian Geotechnical Journal* 5(4): 225-244.

NCEER. 1997. *Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils*. Edited by T. L. Youd and I. M. Idriss. Technical Report NCEER-97-0022. Buffalo, N.Y.: National Center for Earthquake Engineering Research.

NCHRP. 1991. *Manual for the Design of Bridge Foundations*. NCHRP Report 343. Washington, D.C.: National Cooperative Highway Research Program.

NFEC. 1986a. *Soil Mechanics*. NFEC Design Manual 7.01. Alexandria, Va.: Naval Facilities Engineering Command.

NFEC. 1986b. *Foundations & Earth Structures*. NFEC Design Manual 7.02. Alexandria, Va.: Naval Facilities Engineering Command.

Prakash, Shamsher, and Hari D. Sharma. 1990. *Pile Foundations in Engineering Practice*. New York, N.Y.: John Wiley & Sons.

Pyke, Robert, and Mohsen Beikae. 1984. A New Solution for the Resistance of Single Piles to Lateral Loading. In *Laterally Loaded Deep Foundations: Analysis and Performance*, 3-20. ASTM STP 835. Edited by J. A. Langer, E. T. Mosley, and C. D. Thompson. American Society for Testing and Materials.

Robertson, P. K. and J. M. Hughes. 1986. Determination of Properties of Sand from Self-Boring Pressuremeter Tests. In *The Pressuremeter and Its Marine Applications*, 283-302. ASTM Special Publication 950. American Society for Testing and Materials.

Salgado, Rodrigo. 2008. *The Engineering of Foundations*. New York, N.Y.: McGraw-Hill.

Schmertmann, John H. 1970. Static Cone To Compute Static Settlement Over Sand. *ASCE Journal of the Soil Mechanics & Foundations Division* 96(SM3): 1011-1043.

Schmertmann, John H. 1978. Guidelines for CPT: Performance and design. Report FHWA-TS-78-209, Federal Highway Administration, Washington D.C. 145 pp.

Schmertmann, John H., John Paul Hartman, and Philip R. Brown. 1978. Improved Strain Factor Diagrams. *ASCE Journal of the Geotechnical Engineering Division* 104(GT*): 1131-1135.

Terzaghi, Karl. 1955. Evaluation of Coefficients of Subgrade Reaction. *Geotechnique* 5(4): 297-326.

Terzaghi, K., and R. B. Peck. 1967. *Soil Mechanics in Engineering Practice*. New York, N.Y.: John Wiley and Sons.

Table 1 – Presumptive soil properties for post and pier foundation design

Soil Type	Unified Soil Classification	Consistency	Moist Unit Weight, γ		Drained Cohesion, c'		Drained Soil Friction Angle, ϕ[(a)]	Undrained Soil Shear Strength[(b)], S_U		Young's Modulus for Soil, E_S[(c)(d)]		Increase in Young's Modulus per Unit Depth below Grade[(c)(d)(e)], A_E		Poisson's Ratio[(f)], ν
			kN/m³	lbf/ft³	kPa	lbf/in²	Deg	kPa	lbf/in²	MPa	lbf/in²	MPa/m	(lbf/in²)/in	
Homogeneous inorganic clay, sandy or silty clay	CL	soft	19.5	125	0		NA	25	3.5	28	3920	-	-	0.5
		medium to stiff	20.5	130				50	7	44	6160	-	-	
		very stiff to hard	21.5	135				100	14	60	8400	-	-	
Homogeneous inorganic clay of high plasticity	CH	soft	17.0	110	0		NA	25	3.5	12	1680	-	-	0.5
		medium to stiff	18.0	115				50	7	20	2800	-	-	
		very stiff to hard	19.0	120				100	14	32	4480	-	-	
Inorganic silt, sandy or clayey silt, varved silt-clay-fine sand of low plasticity	ML	soft	19.0	120	0		NA	25	3.5	28	3920	-	-	0.5
		medium to stiff						50	7	44	6160	-	-	
		very stiff to hard						100	14	60	8400	-	-	
Inorganic silt, sandy or clayey silt, varved silt-clay-fine sand of high plasticity	MH	soft	16.5	105	0		NA	25	3.5	12	1680	-	-	0.5
		medium to stiff						50	7	20	2800	-	-	
		very stiff to hard						100	14	32	4480	-	-	
Silty or clayey fine to coarse sand	SM, SC, SP-SM, SP-SC, SW-SM, SW-SC	loose	16.5	105	0		30	NA		-	-	10	37	0.3
		medium to dense	17.0	110			35			-	-	15	55	
		very dense	18.0	115			40			-	-	20	75	
Clean sand with little gravel	SW, SP	loose	18.0	115	0		30	NA		-	-	20	75	0.3
		medium to dense	19.0	120			35			-	-	30	110	
		very dense	19.5	125			40			-	-	40	150	
Gravel, gravel-sand mixture, boulder-gravel mixtures	GW, GP	loose	21.5	135	0		35	NA		-	-	60	220	0.3
		medium to dense					40			-	-	80	300	
		very dense					45			-	-	100	370	
Well-graded mixture of fine- and coarse-grained soil: glacial till, hardpan, boulder clay	GW-GC, GC, SC	loose	19.0	120	0		35	NA		-	-	30	110	0.3
		medium to dense	19.5	125			40			-	-	40	150	
		very dense	20.5	130			45			-	-	50	185	

[(a)] Rapid undrained loading will typically be the critical design scenario in predominately silt and/or clay soils. Laboratory testing is recommended to assess clay friction angle for drained loading analysis.
[(b)] Loading assumed slow enough that sandy soils behave in a drained manner.
[(c)] Estimate of stiffness at rotation of 1° for use in approximating structural load distribution. For evaluation of serviceability limit state use values that are $^1/_3$ of tabulated value.
[(d)] Constant values of stiffness used for calculation of clay response. Stiffness increasing with depth from a value of zero used for calculation of sand response.
[(e)] Assumes soil is located below the water table. Double the tabulated A_E value for soils located above the water table.
[(f)] Poisson ratio of 0.5 (no volume change) assumes rapid undrained loading conditions.

Table 2 – LRFD resistance factors and ASD safety factors for bearing strength assessment

Soil	Associated Clause[(a)]	Method Used to Determine Ultimate Bearing Capacity, q_B	LRFD Resistance Factor for Bearing Strength Assessment, R_B	ASD Safety Factor for Bearing Strength Assessment, f_B
Cohesionless (SP, SW, GP, GW, GW-GC, GC, SC, SM, SP-SM, SP-SC, SW-SM, SW-SC)	10.4.1	General bearing capacity equation with ϕ determined from laboratory direct shear or axial compression tests (see clause 5.8.1)	$0.80 - 0.01 \cdot \phi$	$1.4/(0.80 - 0.01 \cdot \phi)$
		General bearing capacity equation with ϕ determined from SPT data in accordance with clause 5.8.2	$0.62 - 0.01 \cdot \phi$	$1.4/(0.62 - 0.01 \cdot \phi)$
		General bearing capacity equation with ϕ determined from CPT data in accordance with clause 5.8.3	$0.71 - 0.01 \cdot \phi$	$1.4/(0.71 - 0.01 \cdot \phi)$
		General bearing capacity equation with presumptive soil properties from Table 1	$0.58 - 0.01 \cdot \phi$	$1.4/(0.58 - 0.01 \cdot \phi)$
		General bearing capacity equation with presumptive soil properties from Table 1 with soil type verified by construction testing	$0.77 - 0.01 \cdot \phi$	$1.4/(0.77 - 0.01 \cdot \phi)$
	10.4.2	Standard penetration test (SPT)	0.41	3.4
	10.4.3	Cone penetration test (CPT)	0.50	2.8
	10.4.4	Pressuremeter test (PMT)	0.50	2.8
Cohesive (CL, CH, ML, MH)	10.4.1	General bearing capacity equation with undrained shear strength determined from laboratory compression tests (see clause 5.7.1)	0.60	2.3
		General bearing capacity equation with undrained shear strength determined from PBPMT data in accordance with clause 5.7.2	0.60	2.3
		General bearing capacity equation with undrained shear strength determined from CPT data in accordance with clause 5.7.3	0.60	2.3
		General bearing capacity equation with undrained shear strength determined from in-situ vane tests in accordance with clause 5.7.4	0.60	2.3
		General bearing capacity equation with presumptive soil properties from Table 1	0.47	3.0
		General bearing capacity equation with presumptive soil properties from Table 1 with soil type verified by construction testing	0.60	2.3
	10.4.3	Cone penetration test (CPT)	0.60	2.3
	10.4.4	Pressuremeter test (PMT)	0.60	2.3

[(a)] Clause containing the q_B equation to which the resistance/safety factor applies.

Table 3 – LRFD resistance factors and ASD safety factors for lateral strength assessment using the Universal Method of analysis

Soil	Method Used to Determine Ultimate Lateral Soil Resistance, $p_{U,z}$	LRFD Resistance Factor for Lateral Strength Assessment, R_L	ASD Safety Factor for Lateral Strength Assessment, f_L
Cohesionless (SP, SW, GP, GW, GW-GC, GC, SC, SM, SP-SM, SP-SC, SW-SM, SW-SC)	Equation from clause 11.2.1 with soil friction angle ϕ determined from laboratory direct shear or axial compression tests (see clause 5.8.1)	$0.86 - 0.01 \cdot \phi$	$1.4/(0.86 - 0.01 \cdot \phi)$
	Equation from clause 11.2.1 with soil friction angle ϕ determined from SPT data in accordance with clause 5.8.2	$0.66 - 0.01 \cdot \phi$	$1.4/(0.66 - 0.01 \cdot \phi)$
	Equation from clause 11.2.1 with soil friction angle ϕ determined from CPT data in accordance with clause 5.8.3	$0.76 - 0.01 \cdot \phi$	$1.4/(0.76 - 0.01 \cdot \phi)$
	Equation from clause 11.2.1 with soil friction angle ϕ from Table 1	$0.61 - 0.01 \cdot \phi$	$1.4/(0.61 - 0.01 \cdot \phi)$
	Equation from clause 11.2.1 with soil friction angle ϕ from Table 1, with soil type verified by construction testing	$0.82 - 0.01 \cdot \phi$	$1.4/(0.82 - 0.01 \cdot \phi)$
	Pressuremeter test (PMT) in accordance with clause 11.2.2	0.56	2.5
Cohesive (CL, CH, ML, MH)	Equation from clause 11.2.1 with undrained shear strength S_U determined from laboratory compression tests (see clause 5.7.1)	0.68	2.1
	Equation from clause 11.2.1 with undrained shear strength S_U determined from PBPMT data in accordance with clause 5.7.2	0.68	2.1
	Equation from clause 11.2.1 with undrained shear strength S_U determined from CPT data in accordance with clause 5.7.3	0.68	2.1
	Equation from clause 11.2.1 with undrained shear strength S_U determined from in-situ vane tests in accordance with clause 5.7.4	0.68	2.1
	Equation from clause 11.2.1 with undrained shear strength S_U from Table 1	0.54	2.6
	Equation from clause 11.2.1 with undrained shear strength S_U from Table 1 with soil type verified by construction testing	0.68	2.1
	Pressuremeter test (PMT) in accordance with clause 11.2.2	0.68	2.1

Table 4 – LRFD resistance factors and ASD safety factors for lateral strength assessment using the Simplified Method of analysis

Soil	Required Property	Method Used to Determine Required Soil Property	LRFD Resistance Factor for Lateral Strength Assessment, R_L	ASD Safety Factor for Lateral Strength Assessment, f_L
Cohesionless (SP, SW, GP, GW, GW-GC, GC, SC, SM, SP-SM, SP-SC, SW-SM, SW-SC)	Soil friction angle ϕ for equations in clauses 11.4.1, 11.4.3, 11.4.4 and 11.4.6	Laboratory direct shear or axial compression tests (see clause 5.8.1)	$0.86 - 0.01 \cdot \phi$	$1.4/(0.86 - 0.01 \cdot \phi)$
		SPT data in accordance with clause 5.8.2	$0.66 - 0.01 \cdot \phi$	$1.4/(0.66 - 0.01 \cdot \phi)$
		CPT data in accordance with clause 5.8.3	$0.76 - 0.01 \cdot \phi$	$1.4/(0.76 - 0.01 \cdot \phi)$
	Soil friction angle ϕ for equations in clauses 11.4.1 and 11.4.4	Table 1	$0.61 - 0.01 \cdot \phi$	$1.4/(0.61 - 0.01 \cdot \phi)$
		Table 1 with soil type verified by construction testing	$0.82 - 0.01 \cdot \phi$	$1.4/(0.82 - 0.01 \cdot \phi)$
Cohesive (CL, CH, ML, MH)	Undrained shear strength S_U for equations in clauses11.4.2, 11.4.3, 11.4.5 and 11.4.6	Laboratory compression tests (see clause 5.7.1)	0.68	2.1
		PBPMT data in accordance with clause 5.7.2	0.68	2.1
		CPT data in accordance with clause 5.7.3	0.68	2.1
		In-situ vane tests in accordance with clause 5.7.4	0.68	2.1
	Undrained shear strength S_U for equations in clauses 11.4.2 and 11.4.5	Table 1	0.54	2.6
		Table 1 with soil type verified by construction testing	0.68	2.1

Table 5 – LRFD resistance factors and ASD safety factors for uplift strength assessment

Soil	Required Property	Method Used to Determine Required Soil Property	LRFD Resistance Factor for Uplift Strength Assessment, R_U [(a)]	ASD Safety Factor for Uplift Strength Assessment, f_U [(a)]
Cohesionless (SP, SW, GP, GW, GW-GC, GC, SC, SM, SP-SM, SP-SC, SW-SM, SW-SC)	Soil friction angle ϕ for use in the equations of clauses 12.5.1.1 and 12.5.1.2	Laboratory direct shear or axial compression tests (see clause 5.8.1)	$1.20 - 0.015 \cdot \phi$	$1.4/(1.20 - 0.015 \cdot \phi)$
		SPT data in accordance with clause 5.8.2	$0.93 - 0.015 \cdot \phi$	$1.4/(0.93 - 0.015 \cdot \phi)$
		CPT data in accordance with clause 5.8.3	$1.07 - 0.015 \cdot \phi$	$1.4/(1.07 - 0.015 \cdot \phi)$
		Table 1	$0.87 - 0.015 \cdot \phi$	$1.4/(0.87 - 0.015 \cdot \phi)$
		Table 1 with soil type verified by construction testing	$1.16 - 0.015 \cdot \phi$	$1.4/(1.16 - 0.015 \cdot \phi)$
Cohesive (CL, CH, ML, MH)	Undrained shear strength S_U for use in the equation of clause 12.5.2	Laboratory compression tests (see clause 5.7.1)	0.70	2.0
		PBPMT data in accordance with clause 5.7.2	0.70	2.0
		CPT data in accordance with clause 5.7.3	0.70	2.0
		In-situ vane tests in accordance with clause 5.7.4	0.70	2.0
		Table 1	0.56	2.5
		Table 1 with soil type verified by construction testing	0.70	2.0

[(a)] In all cases, R_U is limited to a maximum value of 0.93 and F_U is limited to a minimum value of 1.50.

Table 6 – Bearing capacity factors as a function of soil friction angle

Soil Friction Angle, ϕ	$\tan\phi$	$1-\sin\phi$	N_γ	N_q	s_q	d_F/B								
						2	3	4	5	6	7	8	10	12
						$\tan^{-1}(d_F/B)$								
						1.11	**1.25**	**1.33**	**1.37**	**1.41**	**1.43**	**1.45**	**1.47**	**1.49**
						d_q								
0	0.000	1.000	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	0.017	0.983	0.07	1.09	1.02	1.04	1.04	1.04	1.05	1.05	1.05	1.05	1.05	1.05
2	0.035	0.965	0.15	1.20	1.03	1.07	1.08	1.09	1.09	1.09	1.09	1.09	1.10	1.10
3	0.052	0.948	0.24	1.31	1.05	1.10	1.12	1.12	1.13	1.13	1.13	1.14	1.14	1.14
4	0.070	0.930	0.34	1.43	1.07	1.13	1.15	1.16	1.17	1.17	1.17	1.18	1.18	1.18
5	0.087	0.913	0.45	1.57	1.09	1.16	1.18	1.19	1.20	1.20	1.21	1.21	1.21	1.22
6	0.105	0.895	0.57	1.72	1.11	1.19	1.21	1.22	1.23	1.24	1.24	1.24	1.25	1.25
7	0.123	0.878	0.71	1.88	1.12	1.21	1.24	1.25	1.26	1.27	1.27	1.27	1.28	1.28
8	0.141	0.861	0.86	2.06	1.14	1.23	1.26	1.28	1.29	1.29	1.30	1.30	1.31	1.31
9	0.158	0.844	1.03	2.25	1.16	1.25	1.28	1.30	1.31	1.32	1.32	1.33	1.33	1.34
10	0.176	0.826	1.22	2.47	1.18	1.27	1.30	1.32	1.33	1.34	1.34	1.35	1.35	1.36
11	0.194	0.809	1.44	2.71	1.19	1.28	1.32	1.34	1.35	1.36	1.36	1.37	1.37	1.38
12	0.213	0.792	1.69	2.97	1.21	1.30	1.33	1.35	1.37	1.37	1.38	1.39	1.39	1.40
13	0.231	0.775	1.97	3.26	1.23	1.31	1.35	1.37	1.38	1.39	1.40	1.40	1.41	1.41
14	0.249	0.758	2.29	3.59	1.25	1.32	1.36	1.38	1.39	1.40	1.41	1.41	1.42	1.43
15	0.268	0.741	2.65	3.94	1.27	1.33	1.37	1.39	1.40	1.41	1.42	1.43	1.43	1.44
16	0.287	0.724	3.06	4.33	1.29	1.33	1.38	1.40	1.41	1.42	1.43	1.44	1.44	1.45
17	0.306	0.708	3.53	4.77	1.31	1.34	1.38	1.41	1.42	1.43	1.44	1.44	1.45	1.46
18	0.325	0.691	4.07	5.26	1.32	1.34	1.39	1.41	1.43	1.44	1.44	1.45	1.46	1.46
19	0.344	0.674	4.68	5.80	1.34	1.35	1.39	1.42	1.43	1.44	1.45	1.45	1.46	1.47
20	0.364	0.658	5.39	6.40	1.36	1.35	1.39	1.42	1.43	1.44	1.45	1.46	1.46	1.47
21	0.384	0.642	6.20	7.07	1.38	1.35	1.39	1.42	1.43	1.44	1.45	1.46	1.46	1.47
22	0.404	0.625	7.13	7.82	1.40	1.35	1.39	1.42	1.43	1.44	1.45	1.46	1.46	1.47
23	0.424	0.609	8.20	8.66	1.42	1.35	1.39	1.42	1.43	1.44	1.45	1.46	1.46	1.47
24	0.445	0.593	9.44	9.60	1.45	1.35	1.39	1.42	1.43	1.44	1.45	1.45	1.46	1.47

Table 6 (continued) – Bearing capacity factors as a function of soil friction angle

Soil Friction Angle, ϕ	$\tan\phi$	$1-\sin\phi$	N_γ	N_q	s_q	d_F/B = 2	3	4	5	6	7	8	10	12
					$\tan^{-1}(d_F/B)$	1.11	1.25	1.33	1.37	1.41	1.43	1.45	1.47	1.49
					d_q									
25	0.466	0.577	10.87	10.66	1.47	1.34	1.39	1.41	1.43	1.44	1.44	1.45	1.46	1.46
26	0.488	0.562	12.54	11.85	1.49	1.34	1.38	1.41	1.42	1.43	1.44	1.45	1.45	1.46
27	0.510	0.546	14.47	13.20	1.51	1.34	1.38	1.40	1.42	1.43	1.43	1.44	1.45	1.45
28	0.532	0.531	16.71	14.72	1.53	1.33	1.37	1.40	1.41	1.42	1.43	1.43	1.44	1.45
29	0.554	0.515	19.33	16.44	1.55	1.33	1.37	1.39	1.40	1.41	1.42	1.43	1.43	1.44
30	0.577	0.500	22.40	18.40	1.58	1.32	1.36	1.38	1.40	1.41	1.41	1.42	1.42	1.43
31	0.601	0.485	25.99	20.63	1.60	1.31	1.35	1.37	1.39	1.40	1.40	1.41	1.42	1.42
32	0.625	0.470	30.21	23.17	1.62	1.31	1.34	1.37	1.38	1.39	1.39	1.40	1.41	1.41
33	0.649	0.455	35.18	26.09	1.65	1.30	1.34	1.36	1.37	1.38	1.38	1.39	1.40	1.40
34	0.675	0.441	41.06	29.43	1.67	1.29	1.33	1.35	1.36	1.37	1.37	1.38	1.39	1.39
35	0.700	0.426	48.02	33.29	1.70	1.28	1.32	1.34	1.35	1.36	1.36	1.37	1.37	1.38
36	0.727	0.412	56.30	37.74	1.73	1.27	1.31	1.33	1.34	1.35	1.35	1.36	1.36	1.37
37	0.754	0.398	66.18	42.91	1.75	1.26	1.30	1.32	1.33	1.34	1.34	1.35	1.35	1.36
38	0.781	0.384	78.01	48.92	1.78	1.26	1.29	1.31	1.32	1.32	1.33	1.33	1.34	1.34
39	0.810	0.371	92.23	55.94	1.81	1.25	1.28	1.30	1.31	1.31	1.32	1.32	1.33	1.33
40	0.839	0.357	109.39	64.18	1.84	1.24	1.27	1.28	1.29	1.30	1.31	1.31	1.32	1.32
41	0.869	0.344	130.18	73.88	1.87	1.23	1.26	1.27	1.28	1.29	1.29	1.30	1.30	1.31
42	0.900	0.331	155.51	85.35	1.90	1.22	1.25	1.26	1.27	1.28	1.28	1.29	1.29	1.29
43	0.933	0.318	186.48	98.99	1.93	1.21	1.24	1.25	1.26	1.27	1.27	1.27	1.28	1.28
44	0.966	0.305	224.58	115.28	1.97	1.20	1.22	1.24	1.25	1.25	1.26	1.26	1.26	1.27
45	1.000	0.293	271.68	134.84	2.00	1.19	1.21	1.23	1.24	1.24	1.25	1.25	1.25	1.26
46	1.036	0.281	330.25	158.46	2.04	1.18	1.20	1.22	1.22	1.23	1.23	1.24	1.24	1.24
47	1.072	0.269	403.54	187.15	2.07	1.17	1.19	1.21	1.21	1.22	1.22	1.22	1.23	1.23
48	1.111	0.257	495.86	222.24	2.11	1.16	1.18	1.19	1.20	1.21	1.21	1.21	1.22	1.22
49	1.150	0.245	612.97	265.42	2.15	1.15	1.17	1.18	1.19	1.19	1.20	1.20	1.20	1.21
50	1.192	0.234	762.64	318.96	2.19	1.14	1.16	1.17	1.18	1.18	1.19	1.19	1.19	1.19

Table 7– Data for example V_U – M_U envelope formulation

Foundation and soil parameters: foundation width *b* is 4.5 in, foundation depth d_F is 48 in, soil is cohesionless with angle of internal friction of 35 degrees and corresponding coefficient of passive earth pressure K_P of 3.69, soil density is 0.637 lbm/in^3, each soil spring is used to model a 6-in thick layer of soil.

Spring number	Distance from surface to spring, *z*	Effective vertical soil stress at spring location	Ultimate lateral soil resistance at spring location, $p_{U,z}$	Absolute maximum force allowed in spring F_{ult}
	in	lbf/in^2	lbf/in^2	lbf
1	3	0.19	2.1	57
2	9	0.57	6.3	171
3	15	0.95	10.6	285
4	21	1.34	14.8	400
5	27	1.72	19.0	514
6	33	2.10	23.3	628
7	39	2.48	27.5	742
8	45	2.86	31.7	856

Depth to ultimate pivot point, d_{RU}, in	Ultimate pivot point location as function of total foundation depth, d_{RU}/d_F	Ultimate groundline shear, V_U, lbf	Ultimate groundline moment capacity, M_U, lbf-in	M_U/V_U
0	0	-3653	1.16E+05	-31.9
6	0.125	-3539	1.16E+05	-32.8
12	0.250	-3197	1.13E+05	-35.4
18	0.375	-2626	1.04E+05	-39.8
24	0.500	-1827	8.77E+04	-48.0
30	0.625	-799	5.99E+04	-75.0
36	0.750	457	1.85E+04	40.5
42	0.875	1941	-3.94E+04	-20.3
48	1.000	3653	-1.16E+05	-31.9

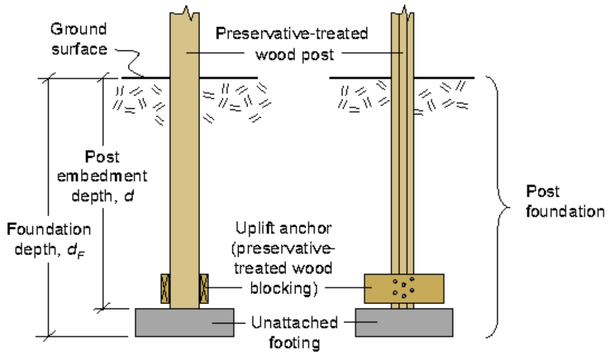


Figure 1 – Preservative-treated wood post foundation

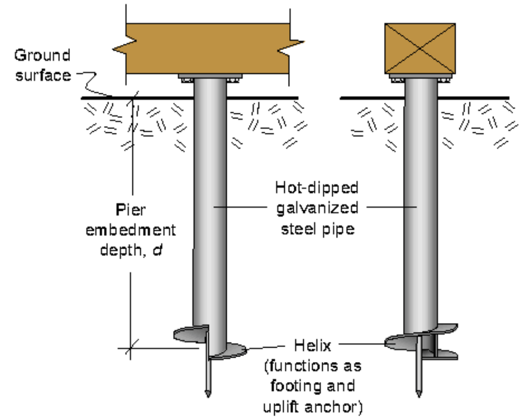


Figure 2 – Helical pier foundation

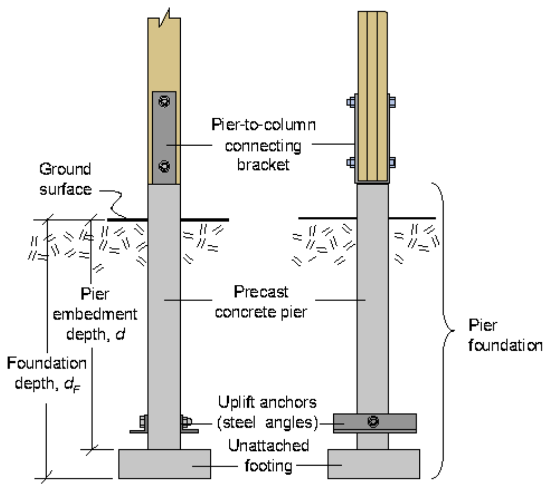


Figure 3 – Precast concrete pier foundation

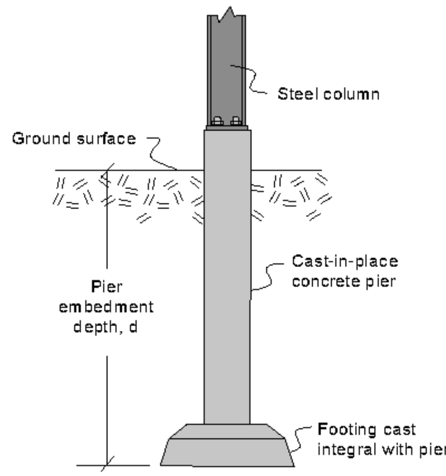


Figure 4 – Cast-in-place concrete pier foundation

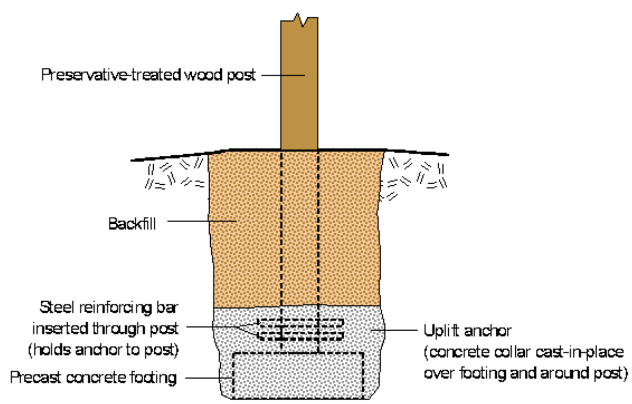


Figure 5 – Post foundation with cast-in-place concrete collar

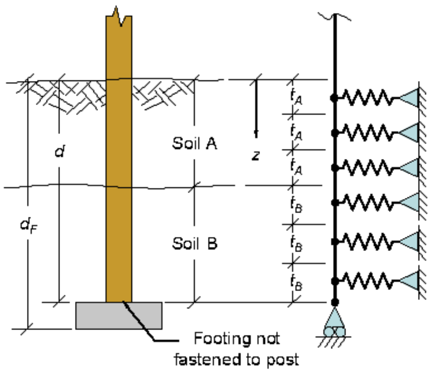


Figure 6 – Two-dimensional structural analog for a post/pier foundation. Spacing of soil springs dictated by thickness of each soil layer.

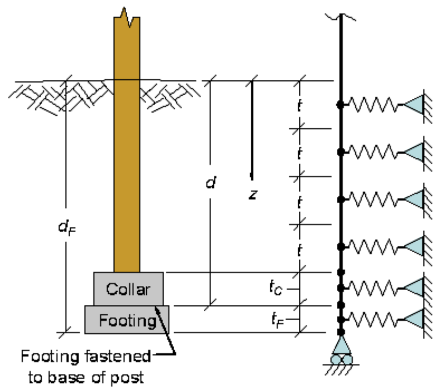


Figure 7 – Two-dimensional structural analog for a post/pier foundation. Different soil springs are used to model soil acting on the collar, attached footing, and pier/post because of the difference in width of the three foundation elements.

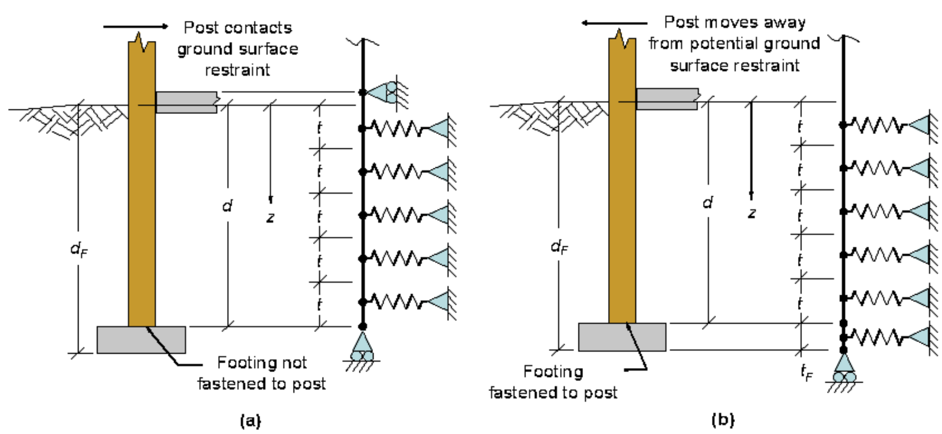


Figure 8 – Two-dimensional structural analogs for a post/pier foundation. If pier/post foundation is moving away from a surface restraint, do not model the surface restraint with a support.

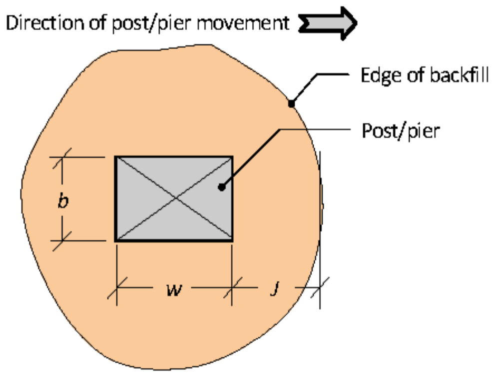


Figure 9 – Top view of foundation showing distance *J* between the post/pier and edge of backfill

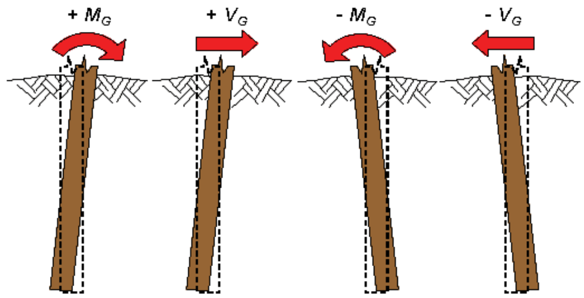


Figure 10 – Sign convention for groundline shear and groundline bending moment forces

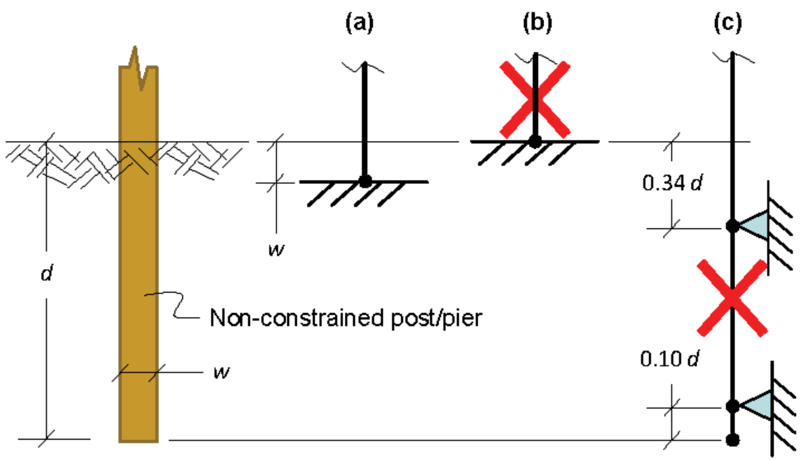


Figure 11 – Modeling analogs: (a) fixed base analog that is recommended when modeling a non-constrained pier/post to obtain M_G and V_G, (b) fixed base analog that is not recommended as it is too rigid, and (c) old two support analog that is too flexible for deeper foundations and too difficult to use.

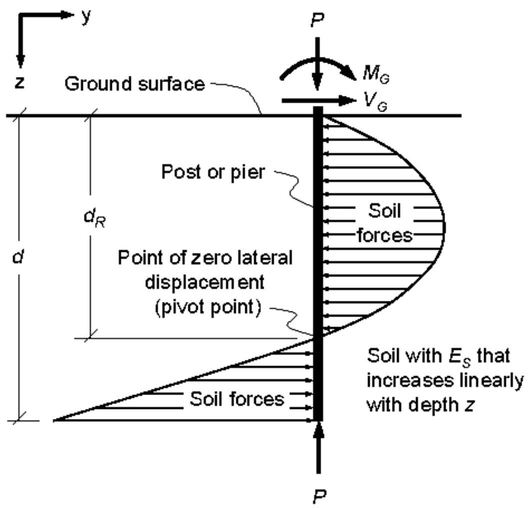


Figure 12 – Forces acting on a non-constrained post/pier of fixed width *b* when soil stiffness increases linearly with depth

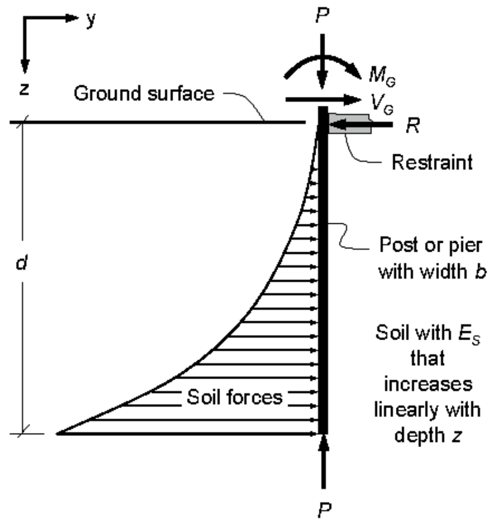


Figure 13 – Forces acting on a ground surface-constrained post/pier of fixed width *b* when soil stiffness increases linearly with depth

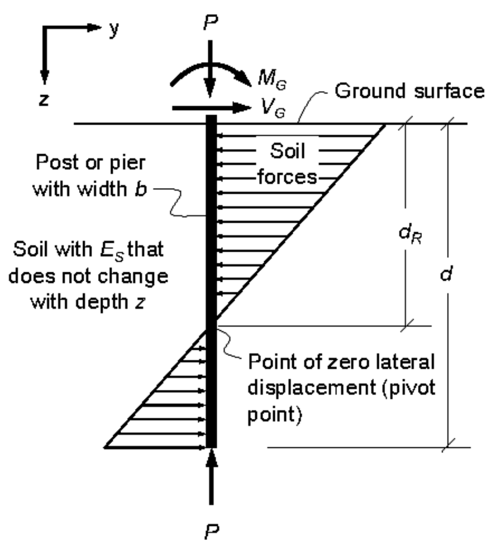


Figure 14 – Forces acting on a non-constrained post/pier of fixed width *b* when soil stiffness is constant with depth

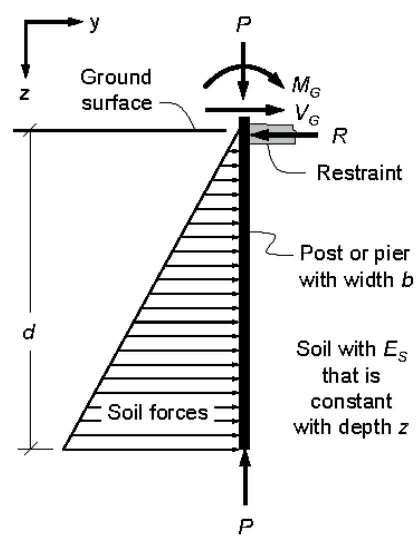


Figure 15 – Forces acting on a ground surface-constrained post/pier of fixed width *b* when soil stiffness is constant with depth

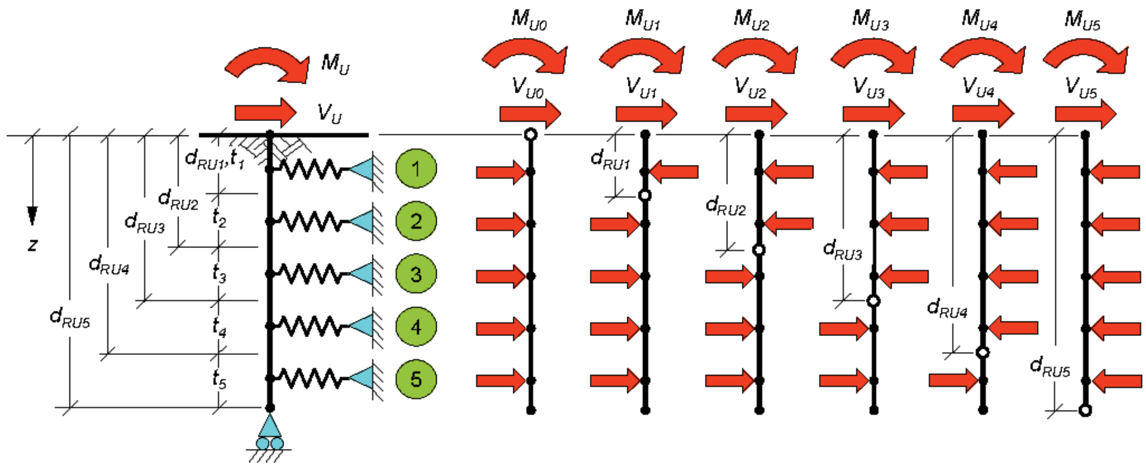


Figure 16 – Five soil spring model and associated free body diagrams for six different ultimate pivot point locations.

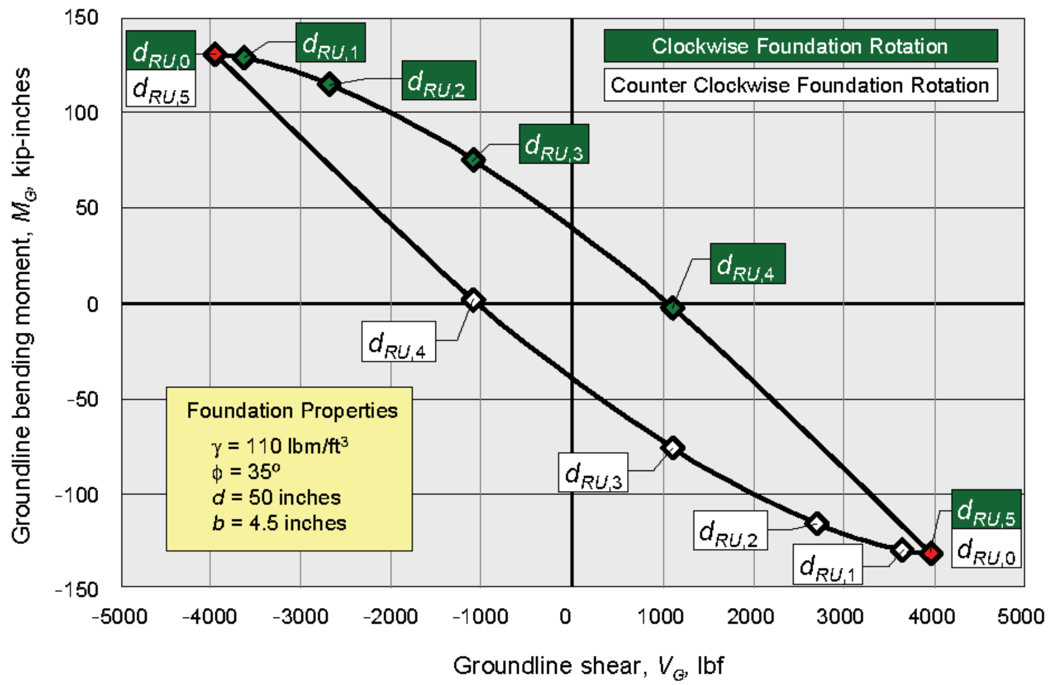


Figure 17 – V_U – M_U envelope developed using free body diagrams in Figure 16.

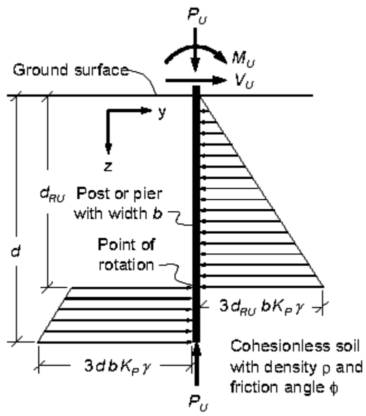


Figure 18 – Forces acting on a non-constrained post/pier of fixed width *b* in cohesionless soil at failure

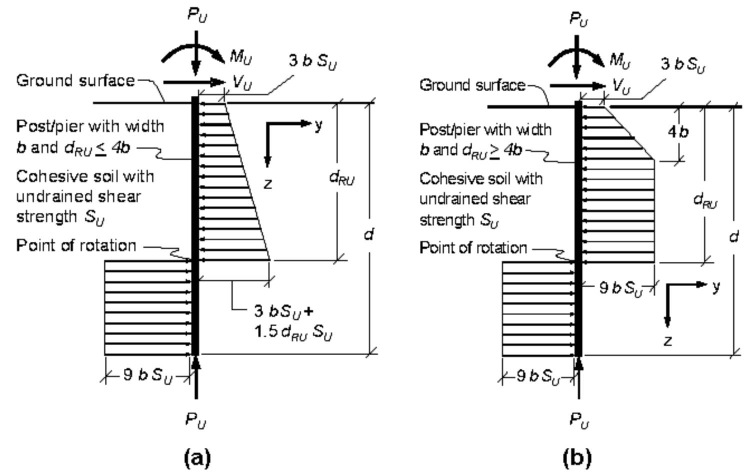
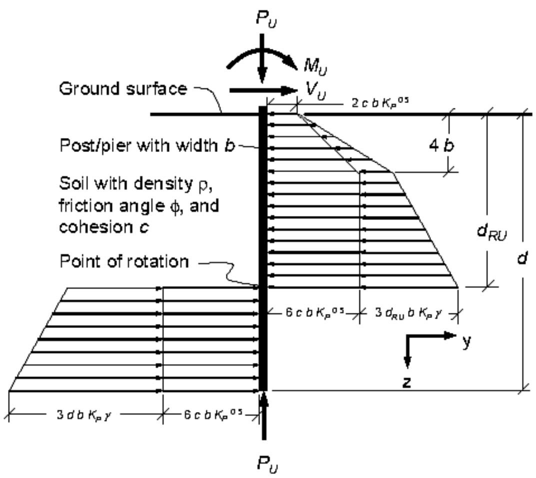


Figure 19 – Forces acting on a non-constrained post/pier of fixed width *b* in cohesive soil at failure (a) when d_{RU} is less than 4 *b*, and (b) when d_{RU} is greater than 4 *b*



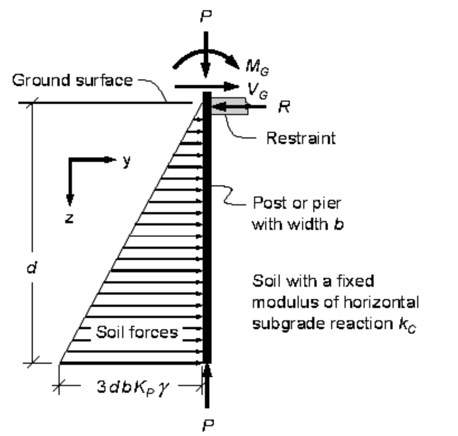


Figure 20 – Forces acting on a non-constrained post/pier of fixed width *b* in a homogenous soil at failure

Figure 21 – Forces acting on a constrained post/pier of fixed width *b* in cohesionless soil at failure

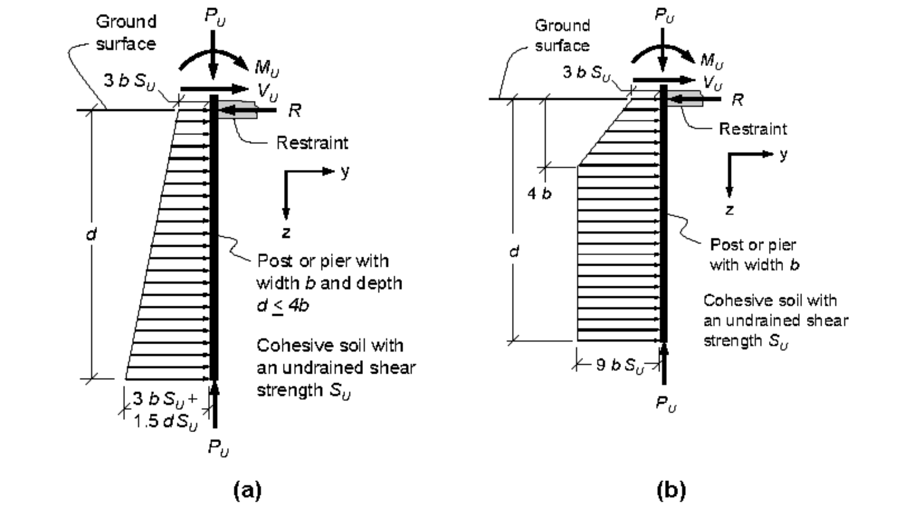


Figure 22 – Forces acting on a constrained post/pier of fixed width *b* in cohesive soil at failure (a) when *d* is less than 4 *b*, and (b) when *d* is greater than 4 *b*

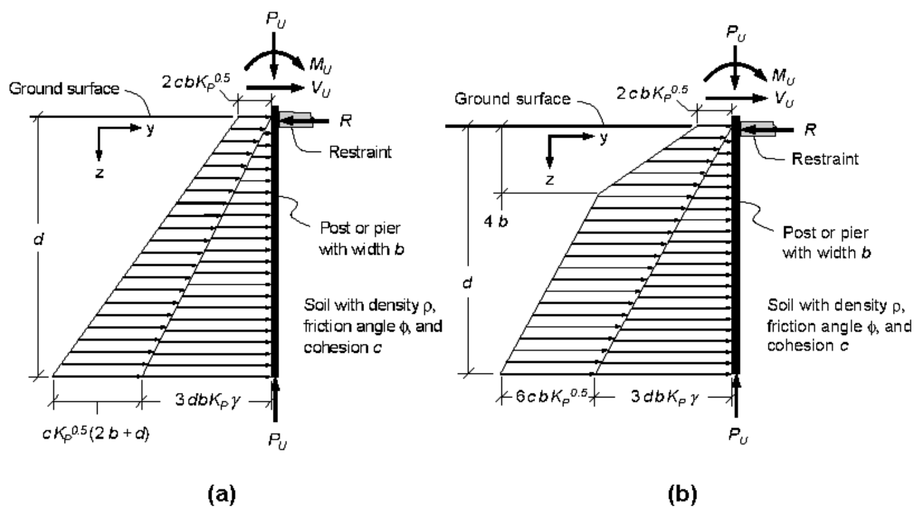


Figure 23 – Forces acting on a constrained post/pier of fixed width *b* in a homogenous soil at failure (a) when *d* is less than 4 *b*, and (b) when *d* is greater than 4 *b*

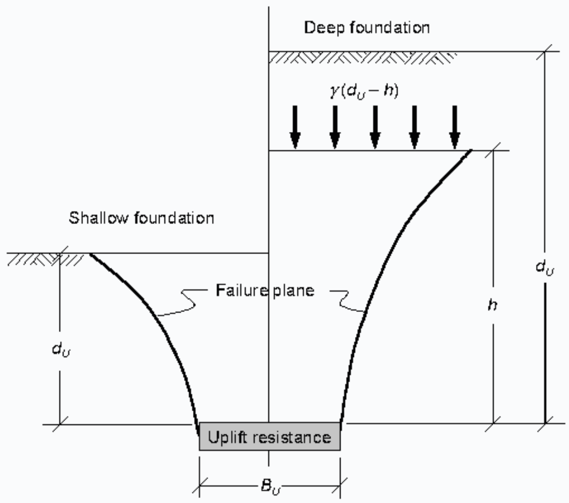


Figure 24 – Modes of uplift failure for uplift resistance systems at different depths

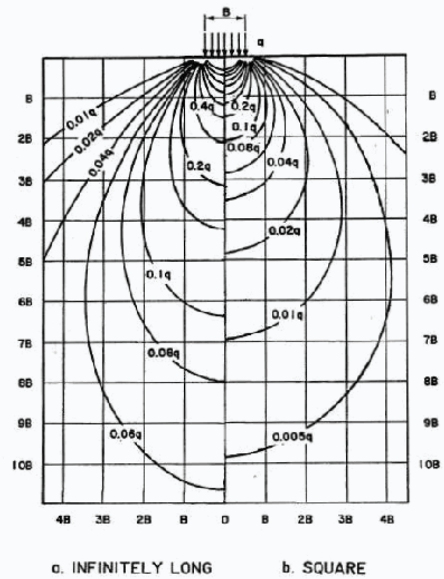


Figure 25 – Stress distributions under continuous and square footings as predicted via elastic theory

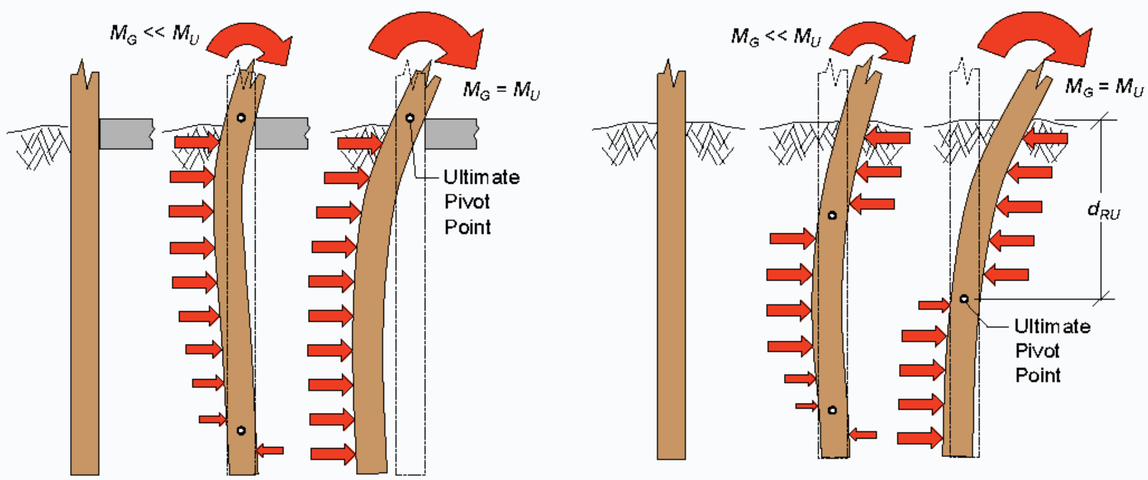


Figure 26 – Surface-constrained (left) and non-constrained (right) post foundations subjected to a groundline bending moment.

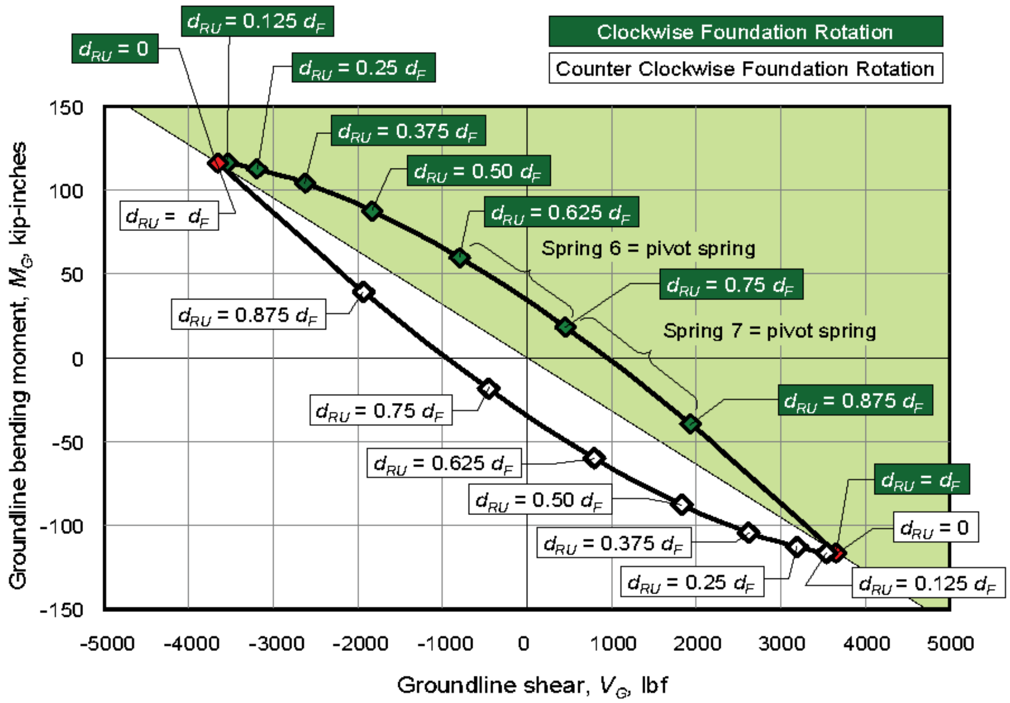


Figure 27 – A $V_U – M_U$ envelope for an 8 soil spring model based on data in Table 7.

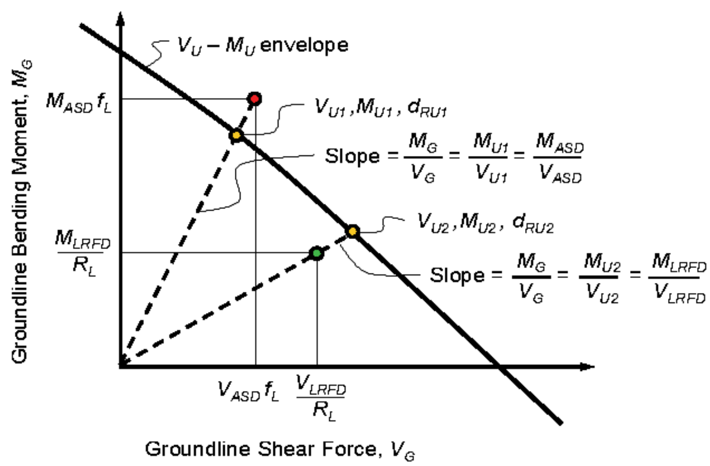


Figure 28. Using a $V_U – M_U$ envelope to check the adequacy of a foundation.

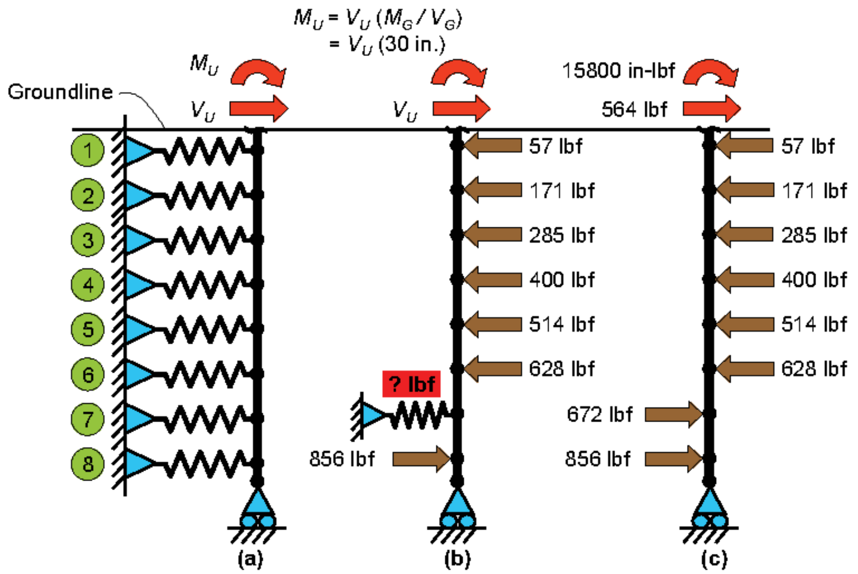


Figure 29. Determining V_U and M_U for a specified M_G/V_G ratio and associated pivot spring.

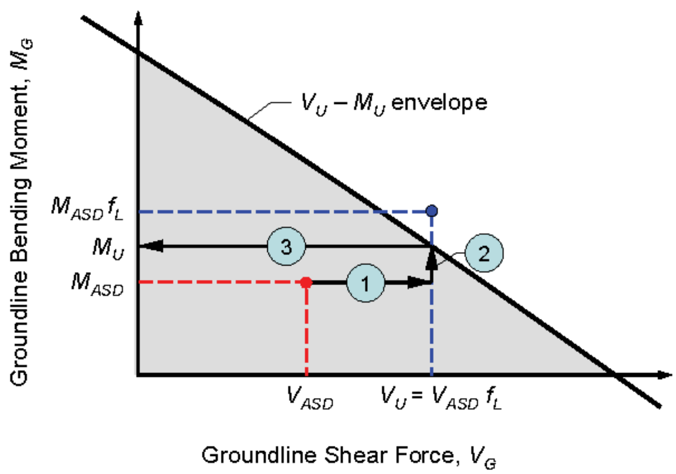


Figure 30. Graphical depiction of lateral strength checking process for Simplified Method of analysis.

ANSI/ASAE EP559.1 W/Corr. 1 AUG2010 (R2014)
Design Requirements and Bending Properties for Mechanically Laminated Wood Assemblies

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ANSI/ASAE EP559.1 W/Corr. 1 AUG2010 (R2014)
Revision approved August 2010; reaffirmed January 2015 as an American National Standard

Design Requirements and Bending Properties for Mechanically Laminated Wood Assemblies

Developed by the ASAE Mechanically Laminated Post Design Subcommittee of the Structures Group; approved by the Structures and Environment Division Standards Committee; adopted by ASAE December 1996; approved as an American National Standard February 1997; reaffirmed by ANSI February 2003; reaffirmed by ASAE February 2003; reaffirmed by ASABE and ANSI February 2008; revised and approved by ANSI August 2010; corrigenda 1 issued March 2011; reaffirmed by ASABE December 2014; reaffirmed by ANSI January 2015.

Corrigenda 1 corrected publication errors in equation 3 (7.3.1).

Keywords: Beams, Columns, Girders, Laminated Lumber, Laminating, Lumber, Wood Design, Wood Structures

1 Purpose and Scope

1.1 The purpose of this Engineering Practice is to establish guidelines for designing and calculating allowable bending properties of mechanically laminated wood assemblies used as structural members.

1.2 The scope of this Engineering Practice is limited to mechanically laminated assemblies with three or four wood laminations that have the following characteristics:

1.2.1 The actual thickness of each lamination is between 38 and 51 mm (1.5 and 2.0 in.).

1.2.2 All laminations have the same depth (face width), d.

1.2.3 Faces of adjacent laminations are in contact.

1.2.4 The centroid of each lamination is located on the centroidal axis of the assembly (axis Y-Y in Figure 1a), that is, no laminations are offset.

1.2.5 Concentrated loads are distributed to the individual laminations by a load distributing element.

1.2.6 All laminations are of the same grade and species of lumber or structural composite lumber.

1.2.7 There is no more than one common end joint per lamination within a splice region.

1.3 The provisions of this Engineering Practice do not apply to assemblies designed for biaxial bending. The design requirements in clause 4, and allowable bending properties in clauses 5 and 6, are only for uniaxial bending about axis Y-Y (Figure 1a). Spliced assemblies with butt joints shall have sufficient lateral support to prevent out-of-plane (lateral) movement or buckling, and/or delamination in the splice region.

1.4 This Engineering Practice does not preclude the use of assembly designs not meeting the criteria in clauses 1.2 and 1.3.

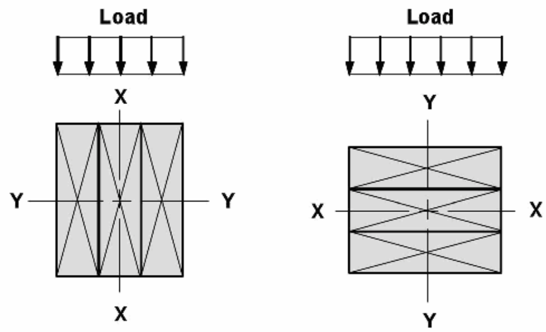

Figure 1 – (a) Vertically laminated, (b) horizontal laminated assemblies

2 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this Engineering Practice. At the time of publication, the editions were valid. All standards are subject to revision, and parties to agreements based on this Engineering Practice are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Standards organizations maintain registers of currently valid standards.

AF&PA (2005), National Design Specification (NDS) for Wood Construction

AITC Test T110-2007, Cyclic Delamination Test

ANSI/TPI 1-2007, National Design Standard for Metal Plate Connected Wood Truss Construction

ANSI/AITC 405-2008, Standard for Adhesives for Use in Structural Glued Laminated Timber

ASTM A153/A153M-05, Specifications for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A 653/A 653M-09, Standard Specification for Steel Sheet, Zinc-Coated (galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process

ASTM B 695, Standard Specification for Coating of Zinc Mechanically Deposited on Iron and Steel

ASTM D 198-08, Standard Methods of Static Testing of Timbers in Structural Sizes

ASTM D 245-06, Standard Methods for Establishing Structural Grades and Related Allowable Properties for Visually Graded Lumber

ASTM D 3737-08, Standard Methods for Establishing Stresses for Structural Glued-Laminated Timber (Glulam)

ASTM D 7469-08, Standard Test Methods for End Joints in Structural Wood Products

AWPA U1-09, Use Category System: User Specification for Treated Wood

NIST PS20-05, American Softwood Lumber Standard

3 Definitions

3.1 mechanically laminated assembly (mech-lam): A structural assembly consisting of suitably selected wood layers joined with nails, screws, bolts, and/or other mechanical fasteners. Individual wood layers may be comprised of solid-sawn lumber or structural composite lumber such as laminated strand lumber (LSL), laminated veneer lumber (LVL) or parallel strand lumber (PSL).

3.2 nail-laminated assembly (nail-lam): Used interchangeably with "mechanically laminated assembly" when nails are the only fastener used to join individual layers.

3.3 screw-laminated assembly (screw-lam): Used interchangeably with "mechanically laminated assembly" when screws are the only fastener used to join individual layers.

3.4 vertically laminated assembly: An assembly primarily designed to resist bending loads applied parallel to the planes of contact between individual layers (Figure 1a). Virtually all mechanically laminated assemblies are designed as vertically laminated assemblies.

3.5 horizontally laminated assembly: An assembly primarily designed to resist bending loads applied normal to the planes of contact between individual layers (Figure 1b). Mechanically laminated assemblies designed as horizontally laminated assemblies do not fall under the scope of this Engineering Practice.

3.6 unspliced assembly: A mechanically laminated assembly that contains no end joints or contains only certified structural glued end joints.

3.6.1 certified structural glued end joint: Any end joint that meets the material and manufacturing requirements outlined in clause 4.5.

3.7 spliced assembly: A mechanically laminated assembly that contains one or more common end joints.

3.7.1 common end joint: An end joint that does not meet requirements for classification as a certified structural glued end joint. Common end joints include, but are not limited to: glued scarf joints and glued finger joints that do not meet the requirements of clause 4.5, butt joints, and metal connector plate (MCP) reinforced butt joints.

3.8 overall splice length, *L:* The distance between the two farthest removed (extreme outer) common end joints in a group of end joints that contains one common end joint in each layer (Figure 2).

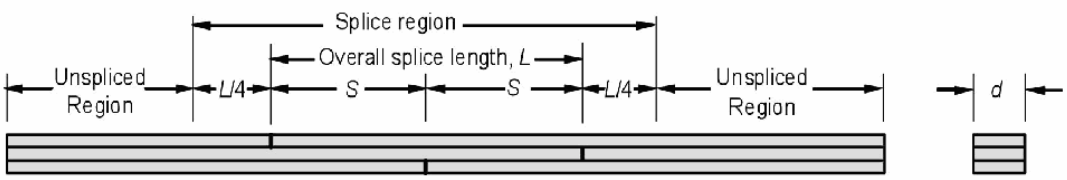

Figure 2 – Spliced assembly definitions

3.9 joint spacing, *S:* The distance between end joints (Figure 2). When end joints are equally spaced and there is only one end joint in each layer, *S* is equal to the overall splice length divided by $n - 1$, where n is the number of layers.

3.10 splice region: That portion of an assembly located between and within a distance of $L/4$ of a group of common end joints. In an assembly with one end joint in each layer, the total length of the splice region is equal to 1.5L (Figure 2). Although there can be more than one splice region per assembly, the splice regions shall not overlap.

3.11 unspliced region: Those portions of an assembly not included in a splice region (Figure 2).

3.12 joint arrangement: The relative location of end joints in a spliced assembly.

3.13 allowable stress design (ASD): A method of sizing a structural member such that elastically computed stresses produced in the member by design loads (a.k.a. nominal or service loads) do not exceed the member's specified allowable stress. Also called "working stress design".

3.14 load and resistance factor design (LRFD): A method of sizing a structural member such that the computed forces produced in the member by factored design loads do not exceed the member's factored resistance (design strength). Also called "strength design".

4 Material and Manufacturing Requirements

4.1 Lumber. Laminations (lumber) shall be identified by the grade mark of, or certificate of inspection issued by, a lumber grading or inspection bureau or agency recognized as being competent (see NIST PS20).

4.2 Preservative wood treatment. Any mechanically laminated assembly or portion thereof that is in ground contact or in fresh water shall be pressure preservative-treated in accordance with AWPA U1 Use Category 4B requirements for sawn products as given in Table 1. This level of treatment shall extend a minimum of 400 mm (16 in.) above the ground or waterline. Mech-lam assemblies that are located above ground, but are exposed to all weather cycles, including prolonged wetting, should be treated in accordance with AWPA U1 Use Category 4A requirements for sawn products as given in Table 1.

4.3 Restricted use of preservatives. The US Environmental Protection Agency has restricted, but not banned, the use of creosote, pentachlorophenol, and inorganic arsenicals, including CCA. The restrictions are variable. They may require only coating for a specific use, while in other cases they are prohibited. Generally, more restrictions occur where the environment is enclosed, and severe restrictions are imposed around feed and water. For specific criteria and limitations, refer to the appropriate government documents. The primary on-line source for U.S. government regulations is regulations.gov (http://www.regulations.gov/). Other sources for information relating to wood preservative treatments include the U.S Consumer Product Safety Commission (http://www.cpsc.gov/) and the National Pesticide Information Center (http://npic.orst.edu/index.html).

4.4 Fasteners in treated lumber. Mechanical fasteners used above grade to join waterborne preservative—treated lumber, shall be of AISI type 304 or 316 stainless steel, silicon bronze, or copper, or shall contain a coating applied in accordance with the treated wood or fastener manufacturer's recommendations for AWPA U1 Use Category 4A treatment levels for sawn lumber products. In the absence of manufacturer's recommendations, a minimum of ASTM A653, type G185 zinc-coated galvanized steel, or equivalent, shall be used. Mechanical fasteners that are used below grade to assure compatibility of deformation between treated laminates shall be of AISI type 304 or 316 stainless steel.

4.5 Certified structural glued end joints. Certified structural glued end joints shall be manufactured using adhesives meeting the requirements of 4.5.1. The production process shall be subject to initial qualification in accordance with 4.5.2, daily quality control in accordance with 4.5.3, and periodic auditing by an accredited inspection agency in accordance with 4.5.4.

4.5.1 Adhesives. Adhesives used in certified structural glued end joints shall conform to the requirements of AITC 405.

4.5.2 Initial Qualification. The production of certified structural glued end joints shall be subject to initial qualification by testing a minimum of 30 specimens for strength in accordance with ASTM D7469-08 and a minimum of 5 specimens for delamination in accordance with AITC Test T110.

4.5.2.1 Strength Requirement. The 5% tolerance limit with 75% confidence for bending strength shall meet or exceed 2.1 times the adjusted edgewise bending design value, F_b', calculated in accordance with the National Design Specifications (NDS®) for Wood Construction for normal load duration and dry-service conditions. When the end joint connects lumber with different F_b' values, the required strength shall be based on the lesser of the two F_b' values.

Table 1 – Minimum Preservation Treatment Levels for Mechanically Laminated Wood Assemblies[a)]

Wood Species→	Southern Pine, Mixed Southern Pine, Radiata Pine, Patula Pine, Caribbean Pine, Ponderosa Pine, Red Pine, Eastern White Pine, Coastal Douglas-fir, Hem-fir, Hem-fir North, Subalpine Fir		Jack Pine, Lodgepole Pine		Western White Spruce, Engelmann Spruce, Sitka Spruce		Spruce-Pine-Fir West		Redwood	
Mechanically Laminated Assemble Use Location →	Exposed Above Ground	In Freshwater or Ground Contact	Exposed Above Ground	In Freshwater or Ground Contact	Exposed Above Ground	In Freshwater or Ground Contact	Exposed Above Ground	In Freshwater or Ground Contact	Exposed Above Ground	In Freshwater or Ground Contact
AWPA Use Category for Sawn Products →	4A	4B	4A	4B	4A	4B	4A	4B	4A	4B
Oilborne and Creosote-Based Treatments	**Preservative Retentions kg/m³ (lbm/ft³)**									
Creosote (CR), Creosote Solution (CR-S), Creosote-Petroleum Solution (CR-PS)	160 (10.0)	160 (10.0)	160 (10.0)	160 (10.0)	160 (10.0)	160 (10.0)	#	#	160 (10.0)	160 (10.0)
Pentachlorophenol (penta) Solvent A (PCP-A), Pentachlorophenol (penta) Solvent C (PCP-C)	8.0 (0.50)	8.0 (0.50)	6.4 (0.40)	8.0 (0.50)	6.4 (0.40)	8.0 (0.50)	#	#	8.0 (0.50)	8.0 (0.50)
Copper Naphthenate	0.96 (0.06)	1.2 (0.075)	0.96 (0.06)	1.2 (0.075)	0.96 (0.06)	1.2 (0.075)	#	#	0.96 (0.06)	1.2 (0.075)
Waterborne Treatments	**Preservative Retentions kg/m³ (lbm/ft³)**									
Acid Copper Chromate (ACC)	8.0 (0.50)	#	8.0 (0.50)	#	8.0 (0.50)	#	#	#	8.0 (0.50)	#
Chromated Copper Arsenate Type C (CCA), Ammoniacal Copper Zinc Arsenate (ACZA)	6.4 (0.40)	9.6 (0.60)	6.4 (0.40)	9.6 (0.60)	6.4 (0.40)	9.6 (0.60)	6.4 (0.40)	9.6 (0.60)	6.4 (0.40)	9.6 (0.60)
Ammoniacal Copper Quat Type B (ACQ-B)	6.4 (0.40)	9.6 (0.60)	#	#	6.4 (0.40)	9.6 (0.60)	#	#	#	#
Ammoniacal Copper Quat Type C (ACQ-C)	6.4 (0.40)	9.6 (0.60)	6.4 (0.40)	9.6 (0.60)	#	9.6 (0.60)	6.4 (0.40)	9.6 (0.60)	#	9.6 (0.60)
Ammoniacal Copper Quat Type D (ACQ-D)	6.4 (0.40)	9.6 (0.60)	6.4 (0.40)	9.6 (0.60)	6.4 (0.40)	9.6 (0.60)	#	9.6 (0.60)	#	9.6 (0.60)
Copper Azole Type C (CA-C)	2.4 (0.15)	5.0 (0.31)	#	5.0 (0.31)	#	#	#	#	#	#
Copper Azole Type B (CA-B)	3.3 (0.21)	5.0 (0.31)	#	5.0 (0.31)	#	#	#	#	#	#
Copper Azole Type A (CBA-A)	6.5 (0.41)	9.8 (0.61)	#	9.8 (0.61)	#	#	#	#	#	#
Waterborne Copper Naphthenate (CuN-W)	1.76 (0.11)	#	1.76 (0.11)	#	#	#	#	#	#	#

a) From AWPA U1-09
Either no proposal for standardization and/or data demonstrating efficacy of a preservative/species combination has been submitted to AWPA; or the use of the preservative/species combination has been proven ineffective

4.5.2.2 Delamination Requirement. Delamination after one complete cycle shall not exceed 5% for softwoods or 8% for hardwoods. If delamination exceeds these values after one cycle, a second cycle shall be performed on the same specimens, in which case the delamination shall not exceed 10%.

4.5.3 Daily Quality Control. All glued end joints produced during a work shift shall qualify as certified structural glued end joints if all end joints sampled in accordance with clause 4.5.3.1 meet the strength requirements of clause 4.5.3.2 and the delamination requirements of 4.5.3.3.

4.5.3.1 Sampling. The number of end joints to be tested for strength and delamination shall be a minimum of 1 per 200 manufactured joints, but no less than 2 end joints per work shift, with one of these joints being the first produced during the work shift and the other being the last produced during the work shift. In addition, the first production joint produced following a change of end joint cutter heads shall be tested, and the first joint produced following any major change in end joint production variables shall be tested. Major changes include, but are not limited to, changes in lumber dimension, lumber grade, lumber species, lumber treatment, and curing procedure.

4.5.3.2 Strength. A glued end joint must not fail when subjected to the appropriate qualifying proof load (QPL). The QPL is an edge-wise bending load applied in accordance with the requirements of ASTM D7469 with the end joint located midway between load points. The magnitude of the QPL is the load that induces a maximum wood bending stress in the sample equal to 2.1 times the adjusted bending design value, F_b', calculated in accordance with the *National Design Specifications* (NDS®) for *Wood Construction* for normal load duration and dry-service conditions. When the end joint connects lumber with different F_b' values, the QPL shall be based on the lesser of the two F_b' values.

4.5.3.2.1 End joint failure. Is any failure that is initiated by the joint. This does not include wood fractures that originate at locations away from the joint and extend to the joint where they may then initiate a glue bond failure or wood fracture in the end joint.

4.5.3.2.2 Non joint failure. Is any failure that is not classified as an end joint failure. If a non joint failure occurs prior to full application of the QPL, the test is inconclusive with respect to end joint strength and another end joint specimen must be tested. Where possible, this replacement specimen should be the end joint manufactured immediately before or after the end joint associated with the inconclusive test.

4.5.3.2.3 Documentation of test. A record shall be kept of each test that includes: date and time of test; lumber size, species and grade; qualifying proof load; load rate; and details of any failure that occurs prior to reaching the QPL.

4.5.3.2.4 Use of test specimens. Test specimens that meet the strength requirements of clause 4.5.3.2 without visible or audible signs of failure can be used in the production of laminated assemblies.

4.5.3.3 Cyclic delamination. Tests shall be conducted in accordance with AITC Test T110. Delamination after one complete cycle shall not exceed 5% for softwoods or 8% for hardwoods. If delamination exceeds these values after one cycle, a second cycle shall be performed on the same specimens, in which case the delamination shall not exceed 10%.

4.5.3.3.1 Documentation of test. A record shall be kept of each test that includes: date and time of test, identifying information for batch of end joints being tested, and the required report from AITC Test T110.

4.5.4 Periodic Auditing. All certified structural glued end joints shall be manufactured in facilities that are subject to periodic, unannounced audits by an accredited inspection agency. All processes and records relevant to the production of such end joints shall be subject to audit.

4.5.4.1 Accredited Inspection Agency. An accredited inspection agency is defined as an entity that:

(a) Operates an inspection system which audits the quality control systems for certified structural end joints.

(b) Provides the facilities and personnel to perform the audit and to verify the required testing.

(c) Determines the individual facility's ability to produce certified structural end joints in accordance with this standard.

(d) Provides periodic auditing of the plant's production operations and production quality to ensure compliance with this standard.

(e) Enforces the proper use of the inspection agency quality marks and certificates

(f) Has no financial interest in, or is not financially dependent upon, any single company manufacturing any portion of the product being inspected or tested.

(g) Is not owned, operated, or controlled by any single company manufacturing any portion of the product being inspected or tested.

(h) Provides an arbitration review board to arbitrate disputes between the agency and the laminator. Such a board shall include, but not be limited to, three persons:

1. A recognized independent authority in the field of engineered timber construction to serve as chairman
2. At least one registered professional engineer knowledgeable in the design and use of the final product.
3. At least one person knowledgeable in the manufacture and quality control of certified structural glued end joints.

(i) Is accredited under ISO/IEC Standard 17020 as an Inspection Agency.

4.6 Metal connector plates. Metal connector plates used to reinforce common end joints shall meet all applicable requirements specified in ANSI/TPI 1 except that no specific structural design evaluation is required beyond that given in clause 5.4 of this EP.

5 Nail- and Screw-Laminated Assembly Design Requirements

5.1 End joint arrangement. End joint arrangement is dependent on the number of layers, type of end joints, and presence (or absence) of joint reinforcement. End joint arrangements described in Table 2 and shown in Figure 3 shall be used for common end joints.

5.2 Overall splice length. Wood stresses and fastener shear forces within the splice region can increase rapidly as overall splice length is reduced. For applications where the splice region is located at a point of high assembly bending moment, the minimum overall splice lengths in Table 3 are recommended. When the splice region is centered at a point of low assembly bending moment, overall splice lengths shorter than those in Table 3 may be more practical.

Table 2 – Recommended joint arrangements

Number of Layers	Common End Joint Type	Outside Butt Joint Reinforcement[1)]	Recommended Joint Arrangements[2)]
3	Butt joints	No	3A
	Butt joints	Yes	3A, 3B
	Glued end joints[3)]	NA	3A, 3B
4	Butt joints	No	4B, 4C
	Butt joints	Yes	4A
	Glued end joints[3)]	NA	4A, 4B, 4C

1) See clause 5.4.
2) See Figure 3.
3) Glued end joints that do not meet the requirements in clause 4.5 for certified structural glued end joints.

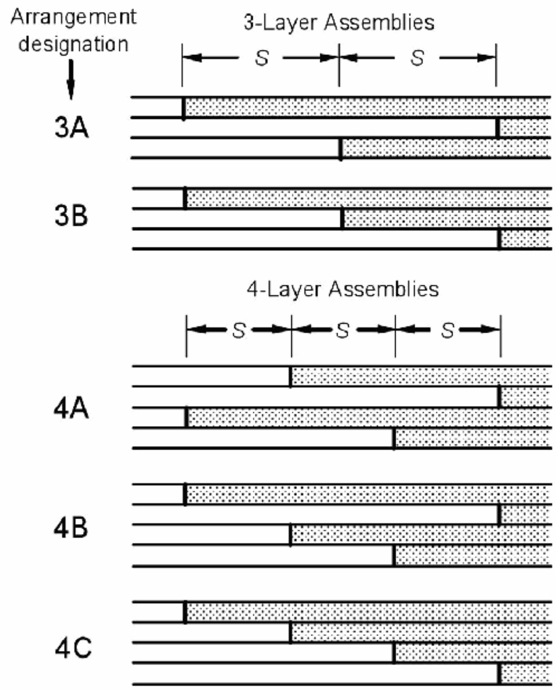

Figure 3 – Joint arrangements for three- and four-layer spliced assemblies

Table 3 – Recommended minimum overall splice lengths

Actual Face Width of Laminations, mm(in.)	Minimum Overall Splice Length, m (in.)	
	Glued End Joints[1)]	Butt Joints
140 (5.5)	0.61 (24)	1.22 (48)
184 (7.25)	0.91 (36)	1.52 (60)
235 (9.25)	0.91 (36)	1.83 (72)
286 (11.25)	1.22 (48)	2.44 (96)

[1)] See clause 4.5

5.3 Fastener requirements. The number of nails or screw fasteners required in an assembly is dependent on the amount of shear that must be transferred between layers (interlayer shear capacity). Fastener location is controlled by spacing requirements which reduce the likelihood of splitting, yet ensure a good distribution of fasteners.

5.3.1 Interlayer shear capacity. Minimum required interlayer shear capacities are expressed on the basis of force per interface per unit length of assembly. There are two design levels. Level I values are listed in Table 4 and apply to: (1) unspliced assemblies, (2) unspliced regions of spliced assemblies, and (3) spliced assemblies with common glued end joints (i.e., glued joints that do not meet the requirements of clause 4.5). Level II values apply to the splice region of all assemblies with butt joints even when the butt joints are reinforced. Use equation 1 to calculate level II values. This equation only applies to assemblies with overall splice lengths equal to or greater than the Table 3 minimums.

$$ISC = F_b' d\left(0.0024 + Ad/L^2 - E/B\right) \quad (1)$$

where:

ISC is minimum required interlayer shear capacity per interface per unit length of assembly, N/mm (lbf/in.);

F_b' is adjusted bending design value for the unspliced region (see clause 6.1), MPa (lbf/in.^{2});

d is assembly depth (lamination face width), mm (in.);

L is overall splice length, mm (in.);

E is wood modulus of elasticity, MPa (lbf/in.^{2});

A is a constant = 43.3 mm (1.708 in.);

B is a constant = 8,600,000 MPa (12.46×10^8 lbf/in.^{2}).

Table 4 – Minimum required interlayer shear capacities—Level I 1)

Actual Face Width of Laminations, mm(in.)	Minimum Required Interlayer Shear Capacity per Interface per Unit Length of Assembly, N/mm (lbf/in.)	
	Allowable Stress Design (ASD)	Load and Resistance Factor Design (LRFD)
140 (5.5)	2.1 (12)	2.8 (16)
184 (7.25)	2.6 (15)	3.5 (20)
235 (9.25)	3.3 (19)	4.5 (26)
286 (11.25)	4.2 (24)	5.8 (32)

1) For unspliced assemblies, assemblies with either common glued end joints and/or certified structural glued end joints, and unspliced regions of assemblies with butt joints.

5.3.2 Fastener density. The minimum number of nails or screw fasteners required for lamination is obtained by dividing the minimum required interlayer shear capacity (ISC) by the adjusted lateral design load, *Z'*, of an individual fastener. The adjusted lateral design load for a fastener shall be calculated in accordance with AF&PA National Design Specification (NDS®) for Wood Construction.

5.3.3 Fastener diameter. Unless pre-bored holes are utilized, the diameter of fasteners without self-drilling capabilities shall not exceed one-eighth the actual thickness of a lamination. For screws and threaded nail fasteners, the diameter is taken as the diameter of the shank or unthreaded portion of the fastener.

5.3.4 Fastener location. To reduce the likelihood of wood splitting, the minimum fastener spacings in Table 5 shall be followed. To ensure a good distribution of fasteners, the following additional provisions shall be adhered to:

5.3.4.1 A minimum of two fastener rows shall be provided.

5.3.4.2 One fastener row shall be placed within 20 fastener diameters of one edge and another fastener row within 20 fastener diameters of the other edge. The spacing (pitch) between fasteners in each of these two rows shall not exceed 0.45 m (18 in.).

5.3.4.3 At least half of the fastener rows shall have a fastener within 20 diameters of each side of each butt joint. All fastener rows shall have a fastener within 35 fastener diameters of each side of each butt joint.

Table 5 – Minimum fastener spacings

	Nail/Screw Diameters
Edge distance	10
End distance	15
Spacing (pitch) between fasteners in a row	20
Spacing (gage) between rows of fasteners	
In-line	10
Staggered	5

5.4 Butt-joint reinforcement. The strength and stiffness of assemblies with simple butt joints can be improved by reinforcing joints in the outside laminations with metal plate connector. To apply the bending strength modification factor in Table 8, each outside joint shall be reinforced with one metal connector plate (MCP). The MCP shall be centered on the joint and meet the following requirements:

5.4.1 Width shall be no less than 90% of the actual face width of the laminations;

5.4.2 Length shall be no less than 1.5 times the MCP width;

5.4.3 Thickness shall be no less than 0.91 mm (0.036 in., 20 gage) for assemblies with depths of 140 and 184 mm (5.5 and 7.25 in.), and no less than 1.47 mm (0.058 in., 16 gage) for assemblies with depths of 235 and 286 mm (9.25 and 11.25 in.);

5.4.4 The allowable design value in tension, V_t, for the MCP must meet the following criteria:

$$V_t \geq 0.22 F_b' \, t \, d^2 / w^2 \quad (2)$$

where:

V_t is allowable MCP design value in tension (ASD allowable load per unit of plate width), N/mm (lbf/in.);

F_b' is ASD adjusted bending design value for the unspliced region of the assembly, MPa (lbf/in.^{2}), from clause 6.1;

t is thickness of an individual lamination, mm (in.);

d is assembly depth (lamination face width), mm (in.);

w is MCP width, mm (in.).

6 Bending Design Strength

6.1 Unspliced assemblies. The adjusted bending design value, F_b' for mechanically laminated assemblies without end joints and mechanically laminated assemblies with certified structural glued end joints shall be calculated according to AF&PA National Design Specification (NDS®) for Wood Construction. All provisions of the NDS shall apply with the exception that the appropriate repetitive member factor, C_r, from Table 6 can be used for any unspliced mechanically laminated assembly with an interlayer shear capacity that meets or exceeds the values in Table 4. Table 7a contains NDS® reference bending design values for selected visually graded softwood species that have been adjusted by the appropriate repetitive member factor and the appropriate NDS® size factor, C_F. Table 7b contains similarly adjusted NDS® reference bending stresses for machine stress rated lumber. To obtain fully adjusted bending design values (F_b') for allowable stress design (ASD), Table 7a and 7b values shall be multiplied by the load duration factor (C_D), wet service factor (C_M), temperature factor (C_t), beam stability factor (C_L), and incising factor (C_i). To obtain F_b' for load and resistance factor design (LRFD), Table 7a and 7b values shall be multiplied by the appropriate format conversion factor (K_F), resistance factor for bending (φ_b), time effect factor (λ), wet service factor (C_M), temperature factor (C_t), beam stability factor (C_L), and incising factor (C_i). For both ASD and LRFD, the beam stability factor (C_L) shall be calculated in accordance with clause 6.1.1. The wet-service factor (C_M) shall be applied where the moisture content in service will exceed 19% for an extended period of time. Generally this adjustment applies to any assembly requiring preservative treatment.

6.1.1 Beam stability factor. To adjust for stability, the NDS® beam stability factor, C_L, is used. The beam stability factor is a function of the slenderness ratio, R_B, which in turn is a function of dimensions d and b, and the effective span length of the bending member between points of lateral support, L_e. For the purpose of calculating the slenderness ratio, R_B, for mechanically laminated assemblies, b shall be equated to 60% of the actual assembly thickness, and d to the actual face width of a lamination. The effective span length, L_e, is a function of the unsupported length, L_u. The unsupported length shall be set equal to the on-center spacing of bracing that keeps the assembly from buckling laterally.

Table 6 – Repetitive member factors[1)]

	Number of Laminations	
	3	4
Visually graded	1.35	1.40
Mechanically graded	1.25	1.30

[1)] For mechanically laminated dimension lumber assemblies with minimum inlayer shear capacity as specified in Table 4.

Table 7a – Partially adjusted reference bending design values for visually graded dimension lumber used in unspliced mechanically laminated assemblies

Partially Adjusted Reference Bending Design Values[1)], MPa lbf/in.[2)]																			
Actual Width of Individual Layers, mm (in.)																			
		140 (5.5)				184 (7.25)				235 (9.25)				286 (11.25)					
Number of Laminations																			
Lumber Species[2)]	Lumber Grade	3		4		3		4		3		4		3		4		Modulus of Elasticity, GPa ($\times 10^6$ lbf/in.^{2})	
DFL	Sel St	18.2	2635	18.8	2730	16.8	2430	17.4	2520	15.4	2230	15.9	2310	14.0	2025	14.5	2100	13.1	1.9
DFL	No. 1 & Better	14.5	2105	15.1	2185	13.4	1945	13.9	2015	12.3	1780	12.7	1850	11.2	1620	11.6	1680	12.4	1.8
DFL	No. 1	12.1	1755	12.5	1820	11.2	1620	11.6	1680	10.2	1485	10.6	1540	9.3	1350	9.7	1400	11.7	1.7
DFL	No.2	10.9	1580	11.3	1640	10.1	1460	10.4	1510	9.2	1335	9.6	1385	8.4	1215	8.7	1260	11.0	1.6
HF	Sel Str	16.9	2455	17.6	2550	15.6	2270	16.2	2350	14.3	2080	14.9	2155	13.0	1890	13.5	1960	11.0	1.6
HF	No. 1 & Better	13.3	1930	13.8	2000	12.3	1780	12.7	1850	11.3	1635	11.7	1695	10.2	1485	10.6	1540	10.3	1.5
HF	No. 1	11.8	1710	12.2	1775	10.9	1580	11.3	1640	10.0	1450	10.4	1500	9.1	1315	9.4	1365	10.3	1.5
HF	No.2	10.3	1490	10.7	1545	9.5	1375	9.8	1430	8.7	1260	9.0	1310	7.9	1150	8.2	1190	9.0	1.3
SP	Dense Sel Str	25.1	3645	26.1	3780	22.8	3310	23.6	3430	20.0	2905	20.8	3010	19.1	2770	19.8	2870	13.1	1.9
SP	Sel Str	23.7	3445	24.6	3570	21.4	3105	22.2	3220	19.1	2770	19.8	2870	17.7	2565	18.3	2660	12.4	1.8
SP	Non-Dense SS	21.9	3175	22.7	3290	19.5	2835	20.3	2940	17.2	2500	17.9	2590	16.3	2365	16.9	2450	11.7	1.7
SP	No. 1 Dense	16.3	2365	16.9	2450	15.4	2230	15.9	2310	13.5	1960	14.0	2030	12.6	1825	13.0	1890	12.4	1.8
SP	No.1	15.4	2230	15.9	2310	14.0	2025	14.5	2100	12.1	1755	12.5	1820	11.6	1690	12.1	1750	11.7	1.7
SP	Non-Dense No. 1	14.0	2025	14.5	2100	12.6	1825	13.0	1890	11.2	1620	11.6	1680	10.7	1555	11.1	1610	11.0	1.6
SP	No. 2 Dense	13.5	1960	14.0	2030	13.0	1890	13.5	1960	11.2	1620	11.6	1680	10.7	1555	11.1	1610	11.7	1.7
SP	No. 2	11.6	1690	12.1	1750	11.2	1620	11.6	1680	9.8	1420	10.1	1470	9.1	1315	9.4	1365	11.0	1.6
SP	Non-Dense No. 2	10.7	1555	11.1	1610	10.2	1485	10.6	1540	8.8	1285	9.2	1330	8.4	1215	8.7	1260	9.7	1.4

[1)] Reference bending design values (F_b) from the 2005 NDS after adjustment for size (C_F) and repetitive member use (C_r). To obtain a fully adjusted bending design value (F_b') for allowable stress design (ASD) multiply table value by the load duration factor (C_D), wet service factor (C_M), temperature factor (C_t), beam stability factor (C_L), and incising factor (C_i). To obtain F_b' for load and resistance factor design (LRFD) multiply table value by the appropriate format conversion factor (K_F), resistance factor for bending (φ_b), time effect factor (λ), wet service factor (C_M), temperature factor (C_t), beam stability factor (C_L), and incising factor (C_i).

[2)] *DFL*, Douglas Fir-Larch; *HF*, HemFir; *SP*, Southern Pine.

Table 7b – Partially adjusted reference bending design values for machine stress rated dimension lumber used in unspliced mechanically laminated assemblies

Lumber Grade	Partially Adjusted Reference Bending Design Value[1)] MPa, lbf/in²				Lumber Grade	Partially Adjusted Reference Bending Design Value[1)] MPa, lbf/in²			
	Number of laminations					Number of laminations			
	3		4			3		4	
900f-1.0E	7.79	1125	8.07	1170	1800f-1.8E	15.5	2250	16.1	2340
1200f-1.2E	10.3	1500	10.8	1560	1950f-1.5E	16.8	2440	17.5	2535
1250f-1.4E	10.8	1565	11.2	1625	1950f-1.7E	16.8	2440	17.5	2535
1350f-1.3E	11.6	1690	12.1	1755	2000f-1.6E	17.2	2500	17.9	2600
1400f-1.2E	12.1	1750	12.5	1820	2100f-1.8E	18.1	2625	18.8	2730
1450f-1.3E	12.5	1815	13.0	1885	2250f-1.7E	19.4	2815	20.2	2925
1450f-1.5E	12.5	1815	13.0	1885	2250f-1.8E	19.4	2815	20.2	2925
1500f-1.4E	12.9	1875	13.4	1950	2250f-1.9E	19.4	2815	20.2	2925
1600f-1.4E	13.8	2000	14.3	2080	2250f-2.0E	19.4	2815	20.2	2925
1650f-1.3E	14.2	2065	14.8	2145	2400f-1.8E	20.7	3000	21.5	3120
1650f-1.5E	14.2	2065	14.8	2145	2400f-2.0E	20.7	3000	21.5	3120
1650f-1.6E	14.2	2065	14.8	2145	2500f-2.2E	21.5	3125	22.4	3250
1650f-1.8E	14.2	2065	14.8	2145	2550f-2.1E	22.0	3190	22.9	3315
1700f-1.6E	14.7	2125	15.2	2210	2700f-2.0E	23.3	3375	24.2	3510
1750f-2.0E	15.1	2190	15.7	2275	2700f-2.2E	23.3	3375	24.2	3510
1800f-1.5E	15.5	2250	16.1	2340	2850f-2.3E	24.6	3565	25.5	3705
1800f-1.6E	15.5	2250	16.1	2340	3000f-2.4E	25.9	3750	26.9	3900

[1)] Reference bending design values (F_b) from the 2005 NDS after adjustment for size (C_F) and repetitive member use (C_r). To obtain a fully adjusted bending design value (F_b') for allowable stress design (ASD) multiply table value by the load duration factor (C_D), wet service factor (C_M), temperature factor (C_t), beam stability factor (C_L), and incising factor (C_i). To obtain F_b' for load and resistance factor design (LRFD) multiply table value by the appropriate format conversion factor (K_F), resistance factor for bending (φ_b), time effect factor (λ), wet service factor (C_M), temperature factor (C_t), beam stability factor (C_L), and incising factor (C_i).

6.2 Spliced assemblies with simple butt joints. The strength and stiffness of a mechanically laminated assembly are reduced within the vicinity of simple butt joints. For design purposes, spliced assemblies shall be segmented into spliced and unspliced regions as defined in clauses 3.10 and 3.11. The adjusted bending design value F_b' for the unspliced regions shall be calculated in accordance with clause 6.1. The adjusted bending design value of the splice region shall be obtained by multiplying the adjusted bending design value for the unspliced regions of the assembly by an appropriate bending strength modification factor. Bending strength modification factors are determined by test according to clause 6.4. For nail- and screw-laminated assemblies that meet all requirements of clause 5, the bending strength modification factors in Table 8 can be used. In addition, within the splice region of assemblies with simple butt joints, the distance between points of lateral support shall not exceed 1.0 m (39 inches) unless a greater distance can be justified via testing.

Table 8 – Bending strength modification factors for nail-laminated assemblies[1)]

Joint Description	Bending Strength Modification Factor
Unreinforced butt joints	0.42
Each outside butt joint reinforced with one MCP	0.55

[1)] Factors apply only to nail-laminated assemblies that meet all requirements in clause 5. Recommended joint arrangements and minimum overall splice lengths in tables 2 and 3 shall be used.

6.3 Testing spliced, mechanically laminated assemblies. Tests used to determine the bending strength and stiffness of the splice region of an assembly shall be conducted in accordance with ASTM D198. A two-point loading shall be used with all end joints in spliced assemblies located between the load points (i.e., in the constant moment region). Specimens shall be fabricated according to clause 6.3.1. The bending strength modification factor shall be determined in accordance with clause 6.3.2.

6.3.1 Specimen fabrication. An equal number of spliced and unspliced assemblies (five minimum) shall be tested. The spliced and unspliced assemblies shall be identical in size and fabricated from the same batch of lumber. Lumber shall be allocated to the spliced and unspliced assembly groups such that the distribution of wood modulus of elasticity (*E*) values is similar for both groups. The latter can be accomplished by sorting lumber by *E* (in either ascending or descending order) and assigning every other piece to the same group.

6.3.2 Bending strength modification factor. When fewer than 25 assemblies of each type have been tested, the bending strength modification factor shall be obtained by dividing the mean ultimate bending moment for the spliced assemblies by the mean ultimate bending moment for the unspliced assemblies, and dividing the resulting value by the appropriate adjustment factor from Table 9. When 25 or more assemblies of each type have been tested, the bending strength modification factor shall be obtained by dividing the 5% point estimate of ultimate bending moment for the spliced assemblies by the 5% point estimate of ultimate bending moment for the unspliced assemblies.

Table 9 – Adjustment factors for mean strength ratio[1)]

n[2)]	Spliced Assemblies with Outside Butt-Joint Reinforcement Only	All Other Spliced Assemblies
5	0.88	0.77
10	0.92	0.80
15	0.93	0.81
20	0.935	0.815
25	0.94	0.82

[1)] Multiply adjustment factor by ratio of mean strengths of spliced and unspliced assemblies to obtain the bending strength modification factor.

[2)] n is the number of spliced (or unspliced) assemblies tested.

7 Bending Stiffness

7.1 Assemblies without end joints. The modulus of elasticity (*E*) of an assembly without end joints is equal to the average *E* of the individual laminations.

7.2 Assemblies with glued end joints. The *E* of spliced assemblies with common glued end joints and/or certified structural glued end joints is equal to the average *E* of the individual laminations.

7.3 Assemblies with butt joints. The stiffness of a mechanically laminated assembly is reduced within the vicinity of simple butt joints. For structural analysis purposes, spliced assemblies can be segmented into spliced and unspliced regions as defined in clauses 3.10 and 3.11, respectively. The E of the unspliced regions is equal to the average E of the individual laminations. An "effective" *E* for the spliced region is obtained by multiplying the E of the unspliced regions of the assembly by a bending stiffness modification factor.

7.3.1 Bending stiffness modification factors. The bending stiffness modification factor for any spliced assembly can be determined from tests conducted in accordance with clause 6.3. Use the equations in Table 10 to obtain stiffness modification factors from the test data. Equation 3 can be used to calculate the bending stiffness modification factor for spliced nail-lams and spliced screw-lams without butt-joint reinforcement that meet the requirements of clause 5.

$$\alpha = 0.887 - 1.329\left[d^{3}Et/\left(L^{5}Kp\right)\right]^{0.25} \qquad (3)$$

where:

- α is bending stiffness modification factor;
- d is face width of laminations, mm (in.);
- t is thickness of an individual lamination, mm (in.);
- L is overall splice length, mm (in.);
- K is stiffness of an individual fastener joint (i.e., shear force divided by interlayer slip), N/mm (lbf/in.);
- p is average fastener density in the splice region (fasteners per unit contact area), $1/mm^2$ ($1/in.^2$);
- E is wood modulus of elasticity, MPa ($lbf/in.^2$).

Table 10 – Equations for calculating bending stiffness modification factors from test data[1)]

Location of Load Point	Location of Deflection Measurement	
	Load Point	Midspan
$b \geq a$	$\alpha = \dfrac{D - 2b}{4EI\Delta_l/(a^2P) + 4a/3 - 2b}$	$\alpha = \dfrac{D^2/4 - b^2}{4EL\Delta_m/(aP) + a^2/3 - b^2}$
$b \geq a$	$\alpha = \dfrac{3a^2D - 4a^3 - 2b^3}{12EI\Delta_l/P - 2b^3}$	$\alpha = \dfrac{3aD^2/8 - b^3 - 2a^3/2}{6EI\Delta_m/P - b^3}$

where:

- α is bending stiffness modification factor
- D is distance between supports
- a is distance between support and load point
- b is distance from support to spliced region. Equal to $(D - 1.5L)/2$
- Δ_l is load point deflection for spliced assembly due to load P
- Δ_m is midspan deflection for spliced assembly due to load P
- P is total applied load (sum of both load points)
- EI is effective flexural rigidity of the unspliced assembly. Equal to the product of wood modulus of elasticity and moment of inertia
- L is overall splice length

[1)] See Figure 4 for graphical depiction of equation variables.

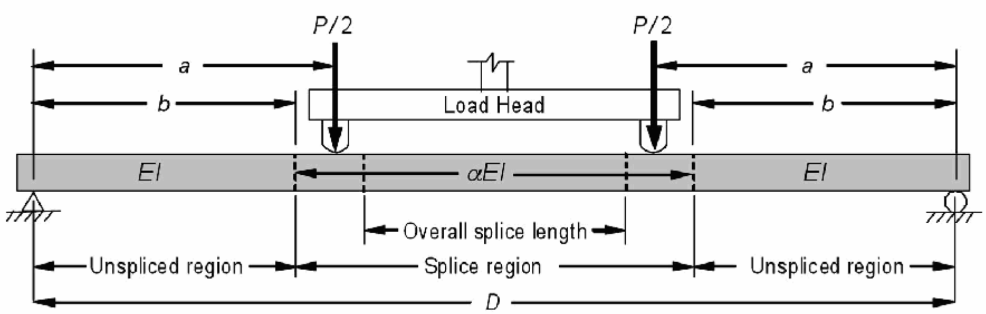

Figure 4 – Model of a spliced assembly under a two-point loading; reduced flexural stiffness in the splice region

8 Commentary

8.1 Purpose and scope

8.1.1 Mechanically laminated assemblies are widely used as structural columns in post-frame buildings. The suitability of such columns is generally dependent on their bending properties. Bending properties for a mechanically laminated assembly vary significantly depending upon orientation and whether or not it contains butt joints.

8.1.2 Although this Engineering Practice does not address axial assembly strength, the designer should consider all appropriate design conditions including possible axial and bending load combinations.

8.1.2.1 Adjusted compression design value parallel-to-grain, F_c'. Provisions in Section 15.3 of the NDS can be used to calculate the adjusted compression design value parallel-to-grain, F_c', for both spliced and unspliced mechanically laminated assemblies. In order to apply NDS Section 15.3 to spliced assemblies: (1) members must be in full contact at all end-joints; that is, there can be no gaps between members at an end joint, (2) lateral support must be provided to prevent weak axis buckling (i.e., buckling perpendicular to the wide faces of the individual layers) in the vicinity of all end joints, or face plates capable of preventing weak axis buckling must be installed, and (3) the slenderness ratio, l_{e1}/d_1, for buckling about the strong axis must be divided by the square root of the bending stiffness modification factor as determined in accordance with Clause 7.3.1. This adjustment to the slenderness ratio has the same net effect on the critical bucking design value for compression, F_{cE}, as multiplying the E_{min}' by the bending stiffness modification factor. Multiplying E_{min}' by the bending stiffness modification factor properly accounts for the increase in assembly bending flexibility (and hence the increased buckling potential) associated with the end joints. Note that if there is no end joint within the length le_1 used to define the effective length, l_{e1}, the bending stiffness modification factor for that length is equal to 1.0. In practice, it is not uncommon to also set the bending stiffness modification factor equal to 1.0 for lengths in which all end joints are no more than about 2 d_1 from a point of zero bending moment.

8.1.3 The scope of this Engineering Practice is limited to three- and four-layer assemblies because they represent the vast majority of assemblies used in post-frame building construction, and are the only mechanically laminated assemblies that have been extensively tested and modeled to date. The scope of this Engineering Practice is limited to uniaxial bending about axis Y-Y (Figure 1a) because: (1) mechanically laminated assemblies are generally substantially weaker when bent about axis X-X, and (2) calculating biaxial bending stresses in mechanically laminated assemblies is a complex function of boundary conditions, the stiffness of individual laminations, and the stiffness of interlayer connections.

8.2 Definitions

8.2.1 Splice region. Defining a splice region is very important for assemblies with simple butt joints. In such assemblies, the splice region is required to have more interlayer connectors and is assigned bending strength and stiffness values that are lower than those for unspliced regions of the assembly. The decision to terminate the splice region at a distance of L /4 from the outer end joints in a group of common end joints (resulting in a splice region length of 1.5 times the overall splice length, L) was based on finite element analyses of three- and four-layer assemblies. These analyses showed that fastener shear forces fall off rapidly as the distance from the extreme outer joints increases. At a distance L /4 from the extreme outer joints, the fastener shear forces have dropped to level where they are at or below the average shear force of the fasteners located between the two extreme outer end joints.

8.3 Material and manufacturing requirements

8.3.1 Preservative wood treatment. Treatment of exposed, above-ground assemblies in accordance with AWPA Use Category 4A (instead of AWPA Use Category 3B) recognizes the more critical nature of the assemblies, as well as the greater adsorption of water by the assemblies due to their interlayer planes. Water adsorbed between layers may not evaporate as rapidly as surface moisture. The addition of construction adhesive between layers may also impede interlayer drying.

8.3.2 Fasteners in treated lumber. Clause 4.4 was based in part on Section 2.4.1 of The Permanent Wood Foundation System—Design, Fabrication and Installation Manual (AF&PA, 1992). The requirements in this document are based on the results of a 17-year Forest Products Laboratory study (Baker, 1992).

8.3.3 Certified structural glued end joints. Sampling requirements in clause 4.5.3.1 are based in part on sampling requirements published in ANSI/AITC A19/0.1 for glued end joints used in glued laminated timber. Strength requirements in clause 4.5.3.2 are based in part on the Glued Lumber Policy published by the American Lumber Standard Committee. Clause 4.5.3.2.4 permits test specimens to be used in the production of laminated assemblies as long as the strength requirements of clause 4.5.3.2 are met during testing without visible or audible signs of a failure. While it is recognized that damage can accumulate within a specimen by subjecting it to the qualifying proof load (QPL), as long as this QPL is met (but not exceeded by more than 1 or 2 percent), and there are no visible or audible signs of failure, any accumulated damage should not be at a level that would justify a reduction in design strength. Allowing test specimens to be incorporated into production assemblies recognizes the value of minimizing solid waste and/or downcycling of wood resources.

8.4 Nail- and screw-laminated assembly design requirements

8.4.1 Most mechanically laminated assemblies used in construction are nail-laminated, although an increasing number of screw-laminated are being used. When these assemblies contain simple butt joints, the bending strength and stiffness of the assemblies are controlled by overall splice length, fastener location and density, and presence (or absence) of butt-joint reinforcement. Clause 5 of this Engineering Practice contains design requirements for these assembly variables. When these design requirements are followed (i.e., recommended minimum splice lengths, joint arrangements, and fastener capacities are used), the bending strength and stiffness of the spliced assemblies can be calculated according to procedures outlined in clauses 6 and 7. In other words, there is no need to conduct laboratory tests to determine bending properties of spliced nail-lams or of spliced screw-lams.

8.4.2 Joint arrangement. The recommended joint arrangements (Table 2) and minimum overall splice lengths (Table 3) were selected after extensive finite element analysis (FEA) and laboratory testing. The ability of FEA to accurately predict the behavior of assemblies has been demonstrated in four major studies (Bohnhoff et al., 1989; Bohnhoff et al., 1991; Bohnhoff et al., 1993; Williams et al., 1996). Assemblies featuring joint arrangements 3A, 4A, and 4B have been laboratory tested, while assemblies with joint arrangements 3B and 4C have not.

8.4.3 Overall splice length. Minimum overall splice length is primarily controlled by fastener shear forces in assemblies that are 140 and 184 mm (5.5 and 7.25 in.) deep, and by wood shear stresses in assemblies fabricated from 235 and 286 mm (9.25 and 11.25 in.) wide lumber. When overall splice lengths less than those in Table 3 are used for 140 and 184 mm deep assemblies, the number of fasteners required within the splice region to maintain strength becomes excessive and minimum fastener spacings are difficult to maintain.

8.4.3.1 The minimum splice lengths listed in Table 3 for mechanically laminated assemblies with common glued end joints are half as long as those specified for assemblies with simple butt joints. This decrease in required splice length reflects the fact that interlayer shear transfer is considerably less in mechanically laminated assemblies with glued end joints than it is in assemblies with simple butt joints. It is important to note that the effect of overall splice length on the strength of mechanically laminated assemblies with glued end joints has not been investigated, this despite the fact that such assemblies are commonly used in post-frame buildings. To this end, the minimum splice lengths listed in Table 3 for assemblies with common glued end joints are felt to be slightly conservative. Based on a brief review of literature, it would appear that the spacing of end joints in vertically glued-laminated (glulam) assemblies has also not been studied.

8.4.3.2 Recommended minimum overall splice lengths increase as the face width of the laminations increase because assembly bending strength increases as lamination width increases. Unless the minimum overall splice length is increased along with lamination face width, the strength gain associated with the increased width will be compromised by a lower bending strength in the splice region.

8.4.4 Interlayer shear capacity. The number of fasteners per interface per unit length of assembly, n_F, multiplied by the NDS® adjusted allowable lateral load per fastener, Z', is the design interlayer shear capacity per interface per unit length of assembly . For unspliced regions, this design capacity (i.e., the product of n_F and Z') must exceed the appropriate minimum required ISC value from Table 4 (i.e., the Level I ISC value). The minimum required ISC values in Table 4 for LRFD were obtained by multiplying the ASD values by a factor of 1.35. In theory, this ratio should be equal to $K_F\ \varphi\ \lambda\ /C_D$, where from the NDS®, K_F is a ASD to LRFD format conversion factor, φ a LRFD resistance factor, λ the LRFD time effect factor, and C_D, the ASD load duration factor. In accordance with the NDS, the product of K_F and φ is numerically equal to 2.16. The ratio of C_M to λ was taken as 1.60.

For spliced regions, the product of n_F and Z' must exceed the minimum required ISC value calculated using equation 1 (i.e., the Level II ISC value). Equation 1 produces different required ISC values for ASD and LRFD because the adjusted bending design stress, F_b', is different for ASD and LRFD methodologies. Equation 1 is based on an EISS (effective interlayer shear stress) equation developed by Bohnhoff (1996). The EISS equation predicts the average interlayer shear stress in the 25% most highly loaded fasteners within the splice region when the average interlayer slip of these fasteners is 0.38 mm (0.015 in.). Equation 1 yields values that are two-thirds of those obtained from the EISS equation. The two-thirds factor was applied because designs with this lower shear capacity did not experience nail-related failures when laboratory tested. Care should be taken not to over-specify shear capacity since over-nailing or over-screwing can negatively influence assembly strength.

8.4.4.1 Fastener location. The minimum fastener spacings in Table 5 are based on a study of actual assembly failures. These minimums are more conservative than those published in the NDS® Commentary (AF&PA, 2005). In addition to the minimum nail spacings, clause 5.3.4 also contains provisions to ensure a good distribution of fasteners. These provisions were based in part on the requirements given for mechanically laminated built-up columns in clause 15.3.3 of the NDS®.

8.4.5 Butt-joint reinforcement. Specifications in clause 5.4 are based on tests conducted by Bohnhoff et al. (1991) and Williams et al. (1994). Equation 2 ensures that the ratio of metal connector plate (MCP) bending capacity to lamination bending capacity is consistent with that for assembly designs used to establish the 0.55 factor in Table 8. For the MCP geometries specified in clause 5.4, tests show that plate bending strength is controlled by plate tensile strength and not by the lateral resistance of tooth-to-wood connections. The allowable MCP design value in tension V_t, is equal to the tensile force required to fracture the plate, multiplied by 0.6 (which is an ultimate-to-allowable strength conversion factor), and divided by plate width.

Ultimate tensile strength for a MCP is typically determined by simultaneously loading a pair of MCPs in accordance with ANSI/TPI 1-2007 Section 5.4. To obtain V_t for use in equation 2, divide the total tension load required to fracture the two MCPs (identified as P_{tp} in ANSI/TPI 1-2007) by 2.0 and the MCP width. Clause 5.4 in this document only applies to assemblies with a single MCP on each outside lamination and thus V_t in equation 2 is the force per unit width required to fracture a single plate.

8.5 Bending design stress

8.5.1 Repetitive member factors. Repetitive member factors in Table 6 are based on test results from four major studies (Bonnickson and Suddarth, 1966; Bohnhoff et al., 1991; Williams et al., 1994; Chiou, 1995).

8.5.2 Slenderness ratio. The slenderness ratio required for calculation of the beam stability factor is based on a width, *b*, that is equal to 60% of the actual width of the assembly. This 40% reduction is used to account for the decrease in bending stiffness about axis X-X (Figure 1) that is associated with slip between individual wood layers. This slip allows for additional lateral movement, which increases the potential for lateral torsional buckling. Actual reduction in lateral torsional buckling strength is a complex function of interlayer shear stiffness and strength, member depth, number of layers, presence and relative location of end joints, and spacing of lateral supports. To apply the 60% factor, the interlayer shear capacity should be no less than specified in Clause 5.3.1.

8.5.3 Bending strength modification factors. The Table 8 values are based on tests conducted by Bohnhoff et al. (1991) and Williams et al. (1994) on assemblies with minimum overall splice lengths.

8.5.4 Testing laminated assemblies. When the bending strength modification factors in Table 8 do not apply, a series of laboratory tests must be conducted. Both spliced assemblies and unspliced assemblies are tested and the bending strength modification factor is calculated from the test results using procedures outlined in clause 6.3.2. In the past, it was common practice to determine the ASD design bending strength of a new spliced assembly design by testing a series of the assemblies and then dividing the 5% point estimate of ultimate bending moment by a factor of 2.1. The drawbacks of this method were that (1) the reduction in strength due to splicing could not be calculated (since unspliced assemblies had not been tested), and (2) the resulting design value applies only to assemblies fabricated from the same batch of lumber as that used to fabricate the test specimens (lumber strength and stiffness can vary significantly from batch to batch, even though both batches may be of the same grade and species). Both of these shortcomings are avoided with the outlined procedure.

8.5.5 Calculation of bending strength modification factors from test data. The bending strength modification factor is defined as ratio of the 5% point estimate of ultimate bending moment for the spliced assemblies to the 5% point estimate of ultimate bending moment for the unspliced assemblies. Because 5% point estimates can be largely influenced by the number of assemblies tested and the distribution selected to represent the data, a generally conservative procedure is provided for use when the total number of each assembly type tested is less than 25. This more conservative procedure is easier to apply since it does not require that test data be fit to a probability density function, only that the mean ultimate bending moment for each assembly type be calculated. To obtain the bending strength modification factor, the ratio of mean ultimate bending moment for spliced assemblies to that for unspliced assemblies is multiplied by the appropriate adjustment factor from Table 9. This adjustment factor accounts for the number of assemblies tested and for the difference between mean assembly strength and the 5% point estimate of assembly strength. The Table 9 factors were developed assuming: (1) normal distributions of bending strength for all assembly types, (2) a ratio of 1.50 between the bending strength COV for spliced assemblies (without outside butt-joint reinforcement) and the bending strength COV of unspliced assemblies, (3) a ratio of 1.00 between the bending strength COV for spliced assemblies with outside butt-joint reinforcement and the bending strength COV of unspliced assemblies.

When more than 25 assemblies have been tested, clause 6.3.2 requires calculation of 5% point estimates. Although this is a more involved process, it will also yield results less conservative than those obtained using mean strengths and the Table 9 factors. If the distribution of ultimate bending strength for both spliced and unspliced assemblies is assumed to be normally distributed, the ratio of 5% point estimates (i.e., the bending strength modification factor) would be given as:

$$\text{Bending strength modification factor} = M_S(1-1.645S_S)/[M_U(1-1.645S_U)] \quad (4)$$

where:

M_S is mean strength of the spliced assemblies

S_S is standard deviation of spliced assembly strength

M_U is mean strength of the unspliced assemblies

S_U is standard deviation of unspliced assembly strength

8.6 Bending stiffness

8.6.1 Assemblies without end joints. When the layers of an unspliced assembly are forced (by a load-distributing element) to have the same displaced geometry, there is little, if any, slip between the individual layers. When there is little or no slip between individual layers, and each layer has (1) the same moment of inertia, and (2) a centroid located on the centroidal axis Y-Y (Figure 1), then the modulus of elasticity *E* of the assembly is equal to the average E of the layers.

8.6.2 Assemblies with glued end joints. The criteria for assemblies without end joints also applies to spliced assemblies with both common and certified structural glued end joints because at a glued end joint the members forming the joint have the same rotation and vertical displacement. Although an assembly with common glued end joints will not have the bending strength of an identical assembly with certified structural glued end joints, both assemblies will behave as assemblies void of end joints up until their respective points of failure.

8.6.3 Assemblies with butt joints. To be accurately represented in a plane-frame structural analog, an assembly with butt joints must be divided into elements. To be consistent with the rest of this Engineering Practice, spliced assemblies are segmented into spliced and unspliced regions as defined in clauses 3.10 and 3.11, respectively.

8.6.4 Bending stiffness modification factors. The equations in Table 10 apply only to assemblies tested under a symmetric two-point loading. They were derived using the conjugate beam method. Use of these equations requires a good estimate of the effective rigidity of the unspliced section, *EI*, which is the product of wood modulus of elasticity and moment of inertia. For the stiffness modification factor to be meaningful, EI must be determined by a laboratory test of lumber representative of that used to fabricate the spliced assemblies (either individual pieces or unspliced assemblies can be tested).

The load P used in the Table 10 equations should correspond to a total load that would induce design level stresses in the assembly. If a series of tests have been conducted, equate *P/Δ* to the average slope of the linear portion of the load-deflection plots, and set *EI* equal to the average flexural rigidity of the test assemblies.

8.6.4.1 Equation 3 is from Bohnhoff (1996) and requires an estimate of individual nail-joint stiffness, *K*, which is the slope of the relationship between nail shear force and interlayer slip. For common wire nails, the secant stiffness corresponding to an interlayer slip of 0.38 mm (0.015 in.) can be approximated as:

$$K = CG^{1.25}D^{1.25}$$

where:

K is interlayer stiffness, N/mm (lbf/in.);

G is specific gravity based on oven-dry weight and volume;

D is nail diameter, mm (in.);

C = 415.3 (for K in N/mm and *D* in mm);

= 303600 (for K in lbf/in and *D* in in.)

Annex A
(informative)
Bibliography

The following documents are cited as reference sources used in the development of this Engineering Practice:

American Forest and Paper Association (AF&PA). Revisions to the permanent wood foundation system—Design, fabrication, and installation manual. Washington D.C.; 1992.

American Forest and Paper Association (AF&PA). National design specifications for wood construction with commentary and supplement: design values for wood construction. Washington D.C.; 2005.

American Institute of Timber Construction (AITC). ANSI/AITC A190.1-2007, Structural glued laminated timber. Centennial, CO, 2007.

American Lumber Standard Committee. Glued lumber policy. February 18, 2009.

Baker, A. J. Corrosion of nails in CCA- and ACA-treated wood in two environments. Forest Products Journal 42(9):39-41; 1992.

Bohnhoff, D. R. Evaluation of spliced, nail-laminated wood members without butt joint reinforcement. Transactions of the ASAE 32(5):1797-1806; 1989.

Bohnhoff, D. R., S. M. Cramer, R. C. Moody, and C. O. Cramer. Modeling vertically mechanically laminated lumber. J. Structural Division ASCE 115(10):2661-2679; 1989.

Bohnhoff, D. R., R. C. Moody, S. P. Verrill, and L. F. Shirek. Bending properties of reinforced and unreinforced spliced nail-laminated posts. Res. Paper FPL-RP-503. USDA Forest Service, Forest Products Laboratory; 1991.

Bohnhoff, D. R., A. B. Senouci, R. C. Moody, and P. A. Boor. Bending properties of STP-laminated posts. ASAE Paper No. 93-4060, ASAE, St. Joseph, MI; 1993.

Bohnhoff, D. R. Interlayer shear and stiffness of spliced, nail-laminated posts. Transactions of the ASAE 39(2):713-719; 1996.

Bonnickson, L. W., and S. K. Suddarth. Structural reliability analysis for a wood load sharing system. J. Materials 1(3):491-508; 1966.

Chiou, Wen-Shan. Bending properties of unspliced, vertically mechanically laminated assemblies. Ph.D. Thesis. University of Wisconsin-Madison, Madison, WI; 1995.

Williams, G. D., D. R. Bohnhoff, and R. C. Moody. Bending properties of four-layer nail-laminated posts. Res. Pap. FPL-RP-528. USDA Forest Service, Forest Products Laboratory; 1994.

Williams, G. D., D. R. Bohnhoff, and R. C. Moody. Locating butt-joints in four-layer, nail-laminated assemblies . Transactions of the ASAE 39(2):699-711; 1996.

Annex B
(informative)
Spliced nail-laminated assembly design example (ASD)

Problem: Design a three-layer spliced nail-laminated assembly. Use nominal 2- by 6-in. No. 2 southern pine lumber and 10d common wire nails. End joints will not be glued or reinforced. Load is transferred to the assembly by secondary framing members spaced 36 inches apart. These framing members also provide lateral support. Controlling load combination includes wind and snow. One end of the assembly will be located below grade. The entire splice region will be located above grade in a dry environment.

Solution:

Step 1—Adjusted Bending Design Value for Unspliced Regions, F_b'

a. Partially adjusted reference bending value from Table 7a = 1690 lbf/in.^{2}

b. Adjustment factors from NDS®: load duration (CD) = 1.6; wet service factor (CM) for below grade regions = 0.85; wet service factor (CM) for above grade regions = 1.0; temperature factor (Ct) = 1.0; incising factor (Ci) = 1.0

c. Reference design value Fb multiplied by all appropriate ASD adjustment factors except CL:

Below grade regions: Fb* = 1690 lbf/in.2 (1.6)(0.85) = 2300 lbf/in.^{2}

Above grade regions: Fb* = 1690 lbf/in.2 (1.6) = 2700 lbf/in.2

d. Slenderness ratio ($R_B = (L_e\ d\ /\ b^2)^{0.5}$: From the NDS®, effective length L_e = 1.84 L_u = 66.2 inches (L_u is the 36 inch distance between points of lateral support). From clause 6.1.1, thickness b is equated to 60% of the actual assembly thickness or 0.60 (4.50 inches) = 2.70 inches, and d is the actual face width of a lamination or 5.50 inches.

$$R_B = (L_e\ d\ /\ b^2)0.5 = [(66.2 \text{ in.})(5.50 \text{ in.})/42.70 \text{ in.})^2]^{0.5} = 7.07 \text{ in.}$$

e. Beam stability factor, C_L. From NDS with E_{min} = 580,000 bf/in.^{2} (NDS® Table 4B) and R_B = 7.07 inches, C_L for above grade regions is equal to 0.988. For below grade regions, C_L = 1.00 because soil provides continuous lateral support.

f. Adjusted bending design value for unspliced regions above grade: F_b' = 2700 lbf/in.^{2} (0.988) = 2670 lbf/in.. For below grade, unspliced regions, F_b' = 2300 lbf/in.^{2}

Step 2—Adjusted Bending Design Value for Spliced Regions, F_b'

a. Allowable bending design value in above-grade splice region = 0.42 × F_b' for above grade splice region = 1120 lbf/in.^{2} The 0.42 value is the bending strength modification factor from Table 8. To use this value, all minimum design recommendations in clause 4 must be followed.

Step 3—Recommended Splice Arrangement & Overall Splice Length

a. For a three-layer assembly with unreinforced butt joints, splice arrangement 3A is recommended (Table 2)

b. Recommended minimum overall splice length, L, for a nominally 6-in.-deep assembly (Table 3) = 4 feet

Step 4—Required Interlayer Shear Capacity

a. Unspliced regions (level I value from Table 4) = 12 lbf/in.

b. Splice regions (Equation 1 with: F_b' = 2670 lbf/in.^{2}; d = 5.5 in.; L = 48 in.; and E = 1,600,000 lbf/in.^{2} = 76.3 lbf/in.

Step 5—Adjusted Lateral Design Load for a Nail Joint, Z'

a. Tabulated lateral design value (Z) for a 10d common wire nail in southern pine (from NDS table 11N) = 128 lbf. Applicable adjustment factors include the load duration factor of 1.60 and a wet service factor of 0.7 for nails located below grade.

Below grade regions: Z' = 128 lbf (1.60)(0.85) = 174 lbf

Above grade regions: Z' = 128 lbf (1.60) = 205 lbf

Step 6—Minimum Required Number of Nails

a. Nails required (per interface) for a 48 in. section of the splice region = (48 in.)(76.3 lbf/in.)/(205 lbf/nail) = 18 nails

b. Nails required (per interface) for a 12 in. section of the splice region=(12 in.)(76.3 lbf/in.)/(205 lbf/nail) = 5 nails

c. Nails required in unspliced regions above grade =(12 lbf/in.)/(205 lbf/nail) =0.058 nails/in.=1 nail every 17 in.

d. Nails required in unspliced regions below grade =(12 lbf/in.)/(174 lbf/nail) =0.069 nails/in.=1 nail every 14.5 in.

Step 7—Minimum spacings based on 0.148 in. nail diameter

a. Edge distance = 1.48 in.

b. End distance = 2.22 in.

c. Spacing (pitch) between fasteners in a row = 2.96 in.

d. Spacing (gage) between rows of fasteners (in-line) = 1.48 in.

e. Spacing (gage) between rows of fasteners (staggered) = 0.74 in.

Step 8—Nail Layout

a. A nail pattern that meets the proceeding requirements is shown in Figure 5.

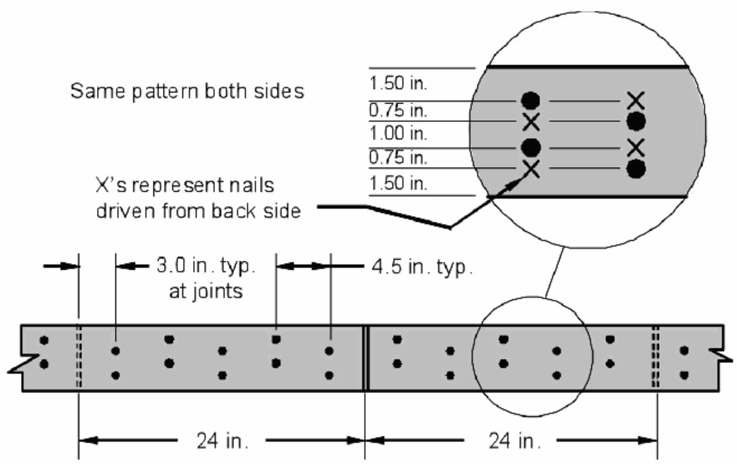

Figure 5 – Example nail pattern for a three-layer spliced assembly fabricated using 10 d common wire nails. Only a portion of the splice region is shown. The same nail pattern is used on both sides of the assembly.

Date Submitted	12/15/2018	**Section**	35	**Proponent**	Joseph Belcher for AAF
Chapter	35	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

N/A

Summary of Modification

Updates the AAF Guide to Aluminum Construction in High Wind Areas.

Rationale

The AAF is working with Dr. Timothy Reinhold, P.E. to get the AAF Guide updated to comply with ASCE 7-16. The design pressure for screen enclosures of Table 2002.4 are not affected because they are based on wind tunnel testing and the analysis of the wind tunnel data. There will be increases on solid roofs and we are working on completing those updates. Unfortunately, Hurricane Michael took some time and delayed the work. I am going to forward a copy of the AAF to the Structural TAC members and the staff and will provide the updated information during the Public Comment period.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact on cost of enforcement of code as the AAF Guide has been adopted for a number of years.

Impact to building and property owners relative to cost of compliance with code

No impact on cost of code compliance for property owners as the AAF Guide has been adopted for a number of years.

Impact to industry relative to the cost of compliance with code

No impact on cost of code compliance to industry as the AAF Guide has been adopted for a number of years. There will be an increase in uplift loads in the 15% range on solid roofs but that is due to changes in ASCE 7-16; not the AAF Guide.

Impact to small business relative to the cost of compliance with code

No cost impact relative to compliance with the code. No impact on cost of code compliance to small business as the AAF Guide has been adopted for a number of years. There will be an increase in uplift loads in the 15% range on solid roofs but that is due to changes in ASCE 7-16; not the AAF Guide.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The proposal is connected with the welfare and safety of the public because it updates a construction document to meet the latest design pressures due to the effects of wind.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The proposal improves the code because it is updating a prescriptive document to meet the latest design pressures due to the effects of wind.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The change does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The proposed change does not degrade the effectiveness of the code.

Chapter 35 AAF

AAF	Aluminum Association of Florida 3203 Lawton Road #110 Orlando, FL 32803	
Standard Reference Number	Title	Referenced in code section number
AAF- ~~14~~ 20	Guide to Aluminum Construction in High Wind Areas (~~2014~~) (2020).	2002.4.1, 1622.1.2

S8111

Date Submitted	12/13/2018	**Section**	101	**Proponent**	Ann Russo5
Chapter	2713	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

M101.1, M101.2, M101.3, M101.4

Summary of Modification

The amendments to Appendix M are necessary because the analysis and structural design aspects of FEMA P-646 (2012) have been superseded by ASCE 7-2016

Rationale

The amendments to Appendix M are necessary because the analysis and structural design aspects of FEMA P-646 (2012), Guidelines for Design of Structures for Vertical Evacuation from Tsunamis, have been superseded by ASCE 7-2016, Minimum Design Loads and Associated Criteria for Buildings and Other Structures. ASCE 7-16 now has a Chapter 6 on tsunami loads and effects, which also includes a set of tsunami design zone maps. As an accredited consensus- based standard, ASCE 7-16 incorporates more recent knowledge that takes precedence over the older FEMA guidelines. In particular, the FEMA guidelines for determining inundation depth, flow speed, and waterborne debris impact forces were found to lack reliability. The proposal updates Appendix M to make it refer to the tsunami evacuation and site planning criteria of P-646-12 and not to its tsunami hazard mapping and structural design guidelines, thereby removing conflicts that would otherwise occur between the two documents. The title of Appendix M is revised because the original title was overly broad; FEMA P646 only concerns tsunami refuge structures.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None expected

Impact to building and property owners relative to cost of compliance with code

None expected

Impact to industry relative to the cost of compliance with code

None expected

Impact to small business relative to the cost of compliance with code

None expected

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves options for life safety in affected zones

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves design guidance and Code enforcement where appendix adopted

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not

Does not degrade the effectiveness of the code

Does not

Revise as follows:

SECTIONM101
REFUGE STRUCTURES FOR VERTICAL EVACUATION FROMTSUNAMI-GENERATED FLOOD HAZARD

Date Submitted	12/13/2018	**Section**	101.1	**Proponent**	Ann Russo5
Chapter	Appendix M	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

M101, M101.2, M101.3, M101.4

Summary of Modification

The amendments to Appendix M are necessary because the analysis and structural design aspects of FEMA P-646 (2012) have been superseded by ASCE 7-2016

Rationale

The amendments to Appendix M are necessary because the analysis and structural design aspects of FEMA P-646 (2012), Guidelines for Design of Structures for Vertical Evacuation from Tsunamis, have been superseded by ASCE 7-2016, Minimum Design Loads and Associated Criteria for Buildings and Other Structures. ASCE 7-16 now has a Chapter 6 on tsunami loads and effects, which also includes a set of tsunami design zone maps. As an accredited consensus- based standard, ASCE 7-16 incorporates more recent knowledge that takes precedence over the older FEMA guidelines. In particular, the FEMA guidelines for determining inundation depth, flow speed, and waterborne debris impact forces were found to lack reliability. The proposal updates Appendix M to make it refer to the tsunami evacuation and site planning criteria of P-646-12 and not to its tsunami hazard mapping and structural design guidelines, thereby removing conflicts that would otherwise occur between the two documents. The title of Appendix M is revised because the original title was overly broad; FEMA P646 only concerns tsunami refuge structures.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None expected

Impact to building and property owners relative to cost of compliance with code

None expected

Impact to industry relative to the cost of compliance with code

None expected

Impact to small business relative to the cost of compliance with code

None expected

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves options for life safety in affected zones

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves design guidance and Code enforcement where appendix adopted

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not

Does not degrade the effectiveness of the code

Does not

Revise as follows:

~~**M101.1General.**~~

The purpose of this appendix is to provide tsunami ~~regulatory~~ vertical evacuation planning criteria for those coastal communities that have a tsunami hazard ~~and have elected to develop and adopt~~ as shown in ~~a map of their tsunami hazard inundation zone~~ Tsunami Design Zone Map.

S8117

Date Submitted	12/13/2018	Section	101.2	Proponent	Ann Russo5
Chapter	Appendix M	Affects HVHZ	No	Attachments	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments	No	Alternate Language	No

Related Modifications

M101, M101.1, M101.3, M101.4

Summary of Modification

The amendments to Appendix M are necessary because the analysis and structural design aspects of FEMA P-646 (2012) have been superseded by ASCE 7-2016

Rationale

The amendments to Appendix M are necessary because the analysis and structural design aspects of FEMA P-646 (2012), Guidelines for Design of Structures for Vertical Evacuation from Tsunamis, have been superseded by ASCE 7-2016, Minimum Design Loads and Associated Criteria for Buildings and Other Structures. ASCE 7-16 now has a Chapter 6 on tsunami loads and effects, which also includes a set of tsunami design zone maps. As an accredited consensus- based standard, ASCE 7-16 incorporates more recent knowledge that takes precedence over the older FEMA guidelines. In particular, the FEMA guidelines for determining inundation depth, flow speed, and waterborne debris impact forces were found to lack reliability. The proposal updates Appendix M to make it refer to the tsunami evacuation and site planning criteria of P-646-12 and not to its tsunami hazard mapping and structural design guidelines, thereby removing conflicts that would otherwise occur between the two documents. The title of Appendix M is revised because the original title was overly broad; FEMA P646 only concerns tsunami refuge structures.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None expected

Impact to building and property owners relative to cost of compliance with code

None expected

Impact to industry relative to the cost of compliance with code

None expected

Impact to small business relative to the cost of compliance with code

None expected

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves options for life safety in affected zones

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves design guidance and Code enforcement where appendix adopted

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not

Does not degrade the effectiveness of the code

Does not

Revise as follows:

M101.2Definitions.

The following words and terms shall, for the purposes of this appendix, have the meanings shown herein. Refer to Chapter 2 of this code for general definitions.

~~**TSUNAMI HAZARD ZONE.** The area vulnerable to being flooded or inundated by a design event tsunami as identified on a community's Tsunami Hazard Zone Map.~~

TSUNAMI HAZARD DESIGN ZONE MAP. ~~A map adopted by the community~~ that designates the extent of inundation by a ~~design event tsunami. This map shall be based on the tsunami inundation map that is developed and provided to a community~~ Maximum Considered Tsunami as defined by ~~either the applicable state agency or the National Atmospheric and Oceanic Administration (NOAA) under the National Tsunami Hazard Mitigation Program, but shall be permitted to utilize a different probability or hazard level~~ Chapter 6 of ASCE 7.

S8118

Date Submitted	12/13/2018	**Section**	101.3	**Proponent**	Ann Russo5
Chapter	Appendix M	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

M101, M101.1, M101.2, M101.4

Summary of Modification

The amendments to Appendix M are necessary because the analysis and structural design aspects of FEMA P-646 (2012) have been superseded by ASCE 7-2016

Rationale

The amendments to Appendix M are necessary because the analysis and structural design aspects of FEMA P-646 (2012), Guidelines for Design of Structures for Vertical Evacuation from Tsunamis, have been superseded by ASCE 7-2016, Minimum Design Loads and Associated Criteria for Buildings and Other Structures. ASCE 7-16 now has a Chapter 6 on tsunami loads and effects, which also includes a set of tsunami design zone maps. As an accredited consensus- based standard, ASCE 7-16 incorporates more recent knowledge that takes precedence over the older FEMA guidelines. In particular, the FEMA guidelines for determining inundation depth, flow speed, and waterborne debris impact forces were found to lack reliability. The proposal updates Appendix M to make it refer to the tsunami evacuation and site planning criteria of P-646-12 and not to its tsunami hazard mapping and structural design guidelines, thereby removing conflicts that would otherwise occur between the two documents. The title of Appendix M is revised because the original title was overly broad; FEMA P646 only concerns tsunami refuge structures.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None expected

Impact to building and property owners relative to cost of compliance with code

None expected

Impact to industry relative to the cost of compliance with code

None expected

Impact to small business relative to the cost of compliance with code

None expected

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves options for life safety in affected zones

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves design guidance and Code enforcement where appendix adopted

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not

Does not degrade the effectiveness of the code

Does not

Revise as follows:

M101.3 Establishment of tsunami ~~hazard~~ design zone.

Where applicable~~, if a community has adopted a~~ the Tsunami ~~Hazard~~ Design Zone Map~~, that map~~ shall ~~be used to establish a community's tsunami hazard zone~~ meet or exceed the inundation limit given by the ASCE 7 Tsunami Design Geodatabase.

S8120

Date Submitted	12/13/2018	**Section**	101.4	**Proponent**	Ann Russo5
Chapter	Appendix M	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

M101, M101.1, M101.2, M101.3

Summary of Modification

The amendments to Appendix M are necessary because the analysis and structural design aspects of FEMA P-646 (2012) have been superseded by ASCE 7-2016

Rationale

The amendments to Appendix M are necessary because the analysis and structural design aspects of FEMA P-646 (2012), Guidelines for Design of Structures for Vertical Evacuation from Tsunamis, have been superseded by ASCE 7-2016, Minimum Design Loads and Associated Criteria for Buildings and Other Structures. ASCE 7-16 now has a Chapter 6 on tsunami loads and effects, which also includes a set of tsunami design zone maps. As an accredited consensus- based standard, ASCE 7-16 incorporates more recent knowledge that takes precedence over the older FEMA guidelines. In particular, the FEMA guidelines for determining inundation depth, flow speed, and waterborne debris impact forces were found to lack reliability. The proposal updates Appendix M to make it refer to the tsunami evacuation and site planning criteria of P-646-12 and not to its tsunami hazard mapping and structural design guidelines, thereby removing conflicts that would otherwise occur between the two documents. The title of Appendix M is revised because the original title was overly broad; FEMA P646 only concerns tsunami refuge structures.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None expected

Impact to building and property owners relative to cost of compliance with code

None expected

Impact to industry relative to the cost of compliance with code

None expected

Impact to small business relative to the cost of compliance with code

None expected

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves options for life safety in affected zones

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves design guidance and Code enforcement where appendix adopted

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not

Does not degrade the effectiveness of the code

Does not

Revise as follows:

M101.4 ~~Construction~~Planning of tsunami vertical evacuation refuge structures within the tsunami ~~hazard~~design zone.

~~Construction of structures designated Risk Categories III and IV as specified under Section 1604.5 shall be prohibited~~ Tsunami Vertical Evacuation Refuge Structures located within a tsunami hazard design zone shall be planned, sited, and developed in general accordance with the planning criteria of FEMA P646 guidelines.

~~**Exceptions:**~~

1. ~~1.A vertical evacuation tsunami refuge shall be permitted to be located in a tsunami hazard zone provided it is constructed in accordance with FEMA P646.~~
2. ~~2.Community critical facilities shall be permitted to be located within the tsunami hazard zone when such a location is necessary to fulfill their function, providing suitable structural and emergency evacuation measures have been incorporated.~~

Exception: These criteria shall not be considered mandatory for evaluation of existing buildings for evacuation planning purposes.

S7461

154

Date Submitted	12/8/2018	**Section**	202	**Proponent**	Rebecca Quinn obo FL Dept Emerg Mg
Chapter	2	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments	**No**	**Alternate Language**	**No**

Related Modifications

7462 (building volume)

Summary of Modification

In FBC Existing Building, match proposed definition for "Existing Structure" in FBC Building, rather than be specific to flood.

Rationale

This code proposal was submitted for the I-Codes (ADM13-16). The purpose of this code change is to have consistent definitions of "existing building" and "existing structure" in the building and existing building volumes of the Florida Building Code. The terms are used interchangeably in the codes. The proposal modifies the definition to remove the flood-specific sentence.

The 6th Ed. FBC, existing building volume, added the definition for “existing structure.” For the I-Codes, FEMA concurred with addition of the basic definition, without a sentence pertaining to application of provisions for flood hazard areas. The determination as to whether improvements or repairs for existing buildings and structures in flood hazard areas constitute substantial improvement or repair of substantial damage is made for all existing buildings. As flood hazard data are changing over time, sometimes with higher base flood elevations or changed flood zone designations, compliance that is triggered by substantial improvement or substantial damage includes bringing building into compliance with the revised flood hazard data. In addition, there’s a presumption that buildings built after the community’s first flood ordinance are fully compliant, which may not be the case if unpermitted improvements or additions were made that alter whether the building remains compliant.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Definition clarification makes easier to enforce because only one definition is used for all existing buildings in flood hazard areas.

Impact to building and property owners relative to cost of compliance with code

Definition clarification does not change in costs when compliance with flood provisions is triggered.

Impact to industry relative to the cost of compliance with code

Definition clarification does not change in costs when compliance with flood provisions is triggered.

Impact to small business relative to the cost of compliance with code

Definition clarification does not change in costs when compliance with flood provisions is triggered.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Definition clarification does not change the purpose of the flood provisions to protect health, safety and general welfare.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Definition clarification does not change the compliance requirements with respect to products, methods or systems used for flood resistant constructions.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Definition clarification does not change the compliance requirements with respect to products, methods or systems used for flood resistant constructions.

Does not degrade the effectiveness of the code

Definition clarification does not alter the effectiveness of the code.

EXISTING STRUCTURES ~~(for flood hazard areas)~~. ~~See Section 1612.2 of the *Florida Building Code, Building.*~~ A structure erected prior to the date of adoption of the appropriate code, or one for which a legal building *permit* has been issued.

S7483

Date Submitted	12/14/2018	**Section**	202	**Proponent**	Joseph Crum
Chapter	2	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

G21-16 EXIST BLDG

Summary of Modification

The edit changes "this code" to "the FBCB." The current language is an obsolete holdover from the version of the definition that went with FBC Chapter 34.

Rationale

This proposal makes editorial revisions that clarify the intent of the definition and facilitate its implementation.
The edit changes "this code" to "the FBC." The current language is an obsolete holdover from the version of the definition that went with FBC Chapter 34.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Clarification of definition only. No impact on enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction.
This change is editorial and therefore will not change any construction requirements.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction.
This change is editorial and therefore will not change any construction requirements.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction.
This change is editorial and therefore will not change any construction requirements.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This change is editorial and therefore will not change any construction requirements.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This change is editorial and therefore will not change any construction requirements or effect the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This change is editorial and therefore will not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This change is editorial and therefore does not degrade the effectiveness of the code.

2015 Florida Building Code Existing Buildings
Section 202

Revise as follows:

[BS]SUBSTANTIAL STRUCTURAL DAMAGE. A condition where one or both of the following apply:

1. The vertical elements of the lateral force-resisting system have suffered damage such that the lateral load-carrying capacity of any story in any horizontal direction has been reduced by more than 33 percent from its pre-damage condition.

2. The capacity of any vertical component carrying gravity load, or any group of such components, that supports more than 30 percent of the total area of the structure's floors and roofs has been reduced more than 20 percent from its pre-damage condition and the remaining capacity of such affected elements, with respect to all dead and live loads, is less than 75 percent of that required by ~~this code~~ the Florida Building Code Building for new buildings of similar structure, purpose and location.

S7487

Date Submitted	11/28/2018	**Section**	202	**Proponent**	Joseph Crum
Chapter	2	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No **Alternate Language** No

Related Modifications

G21-16

Summary of Modification

The edit changes "this code" to "the FBC." The current language is an obsolete holdover from the version of the definition that went with FBC Chapter 34.

Rationale

This proposal makes editorial revisions that clarify the intent of the definition and facilitate its implementation. The edit changes "this code" to "the FBC." The current language is an obsolete holdover from the version of the definition that went with FBC Chapter 34.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This change is editorial and therefore will not effect the enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This change is editorial and therefore will not change any construction requirements

Impact to industry relative to the cost of compliance with code

This change is editorial and therefore will not change any construction requirements

Impact to small business relative to the cost of compliance with code

This change is editorial and therefore will not change any construction requirements

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This change is editorial and therefore will not change any construction requirements.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This change is editorial and therefore will not change any construction requirements or effect the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This change is editorial and therefore, does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This change is editorial and therefore, does not degrade the effectiveness of the code.

Section 202

Revise as follows:

[BS]SUBSTANTIAL STRUCTURAL DAMAGE. A condition where one or both of the following apply:

1. 1.The vertical elements of the lateral force-resisting system have suffered damage such that the lateral load-carrying capacity of any story in any horizontal direction has been reduced by more than 33 percent from its pre-damage condition.

2. 2.The capacity of any vertical component carrying gravity load, or any group of such components, that supports more than 30 percent of the total area of the structure's floors and roofs has been reduced more than 20 percent from its pre-damage condition and the remaining capacity of such affected elements, with respect to all dead and live loads, is less than 75 percent of that required by ~~this code~~ <u>the Florida Building Code Building</u> for new buildings of similar structure, purpose and location.

S8157

Date Submitted	12/14/2018	**Section**	202	**Proponent**	Ann Russo4
Chapter	2	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

301.1.4.1
TABLE 301.1.4.1
301.1.4.2
TABLE 301.1.4.2
606.2.2.1 606.2.2.3
707.3.1
807.5
907.4.2 907.4.3 907.4.5 907.4.6
1007.3.1
1103.3 1103.3.1 1103.3.2

Summary of Modification

Simplifies the code's terminology. The proposal also makes a coordinated change to the existing definition of "seismic loading." By revising the definition as proposed, FEBC provisions can now just refer to "full seismic loads" or "reduced seismic loads."

Rationale

This change simplifies the terminology in the FEBC, increasing usability and reducing potential errors. It removes unwieldy language and substitutes clearer, more concise language. The modification takes care of coordinating this terminology change throughout the FEBC.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity as this is already a code requirement

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners as this is already a code requirement

Impact to industry relative to the cost of compliance with code

No impact to industry as this is already a code requirement

Impact to small business relative to the cost of compliance with code

No impact to small businesses as this is already a code requirement

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by cleaning up wording that could cause confusion

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by cleaning up wording that could cause confusion

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities, this is a current code requirement that does not limit materials, products, methods, or systems of construction

Does not degrade the effectiveness of the code

Improves the effectiveness of code by cleaning up wording that could cause confusion

Revise as follows:

[BS] SEISMIC ~~LOADING~~ FORCES The loads, forces, and related requirements prescribed herein, related to the response of the ~~structure~~ building to earthquake motions, to be used in the analysis and design of the structure and its components. Seismic forces are considered either full or reduced, as provided in Chapter 3.

[BS] 301.1.4.1 Compliance with ~~Florida Building Code-level~~ full seismic forces. Where compliance ~~with~~ requires the ~~seismic design provisions~~ use of ~~the Florida Building Code is required~~ full seismic forces, the criteria shall be in accordance with one of the following:

1. **One-hundred percent of the values in the Florida Building Code. Where the existing seismic force-resisting system is a type that can be designated as "Ordinary," values of *R*,**
   O_0 and C_d used for analysis in accordance with Chapter 16 of the Florida Building Code shall be those specified for structural systems classified as "Ordinary" in accordance with Table 12.2-1 of ASCE 7, unless it can be demonstrated that the structural system will provide performance equivalent to that of a "Detailed," "Intermediate" or "Special" system.
2. ASCE41,usingaTier3procedureandthetwolevelperformanceobjectiveinTable301.1.4.1for the applicable risk category.

TABLE [BS] 301.1.4.1

PERFORMANCE OBJECTIVES FOR USE IN ASCE 41 FOR COMPLIANCE WITH ~~FLORIDA BUILDING CODE-LEVEL~~ FULL SEISMIC FORCES

[BS] 301.1.4.2 Compliance with reduced ~~Florda Building Code-level~~ seismic forces. Where seismic evaluation and design is permitted to ~~meet~~ use reduced ~~International Building Code~~ seismic ~~force levels~~ forces, the criteria used shall be in accordance with one of the following:

The *Florida Building Code* using 75 percent of the prescribed forces. Values of *R*, O_0 and C_d used for analysis shall be as specified in Section 301.1.4.1 of thiscode.

Structuresorportionsofstructuresthatcomplywiththerequirementsoftheapplicablechapterin Appendix A as specified in Items 2.1 through 2.5 and subject to the limitations of the respective Appendix A chapters shall be deemed to comply with thissection.

The seismic evaluation and design of unreinforced masonry bearing wall buildings in Risk Category I or II are permitted to be based on the procedures specified in AppendixChapter A1.

Seismic evaluation and design of the wall anchorage system in reinforced concreteand reinforced masonry wall buildings with flexible diaphragms in Risk Category I or II are permitted to be based on the procedures specified in ChapterA2.

2.3. Seismicevaluationanddesignofcripplewallsandsillplateanchorageinresidentialbuildings of light-frame wood construction in Risk Category I or II are permitted to be based on the procedures specified in Chapter A3.

2.4. Seismic evaluation and design of soft, weak, or open-front wall conditions in multiunit residentialbuildingsof woodconstructioninRiskCategoryIorIIarepermittedtobebased on the procedures specified in ChapterA4.

2.5. Seismic evaluation and design of concrete buildings assigned to Risk Category I, II or III are permitted to be based on the procedures specified in ChapterA5.

3. ASCE 41, using the performance objective in Table 301.1.4.2 for the applicable riskcategory.

[BS] 606.2.2.1 Evaluation. The building shall be evaluated by a registered design professional, and the evaluation findings shall be submitted to the *code official*. The evaluation shall establish whether the damaged building, if repaired to its predamage state, would comply with the provisions of the *Florida Building Code* for load combinations that include wind or earthquake effects, except that the seismic forces shall be the reduced ~~International Building Code-level~~ seismic forces.

[BS] 606.2.2.3 Extent of repair for noncompliant buildings. If the evaluation does not establish that the building in its predamage condition complies with the provisions of Section 606.2.2.1, then the building shall be rehabilitated to comply with the provisions of this section. The wind loads for the *repair* and *rehabilitation* shall be those required by the building code in effect at the time of original construction, unless the damage was caused by wind, in which case the wind loads shall be in accordance with ____the *Florida Building Code*. The seismic loads forces for this *rehabilitation* design shall be those required by the building code in effect at the time of original construction, but not less than the reduced ~~FLorida Building Code-level~~ seismic forces.

[BS] 707.3.1 Bracing for unreinforced masonry bearing wall parapets. Where a permit is issued for reroofing for more than 25 percent of the roof area of a building assigned to Seismic Design Category D, E or F that has parapets constructed of unreinforced masonry, the work shall include installation of parapet bracing to resist the reduced ~~Florida Building Code level~~ seismic forces ~~as specified in Section 301.1.4.2 of this code~~, unless an evaluation demonstrates compliance of such items.

[BS] 807.5 Existing structural elements resisting lateral loads. Except as permitted by Section 807.6, where the alteration increases design lateral loads, or where the alteration results in prohibited structural irregularity as defined in ASCE 7, or where the alteration decreases the capacity of any existing lateral load-carrying structural element, the structure of the altered building or structure shall be shown to meet the wind and seismic provisions of the *Florida Building Code*. Reduced ~~FloridaBuilding Code-level~~ seismic forces ~~in accordance with Section 301.1.4.2~~ shall be permitted.

> **Exception:** Any existing lateral load-carrying structural element whose demand-capacity ratio with the alteration considered is not more than 10 percent greater than its demand-capacity ratio with the alteration ignored shall be permitted to remain unaltered. For purposes of calculating demand-capacity ratios, the demand shall consider applicable load combinations with design lateral loads or forces in accordance with *Florida Building Code* Sections 1609 and 1613. Reduced ~~*Florida* Building Code level~~ seismic forces ~~in accordance with Section 301.1.4.2~~ shall be permitted. For purposes of this exception, comparisons of demand-capacity ratios and calculation of design lateral loads, forces and capacities shall account for the cumulative effects of additions and alterations since original construction.

[BS] 907.4.2 Substantial structural alteration. Where more than 30 percent of the total floor and roof areas of the building or structure have been or are proposed to be involved in structural *alteration* within a 5-year period, the evaluation and analysis shall demonstrate that the lateral load-resisting system of the altered building or structure complies with the *Florida Building Code* for wind loading and with reduced ~~Florida Building Code-level~~ seismic forces ~~in accordance with Section 301.1.4.2~~. The areas to be counted toward the 30 percent shall be those areas tributary to the vertical load-carrying components, such as joists, beams, columns, walls and other structural components that have been or will be removed, added or altered, as well as areas such as mezzanines, penthouses, roof structures and in-filled courts and shafts.

[BS] 907.4.3 Seismic Design Category F. Where the building is assigned to Seismic Design Category F, the evaluation and analysis shall demonstrate that the lateral load-resisting system of the altered building or structure complies with reduced ~~Florida Building Code-level~~ seismic forces ~~in accordance with Section 301.1.4.2~~ and with the wind provisions applicable to a limited structural alteration.

[BS] 907.4.5 Wall anchors for concrete and masonry buildings. For any building assigned to Seismic Design Category D, E or F with a structural system consisting of concrete or reinforced masonry walls with a flexible roof diaphragm and any building assigned to Seismic Design Category C, D, E or F with a structural system consisting of unreinforced masonry walls with any type of roof diaphragm, the alteration work shall include installation of wall anchors at the roof line to resist the reduced ~~Florida Building Code-level~~ seismic forces ~~in accordance with Section 301.1.4.2~~, unless an evaluation demonstrates compliance of existing wall anchorage.

~~**[BS] 907.4.6 Bracing for unreinforced masonry parapets.**~~ Parapets constructed of unreinforced masonry in buildings assigned to Seismic Design Category C, D, E or F shall have bracing installed as needed to resist the reduced ~~Florida Building Code-~~level seismic forces ~~in accordance with Section 301.1.4.2~~, unless an evaluation demonstrates compliance of such items.

[BS] 1007.3.1 Compliance with ~~International Building Code-level~~full seismic forces. Where a building or portion thereof is subject to a *change of occupancy* that results in the building being assigned to a higher risk category based on Table 1604.5 of the *International Building Code,* the building shall comply with the requirements for ~~Florida Building Code-level~~full seismic forces ~~as specified in Section 301.1.4.1~~for the new risk category.

Exceptions:

1. Where approved by the *code official*, specific detailing provisions required for a new structure are not required to be met where it can be shown that an equivalent level of performance and seismic safety is obtained for the applicable risk category based on the provision for reduced ~~Florida Building Code-level~~ seismic forces ~~as specified in Section301.1.4.2~~.
2. Where the area of the new occupancy with a higher hazard category is less than or equal to 10 percent of the total building floor area and the new occupancy is not classified as Risk Category IV. For the purposes of this exception, buildings occupied by two or more occupancies not included in the same risk category, shall be subject to the provisions of Section 1604.5.1 of the *FloridaBuilding Code*. The cumulative effect of the area of occupancy changes shall be considered for the purposes of thisexception.
3. Unreinforced masonry bearing wall buildings in Risk Category III when assigned to Seismic Design Category A or B shall be allowed to be strengthened to meet the requirements of Appendix Chapter A1 of this code [Guidelines for the Seismic Retrofit of Existing Buildings(GSREB)].

[BS] 1103.3 Lateral force-resisting system. The lateral force-resisting system of *existing buildings* to which additions are made shall comply with Sections 1103.3.1, 1103.3.2 and 1103.3.3.

Exceptions:

1. Buildings of Group R occupancy with no more than five dwelling or sleeping units used solely for residential purposes where the *existing building* and the *addition* comply with the conventional light-frame construction methods of the *Florida Building Code* or the provisions of the *International ResidentialCode*.
2. Any existing lateral load-carrying structural element whose demand-capacity ratio with the addition considered is not more than 10 percent greater than its demand-capacity ratio with the addition ignored shall be permitted to remain unaltered. For purposes of this exception, comparisons of demand-capacity ratios and calculation of design lateral loads, forces and capacities shall account for the cumulative effects of additions and alterations since original construction. For purposes of calculating demand capacity ratios, the demand shall consider applicable load combinationsinvolving~~Florida BuildingCode-level~~fullseismicforces ~~inaccordancewithSection301.1.4.1~~.

[BS] 1103.3.1 Vertical addition. Any element of the lateral force-resisting system of an *existing building* subjected to an increase in vertical or lateral loads from the vertical *addition* shall comply with the *Florida Building Code* wind provisions and

the ~~Florida Building Code-level~~ full seismic forces ~~specified in Section 301.1.4.1 of this code~~.

[BS] 1103.3.2 Horizontal addition. Where horizontal *additions* are structurally connected to an existing structure, all lateral force- resisting elements of the existing structure affected by such *addition* shall comply with the *Florida Building Code* wind provisions and the ~~FBC level~~ full seismic forces ~~specified in Section 301.1.4.1 of this code~~.

S8391

Date Submitted	12/15/2018	**Section**	202	**Proponent**	Kimberly Gilliam
Chapter	2	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation	Pending Review
Commission Action	Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

[BS] 1007.1, [BS] 1007.2, [BS] 1007.3.2

Summary of Modification

This proposal clarifies the structural provisions of the FBC, Existing Building with the added definition of "risk category" that is drawn from the FBC, Building.

Rationale

This proposal clarifies the structural provisions of the FBC, Existing Building with the added definition of "risk category" that is drawn from the FBC, Building.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None. The proposed modification is a clarification.

Impact to building and property owners relative to cost of compliance with code

None. The proposed modification is a clarification.

Impact to industry relative to the cost of compliance with code

None. The proposed modification is a clarification.

Impact to small business relative to the cost of compliance with code

None. The proposed modification is a clarification.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

No, the proposed modification is a clarification.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, the clarifications provide a better coordinated Code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

No, the clarifications provide a better coordinated Code.

Section 202
Add new definition as follows:

RISK CATEGORY. A categorization of buildings and other structures for determination of flood, wind,snow, ice and earthquake loads based on the risk associated with unacceptable performance, as provided in Section 1604.5 of the *Florida Building Code, Building.*

Section 1007
Revise as follows:

[BS]1007.1 ~~Gravity~~ Live loads.

~~Buildings or portions thereof subject to~~ Structural elements carrying tributary live loads from an area with a *change of occupancy* ~~where such change in~~ shall satisfy the ~~nature~~ requirements of ~~occupancy results in higher uniform or concentrated loads based on the Florida Building Code, Building, Table 1607.1 shall comply with the gravity load provisions~~ Section 1607 of the Florida Building Code, Building. Design live loads for areas of new occupancy shall be based on Section 1607 of the *Florida Building Code, Building.* Design live loads for other areas shall be permitted to use previous approved design live loads.

> **Exception:** ~~Structural elements whose stress is not increased by more than 5 percent.~~ Structuralelements whose demand-capacity ratio considering the change of occupancy is not more than 5percent greater than the demand-capacity ratio based on previously approved live loads need notcomply with this section.

[BS]1007.2 Snow and wind loads.

~~Buildings and structures subject to~~ When a ~~*change of occupancy*~~ ~~where such~~ change ~~in the nature~~ of occupancy results in a structure being assigned to a higher ~~wind or snow~~ risk ~~categories based on~~ category, the structure shall satisfy the requirements of Sections 1608 and 1609 of the Florida Building Code, Building ~~Table 1604.5~~, (High-Velocity Hurricane Zones shall comply with Section 1620) ~~shall be analyzed and shall comply with~~ the ~~applicable wind or snow load provisions of the~~ Florida Building Code, Building~~.~~ for the new risk category.

> **Exception:** ~~Where the new occupancy with a higher risk category is less than or equal to 10 percent of the total building floor area. The cumulative effect of the area of occupancy changes shall be considered for the purposes of this exception.~~ Where the area of the new occupancy is less than 10percent of the building area, compliance with this section is not required. The cumulative effect ofoccupancy changes over time shall be considered.

BACK

Code Change No: EB50-16

Original Proposal

Section: 202 (New), [BS] 1007.1, [BS] 1007.2, [BS] 1007.3.2

Proponent: David Bonowitz, representing National Council of Structural Engineers Associations (dbonowitz@att.net)

THIS CODE CHANGE WILL BE HEARD BY THE IBC-STRUCTURAL CODE COMMITTEE. SEE THE TENTATIVE HEARING ORDER FOR THIS COMMITTEE.

Add new definition as follows:

RISK CATEGORY. A categorization of buildings and other structures for determination of flood, wind, snow, ice and earthquake loads based on the risk associated with unacceptable performance, as provided in Section 1604.5 of the *International Building Code*.

Revise as follows:

[BS] 1007.1 ~~Gravity~~ Live loads. ~~Buildings or portions thereof subject to~~ Structural elements carrying tributrary live loads from an area with a *change of occupancy* ~~where such change in~~ shall satisfy the ~~nature~~ requirements of ~~occupancy results in higher uniform or concentrated loads based on Table 1607.1 of the *International Building Code* shall comply with the gravity load provisions~~ Section 1607 of the *International Building Code*. Design live loads for areas of new occupancy shall be based on Section 1607 of the *International Building Code*. Design live loads for other areas shall be permitted to use previously approved design live loads.

> **Exception:** ~~Structural elements whose stress is not increased by more than 5 percent.~~ Structural elements whose demand-capacity ratio considering the change of occupancy is not more than 5 percent greater than the demand-capacity ratio based on previously approved live loads need not comply with this section.

[BS] 1007.2 Snow and wind loads. ~~Buildings and structures subject to~~ When a ~~*change of occupancy* where such~~ change ~~in the nature~~ of occupancy results in a structure being assigned to a higher ~~wind or snow~~ risk ~~categories based on Table 1604.5~~ category, the structure shall satisfy the requirements of Sections 1608 and 1609 of the *International Building Code* ~~shall be analyzed and shall comply with~~ for the ~~applicable wind or snow load provisions of the *International Building Code*~~ new risk category.

> **Exception:** ~~Where the new occupancy with a higher risk category is less than or equal to 10 percent of the total building floor area. The cumulative effect of the area of occupancy changes shall be considered for the purposes of this exception.~~ Where the area of the new occupancy is less than 10 percent of the building area, compliance with this section is not required. The cumulative effect of occupancy changes over time shall be considered.

[BS] 1007.3.2 Access to Risk Category IV. ~~Where a *change of occupancy* is such~~ Any structure that ~~compliance with Section 1007.3.1 is required and the building is~~ provides operational access to an adjacent structure assigned to Risk Category IV, as the ~~operational access to the building~~ result of a change of occupancy shall ~~not be through an adjacent structure, unless that structure conforms to~~ itself satisfy the requirements of Section 1613 of the *International Building Code* for Risk Category IV structures using *International Building Code*-level seismic forces. Where operational access to the Risk

Category IV structure is less than 10 feet (3048 mm) from either an interior lot line or from another structure, access protection from potential falling debris shall be provided ~~by the owner of the Risk Category IV structure~~.

Reason: This proposal makes editorial changes for consistency, clarity, and simplification. The revisions use the preferred wording and logic approved for other sections in recent code cycles, so as to make the structural provisions more uniformly understandable and enforceable throughout the IEBC. The revisions by section:
202:

- Add the definition of Risk Category, identical to that provided in the IBC, but with reference to IBC Section 1604.5. This makes it unnecessary to refer repeatedly to Table 1604.5 and other rules for mixed occupancies and risk categories.

1007.1:

- Change title to Live loads. The code does not define "gravity loads," which could be construed to include snow and rain. More important, any change in dead load would indicate an alteration, not a change of occupancy.
- There is no need to determine whether the CoO has increased the design live loads. Instead, just design for the new design loads and use the 5% exception where it applies. This is the effect of the current provision in any case. More important, we believe it is not the intent of the code to permit a new occupancy in an under-designed space. Therefore, to compare the Table 1607.1 design loads for the new occupancy and the previous occupancy might not be sufficient if the actual structure was designed originally for much smaller design live loads than Table 1607.1 would requiretoday.
- The allowance for "previously approved design live loads" outside the Change of Occupancy area is consistent with the allowance for alterations in 807.3 and 403.3.1.
- The 5 percent rule is retained, with the comparison clarified.

1007.2:

- Update the wording. There is no longer a "wind or snow risk category."
- Retain the 10% exception for a small area of changed occupancy. Note that 1007.3.1 allows this exception only for a change to RC II or III, not to RC IV. If that is sensible for seismic loads, it is probably also sensible for wind and snow, but this proposal is meant to be editorial only.

1007.3 and 1007.3.1: No changes proposed here. Since the Prescriptive method has a similar seismic provision (but no wind, snow, or live load provision yet), editorial revisions to 1007.3 and 1007.3.1 will be proposed separately in tandem with revisions to 407.4
1007.3.2:

- Clarify the logic.
- Clarify the applicable seismic criteria consistent with similar sections.
- Delete the reference to the owner. The owner or permit applicant is always responsible for compliance; there is nothing about this provision that requires a special charge to the owner.

Cost Impact: Will not increase the cost of construction
This is an editorial change, so there will be no change to construction requirements.

Report of Committee Action Hearings

Committee Action: **Approved as Submitted**

Committee Reason: Agreement with the proponent's reason which indicates this proposal clarifies the structural provisions of the IEBC with the added definition of "risk category" that is drawn from the IBC. These changes, which are primarily editorial, make the IEBC provisions more understandable and enforceable.

Assembly Action: **None**

Final Action Results

EB50-16	**AS**

Date Submitted 12/10/2018 **Section** 303.3 **Proponent** Steve Szoke
Chapter 3 **Affects HVHZ** No **Attachments** Yes
TAC Recommendation Pending Review
Commission Action Pending Review

Comments
General Comments **Yes** **Alternate Language** **No**

Related Modifications

Chapter 35

Summary of Modification

Add reference to ACI 562-19:Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures for evaluation and repair of structural concrete

Rationale

Reason statement and cost impact provided in uploaded file: Mod_7840_Rationale_03-01 FL IEBC Sec 303 Add 562 181210 DRAFT.pdf

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Where used, ACI 562 will provide increased uniformity in the evaluation and repair of existing structural concrete.

Impact to building and property owners relative to cost of compliance with code

Where used, ACI 562 improve the understanding and expectations of property owners, contractors, designers, and code officials. Further the code will improve the confidence in the performance of repairs fro all involved in future use of the building, inlcuding the occupants.

Impact to industry relative to the cost of compliance with code

The use of ACI 562 in many cases reduces the cost of repair. See cost impact on reason statement.

Impact to small business relative to the cost of compliance with code

No increase in cost is anticipated. There is the potential to reduce costs as previously described. See cost impact on reason statement.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, see the background in the attached reason statement.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, See reason statement.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

There is no discrimination of materials, products, methods, or systems. Building code still allow for alternative means and methods.

Does not degrade the effectiveness of the code

Improves the effectiveness of the code and is expected to be especially beneficial where degradation to concrete is common, such as marine environments and structures exposed to salt air and moisture.

1st Comment Period History

S7840-G1

Proponent Hany Jawaheri Zadeh **Submitted** 2/15/2019 **Attachments** Yes

Comment:

Please see the attached letter.
Thanks.

1st Comment Period History

S7840-G2

Proponent Garth Fallis **Submitted** 2/16/2019 **Attachments** Yes

Comment:

Vector Corrosion Services Inc. recommends ACI 562 Repair code to be adopted into Florida building code.

1st Comment Period History

S7840-G3

Proponent	Garth Fallis	**Submitted**	2/16/2019	**Attachments**	Yes

Comment:

Vector Construction Inc. fully recommends and supports the adoption of the ACI 562 repair code into the building code of Florida.

1st Comment Period History

S7840-G4

Proponent	Ball Chris	**Submitted**	2/16/2019	**Attachments**	Yes

Comment:

NDT Corporation supports the adoption of the ACI 562 Repair Code into Florida Building Code.

1st Comment Period History

S7840-G5

Proponent	Ball Chris	**Submitted**	2/16/2019	**Attachments**	Yes

Comment:

Vector Corrosion Technologies Inc. fully supports the adoption of ACI 562 Repair Code into Florida Building Code.

301.1.3 Performance compliance method.

Repairs, *alterations*, *additions*, changes in occupancy and relocated buildings complying with Chapter 14 of this code shall be considered in compliance with the provisions of this code.

301.1.4 Concrete evaluation and design procedures.

Evaluation and design of structural concrete in compliance with ACI 562 shall be permitted.

Exception: ACI 562 shall not be used to comply with provisions of this code for seismic evaluation and design procedures.

[BS]**301.1.45 Seismic evaluation and design procedures.**

The seismic evaluation and design shall be based on the procedures specified in the Florida Building Code, Building or ASCE 41. The procedures contained in Appendix A of this code shall be permitted to be used as specified in Section 301.1.4.2.

Add reference to **Chapter 16**

ACI

Concrete Institute

Country Club Drive

Hills, MI 48331

ACI 562-19: Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concr

301.1.4

Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures (ACI 562-19) and Commentary

An ACI Standard

Reported by ACI Committee 562

Keith E. Kesner, Chair

Kevin Conroy, Secretary

Voting Members

Tarek Alkhrdaji
F. Michael Bartlett
Randal M. Beard
Eric L. Edelson
Garth J. Fallis
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Jeremiah D. Fasl
Kip Gatto
Anton Gueorguiev
Patrick D. Martin
Timothy M. Montgomery
Jose Pacheco

ACI 562-19, "Code Requirements for Assessment, Repair and Rehabilitation of Existing Concrete Structures," was developed to provide design professionals involved in the assessment of existing concrete structures a code for the assessment of the damage and deterioration, and the design of appropriate repair and rehabilitation strategies. The code provides minimum requirements for assessment, repair, and rehabilitation of existing structural concrete buildings, members, systems and where applicable, nonbuilding structures. ACI 562-19 was specifically developed to work with the International Existing Building code (IEBC) or to be adopted as a stand-alone code.

Keywords: assessment; bond; damage; durability; evaluation; existing structure; fiber-reinforced polymer (FRP); interface bond; licensed design professional; maintenance; rehabilitation; reliability; repair; strengthening; unsafe.

CONTENTS

Chapter 5—Loads, factored load combinations, and strength reduction factors

Chapter 6—Assessment, evaluation, and analysis

Chapter 7—Design of structural repairs

7.1—General

7.2—Strength and serviceability

7.3—Behavior of repaired systems

7.4—Interface bond of cementitious repair materials

7.5—Materials

7.6—Design and detailing considerations

7.7—Repair using supplemental post-tensioning

7.8—Repair using fiber-reinforced polymer (FRP) composites

7.9—Performance under fire and elevated temperatures

Chapter 8—Durability

8.1—General

8.2—Cover

8.3—Cracks

8.4—Corrosion and deterioration of reinforcement and metallic embedments

8.5—Surface treatments and coatings

Chapter 9—Construction

9.1—General

9.2—Stability and temporary shoring requirements

9.3—Temporary conditions

9.4—Environmental issues

Chapter 10—Quality assurance

10.1—General

10.2—Inspection

10.3—Testing of repair materials

10.4—Construction observations

Chapter 11—Commentary references

Appendix A—Criteria as a stand-alone code

A.1—General

A.2—Design-basis code criteria

A.3—Unsafe structural conditions

A.4—Substantial structural damage

A.5—Conditions of deterioration, faulty construction or damage less than substantial structural damage

A.6—Conditions of deterioration, faulty construction, or damage less than substantial structural damage without strengthening

A.7—Additions

A.8—Alterations

A.9—Change of occupancy

Summary of Revisions

Modifications were largely based upon comments received informally after the publication of ACI 562-16.

Major Revisions

The major changes are as follows:

(a) Text was added to simplify use of new materials that have the equivalent of an ICC-ES evaluation report in Chapter 1.

(b) The requirements for the basis of design report were simplified in Chapter 1.

(c) Clarified requirements related to detailing of existing reinforcing steel in Chapter

(d) The commentary in Chapter 8 was updated to include a listing of exposure categories that may affect durability.

Minor Revisions

The minor revisions were aimed at improving the current text to improve readability and integration with other documents. An effort was also made for consistency in terminology with ASCE and other organizations.

PREFACE

This code provides minimum requirements for assessment, repair, and rehabilitation of existing structural concrete buildings, members, systems and where applicable, nonbuilding structures. This code was developed by an ANSI-approved consensus process. This code can supplement the International Existing Building Code (IEBC), supplement the code governing existing structures of a local jurisdictional authority, or act as a stand-alone code in a locality that has not adopted an existing-building code. When this code is used as a stand-alone code, Appendix A is used in place of Chapter 4.

This code provides minimum requirements for assessment, design and construction, or implementation of repairs and rehabilitation, including quality assurance requirements, for structural concrete in service. This code has no legal status unless it is adopted by the jurisdictional authority. Where the code has not been adopted, it serves as a standard to provide minimum requirements for assessment, and design and construction of repair and rehabilitation of existing structural concrete. ACI 318 provides minimum requirements for the materials, design, and detailing of structural concrete buildings and, where applicable, nonbuilding structures, and for new construction within existing structures where noted herein.

Key changes from ACI 562-16 to ACI 562-19 include:

(a) Text was added to simplify use of new materials that have the equivalent of an ICC-ES evaluation report in Chapter 1.

(b) The requirements for the basis of design report were simplified in Chapter 1.

(c) Requirements related to detailing of existing reinforcing steel in Chapter 4 have been clarified.

(d) The commentary in Chapter 8 was updated to include a listing of exposure categories that may affect durability.

CHAPTER 1—GENERAL REQUIREMENTS

1.1—General

1.1.1 ACI 562, "Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures," is hereafter referred to as "this code."

1.1.2 Scope—This code shall apply to assessment, repair, and rehabilitation of existing concrete structures as:

(1) A code supplementing the International Existing Building Code (IEBC)

(2) As part of a locally adopted code governing existing buildings or structures

(3) Or as a stand-alone code for existing concrete structures

1.1.2C *This code defines assessment, design, construction and durability requirements for repair and rehabilitation of existing concrete structures. Throughout this code, the term "structure" means an existing building, member, system, and, where applicable, nonbuilding structures where the construction is concrete or mixed construction with concrete and other materials.*

Chapter 4 provides assessment, repair, and rehabilitation criteria if this code is used as a supplement to the International Existing Building Code (IEBC) for concrete members and systems.

Appendix A provides assessment, repair, and rehabilitation criteria when this code is used as a stand-alone code in a jurisdiction without a code governing existing structures.

1.1.3 The intent of this code is to safeguard the public by providing minimum structural requirements for existing structural concrete members, systems, and buildings.

1.1.3C *The intent of this code is to address the safety of existing structures through assessment requirements that demonstrate an approximation of the structural reliability using demand-capacity ratio limits of Chapter 4 or Appendix A and, if necessary as determined by the assessment, increase the structural capacity by repair or rehabilitation.*

Unless prohibited by the jurisdictional authority, if an existing structure is shown to be unsafe in accordance with 4.3 or A.3, the structure should be rehabilitated using 4.3 or A.3.

Using the demand-capacity ratio limits of 4.5.1 or A.5.1, repair of the existing structural concrete to its predeteriorated state is permitted based on material properties specified in the original construction (per Chapter 6), and substantiated engineering principles of the original design. Where requirements of the original building code are appreciably changed in the current building code, the licensed design professional may consider using 4.5.2 or A.5.2.

Beyond the restoration assessment requirements of 4.5.1 and 4.5.3 or A.5.1 and A.5.3, the structural reliability principles of 4.5.2 or A.5.2 are permitted. These alternative requirements provide acceptable safety if the current building code demand exceeds the original building code demand or if the regulations of the original building code provide an unacceptable level of structural reliability.

1.1.4 All references in this code to the licensed design professional shall be understood to mean persons who possess the knowledge, judgment, and skills to interpret and properly use this code and are licensed in the jurisdiction where this code is being used. The licensed design professional for the project is responsible for, and in charge of, the assessment or rehabilitation design, or both.

1.1.5 The requirements of this code are provided using strength design provisions for demands and capacities, unless otherwise noted.

1.1.5C *When this code permits the original building code regulations to be used and that code uses allowable stress design: those provisions should be substituted for strength design as noted in 4.5.3 or A.5.3; the licensed design professional is not required to use, but should consider using strength design provisions of this code as a check in the assessment of existing structures originally designed with allowable stress methods; and the licensed design professional may judge when the* *original building code is to be replaced by the current building code to provide structurally adequate resistance and reliability.*

1.2—Criteria for the assessment and design of repair and rehabilitation of existing concrete structures

1.2.1 The "existing building code" refers to the code adopted by a jurisdiction that regulates existing buildings or structures.

***1.2.1C** The code governing existing buildings in the United States is commonly the IEBC developed by the International Code Council (ICC). The IEBC provides regulations for evaluations of damage and the limit for damage to be repaired using the original building code. If this limit is exceeded or if the licensed design professional judges the structural safety to be unacceptable based on rational engineering principles, rehabilitation is necessary in accordance with the requirements of the current building code.*

1.2.2 The "current building code" refers to the general building code adopted by a jurisdiction that presently regulates new building design and construction.

***1.2.2C** The current building code establishes the design and construction regulations for new construction. Strength design regulations of the current building code include:*

(a) Required strengths computed using combinations of factored loads (strength design demands)

(b) Design strengths (capacities) based on testing of materials, members, and systems

(c) Analytical methods used to calculate member and system capacity

(d) Strength reduction factors, which have been established to be consistent with reliability indices used with the strength design demands

The load factors and strength reduction factors in the current building code are obtained through rational design code calibration procedures to achieve the targeted reliability indices which produce historically acceptable structural safety for new structures. The targeted reliability indices are generally based on past structural behavior, engineering experiences, costs and consequences of loss, among other criteria. The resulting demand-capacity ratios for new structures provide the limits that are not to be exceeded if designing new construction, but these demand-capacity ratio limits need not to be the same as those for existing structures as noted in sections 4.5.2 and A.5.2.

The general building code in the United States is usually based on the International Building Code (IBC) published by the ICC. Prior to 2015, Chapter 34 of the IBC included provisions for existing structures. For the design and construction of new concrete structures, the IBC and most other older general building codes often reference ACI 318, Building Code Requirements for Structural Concrete and Commentary, with exceptions and additions.

1.2.3 The "original building code" refers to the general building code applied by the jurisdictional authority to the structure in question at the time the existing structure was permitted for construction.

1.2.3C *This definition of "original building code" is consistent with the building code in effect at the time of original permitted construction per the IEBC. In assessing existing structures, the licensed design professional may need to consider changes in the codes enforced by the local jurisdictional authority for the structure from the time of the original design through the time of the completion of construction.*

Reference to design requirements of the original building code should include: demands determined using either nominal loads, load factors, and load combinations of the original *building code, or using allowable design loads and load combinations of the original building code; capacities determined using either strength design and reinforcement detailing provisions, and strength reduction factors of the original building code or using allowable stress design provisions of the original building code; and construction materials. Requirements for concrete design and construction include previous versions of ACI 318, concrete codes predating ACI 318, or concrete provisions within the original building code. A structural assessment using allowable stress design provisions of the original building code should be coupled with an evaluation using current standards or the strength design and reinforcement detailing provisions of this code to increase the understanding of structural behavior and to judge if more consistent and safe remedial recommendations are necessary using the current building code.*

For a structure constructed prior to the adoption of a building code, the licensed design professional should research available standards and practices in effect at the time of construction. The Historic American Engineering Record, a program of the United States Park Service, has information on construction and preservation of historic structures (https://www.nps.gov/hdp/haer/).

1.2.4 Design-basis code criteria

1.2.4.1 The types of design-basis code criteria used in this code are assessment criteria and design-basis criteria. The design-basis code criteria of this code shall be used to assess and design rehabilitations of existing members, systems, and structures.

1.2.4.1C *The design-basis code criteria include requirements for assessment of the existing structure and for design when repairs are required based upon assessment results.*

If a jurisdiction has adopted the IEBC, then the design-basis code criteria are based on the IEBC with supplemental requirements of this code for unsafe structural conditions, damage less than *substantial structural damage, deterioration of concrete and reinforcement, faulty construction, serviceability issues, and durability of existing concrete.*

For substantial structural damage, additions, alterations, and changes in occupancy, the IEBC establishes limits to which an assessment and design of repair and rehabilitation can occur in accordance with the original building code. Above these limits, an assessment and design of the repair and rehabilitation is in accordance with the current building code. Current and original building code provisions are supplemented by this code to address existing concrete members, systems, and structures.

Appendix A applies if a jurisdiction has not adopted the IEBC and has adopted this code. Appendix A of this code can provide design-basis code criteria for unsafe structural conditions, substantial structural damage, damage less than substantial structural damage, deterioration of concrete and reinforcement, faulty construction, additions, alternations, and changes in occupancy, serviceability issues, and durability of existing concrete.

1.2.4.2 Assessment and design-basis criteria and the requirements for applying these criteria are provided in Chapter 4 and Appendix A. Chapter 4 applies if a jurisdiction has adopted the International Existing Building Code (IEBC) as the existing building code. Appendix A applies if a jurisdiction has not adopted the IEBC or if a jurisdiction has adopted this code.

1.2.4.2C Classifying the rehabilitation category using criteria and requirements of Chapter 4 or Appendix A defines the design-basis criteria, which is used to design the repair or rehabilitation work.

1.2.4.3 Assessment criteria shall be used to classify the rehabilitation work and to establish the design-basis criteria.

1.2.4.3.1 It shall be permitted to use the current building code as the assessment criteria for all existing structures.

1.2.4.4 Design-basis criteria shall be used to establish the applicable building code for repair and rehabilitation design.

1.2.4.5 The current building code shall be the design basis code for new members and for connection of new members to existing structures.

1.3—Applicability of this code

1.3.1 This code is applicable when performing an assessment, repair or rehabilitation design and remedial construction of the structural components of existing concrete structures, including buildings and nonbuilding structures.

1.3.1C *Existing concrete structures may require an assessment, repair or rehabilitation design for considerations beyond the minimum requirements of this code.*

Nonbuilding concrete structures can include, but are not limited to arches, tanks, reservoirs, bins and silos, blast- and impact-resistant structures, and chimneys.

1.3.2 Considerations beyond the minimum requirements of this code, such as those for progressive collapse resistance, redundancy, or integrity provisions are permitted. The licensed design professional is permitted to require assessment, design, construction, and quality assurance activities that exceed the minimum requirements of this code. Regulations of the current building code need not be exceeded when assessing, designing repair and rehabilitation work, or installing remedial work of existing structures.

1.3.3 Foundations

1.3.3.1 This code shall apply to the assessment and repair or rehabilitation of existing structural concrete foundation members.

1.3.3.1C *Foundation members and systems should include those constructed using plain or reinforced concrete including but not limited to spread footings, mat foundations, concrete piles, drilled piers, grade beams, pile and pier caps, and caissons embedded in the ground. The design and installation of new pilings fully embedded in the ground are regulated by the current building code. For repair of existing foundation members and systems, the provisions of this code apply if not in conflict with the code governing existing building. For the portions of concrete piling in air or water, or in soil not capable of providing adequate lateral restraint throughout the piling to prevent buckling, the provisions of this code govern.*

1.3.4 Soil-supported slabs

1.3.4.1 This code shall apply to the assessment and repair or rehabilitation of soil-supported structural slabs that transmit vertical loads or lateral forces from the structure to the soil.

1.3.5 Composite members

1.3.5.1 This code shall apply to the assessment and repair or rehabilitation of the concrete portions of composite members.

1.3.6 Precast and prestressed concrete

1.3.6.1 This code shall apply to the assessment and repair or rehabilitation of structural precast and prestressed concrete members, systems, and connections, and cladding transmitting lateral loads to diaphragms or bracing members.

1.3.7 Nonstructural concrete

1.3.7.1 This code is not intended for repair of nonstructural concrete or for aesthetic improvements, except if failure of such repairs would result in an unsafe condition.

***1.3.7.1C** Where nonstructural concrete requires repair, that repair is not required to comply with or satisfy the requirements of this code. The licensed design professional designing repairs to nonstructural concrete should consider the consequence of repair failure to determine if there are provisions of this code that are applicable.*

1.3.8 Seismic resistance

1.3.8.1 Evaluation of seismic resistance and rehabilitation design shall be in accordance with the code governing existing buildings if one has been adopted or this code if a code governing existing buildings has not been adopted. If using this code for evaluation of seismic resistance and rehabilitation design, ASCE/SEI 41 shall apply.

***1.3.8.1C** Provisions in Chapter 10 of ASCE/SEI 41 are based on ACI 369.1-17, which provides specific guidance on evaluation, repair and rehabilitation for existing concrete structures.*

1.3.8.2 If rehabilitation for seismic resistance is not required by the code governing existing buildings or this code, voluntary retrofit for seismic resistance shall be permitted. IEBC shall apply if the IEBC is used with this code for voluntary retrofit of seismic resistance. When this code is used without a code governing existing buildings, the licensed design professional shall use the current building code supplemented by ASCE/SEI 41 and ASCE/SEI 7 to design seismic retrofits.

***1.3.8.2C** Conditions for evaluation of seismic resistance and design of retrofits are provided in Chapter 3 of ACI 369R, Chapter A2 of Appendix A of IEBC, and ASCE/SEI 41.*

Critical conditions requiring engineering review include, but are not limited to: irregular building configurations; nonductile or strong-beam-weak-column frames; and anchorage of walls to diaphragms. Significant improvements to the seismic resistance of a building can be made using *repair techniques that provide less than those detailing and reinforcement methods required for new construction. As an example, providing additional reinforcement to confine concrete in flexural hinging regions will increase the energy dissipation and seismic performance even though the amount of confinement reinforcement may not satisfy the confinement requirements for new structures (Kahn 1980; Priestley et al. 1996; Harris and Stevens 1991). Visual Screening for Potential Seismic Hazards (FEMA P-154), Mitigation of Nonductile Concrete Buildings (ATC-78 Project), Seismic Performance Assessment of Buildings (ATC-58), and Quantification of Building Seismic Performance Factors (FEMA P-695 Report) Identification and Mitigation of Nonductile Concrete Buildings (ATC-78-1) address seismic assessment and resistance in existing concrete structures.*

Components of the seismic-force-resisting system that require strength and ductility should be identified. Force-controlled (nonductile) action is acceptable for some classifications of components of the seismic-force-resisting system (ASCE/SEI 41). The strength requirement of this code, Section 7.1 is applicable to these force-controlled components. ASCE/SEI 41 and ACI 369R provide information on rehabilitation for seismic resistance. Seismic-resisting components requiring energy-dissipating capability should maintain the ability to dissipate energy after repair. Design and detailing requirements for seismic resistance of cast-in-place or precast concrete structures are addressed in ACI 318 and 369R.

1.4—Administration

1.4.1 Whenever this code is in conflict with the regulations of the jurisdictional authority or code governing existing buildings, the jurisdictional authority or code governing existing buildings shall govern.

1.4.2 Whenever this code is in conflict with requirements in other referenced standards, this code shall govern.

1.4.3 Approval of special systems of design or construction—

Systems that are approved by the jurisdictional authority through alternative means and methods clauses in the building design-basis code shall be permitted.

1.4.3C *New methods of design, new materials, and new uses of materials for repair and rehabilitation usually undergo a period of development before being specifically covered in a code. Hence, good systems or components might be excluded from use by implication if means are not available to obtain acceptance. For systems considered under this section, specific tests, load factors, strength reduction factors, deflection limits, and other pertinent requirements should be set by the local jurisdictional authority and should be consistent with the intent of this code. Provisions of this section do not apply to model analysis used to supplement calculations or to strength evaluation of existing structures.*

1.4.4 Materials that are evaluated in a process equivalent to the requirements of the IBC shall be used in accordance with the requirements of the written evaluation report for the material. Material use shall satisfy requirements of this code.

1.4.4C *The IBC (Section 1703 in IBC 2018) includes provisions for approval of alternate materials in new construction. The approval process requires the evaluation to be completed by an approved agency, and the material properties and use requirements be summarized in a written evaluation report. The same process may be used for materials in repair applications, provided* *the materials satisfy the provisions of this code. This process is intended to allow for use of new materials and new classes of materials that do not have approved design or material standards.*

1.5—Responsibilities of the licensed design professional

1.5.1 The licensed design professional for the project is responsible for 1) assessing; 2) designing, detailing, and specifying the work proposed and material requirements; 3) establishing requirements to maintain load paths for the work proposed; and 4) preparing construction documents of the work proposed and specifying a quality assurance program. Construction documents shall indicate the location, nature, and extent of the work proposed.

1.5.1C *During the assessment part of the investigation, the licensed design professional should request that the owner provide all available information regarding the condition of the building, plans, previous engineering reports, disclose the presence of any known hazardous materials in the work area, and any other pertinent information to the parties involved in the work. This information may require that remedial measures be taken before or during the construction process and should be considered in the scope of work.*

1.5.2 Unsafe structural conditions—The licensed design professional for the project shall report observations of exposed structural defects in the existing construction within the work area representing obvious unsafe structural conditions requiring immediate attention to the owner and appropriate authorities.

1.5.2C *During investigation or repair construction, unsafe structural conditions in the work area may be revealed. To protect the public safety, an observed unsafe structural condition should be reported to the contractor, owner, or jurisdictional authority to initiate mitigation of the condition. Mitigation may include temporary shoring or construction as part of the remedial work.*

1.5.3 The licensed design professional for the project shall document the basis of design. The basis of design shall address rehabilitation categories and repair construction within the work area for each structural element and include:

(a) A description of the building,

(b) Modifications such as additions, alterations, or changes in occupancy

(c) Shoring needs

(d) Quality assurance and quality control (QA/QC) requirements

(e) Conditions and details of the proposed rehabilitation work

(f) Known history of concrete repairs and rehabilitations

(g) Assessment criteria and findings

(h) Repair material parameters

1.5.3C *The basis of design provides a summary of the assessment of the existing structure, and a summary of the construction documents from original construction or prior rehabilitation used in the developing the basis of design. The basis of design can be documented in a written report or included in construction documents. Information on some structures may be unavailable or unnecessary if strengthening is not required and should be so documented in the basis of design. The licensed design professional should review requirements of the jurisdictional authority to determine the information to include in the basis of design documentation and filing requirements for the basis of design.*

Additional materials that may be documented in the basis of design include:

(a) Detailed building description, including age of construction, structural systems, identified original building code, and past and current uses

(b) Documentation of unsafe structural conditions in the work area of the structure determined in the assessment

(c) Documentation of substantial structural damage in the work area

(d) Members and systems of the work area requiring increase in capacity beyond the demand of the original building code

(e) Conditions and details of the proposed rehabilitation work

(f) Past history of concrete repairs and rehabilitations

(g) Assessment criteria and findings

(h) Design-basis code criteria and basis of rehabilitation design

(i) Material selection parameters

(j) Shoring requirements such as loads and spacing of shoring members

(k) Quality assurance and quality control (QA/QC) requirements

(l) Types and frequency of future inspection

(m) Types and frequency of future maintenance

(n) Recommendations to address serviceability conditions as discussed in Section 6.6

A maintenance protocol that addresses project-specific conditions provides the most effective method to ensure durability and should be established as part of the repair or rehabilitation design that includes inspections and period of time between inspections, after completion of the repair installation. Maintenance and frequent preventative approaches that occur early in the service life of the structure generally result in improved service life with less interruption and a lower life-cycle cost (Tuutti 1980; ACI 365.1R). Recommendations should be provided to the Owner on inspection and maintenance to be undertaken during the remaining design service life of the repair material or the repaired part of the structure.

A maintenance protocol should be provided in the basis of design, or in as-built or close-out documents. Maintenance of the repair can be incorporated in the instruction manuals from the licensed design professional, contractor, or product manufacturers. Documents and records of observations, inspections and tests should be provided to the owner as necessary for future work.

1.6—Construction documents

1.6.1 The construction documents for rehabilitation work proposed shall provide sufficient detail and clarity to convey the location, nature and extent of the work, and the necessary information to perform the work in conformance with the requirements of this code and the local jurisdictional authority. Specifications shall require that materials used for repair and rehabilitation construction satisfy this code and governing regulatory requirements at the time the work is implemented.

1.6.1C *As necessary, the construction documents should indicate:*

(a) Name and date of issue of the building code and supplements to which the assessment, repairs, or rehabilitation conforms

(b) Design basis code criteria used for conditions addressed by the documents

(c) Design assumptions and construction requirements including specified properties of existing and remedial materials used for the project and the strength requirements at stated ages or stages of the construction

(d) Details, locations and notes indicating the size, configuration, reinforcement, anchors, repair materials, preparation requirements, and other pertinent information to implement the repairs, strengthening, or rehabilitation of the structure

(e) Magnitude and location of prestressing forces

(f) Anchor details for prestressing reinforcement

(g) Development length of reinforcement and length of lap splices

(h) Type and location of mechanical or welded splices of reinforcement

(i) Shoring or bracing criteria necessary before, during, and at completion of the assessment, repair, or rehabilitation projects

(j) Quality assurance program including specific inspections and testing requirements

1.6.2 Calculations pertinent to design shall be filed with the construction documents if required by the jurisdictional authority. Scale-model testing and analysis shall be permitted to supplement calculations.

1.6.2C *Analyses and designs should include calculations, evaluation and design assumptions. If computer-based analyses and designs, such as finite element methods are used, they should include input, and computer-generated output.*

1.6.3 The licensed design professional shall provide the owner with copies of the basis of design report, assessment reports, project documents, field reports, and other project documents produced by the licensed design professional in addition to documenting the location of the completed repairs to the extent of the licensed design professional's contractual obligations.

1.6.3C *Documentation of the project and repairs that have been carried out, including structural observations, inspection reports by others, test results, and recommendations on inspection and maintenance to be undertaken during the remaining design service life of the repaired part of the concrete structure, should be provided to the owner. The extent and type of quality assurance records should include those required in the construction documents. It is good practice for the owner to keep documentation of repairs, inspections, testing, monitoring, and investigations for future reference.*

1.7—Preliminary assessment

1.7.1 Preliminary assessment of an existing structure shall include investigation and review of the structure, plans, construction data, reports, local jurisdictional codes, and other available documents of the existing structure. Existing in-place conditions shall be visually or otherwise investigated to verify existing geometry and structural conditions.

1.7.1C *The goal of the preliminary assessment is to examine available information about the structure within the work area, and to make an initial determination of its adequacy to withstand in-place environmental conditions and design loads. The results of the preliminary assessment should be used to make decisions regarding the current in-place condition, need for additional information, work items necessary as part of the assessment, possible rehabilitation design and construction work to consider, and if there is a need for temporary shoring for safety of the existing structure. The preliminary assessment results should be updated as additional data regarding the examined structure become available.*

The licensed design professional may determine that 4.6 or A.6 applies in a preliminary assessment based on engineering judgment and without analysis if all of the following are confirmed:

(a) Historical performance of the structure and visual observation of the structural condition of members and systems indicate acceptable behavior precluding assessment by 4.3 or A.3

(b) Review of plans and observation of current structural conditions indicate damage or deterioration of the structure below the level requiring assessment by 4.4 and 4.5 or A.4 and A.5

(c) Modifications for additions, alterations, and changes in occupancy are not planned.

Repairs are permitted that address durability and serviceability of 4.6 or A.6 without analyzing members and systems and checking the demand-capacity ratio limits of 4.3 through 4.5 or A.3 *through A.5 if the structure is determined to be structurally acceptable. Structural performance should be considered acceptable if past and present performance has been satisfactory and observations do not indicate structural distress beyond levels expected.*

The extent of damage or deterioration should be limited and the licensed design professional should not have a concern about the capacity of the structure if repairs are completed using the provisions of 4.6 with verifying the demand to capacity limits of 4.4 and 4.5 or A.4 and A.5.

1.7.2 The preliminary assessment shall determine if visibly unsafe structural conditions are present, and shall report these conditions in accordance with 1.5.2 and 1.5.3.

1.7.2C *Unsafe structural conditions may require the owner to install shoring, limit access, or take other measures to mitigate these conditions.*

1.7.3 For the purpose of performing a preliminary assessment, it is permitted to use the criteria of the original or current building code or assessment criteria of Chapter 4 or Appendix A.

1.7.3C *The assumed preliminary assessment criteria should be substantiated or modified in accordance with the assessment details of Chapter 6.*

1.7.4 The in-place strength of the existing structure shall be determined considering in-place geometric dimensions and material properties including effects of material deterioration and other deficiencies. If material properties are not immediately available, a preliminary assessment shall be completed using material properties as described in Chapter 6.

1.7.4C *When required as a part of the preliminary assessment, strength calculations should be based on in-place conditions and should include an assessment of the loss of strength due to deterioration mechanisms. Guidelines for assessing in-place conditions include ACI 201.2R, ACI 214.4R, ACI 228.1R, ACI 228.2R, ACI 364.1R, ACI 437.1R, FEMA P-58, FEMA P-154, FEMA 306, FEMA 307, ASCE/SEI 11, ASCE/SEI 41, ATC-20, ATC-45, and ATC-78 as well as The*

Concrete Society Technical Report 68 (2008). When material test results are initially unavailable, historical properties based on typical values used at the time of construction can be used in preliminary evaluation. If available, material properties from construction documents can also be used in a preliminary evaluation.

The assessment of existing structures should initially focus on critical gravity-load-resisting members such as columns, walls, and members that are expected to have limited ductility, followed by an assessment of the lateral-load-resisting system.

Assessing fire damage and other deterioration mechanisms that result in a change in material properties (such as compressive strength or modulus of elasticity) should include an evaluation of the effect of the damage on the material properties and the impact of the damage on the performance of the existing structure. Examples of deterioration mechanisms that result in possible changes in material properties include corrosion of steel reinforcement, thermal damage, concrete reactions such as alkali-aggregate, and freezing and thawing.

Deficiencies to be documented include cracking, spalls, member deflection, cross-section dimensions different than specified on the original construction drawings, and construction tolerances exceeding those permitted under the original building code.

1.7.5 A structural assessment in accordance with Chapter 6 shall be performed when a member or structure exhibits damage, displacement, deterioration, structural deficiencies, or behavior is observed during the preliminary assessment that are unexpected or inconsistent with available design and construction documents or code requirements for existing structures in effect at the time of construction.

***1.7.5C** The preliminary assessment is generally the first portion of the work necessary to determine the rehabilitation category. Based upon preliminary assessment results, a structural* *assessment may be required to determine the extent of damage or if unsafe structural conditions are present. However, in some cases the licensed design professional may deem that a structural assessment is not required based on judgement in accordance with 1.7.1 and 1.7.1C.*

CHAPTER 2—NOTATION AND DEFINITIONS

This chapter defines notation and terminology used in this code.

c = depth of neutral axis, in.

D = dead load acting on the structure

d_t = distance from extreme compression fiber to centroid of extreme tension reinforcement, in.

$\overline{f}_c$ = average core strength modified to account for the diameter and moisture condition of the core, psi

f_c' = specified concrete compressive strength, psi

f_{ceq} = equivalent specified concrete strength used for evaluation, psi

f_y = specified yield strength of steel reinforcement, psi

$\overline{f}_y$ = average yield strength value for steel reinforcement, psi

f_{yeq} = equivalent yield strength of steel reinforcement used for evaluation, psi

k_c = coefficient of variation modification factor for concrete testing sample sizes

k_s = coefficient of variation modification factor for steel testing sample sizes

L = live load acting on the structure

l_t = span of member under load test and taken as the smaller of: (a) distance between centers of supports; and (b) clear distance between supports plus thickness h of member; for a cantilever, it shall be taken as twice the distance from face of support to cantilever end, in.

n = number of sample tests

R_a = service load capacity of structural member, system, or connection including effects of damage, deterioration of concrete and reinforcement, and faulty construction determined using allowable stresses according to the original building code.

R_n = nominal capacity of structural member, system, or connection excluding the effects of damage, deterioration of concrete and reinforcement, and faulty construction

R_{cn} = current in-place nominal capacity of structural member, system, or connection including the effects of damage, deterioration of concrete and reinforcement, and faulty construction

R_{ex} = nominal resistance of the structure during an extraordinary (that is, low-probability) event computed using the probable material properties

S = snow load acting on the structure

T_g = glass transition temperature, °F

U = demand using nominal loads and factored load combinations for strength design provisions (LRFD)

U_c = demand using nominal loads of the current building code and factored load combinations of ASCE/SEI 7 for strength design provisions (LRFD)

U_o = demand using nominal loads and factored load combinations of the original building code for strength design provisions (LRFD)

U_o^* = demand using nominal loads of the original building code and factored load combinations of ASCE/SEI 7 for strength design provisions (LRFD)

U_s = demand using service loads of the original building code and load combinations of the original building code

V = coefficient of variation (a dimensionless quantity equal to the sample standard deviation divided by the mean) determined from testing of concrete or steel samples from structures

v_u = resultant interface stress demand from the transfer of tension and shear

v_{ni} = nominal interface shear stress capacity

ε_t = net tensile strain in the extreme tension reinforcement at nominal strength

ε_y = yield strain of steel reinforcement

ϕ = strength reduction factor

ϕ_{ex} = strength reduction factor used to check strength of the structure without external reinforcement after an extraordinary event

ϕ_o = strength reduction factor from the original building code used in the design of an existing structure

2.2—Definitions

ACI provides a comprehensive list of definitions through an online resource, "ACI Concrete Terminology." Definitions provided here complement that resource.

2.2C Additional repair-related definitions are provided by "ICRI Concrete Repair Terminology,".

Assessment—refer to structural assessment

assessment criteria—codes, standards, loads, demands, capacities, strength reduction factors, materials, material properties, connections, details, and protections used in the evaluation

bond—(1) adhesion of applied materials to reinforcement or other surfaces against which they are placed, including friction due to shrinkage and longitudinal shear in the concrete and repair materials engaged by the bar deformations; (2) adhesion or cohesion between layers of a repair area or between a repair material and a substrate produced by adhesive or cohesive properties of the repair material or other supplemental materials throughout the service life of the repair.

bond-critical application—strengthening or repair system that relies on load transfer from the substrate to the system material achieved through shear and tension transfer at the interface, where bond rather than mechanical attachment is used as the primary load transfer mechanism.

capacity—the strength, stiffness, ductility, energy dissipation and durability, of a material, member or system as determined by analysis or testing.

Commentary: *This definition has been expanded from ACI Concrete Terminology for this code.*

compatible—the ability of two or more materials to be placed in contact or in sufficiently close proximity to interact with no significant detrimental results.

connector steel—steel elements, such as reinforcing bars, shapes, or plates, embedded in concrete or connected to embedded elements to transfer load, restrain movement, or provide stability.

contact-critical application—strengthening or repair system that relies on load transfer from the substrate to the system material achieved through bearing perpendicular to the interface.

Commentary: An example of a contact critical application is the addition of a confinement jacket around a column.

construction documents—written and graphic documents and specifications prepared or assembled that describe the location, design, materials, and physical characteristics of the elements of a project necessary for obtaining a building permit and for construction of the project.

damage—changes in the capacity of an existing structure resulting from events, such as loads and displacements.

Commentary: Deterioration of existing concrete from aging and faulty construction should not be considered as damage.

dangerous—any concrete building, structure, or portion thereof that meets any of the conditions described below shall be deemed dangerous:

1. The building or structure has collapsed, has partially collapsed, has moved off its foundation, or lacks the necessary support of the ground.

2. There exists a significant risk of collapse, detachment or dislodgement of any portion, member, appurtenance, or ornamentation of the concrete building or structure under nominal loads.

3. Unsafe structural condition has been determined in the building or structure.

Commentary: This definition has been modified from the IEBC for existing concrete. Potentially dangerous conditions of an existing concrete member or system include the following: unsafe structural conditions, instability, falling hazards, or noncompliance with fire resistance ratings.

demand—the force, deformation, energy input, and chemical or physical attack imposed on a material, member, or system which is to be resisted.

design basis code—legally adopted code requirements under which the assessments, repairs, and rehabilitations are designed and constructed.

design-basis criteria—codes, standards, loads, displacement limits, material properties, connections, details, and protections used in the design of mandated or voluntary work.

design service life (of a building, component, or material)—the period of time after installation or repair during which the performance satisfies the specified requirements if routinely maintained but without being subjected to an overload or extreme event.

durability—ability of a material or structure to resist weathering action, chemical attack, abrasion, and other conditions of service and maintain serviceability over a specified time or service life.

effective area of concrete—cross-sectional area of a concrete member that resists axial, shear, or flexural stresses.

effective area of reinforcement—cross-sectional area of reinforcement that resists axial, shear, or flexural stresses.

equivalent cover—a system to supplement insufficient concrete cover to improve durability or fire protection to that equivalent to the minimum cover specified in the design basis code.

evaluation—refer to structural evaluation

existing structure—structure for which a legal certificate of occupancy has been issued. For structures that are not covered by a certificate of occupancy, existing structures are those that are complete and permitted for use or otherwise legally defined as an existing structure or building.

factored load—product of the nominal load and load factor.

faulty construction—deficient construction resulting from errors or omissions in design or improper construction causing displacement of supporting portions of the structure or resulting in deficient materials, geometry, size or location of concrete members, reinforcement or connections.

in-place condition—current condition of an existing structure, system, member, connection including component sizes and geometry, material properties, faulty construction, deterioration, and damage from an event.

interface reinforcement—existing or supplemental reinforcement that is properly anchored on both sides of an interface; post-installed reinforcement such as adhesive anchors or mechanical anchors, or other mechanical connections providing a method of force transfer across an interface.

interface shear stress—shear stress resulting from transfer of forces at bonded interfaces between repair material and existing substrate used to achieve composite behavior.

jurisdictional authority—person or entity that has legal control over the applicable building code and permitting procedures for a structure.

Commentary: An example of a jurisdictional authority is the local building official.

licensed design professional—(1) an engineer or architect who is licensed to practice structural design as defined by the statutory requirements of the professional licensing laws of a state or jurisdiction; (2) the engineer or architect, licensed as described, who is responsible for the structural design of a particular project (also historically engineer of record).

Commentary: This definition is adopted from ACI Concrete Terminology.

nominal load—magnitude of load specified by the design-basis code before application of any factor.

nonstructural concrete—any element made of plain or reinforced concrete that is not required to transfer gravity load, lateral load, or both, along a load path of a structural system to the ground.

owner—corporation, association, partnership, individual, or public body or authority with whom the contractor enters into an agreement and for whom the work is provided. The owner is the party in legal possession of the structure.

rehabilitation—repairing or modifying an existing structure to a desired useful condition.

Commentary: this definition is adapted from ACI Concrete Terminology – "the process of repairing or modifying a structure to a desired useful condition." The definition is specific for concrete rehabilitation and is inclusive of the IEBC definition – "Any work, as described by the categories of work defined herein, undertaken in an existing building." Herein, concrete rehabilitations include: repair to restore original capacity; strengthening to increase the capacity to the current building code requirements; seismic retrofits per ASCE/SEI 41; and modifications addressing additions, alterations, and change of occupancy.

repair—the reconstruction or renewal of concrete parts of an existing structure for the purpose of its maintenance or to correct deterioration, damage, or faulty construction of members or systems of a structure.

Commentary: The definition of repair from ACI Concrete Terminology is "to replace or correct deteriorated, damaged, or faulty materials, components, or elements of a structure." The definition of repair from IEBC is "The reconstruction or renewal of any part of any part of an existing building for the purpose of its maintenance or to correct damage." The definition herein is adapted from the IEBC and is specific for repair of materials, components, or elements of existing concrete structures where structural repair or durability is addressed. Faulty materials, components, or elements of a structure are interpreted to be faulty construction resulting from errors or omissions in design or construction.

repair reinforcement—reinforcement used to provide additional strength, ductility, confinement, or any combination of the three, to the repaired member.

repair, structural—restoring a damaged or deteriorated structure or increasing the capacity of a structure.

Commentary: This definition is adapted from ACI Concrete Terminology – "increasing the load-carrying capacity of a structural component beyond its current capacity or restoring a damaged structural component to its original design capacity." Herein, the definition addresses increasing the capacity to include enhancements such as ductility of existing concrete members. Repairs to nonstructural members, whose failure would cause or result in unsafe structural conditions are considered structural repairs.

repair system—the combination of existing and new components, which may include existing reinforcement, repair materials, supplementary reinforcement and supplemental structural members

retrofit—modification of an existing member, system, or structure to increase its strength, ductility, or both as a means of improving the seismic performance of the structure.

Commentary: Typically used to refer to seismic modifications to increase resistance in an existing structure per ASCE/SEI 41. The definition is adapted from ASCE/SEI 41 – "Improving the seismic performance of structural or nonstructural components of a building."

serviceability—structural performance under service loads.

shoring—props or posts of timber, steel, or other material in compression used for the temporary support of excavations, formwork, or unsafe structures; the process of erecting shores.

specialty engineer—a licensed design professional retained by a contractor to design a delegated portion of the project.

Commentary: The term "specialty engineer" is used in Chapter 9. In this code, the specialty engineer will typically be a licensed design professional that is retained by the contractor to design specific types of components such as precast or shoring members.

stability, global—stability of the overall existing structure with respect to vertical support, uplift, overturning, sway instability, or sliding failure.

stability, local—the stability of an individual member or part of an individual member.

strengthening—process of increasing the load-resistance capacity of an existing structure or a portion thereof.

structural analysis—process of using engineering mechanics to determine internal demands on, and capacities of a structure, member, or system.

structural assessment—the process of investigating by systematically collecting information that affects the performance of an existing structure; evaluating the collected information to make informed decisions regarding the need for repair or rehabilitation; detailing of findings as conclusions and reporting recommendations for the examined structural concrete work area (member, system, or structure).

Commentary: This definition with specific details for existing concrete is adapted from ASCE/SEI 11 – "Systematic collection and analysis of data, evaluation, and recommendations regarding the portions of an existing structure which would be affected by its proposed use."

A structural assessment is the processes of acquiring knowledge of the existing structure used for the purpose of judging the future performance. The results of the investigation and evaluation are used to make decisions on the appropriate course of action regarding the future use of the structure and the suitability of the structure to continue in service.

Herein, assessments should be limited to the work area and may include:

(a) Investigation of the in-place condition of the existing structure by:

i. Collection and review of field data for the structure, such as geometry, material strengths, conditions, symptoms of distress, extent of damage, measurement of displacements, environmental factors and reinforcement sizes, and placement

ii. Collection of background data, such as plans, construction records, original, current, and code governing existing buildings, and historical events

(b) Evaluation of an existing structure, member or system of the work area (refer to commentary for structural evaluation)

(c) Detail findings and conclusions of the investigation and evaluation include:

i. Define the existing structure, member, or system rehabilitation category using the assessment criteria of this code

ii. Identify the work area, scope of work and likely cause or mechanism of damage, distress and deterioration

iii. Identify faulty construction limitations

iv. Appraise test results to determine cause of failure and predict future performance.

(d) Determine repair and rehabilitation concepts, strategies, alternates and recommendations

i. Develop cost-impact or economic study as necessary to appraise remedial work and maintenance

ii. Describe repair and rehabilitation work recommendations

(e) Report conclusions and recommendations include:

i. Work area limits and limitations of information collected and evaluated

ii. Assessment criteria and work of the evaluation such as calculations, tests and analyses

iii. Details of findings (conclusions) and recommendations *iv. Safety issue requirements (for example, recommendation for any temporary shoring)*

structural concrete—plain or reinforced concrete in a member that is part of a structural system required to transfer gravity loads, lateral loads, or both, along a load path to the ground.

structural evaluation—the process of determining, and judging the structural adequacy of a structure, member, or system for its current intended use or performance objective.

Commentary: This definition is adapted from ASCE/SEI 11 – "The process of determining the structural adequacy of the structure or component for its intended use, performance, or both. Evaluation by its nature implies the use of personal and subjective judgment by those functioning in the capacity of experts." An evaluation should determine, to the best of the license design professional's knowledge, the level of quality (structural adequacy, serviceability, or durability) of an existing structure based upon a measured criteria and the judgment of the licensed design professional. An evaluation may require professional judgment to gage structural adequacy. Structural analyses may be required to determine possible ranges of existing structure capacities and variations in demands. The goal of the evaluation process is to appraise the in-place condition to determine adequacy for current or proposed future use. Structural appraisal requires determining capacity and demand, which may vary widely depending on the acquired information, tests, models, and analyses; determining the demand-capacity ratios; and judging structural reliability limits, which may be open to interpretation based on project requirements, structural experience, knowledge, and past performance.

Evaluation activities may include:

(a) Tests to confirm reinforcement location, strength of material properties or structural capacity of existing members or systems or for presence of contaminants.

(b) Analysis of test results to establish reinforcement, statistical equivalent material properties, limits of faulty construction, and structural capacity

(c) Screening of observations and tests for mechanisms and causes of damage, distress, and deterioration

(d) Establishing the assessment criteria

(e) Calculating demand loadings, serviceability limits, lateral displacements, and durability requirements

(f) Analysis of the structure to determine the capacity of the structure to withstand current or future load demands and comply with serviceability limits

i. Determination of demand-capacity ratios to appraise structural adequacy, ascertain classifications, and judge the need for repair and rehabilitation

ii. determination of maintenance requirements necessary for the service life of the structure

substantial structural damage—Except when using Appendix A, substantial structural damage shall be as defined in the IEBC.

When using this code as a stand-alone code, substantial structural damage shall be as defined in A.4.

Commentary: The definition of substantial structural damage is from the IEBC. The definition has been modified, as noted in A.4, when using this code as a stand-alone code.

temporary bracing—temporary supplemental members added to an existing structure to prevent local or global instability during assessment and repair construction.

undercutting—concrete removal above or below reinforcement to allow for existing reinforcement to be encapsulated in repair material.

unsafe structural condition—structural state of existing concrete for an individual structural member, structural system, or structure with instability, potential collapse of overhead components or pieces (falling hazards), noncompliance with fire resistance ratings or demand to capacity ratio limits above acceptable limits defined in this code.

Commentary: This definition is adapted from the IEBC and modified for strength design to be consistent with structural concrete requirements.

CHAPTER 3—REFERENCED STANDARDS

C3 Both current and withdrawn standards are referenced. Standards that are referenced in the design basis code are applicable for the assessment of existing structures. These standards may have been withdrawn by the developing organization; however, they provide information on the materials used at the time of original construction. Refer to 4.3.3 and Chapter 6.

American Concrete Institute

ACI 216.1-14—Code Requirements for Determining Fire Resistance of Concrete and Masonry Construction Assemblies

ACI 318-19—Building Code Requirements for Structural Concrete and Commentary

ACI 369.1-17—Standard Requirements for Seismic Evaluation and Retrofit of Existing Concrete Buildings

ACI 437.2-13—Code Requirements for Load Testing of Existing Concrete Structures and Commentary

ACI 440.6-08—Specification for Carbon and Glass Fiber-Reinforced Polymer Bar Materials for Concrete Reinforcement

ACI 440.8-13—Specification for Carbon and Glass Fiber-Reinforced Polymer (FRP) Materials Made by Wet Layup for External Strengthening of Concrete and Masonry Structures

American Institute of Steel Construction

ANSI/AISC 360-16—Specification for Structural Steel Buildings

American Welding Society

D1.4/D1.4M:2011—Structural Welding Code—Reinforcing Steel

ASTM International

ASTM A15—Specification for Billet-Steel Bars for Concrete Reinforcement (withdrawn 1969)

ASTM A16—Specification for Rail-Steel Bars of Concrete Reinforcement (withdrawn 1969)

ASTM A61—Specification for Deformed Rail Steel Bars for Concrete Reinforcement with 60,000 psi Minimum Yield Strength (withdrawn 1969)

ASTM A160—Specification for Axle-Steel Bars for Concrete Reinforcement (withdrawn 1969)

ASTM A185/A185M-18—Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete (withdrawn 2013)

ASTM A370-14—Standard Test Methods and Definitions for Mechanical Testing of Steel Products

ASTM A408—Specification for Special Large Size Deformed Billet-Steel Bars for Concrete Reinforcement (withdrawn 1968)

ASTM A431—Specification for High-Strength Deformed Billet-Steel Bars for Concrete Reinforcement with 75,000 psi Minimum Yield Strength (withdrawn 1968)

ASTM A432—Specification for Deformed Billet Steel Bars for Concrete Reinforcement with 60,000 psi Minimum Yield Point (withdrawn 1968)

ASTM A497/A497M—Standard Specification for Steel Welded Wire Reinforcement, Deforme4d, for Concrete (withdrawn 2013)

ASTM A615/A615M-14—Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

ASTM A616/A616M-96a—Standard Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement (withdrawn 1999)

ASTM A617/A617M-96a—Standard Specification for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement (withdrawn 1999)

ASTM A706/A706M-14—Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement

ASTM A955/A955M-15—Standard Specification for Deformed and Plain Stainless Steel Bars for Concrete Reinforcement

ASTM A1061/A1061M-09—Standard Test Methods for Testing Multi-Wire Steel Strand

ASTM C42/C42M-13—Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

ASTM C823/C823M-12—Standard Practice for Examination and Sampling of Hardened Concrete in Constructions

ASTM C1580-15—Standard Test Method for Water-Soluble Sulfate in Soil

ASTM C1583/C1583M-13—Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)

ASTM D516-16—Standard Test Method for Sulfate Ion in Water

ASTM D4130-15—Standard Test Method for Sulfate Ion in Brackish Water, Seawater, and Brines

ASTM D4065-12—Standard Practice for Plastics: Dynamic Mechanical Properties: Determination and Report of Procedures

ASTM E329-14a—Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

American Society of Civil Engineers

ASCE/SEI 7—Minimum Design Loads for Buildings and Other Structures

ASCE/SEI 37—Design Loads on Structures during Construction

ASCE/SEI 41—Seismic Evaluation and Retrofit of Existing Buildings

British Standards Institution

BS EN 1504-10:2017—Products and systems for the protection and repair of concrete structures. Definition, requirements, quality control and evaluation of conformity. Site application of products and systems and quality control of the works

International Code Council

IBC—International Building Code

IEBC—International Existing Building Code

CHAPTER 4—CRITERIA WHEN USING THIS CODE WITH THE INTERNATIONAL EXISTING BUILDING CODE (IEBC)

4.1—General

4.1.1 This chapter applies if a jurisdiction has adopted the International Existing Building Code (IEBC) as the existing building code. When this chapter is used, Appendix A does not apply.

4.1.1C *Appendix A is used when this code is used for existing concrete structures as a stand-alone code without the IEBC and may be used to supplement provisions of Chapter 34 in 2012 and previous versions of the IBC.*

4.1.2 The design basis code criteria of the project shall be determined based upon the results of the preliminary assessment (1.7) and the detailed assessment (Chapter 6), if performed, using the requirements set forth in this chapter.

4.1.2C *Structures constructed under previously adopted codes or before the adoption of a building code may not satisfy all current building code requirements. This code and the IEBC contain specific requirements that determine if existing structures should be rehabilitated or retrofitted to satisfy the requirements of the current building code. Local ordinances may also require that a structure be rehabilitated to satisfy the current codes. These requirements should be reviewed at the start of a project.*

An evaluation and remediation of unsafe seismic resistance is excluded from IEBC. The licensed design professional should determine if seismic evaluation and retrofits are necessary using ASCE/SEI 41. Provisions of ASCE/SEI 41 may or may not be applicable to nonbuilding structures. Section 4.3.2 provides minimum assessment criteria for seismic safety provisions.

4.1.3 It shall be permitted to use the current building code as the design basis criteria for all damage states, deterioration, faulty design, or faulty construction.

4.1.4 It shall be permitted to use this code in conjunction with the IEBC to determine the rehabilitation category of work as shown in Table 4.1.4.

***4.1.4C** Unless the local jurisdiction provides more restrictive requirements, this chapter with the IEBC should be used to determine the assessment and design basis criteria based on the rehabilitation category of Table 4.1.4.*

1 **Table 4.1.4—Design basis code criteria references for rehabilitation categories**

Rehabilitation category	Design basis code criteria reference
Unsafe structural conditions for gravity and wind loads	4.3.2
Unsafe structural conditions for seismic forces in regions of high seismicity	4.3.3
Substantial structural damage, definition	IEBC
Substantial structural damage to vertical elements of the lateral-force-resisting system	IEBC
Substantial structural damage to vertical elements of the gravity-load-resisting system	IEBC
Damage less than substantial structural damage with strengthening	4.5
Damage less than substantial structural damage without strengthening	4.6
Deterioration and faulty construction with strengthening	4.5
Deterioration and faulty construction without strengthening	4.6
Additions	IEBC
Alterations	IEBC
Changes in Occupancy	IEBC

2

4.1.5 This code shall be used to design repairs of existing structures. The current building code shall be used to design new concrete members and connections between new concrete members and existing construction.

4.1.6 In design of repair to existing structures using the original building code, detailing of the existing reinforcement need not comply with the current building code, if both of the following conditions are satisfied:

(a) The damage or deterioration to the existing reinforcement is addressed

(b) The repaired structure has capacity equal to or greater than demand per 5.2.2 using the original building code requirements or satisfies the requirements of 4.5.3 when using allowable stress design

4.1.6C *The licensed design professional should review the development of existing reinforcing steel, when cracking damage is evident near the ends of reinforcement, to determine if the cracking is indicative of potential development failure beyond the restrictions of this section. Research has shown that development length equations from previous versions of ACI 318 may be unconservative for top cast plain reinforcing steel bars (Feldman and Cairns 2017). Significant changes have occurred in the building code requirements for development of reinforcing steel.*

When the basis of design is the current building code, the licensed design professional should consider the following:

(a) Assessing demand/capacity ratios for the existing reinforcing steel with current development length provisions

(b) Confinement details of the reinforcement when assessing earthquake resistance

The licensed design professional should determine if structural behavior indicates adequate performance. ACI 224.1R, ACI 437R, and ACI 437.1R provide guidance in judging acceptable performance.

4.2—Compliance method

4.2.1 The compliance method selected and the design basis criteria shall be used consistently for all assessment and rehabilitation design, excluding other options.

4.3—Unsafe structural conditions

4.3.1 A structural assessment shall be performed to determine if unsafe structural conditions are present, when there is a reason to question the capacity of the structure or when unsafe structural conditions are observed as a part of the preliminary assessment.

4.3.1C *Structural assessments are required when damage, deterioration, structural deficiencies or behavior are observed during the preliminary assessment that are unexpected or inconsistent with available construction documents. The structural condition assessment will be performed in accordance with 1.7 or Chapter 6, or both. Results of the assessment should be reviewed to identify the presence of unsafe conditions. Based upon the IEBC definitions of dangerous and unsafe, unsafe structural conditions include conditions where a significant risk of collapse exists under service load conditions.*

4.3.2 For gravity, fluid, soil, and wind loads, unsafe structural conditions include instability, partial collapse, potential collapse, detachment or dislodgement of components or pieces (falling hazards), structures where a significant risk of collapse exists under service load conditions, or demand/capacity ratio exceeds the limit of 4.3.2.2.

4.3.2.1 Unsafe structural conditions shall be reported in accordance with 1.5.2.

4.3.2.2 Unsafe structural conditions exist in members or structures where the demand/capacity ratio is greater than 1.5, as shown in Eq. (4.3.2.2).

$$U_c/\phi R_{cn} > 1.5 \quad (4.3.2.2)$$

In Eq. (4.3.2.2), U_c is the strength design demand determined by using the nominal loads identified in the current building code and the factored load combinations of ASCE/SEI 7, excluding seismic forces; and ϕR_{cn} is the capacity adjusted by the strength reduction factor ϕ in Section 5.3 or 5.4 of this code.

4.3.2.2C *Demand to capacity ratios are used to quantify the adequacy of the member or structure. The threshold demand to capacity ratios determine when different levels of intervention may be required. For each demand to capacity ratio, this code provides direction on how the demand and capacity are determined. Demands may be determined based upon loads associated with current building codes (U_c as defined above) or loads specified during the original design (U_o as defined in section 4.5.1) of the structure. The calculated capacity of the structure will vary depending upon the condition of the structure and extent of evaluation used to confirm as-built properties of the structure.*

In assessing unsafe structural conditions, the demand of Eq. (4.3.2.2) combines current building code nominal gravity loads (dead, live and snow) with lateral loads from fluid, soil and wind (excluding seismic forces), using the factored load combinations of ASCE/SEI 7. A demand to capacity ratio greater than 1.5, calculated using Eq. (4.3.2.2), represents a condition with limited to potentially no margin of safety against failure for ASCE/SEI 7 loads (Stevens and Kesner 2016).

In the assessment of unsafe structural conditions, the licensed design professional should determine if it may be appropriate to include structural redundancies, alternate load paths, primary and secondary supporting elements, redistribution of loads, collapse mechanisms, reduced live loads, measured displacements (listing, leaning and tilting), second-order effects, and other loads specific to the structure, such as drifting snow, self-straining loads, ice, and floods. References for unsafe structural conditions are Galambos et al. (1982), Ellingwood et al. (1982), and Ellingwood and Ang (1972). These references provide basic probability theory and concepts for an evaluation using the specific details of the demand as it relates to the capacity with the strength reduction factors of Section 5.3 for new concrete structures.

4.3.2.3 If the demand/capacity ratio exceeds 1.5 for structures, the design basis criteria shall be the current building code.

4.3.2.4 For structure with no unsafe conditions, Sections 4.4 through 4.9 shall be used to determine the design basis criteria.

4.3.3 Assessment criteria for unsafe structural conditions of seismic resistance is limited to structures in Seismic Design Category D, E, and F of ASCE/SEI 7 and shall be determined using ASCE/SEI 41 and this code. The design basis criteria for rehabilitation design and construction of unsafe structures shall be this code and ASCE/SEI 41.

***4.3.3C** Compliance with ASCE/SEI 41 for Structural Performance Level, Collapse Prevention using an applicable Earthquake Hazard Level should be as determined by the local jurisdictional authority for the assessment of unsafe structural conditions. Assessment of unsafe structural conditions for seismic resistance is not required for structures in regions of low or moderate seismicity. If no requirements for unsafe structural conditions are provided by the local* *jurisdictional authority, the licensed design professional should refer to ATC-78, the IEBC and ASCE/SEI 41 appendices for guidance.*

4.4—Substantial structural damage

4.4.1 Substantial structural damage shall be assessed and rehabilitated as referenced in Table 4.1.4.

4.5—Conditions of deterioration, faulty construction, or damage less than substantial structural damage

4.5.1 If a structure has damage less than substantial structural damage, deterioration, or contains faulty construction, and there is a reason to question the capacity of the structure, it shall be assessed by checking the demand/capacity ratio using the original building code demand (U_o) with nominal loads, factored load combinations, and capacities of the original building code to determine if it exceeds 1.0, as shown in Eq. (4.5.1).

$$U_o/\phi_o R_{cn} > 1.0 \quad (4.5.1)$$

In Eq. (4.5.1), U_o is the strength design demand determined by using the nominal loads and factored load combinations of the original building code, excluding seismic loads. ϕR_{cn} is the capacity adjusted by the reduction factor (ϕ_o) of the original building code.

If $U_o/\phi_o R_{cn}$ is greater than 1.0, repairs shall be permitted to restore the structure to the capacity required by the original building code.

Repair of existing concrete structures shall be permitted to be based on the material properties of the original construction. New concrete members and connections to existing construction shall comply with provisions of the current building code.

Repairs shall be permitted that restore a member or system to the capacity of the original building code based on material properties of the original construction.

4.5.1C *Most existing concrete structures with damage less than substantial structural damage, deterioration, or containing faulty construction, will provide acceptable safety if restored to the strength of the original building code.*

The demand/capacity ratio limit of 1.0 as provided in this section allows strengthening that restores the structural reliability of the existing structure to the level prior to damage and deterioration, or as intended in the original building code.

Historical performance is often an acceptable indicator of adequate safety if the structure has been subjected to known loads even if the demand in the original building code was significantly different from the current building code.

If the capacity of the structure is not in question, such as indicated by the commentary provisions of 1.7.1C, assessment checks are not required.

4.5.2 Alternative assessment criteria for deterioration, faulty construction, or damage less than substantial structural damage shall be permitted, when approved by the jurisdictional authority. The selected alternative assessment criterion shall substantiate acceptable structural safety using engineering principles for existing structures.

4.5.2C *Alternative assessment criterion may be to use the current building code and ASCE/SEI 41. The references of 4.3.2.2C should be considered in the selection of applicable assessment criteria.*

Beyond using the current building code, the assessment criteria should address if the demand or capacity of the original structure or member is significantly inconsistent with current standards resulting in unacceptable structural safety. An increase in load intensity, added loads, change in *load factors, strength reduction factors or load combinations, modification of analytical procedures, or changes in the determined capacity between the original and current building codes (such as a change from allowable stress design (ASD) to strength design) or the benefits received versus the costs incurred should lead the licensed design professional to question the applicability of using the original building code for assessment of an existing structure. Engineering principles used to determine acceptable structural safety are to use either a probabilistic evaluation of loads and capacities to show adequate structural reliability indices or an evaluation procedure using demand/capacity ratios that are derived from the basic engineering principles as presented in current standards.*

An assessment criterion for a structure that has damage less than substantial structural damage, deterioration, or faulty construction excluding seismic forces that is based on the demand/capacity ratios consistent with the IEBC is the following:

a) If the current building code demand (U_c) exceeds the original building code demand (U_o^*) increased by 5 percent ($U_c > 1.05U_o^*$), check the demand/capacity ratio using the current building code demand (U_c) to determine if it exceeds 1.1, as shown in Eq. (C4.5.2a).

$$U_c/\phi R_{cn} > 1.1 \quad (C4.5.2a)$$

If the demand/capacity ratio exceeds 1.1, then that system or member should be strengthened using the current building code demand. If the demand/capacity ratio does not exceed 1.1, then no strengthening is required.

b) If the current building code demand (U_c) does not exceed the original building code demand (U_o^*) increased by 5 percent ($U_c \leq 1.05U_o^*$), check the demand/capacity ratio using the original building code demand (U_o^*) to determine if it exceeds 1.05, as shown in Eq. (C4.5.2b).

$$U_o^*/\phi R_{cn} > 1.05 \qquad (C4.5.2b)$$

If the demand/capacity ratio exceeds 1.05, then that system or member strength should be restored using the original building code demand. If the demand/capacity ratio does not exceed 1.05, then strengthening is not required.

In this assessment criterion, the strength reduction factors (ϕ) of Section 5.3 or 5.4 shall be applied in both Eq. (C4.5.2a) and (C4.5.2b).

The current building code strength design demand (U_c) combines current building code nominal gravity loads (dead, live, and snow) with lateral loads from fluid, soil and wind (excluding seismic) using the factored load combinations of ASCE/SEI 7. The original building code strength design demand (U_o^*) combines original building code nominal gravity loads (dead, live, and snow) and lateral loads from fluid, soil and wind (excluding seismic) using the factored load combinations of ASCE/SEI 7.

It may be appropriate to consider ASCE/SEI 41 seismic provisions, redistribution of loads, reduced live loads, measured displacements (listing, leaning, and tilting), second-order effects, and other loads specific to the structure, such as drifting snow, lateral earth and fluid pressures, self-straining loads, ice, and floods.

The use of structure-specific data is acceptable, if substantiated by the licensed design professional. For these assessment criteria, the demand/capacity ratio provisions in C4.5.2a may be used in the assessment, whether the current building code demand does or does not exceed the original building code demand increased by 5 percent.

4.5.3 If the concrete design regulations of the original building code only used allowable stress design and design service loads, the demand/capacity ratio shall be based on service load demand (U_S) and resistance calculated using allowable stresses (R_a) as shown in Eq. (4.5.3).

This draft is not final and is subject to revision. This draft is for public review and comment.

$$U_s/R_a > 1.0 \qquad (4.5.3)$$

If the demand/capacity ratio exceeds 1.0, then that member or system strength shall be restored using the original building code. If the demand/capacity ratio does not exceed 1.0, then strengthening is not required. Repairs shall be permitted that restore the member or system to its predamage or predeteriorated state. Repair of existing structural concrete is permitted based on material properties of the original construction.

4.5.3C *Before the "Building Code Requirements for Reinforced Concrete (ACI 318-63)" in 1963, the design of reinforced concrete structures was based upon allowable stress or working stress design principles. Original building code demands should include nominal gravity loads (dead, live, and snow) and lateral wind forces including seismic forces using the load combinations of original building code. Displacements (listing, leaning, and tilting), second-order effects, and other loads specific to the structure, such as drifting snow, lateral earth pressures, self-straining loads, ice, and floods should be considered.*

Using allowable stress design is inconsistent with the reliability principles of current strength design provisions. To adequately address safety, consideration should be given to verification using 4.5.2 and a check of seismic resistance using ASCE/SEI 41.

4.5.4 Existing structures other than those to be strengthened per 4.3 through 4.5 shall use 4.6 through 4.9 to determine the design basis criteria.

4.6—Conditions of deterioration, faulty construction, or damage less than substantial structural damage without strengthening

4.6.1 If less-than-substantial structural damage is present, structures damaged, deteriorated, or containing faulty construction that do not require strengthening in accordance with 4.5 shall use Chapters 7 through 10 of this code as the design basis criteria.

4.6.1C *Serviceability requirements including deflection limits and crack control reinforcement in the current building code are not requirements of this code, but should be considered in the assessment and rehabilitation of existing structures.*

4.7—Additions

4.7.1 The existing structure shall be assessed and rehabilitated in accordance with structural requirements of the IEBC per Table 4.1.4 for Additions.

4.8—Alterations

4.8.1 The existing structure shall be assessed and rehabilitated in accordance with structural requirements of the IEBC per Table 4.1.4 according to Alteration level 1, 2, or 3.

4.8.1C *Alterations in this section exclude the remedial work of 4.3 through 4.6.*

4.9—Change of occupancy

4.9.1 The existing structure shall be assessed and rehabilitated in accordance with structural requirements of the IEBC per Table 4.1.4 for changes of occupancy.

CHAPTER 5—LOADS, FACTORED LOAD COMBINATIONS, AND STRENGTH REDUCTION FACTORS

5.1—General

5.1.1 If this code is part of the design basis code, the load factors, load combinations, and strength reduction factors in this chapter shall be used for the assessment of the existing structure and the design of rehabilitation using nominal loads.

5.1.1C *Load factors, load combinations, and strength reduction factors are intended to achieve consistent acceptable levels of safety among all the structural elements in a system. They are obtained through rational design code calibration procedures that consider the accuracy of the strength prediction models and on the expected loads during the design service life of the structure.*

In some instances, a building may need to be upgraded to satisfy current building code requirements in accordance with the provisions of Chapters 4 and 6 or Appendix A and Chapter 6.In this case, nominal loads should be determined in accordance with the existing-building code and standards such as ASCE/SEI 7, ASCE/SEI 37, and ASCE/SEI 41.

5.1.2 It shall not be permitted to use load factors and load combinations from the original building code with strength reduction factors from this chapter. It shall not be permitted to use load factors and load combinations from this chapter with strength reduction factors from the original building code.

5.1.2C *Mixing of load factors and load combinations from one code with strength reduction factors from a different code may result in an inconsistent level of safety. Sections 4.5.2 and A.5.2 use nominal loads from the original codes with factored load combinations and strength reduction factors from this code. The load combinations described in Section 4.5.2C were developed to* *evaluate the demand to capacity ratio of a member when the loads prescribed in the current building code have increased significantly from those used in original construction.*

5.1.3 Loads during the construction period shall be in accordance with the design basis code. If the building is unoccupied during the construction period, it shall be permitted to determine loads in accordance with ASCE/SEI 37. If portions of the building are restricted to construction-only access during the construction period, it shall be permitted to determine loads on only those portions in accordance with ASCE/SEI 37.

5.1.3C *These provisions permit the less stringent loads in ASCE/SEI 37 to be applied for the construction-access only case.*

5.1.4 When assessing an existing structure, consideration shall be given to effects caused by loads or imposed deformations that the structure is subjected to, if required by the jurisdictional authority, even if such effects may not have been specified in the original building code.

5.1.4C *Examples of such loads include vibration or impact loads. Examples of such imposed deformations include unequal settlement of supports, and listing, leaning and tilting, and those due to prestressing, shrinkage, temperature changes, creep.*

5.2—Load factors and load combinations

5.2.1 Design of rehabilitation shall account for existing loads and deformations of the structure; the effects of load redistribution due to damage, deterioration, or load removal; and the sequencing of load application, including construction and shoring loads, during the rehabilitation process.

5.2.2 Rehabilitation design shall confirm that structural members and connections have design strengths at all sections at least equal to the required strengths calculated for factored loads and forces in such combinations as stipulated in this code. Structural evaluation shall consider whether the design strengths of such members and connections at all sections are sufficient.

5.2.2C The basic requirement for strength design or assessment is expressed as:

design strength (for example, capacity) ≥ required strength (for example, demand)

$$\phi(R_n) \geq U$$

The design strength is the nominal strength multiplied by the strength reduction factor ϕ.

5.2.3 Required strength U shall equal or exceed the effects of factored load combinations as specified in the design-basis code.

5.2.3C The required strength U is expressed in terms of factored loads, which are the product of specified nominal loads multiplied by load factors.

5.2.4 Required strength U shall include internal load effects due to reactions induced by prestressing with a load factor of 1.0.

5.2.5 For post-tensioned anchorage zone design or evaluation, a load factor of 1.2 shall be applied to the maximum prestressing jacking force.

5.2.5C The load factor of 1.2 applied to the maximum tendon jacking force results in a design load that exceeds the typical prestressing yield strength. This compares well with the maximum attainable jacking force. For jacking loads less than the maximum tendon jacking force, or for jacking loads applied to nonmetallic prestressing tendons, design of the anchorage for 1.2 times the anticipated jacking force is appropriate given that the jacking load is controlled better than typical dead loads.

5.3—Strength reduction factors for rehabilitation design

5.3.1 Design strength provided by a member, its connections to other members, and its cross sections, in terms of flexure, axial load, shear, and torsion, shall be taken as the nominal strength calculated in accordance with requirements and assumptions of this code, multiplied by the strength reduction factors ϕ in 5.3.2 and 5.3.4.

5.3.2 The strength reduction factor ϕ shall be as follows:

Tension-controlled sections (steel tensile strain at failure exceeding $2.5\varepsilon_y$, where ε_y is the yield strain): 0.90

Compression-controlled sections (tensile strain at failure not exceeding ε_y)

(a) Members with spiral reinforcement: 0.75

(b) Other reinforced members: 0.65

For sections in which the net tensile strain in the extreme tension steel at nominal strength (ε_t) is between the limits for compression-controlled and tension-controlled sections, linear interpolations of ϕ shall be permitted.

Shear and torsion, and interface shear: 0.75

Bearing on concrete (except for post-tensioned anchorage zones and strut-and-tie models): 0.65

Post-tensioned anchorage zones: 0.85

Strut-and-tie models and struts, ties, nodal zones, and bearing areas in such models: 0.75

5.3.2C *For a steel yield strength of 60 ksi, the steel tensile strains corresponding to the tension- and compression-controlled limits are 0.005 and 0.002, respectively. Because the compressive strain in the concrete at nominal strength is typically assumed to be 0.003, the net tensile strain limits for compression-controlled members may also be stated in terms of the ratio* c/d_t*, where c is the depth of the neutral axis at nominal strength, and* d_t *is the distance from the extreme compression fiber to the centroid of extreme tension reinforcement. The* c/d_t *limits for tension- and compression-controlled sections are 0.375 and 0.6, respectively. The 0.6 limit for compression-controlled sections applies to sections reinforced with Grade 60 steel and to prestressed sections.*

For other grades of steel reinforcement, the term c/d_t is a function of the yield strain of the steel reinforcement (ε_y). The c/d_t ratio is calculated as, $c/d_t = 0.003/(0.003 + \varepsilon_y)$.

5.3.3 Computation of development lengths do not require a ϕ-factor.

5.3.4 For flexure, compression, shear, and bearing of structural plain concrete, ϕ shall be 0.60.

5.4—Strength reduction factors for assessment

5.4.1 If the required structural element dimensions and location of reinforcement are determined in accordance with Chapter 6, and material properties are determined in accordance with 6.4, it shall be permitted to increase ϕ from those specified in 5.3, but ϕ shall not exceed:

Tension-controlled section (steel tensile strain at failure exceeding $2.5\varepsilon_y$, where ε_y is the yield strain): 1.0

Compression-controlled sections (tensile strain at failure not exceeding ε_y):

A - Members with spiral reinforcement: 0.9

B - Other reinforced members: 0.8

Shear, torsion, or both; interface shear: 0.8

Bearing on concrete: 0.8

Strut-and-tie models and struts, ties, nodal zones, and bearing areas in such models: 0.8

5.4.1C *Strength reduction factors given in 5.4.1 are larger than those in 5.3.1. These increased values are justified by the improved reliability due to the use of accurate field-obtained material properties, actual in-place dimensions, and well-understood methods of analysis. They have been deemed appropriate for use in ACI 318and have had a lengthy history of satisfactory performance.*

5.4.2 If an evaluation of members with no observed deterioration is based on historical material properties as given in Tables 6.3.2a through 6.3.2c, the ϕ-factors not exceeding those in 5.3 shall apply.

5.4.3 For flexure, compression, shear, and bearing of structural plain concrete, ϕ shall be 0.60.

5.4.3C *The resistance factor for assessment of plain concrete is the same as that specified for design in 5.3.4. Material properties for plain concrete determined in accordance with 6.3.5 may increase its nominal resistance, but the strength reduction factor remains unchanged because plain concrete failures are usually brittle.*

5.5—Additional load combinations for structures rehabilitated with external reinforcing systems

5.5.1 For rehabilitation achieved with external reinforcing systems that are susceptible to damage by vandalism or collision, the required strength of the structure without rehabilitation shall equal or exceed the effects of the load combinations specified in 5.5.2. The performance of externally reinforced elements subjected to fire shall be evaluated using the load combinations specified in 5.5.3.

5.5.1C *The additional load combinations specified in this section are intended to ensure adequate strength should the reinforcing system be sufficiently damaged to become ineffective. External reinforcing systems should be evaluated to determine if they are susceptible to damage from accidental vehicular impact or vandalism. Alternately, the rehabilitation measures may include physical design features that protect the external reinforcing system from these types of damage. The requirements of this section are not intended for the assessment of the effect of blast loadings, blast effects or a generalized assessment of extraordinary events on structures.*

The requirements of this section are not intended for the design of structures that are exposed to elevated temperatures during routine service.

5.5.2 For external reinforcing systems susceptible to damage, the required strength of the structure without such external reinforcement shall satisfy Eq. (5.5.2a) and (5.5.2b)

$$\phi R_n \geq 1.1D + 0.5L + 0.2S \quad (5.5.2a)$$

$$\phi R_n \geq 1.1D + 0.75L \quad (5.5.2b)$$

where D, L and S are the effects due to the specified dead, live, and snow loads, respectively, calculated for the rehabilitated structure; ϕ is the strength reduction factor in 5.3 or 5.4, as applicable; and R_n is the nominal strength of the structural member computed using the material properties determined from Chapter 6, without the contribution of the external reinforcing system.

5.5.2C *These load combinations are intended to minimize the risk of failure of the strengthened structural member in the case where, during normal operating conditions, the external reinforcement is damaged. Such damage may not be detected immediately and so the structure (or structural component) may remain in service until the damage is identified. The load factors for live and snow loads in Eq. (5.5.2a) correspond to the arbitrary point-in-time loadings specified in ASCE7. Equation (5.5.2b) is compatible with ACI 440.2R.*

5.5.2.1 If the applied live load has a high likelihood of being sustained the live load factor in Eq. (5.5.2a) and (5.5.2b) shall be increased to 1.0.

5.5.2.1C *Examples include library stack areas, heavy storage areas, warehouses, and other occupancies with a live load exceeding 100 lb/ft*^{2}.

5.5.3 To account for potential performance issues during a fire event, the required strength of the structural member without external reinforcement shall satisfy Eq. (5.5.3)

$$\phi_{ex} R \geq (0.9 \text{ or } 1.2)D + 0.5L + 0.2S \quad (5.5.3)$$

where $\phi_{ex} = 1.0$, R is the nominal resistance of the structural member, computed using the probable material properties during the fire event; S is the specified snow load. The dead load factor of 0.9 shall be applied when the dead load effect mitigates the total load effect.

5.5.3C *Equation (5.5.3) is intended to ensure that the repaired element will maintain sufficient strength, accounting for its probable reduced material properties due to elevated temperatures, during a fire event. If additional fire protection is applied to the repaired element, its effect on the external reinforcement and existing elements should be considered.*

General building code requirements should be reviewed to determine the required duration and temperature profile of the fire event.

Equation (5.5.3) was developed from Eq. (2.5.1) of ASCE/SEI 7-10. When required by the jurisdictional authority or owner, Section 2.5 in ASCE/SEI 7-10 provides strength requirements for the evaluation of extraordinary events, such as blast, fire, and other extreme events on structures. The evaluation of these extraordinary events is outside of the scope of this code: Equation (5.5.3) is limited to the evaluation of fire effects on structures with external reinforcement. Guidance on computing the structural effects caused by the fire event is provided in 5.5.3.1 and 5.5.3.1C.

Strength of the affected portion of the structure during a fire event should be based on reduced steel and concrete strengths. Guidance concerning probable material properties during a fire event may be obtained from ACI 216.1.

5.5.3.1 Additional live loads incurred during a fire shall be considered, with a load factor of 1.0.

5.5.3.1C *Live loads associated with fighting the fire may include wetting of the building contents, which has been idealized as a live load of 20 lb/ft*^{2}.

5.5.3.2 Internal forces and imposed deformations due to thermal expansion during the fire event shall be considered, with a load factor of 1.0, in determining the demands on the structural system.

5.5.3.2C *Thermal expansion of a member during a fire event will generate internal thrust forces if that expansion is restrained. The generated thrust force, while potentially large, is considerably less than that computed using conventional elastic properties and thermal expansion coefficients. This thrust may increase the moment capacity and the corresponding fire endurance of the restrained member.*

Procedures for calculating thermal induced thrust forces can be found in NIST (2010) and Buchanan (2001). PCI (2010) provides methods for determining (a) the magnitude and location of the thrust generated by a given fire temperature and duration, and (b) the increase in moment capacity caused by a known thrust force.

5.5.3.3 Any contribution of external reinforcement that is not protected using a fireproofing system shall be neglected during a fire event. The contribution of any adhesively bonded external reinforcement to the strength of a member during a fire shall be ignored.

5.5.3.3C *Section 7.9 gives member strength requirements for protected and unprotected external reinforcing systems subjected to elevated temperatures during a fire event.*

5.5.3.4 When the design live load acting on the member to be strengthened has a high likelihood of being present for a sustained period of time, a live load factor of 1.0 shall be used in Eq. (5.5.3).

5.5.3.4C *Refer to 5.5.2.1C.*

CHAPTER 6—ASSESSMENT, EVALUATION, AND ANALYSIS

6.1—Structural assessment

6.1.1 A structural assessment shall be performed if required per 1.7.5 or before rehabilitation of an existing structure. The structural assessment shall comprise 1) an investigation to establish the in-place condition of the structure in the work area, including environment, geometry, material strengths, reinforcing-steel sizes and placement, and signs of distress; 2) an evaluation to define the causes of distress, goals of the rehabilitation, and criteria for selection of rehabilitation solution(s); and 3) development of appropriate rehabilitation strategies.

6.1.1C *Field investigations in support of the structural assessment may include visual observations, destructive testing, and nondestructive testing (NDT). Areas of known deterioration and distress in the structural members should be identified, inspected, and recorded as to the type, location, and degree of severity. Investigation procedures are referenced in ACI 201.1R, ACI 228.1R, ACI 228.2R, ACI 364.1R, ACI 437R, ASCE/SEI 11, ASCE/SEI 41 and FEMA P-154. The affected structural members are not only members with obvious signs of distress but also contiguous members and connections in the structural system.*

The data gathered to determine the existing capacity should include the effects of material degradation, such as loss of concrete strength from chemical attack; freezing and thawing; and loss of steel area due to corrosion or other causes, or misplaced reinforcement; and effects of damaging events, such as impact of earthquakes or fire. The effect of deterioration on the ductility of the member should be considered in the evaluation. The strength or serviceability of a member or structure may be compromised by spalling, excessive cracking, large deflections, or other forms of damage or degradation. Seismic evaluation references for undamaged buildings include FEMA

P-58, FEMA P-154 and ASCE/SEI 41 and for damaged buildings include ATC-20, FEMA 306 and FEMA 307.

6.2—Investigation and structural evaluation

6.2.1 An investigation and structural evaluation shall be performed when there is a reason to question the capacity of the structure in the work area and insufficient information is available to determine if an existing structure is capable of resisting design demands.

6.2.2 Where repairs are required to an individual member or connection in a structure, it shall be determined if similar members or connections beyond the work area also require evaluation.

6.2.2C *If there is no evidence of damage, distress or deterioration of similar members or connections elsewhere in the work area that required repair, there is no need to perform an evaluation of similar members unless unsafe conditions are present. Unsafe conditions may be a concern if there are significant variances from the original design intent such as lower-strength concrete or insufficient reinforcement. In addition, if the similar members are in an environment that could foster deterioration, then evaluation of these members may be necessary to determine if strengthening or durability enhancements may be required.*

6.2.3 An investigation shall document conditions as necessary to perform an evaluation of the structure in the work area.

6.2.3C *Conditions which may need to be documented include (a) through (g):*

(a) The physical condition of the structural members to examine the extent and location of degradation or distress

(b) The adequacy of continuous load paths through the primary and secondary structural members to provide for life safety and structural integrity

(c) As-built information required to determine appropriate strength reduction factors in accordance with Chapter 5

(d) Structural members' orientation, displacements, construction deviations, and physical dimensions

(e) Properties of materials and components from available drawings, specifications, and other documents; or by testing of existing materials

(f) Additional considerations, such as proximity to adjacent buildings, load-bearing partition walls, and other limitations for rehabilitation

(g) Information needed to assess lateral-force-resisting systems, span lengths, support conditions, building use and type, and architectural features

The construction documents may not represent as-built conditions. Therefore, the licensed design professional is encouraged to research and verify that the material properties obtained from record documents are accurate. Material testing may be required to verify these values.

6.2.4 When an analysis is required, it shall be performed in accordance with Section 6.5 and shall consider the following items.

(a) As-measured structural member dimensions

(b) The presence and effect of alterations to the structural system

(c) Loads, occupancy, or usage different from the original design

6.3—Material properties

6.3.1 Concrete compressive strength and steel reinforcement yield strength shall be determined for the structure if a structural evaluation is required. Nominal material properties shall be determined by (a), (b) or (c):

(a) Available drawings, specifications, and previous testing documentation

(b) Historical material properties in accordance with 6.3.2

(c) Physical testing in accordance with 6.4

6.3.1C *The construction documents may not represent as-built conditions. Therefore, the evaluation of material properties may require verification by material testing to confirm that the material properties obtained from record documents are representative.*

Additional factors and characteristics affecting materials that may be required to be evaluated include:

(a) Ductility based on the mechanical characteristics of the component materials.

(b) Presence of corrosion of embedded steel reinforcement, including carbonation, chloride intrusion, and corrosion-induced spalling

(c) Presence of other degradation, such as alkali-silica reaction, sulfate attack, or delayed ettringite formation

(d) Degradation due to cyclic freezing and thawing

(e) Degradation of stiffness and strength due to bar slip in cracked sections and joints damaged in seismic events

(f) Chloride penetration can cause steel reinforcement corrosion, which can lead to cracking and spalling

Other tests for material properties, including petrographic examination, are used.

The choice of tests depends on the structure, member type(s), and distress mechanism.

6.3.2 If available drawings, specifications, or other documents do not provide sufficient information to characterize the material properties, it shall be permitted to determine such properties without physical testing from the historical data provided in Tables 6.3.2a through 6.3.2c.

Table 6.3.2a—Default compressive strength of structural concrete, psi

Time frame	Footings	Beams	Slabs	Columns	Walls
1900-1919	1000	2000	1500	1500	1000
1920-1949	1500	2000	2000	2000	2000
1950-1969	2500	3000	3000	3000	2500
1970-present	3000	3000	3000	3000	3000

Note: Adopted from ASCE/SEI 41.

Table 6.3.2b—Default tensile and yield strength properties for steel reinforcing bars for various periods*

		Structural†	Intermediate†	Hard†				
	Grade	33	40	50	60	65	70	75
	Minimum yield, psi	33,000	40,000	50,000	60,000	65,000	70,000	75,000
Year	**Minimum tensile, psi**	55,000	70,000	80,000	90,000	75,000	80,000	100,000
1911-1959		X	X	X	—	X	—	—
1959-1966		X	X	X	X	X	X	X
1966-1972		—	X	X	X	X	X	—
1972-1974		—	X	X	X	X	X	—
1974-1987		—	X	X	X	X	X	—
1987-Present		—	X	X	X	X	X	—

Note: Adopted from ASCE/SEI 41.

*An entry of "X" indicates the grade was available in those years.

†The terms "structural," "intermediate," and "hard" became obsolete in 1968.

Table 6.3.2c—Default tensile and yield strength properties of steel reinforcement for various ASTM specifications and periods*

				Structural[†]	Intermediate[†]	Hard[†]				
		Grade		33	40	50	60	65	70	75
		Minimum yield, psi		33,000	40,000	50,000	60,000	65,000	70,000	75,000
ASTM Designation[‡]	**Steel type**	**Year range**	**Minimum tensile, psi**	55,000	70,000	80,000	90,000	75,000	80,000	100,000
A15	Billet	1911-1966		X	X	X	—	—		
A16	Rail[§]	1913-1966		—	—	X	—	—		
A61	Rail	1963-1966		—	—	—	X	—		
A160	Axle	1936-1964		X	X	X	—	—		
A160	Axle	1965-1966		X	X	X	X	—		
A185	WWF	1936-present		—	—	—	—	X		
A408	Billet	1957-1966		X	X	X	—	—		
A431	Billet	1959-1966		—	—	—	—	—		X

A432	Billet	1959-1966		—	—	—	X	—		—
A497	WWF	1964-present		—	—	—	—	—	X	—
A615	Billet	1968-1972		—	X	—		—	—	X
A615	Billet	1974-1986		—	X	—	X	—		—
A615	Billet	1987-present		—	X	—	X	—		X
A616-96‖	Rail	1968-present		—	—	—	X	—		—
A617	Axle	1968-present		—	X	—	—	—		—
A706#	Low-alloy	1974-present		—	—	—	X	—	X	—
A955	Stainless	1996-present		—	X	—	X	—		X

Note: Adopted from ASCE/SEI 41.

*An entry of “X” indicates the grade was available in those years.

†The terms structural, intermediate, and hard became obsolete in 1968. Hard grade does not correspond to hardness.

‡ASTM steel is marked with the letter W.

§Rail bars are marked with the letter R.

‖Bars marked with “s!” (ASTM A616-96) have supplementary requirements for bend tests.

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Letter Concept for Support Reference to the ACI Repair Code

February 15, 2019

Florida Building Commission
Florida Department of Business and Professional Development
2601 Blair Stone Road
Tallahassee, FL 32399

Subject: Proposed Modification 7840
Reference ACI 562-19

Dear Florida Building Commissioners:

DeSimone Consulting Engineers recommends the adoption by reference of ACI 562: *Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures* in the *Florida Building Code* as presented in the subject code change proposal submitted by the American Concrete Institute.

DeSimone Consulting Engineers provides structural engineering, façade consulting, and forensic engineering services for all types of buildings. The firm is organized to support clients around the country and around the globe with offices in the United States, South America, and the Middle East. To date, DeSimone has designed over 10,000 projects in 44 states and 54 countries. The Miami office has provided structural engineering services for some of the most notable projects in Florida and the Caribbean. In Miami-Dade County alone, DeSimone has designed over 68 million square feet of new building construction at a project cost of over $15 billion.

As design engineers concerned with the evaluation of existing buildings, it is critically important for us to work within a clear and robust framework of regulations and requirements for evaluation and repair of structural concrete in buildings that require alternations, additions, renovations, or changes in occupancy. The additional provisions of ACI 562 establish such a framework that can clarify the perspective of building owners and building officials and standardize and enhance the technical procedures followed by design engineers, contractors and material suppliers involved in the repair and rehabilitation of structural concrete.

The ambiguity in expectations and scopes of work can also prove very costly. The absence of a unified guideline has increased the likelihood of two opposite outcomes for repair efforts: Insufficient scope of repair and inspection results in increased repair frequency, unsafe conditions and short life cycles. Conversely, exaggerated expectations that demand a repaired structure conform to the codes of new design can result in decisions to demolish and rebuild entire structures. ACI 562 addresses both problems. It elevates the anticipated outcome of repair to ensure a lasting rehabilitation. It also utilizes the information available for an existing structure to unburden the design engineers and building officials of those provisions that are intended to tackle the unknowns of new designs. We believe this approach will tangibly improve the cost-effectiveness of restoration efforts.

Finally, adoption of ACI 562 is rendered even more pressing when considering that the corrosive and concrete-hostile environment of Florida is unmatched by that of other jurisdictions that have

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already recognized the code. To protect buildings against this environment, a stand-alone concrete repair standard is needed in Florida, perhaps more than anywhere else in the US.

DeSimone Consulting Engineers recommends that the Commission adopt the modification discussed above for the development of the 7th Edition of the Florida Building Code. Thank you in advance for your consideration of this recommendation.

Respectfully submitted.

VECTOR CORROSION SERVICES, INC.
8413 Laurel Fair Circle, Ste 200B, Tampa, FL 33610
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eMail: Info@VCServices.com

February 16, 2019

Florida Building Commission
Florida Department of Business and Professional Development
2601 Blair Stone Road
Tallahassee, FL 32399

Subject: Proposed Modification 7840
Reference ACI 562-19

Dear Florida Building Commissioners:

This letter is to recommend approval of adoption by reference of ACI 562 *Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures* in the *Florida Building Code* as presented in the subject code change proposal submitted by the American Concrete Institute.

Vector Corrosion Services Inc. performs investigations and evaluations of reinforced concrete structures. Clearer requirements for investigation are outlined in the code which will improve quality and improve the industry.

We find that it is increasingly more important to add additional minimum requirements for evaluation, repair, and rehabilitation of structural concrete in existing buildings undergoing alternations, additions, renovations, or changes in occupancy. The additional requirements provided in ACI 562 improve the clarity of expectations by owners, designers, contractors, officials, material providers, and other relevant parties regarding repairs and rehabilitation of structural concrete.

Most importantly, the use of ACI 562 provides an increased level of anticipated outcome associated with repairs and rehabilitation regarding the ability to satisfy the intent of the code and provides information that can facilitate the efforts of officials involved in the project.

Other jurisdictions have adopted ACI 562. This standard is especially important in Florida where the environmental exposure corrodes and otherwise deteriorates concrete more rapidly than in other areas of the country.

We recommend that the Commission adopt this modification for the development of the 7th Edition of the Florida Building Code. Thank you in advance for your consideration of this recommendation.

Respectfully submitted,

Matt Miltenberger
President
Vector Corrosion Services Inc.

We Save Structures™

VCSERVICES.COM

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February 16, 2019

Florida Building Commission
Florida Department of Business and Professional Development
2601 Blair Stone Road
Tallahassee, FL 32399

Subject: Proposed Modification 7840
Reference ACI 562-19

Dear Florida Building Commissioners:

This letter is to recommend approval of adoption by reference of ACI 562 *Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures* in the *Florida Building Code* as presented in the subject code change proposal submitted by the American Concrete Institute.

As a concrete repair contractor, Vector Construction Inc. recommends the adoption of the repair code to help standardize expectations and requirements for the repair of concrete structures. This will lead to better quality and longer lasting repairs and ultimately extend the life of existing buildings in Florida.

We find that it is increasingly more important to add additional minimum requirements for evaluation, repair, and rehabilitation of structural concrete in existing buildings undergoing alternations, additions, renovations, or changes in occupancy. The additional requirements provided in ACI 562 improve the clarity of expectations by owners, designers, contractors, officials, material providers, and other relevant parties regarding repairs and rehabilitation of structural concrete.

Most importantly, the use of ACI 562 provides an increased level of anticipated outcome associated with repairs and rehabilitation regarding the ability to satisfy the intent of the code and provides information that can facilitate the efforts of officials involved in the project.

Other jurisdictions have adopted ACI 562. This standard is especially important in Florida where the environmental exposure corrodes and otherwise deteriorates concrete more rapidly than in other areas of the country.

We recommend that the Commission adopt this modification for the development of the 7th Edition of the Florida Building Code. Thank you in advance for your consideration of this recommendation.

Respectfully submitted,

Garth Fallis
VP Construction Technologies
Vector Construction Inc.

We Save Structures™

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February 16, 2019

Florida Building Commission
Florida Department of Business and Professional Development
2601 Blair Stone Road
Tallahassee, FL 32399

Subject: Proposed Modification 7840
Reference ACI 562-19

Dear Florida Building Commissioners:

This letter is to recommend approval of adoption by reference of ACI 562 *Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures* in the *Florida Building Code* as presented in the subject code change proposal submitted by the American Concrete Institute.

NDT Corporation performs investigations of pos-tensioned concrete structures and recommends the adoption of the repair code to help standard expectations and requirements for the repair of concrete structures.

We find that it is increasingly more important to add additional minimum requirements for evaluation, repair, and rehabilitation of structural concrete in existing buildings undergoing alternations, additions, renovations, or changes in occupancy. The additional requirements provided in ACI 562 improve the clarity of expectations by owners, designers, contractors, officials, material providers, and other relevant parties regarding repairs and rehabilitation of structural concrete.

Most importantly, the use of ACI 562 provides an increased level of anticipated outcome associated with repairs and rehabilitation regarding the ability to satisfy the intent of the code and provides information that can facilitate the efforts of officials involved in the project.

Other jurisdictions have adopted ACI 562. This standard is especially important in Florida where the environmental exposure corrodes and otherwise deteriorates concrete more rapidly than in other areas of the country.

We recommend that the Commission adopt this modification for the development of the 7th Edition of the Florida Building Code. Thank you in advance for your consideration of this recommendation.

Respectfully submitted,

Bill Horne
President
NDT Corporation

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February 16, 2019

Florida Building Commission
Florida Department of Business and Professional Development
2601 Blair Stone Road
Tallahassee, FL 32399

Subject: Proposed Modification 7840
Reference ACI 562-19

Dear Florida Building Commissioners:

This letter is to recommend approval of adoption by reference of ACI 562 *Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures* in the *Florida Building Code* as presented in the subject code change proposal submitted by the American Concrete Institute.

Vector Corrosion Technologies Inc. is a supplier of corrosion protection products to the concrete repair industry.

We find that it is increasingly more important to add additional minimum requirements for evaluation, repair, and rehabilitation of structural concrete in existing buildings undergoing alternations, additions, renovations, or changes in occupancy. The additional requirements provided in ACI 562 improve the clarity of expectations by owners, designers, contractors, officials, material providers, and other relevant parties regarding repairs and rehabilitation of structural concrete.

Most importantly, the use of ACI 562 provides an increased level of anticipated outcome associated with repairs and rehabilitation regarding the ability to satisfy the intent of the code and provides information that can facilitate the efforts of officials involved in the project.

Other jurisdictions have adopted ACI 562. This standard is especially important in Florida where the environmental exposure corrodes and otherwise deteriorates concrete more rapidly than in other areas of the country.

We recommend that the Commission adopt this modification for the development of the 7th Edition of the Florida Building Code. Thank you in advance for your consideration of this recommendation.

Respectfully submitted,

David Whitmore
President
Vector Corrosion Technologies Inc.

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ACI 03-01-19
SEC 301 ADDS ACI 562 181209
ACI Proposed Code Change

Section 301.1.4 Add new Section and reference to Chapter 3 as follows and renumber subsequent Sections:

301.1.4 Concrete evaluation and design procedures. Evaluation and design of structural concrete in compliance with ACI 562 and this code shall be permitted.

Exception: ACI 562 shall not be used to comply with provisions of this code for seismic evaluation and design procedures.

303.1.45 Seismic evaluation and design procedures. [No change to text, renumber Section and subsections]

ACI

American Concrete Institute
38800 Country Club Drive
Farmington Hills, MI 48331

562-19: Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures
303.3

Reason:
Concept – This code change proposal adds ACI 562: *Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures*, to establish minimum requirements for the design, construction, repair, and rehabilitation of concrete structural elements in buildings for various levels of desired performance as deemed appropriate for the project. In addition to improved life safety, the requirements clearly define objectives and anticipated performance for the code official, owners, designers, contractors and installers. The proposed language is permissive, allowing other methods to be used to comply with the intent of the building code.
The Exception provides language to appropriately exclude the use of ACI 562 for seismic evaluation, repair and rehabilitation, consistent with the scope of ACI 562. The language is provided so the user does not resort to the ACI 562 simply to discover that its scope excludes seismic resistance.

Background – In 2006, the repair industry approached ACI asking for a concrete repair and rehabilitation code that would improve the overall quality of concrete repairs by establishing common requirements and establishing clear responsibilities between owners, designers, and contractors. This code would also provide building code officials with a reference by which to evaluate rehabilitated concrete structures. ACI, following its rigorous American National Standards Institute accredited standards development process assembled a code committee with balanced representation and produced the first official code in 2012. The committee members reviewed and considered numerous reports and publications related to concrete repair and rehabilitation to identify and develop requirements consistent with current industry practice. The committee has received feedback from users of the code and are now completing their third version of this code, ACI 562-19.

Scope – ACI 562 complements the Florida EBC by providing specific direction on how to design concrete repairs and how to handle the unique construction problems associated with repair. This standard helps the designer assess the existing structure in accordance with the IEBC. The standard then provides the requirements that bridge the inconsistencies and gaps in acceptable criteria that occur from the two following situations that a designer must solve: one, repairing a structure according to the original building code used at the time it was built using today's construction methods and materials; or, repairing a structure built according to an older building code but repaired according to the latest building code. Note that ACI 562 does not address the evaluation of lateral-force resisting systems in high seismic areas. ASCE 41 is the appropriate standard for this situation as stated in the FL EBC and ACI 562.

Benefits – There are many benefits that ACI 562 provides for the designer, owner, contractor, materials providers, building code official and the public. A few of these benefits are:

- Provides a level of expectation of life safety to the public in buildings where repairs or rehabilitation is performed on concrete structural elements.
- Provides clearly defined, uniform requirements aimed at extending the service life of existing structures.
- Provides minimum requirements for efficiency, safety, and quality of concrete repair.
- Establishes clear responsibilities between owners, designers, and contractors.
- Provides building code officials with a means to evaluate rehabilitation designs.
- Provides specific repair requirements that often result in less costly repairs compared to repairs required to meet only new construction requirements.

Flexibility – ACI 562 permits flexibility in evaluation, design, construction and repair materials to provide economies while establishing expected performance for the service-life of the rehabilitation or repairs.

Resources – Also, there many resources that complement ACI 562. Among these are:

- *Concrete Repair Manual: Fourth Edition 2013*
- ACI 563-18, *Specifications for Repair of Structural Concrete in Buildings*
- MNL-3(16) *Guide to the Code for Assessment, Repair, and Rehabilitation of Existing Concrete Structures*

These resources are readily available to provide greater understanding of assessment, repair and rehabilitation of concrete structural elements. ACI MNL-3 provides case studies demonstrating the ease of use of ACI 562. Numerous technical notes, reports, guides, and specifications that provide background information and technical support are available through other organizations, such as American Society of Civil Engineers, British Research Establishment, Concrete Society, International Concrete Repair Institute, National Association of Corrosion Engineers, Post-Tensioning Institute, Society for Protective Coatings, and US Army Corps of Engineers. Many of these organizations publications related to concrete repair can be found in the Concrete Repair Manual.

Sustainability - Reference of ACI 562 in the IEBC will help improve the confidence of owners, builders, and developers regarding effective repairs, upgrades, and reuse of existing buildings in lieu of demolition and replacement. Typically, extending the life of existing buildings is substantially more sustainable than demolition and new construction. Adoption of ACI 562 by reference is needed to help facilitate efforts that conserve energy and resources while maintaining a minimum level of requirements to ensure reasonable levels of life safety, and welfare are afforded to the public.

Bibliography –

- Concrete Repair Manual - 4th Edition: 2-Volume Set, ACI and ICRI, 2013, 2093 pp.
- https://www.concrete.org/store/productdetail.aspx?ItemID=RPMN13PACK&Format=HARD_COPY
- Guide to the Code for Assessment, Repair, and Rehabilitation of Existing Concrete Buildings, ACI and ICRI, 2016, 176 pp. https://www.concrete.org/store/productdetail.aspx?ItemID=MNL316&Language=English

State and Local Adoptions – Several jurisdictions already addressed the need for these requirements. ACI 562 is already being used in several jurisdictions:

Hawaii: Hawaii was the first state to adopt ACI 562 by reference. The following provisions are included in the State Building Code Council HAWAII STATE BUILDING CODE, which became effective on January 1, 2018:

"3401.6 Alternative compliance.

1) Work performed in accordance with the International Existing Building Code shall be deemed to comply with the provisions of this chapter.

2) Work performed in accordance with the 2016 version of the American Concrete Institute Committee 562, "Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures" shall be deemed to comply with this chapter when used as a supplement to the requirements of this chapter or the International Existing Building Code. Wherever the term International Existing Building Code (IEBC) is used in ACI 562-16, it shall mean International Existing Building Code or Chapter 34 of the International Building Code."

Ohio: The Ohio Board of Building Standards Ohio adopted rule changes identified as Amendments Group 95. Included in this group is:

3401.6 Concrete evaluation and design procedures. Evaluation and design of structural concrete repairs and rehabilitation shall be in compliance with Chapter 34 and ACI 562.

ACI, a professional technical society, has developed this standard in response to industry needs and to help assure minimum levels of life safety results where repairs and rehabilitation are associated with concrete structural elements. For this reason and the other benefits identified in this reason statement, ACI recommends this code change proposal for committee approval as submitted.

New York City: The New York City Buildings Department issued *BUILDINGS BULLETIN 2015-017* in December 2017 Conditions of Acceptance for Fiber Reinforced Cementitious Matrix strengthening systems.

FRCM shall comply with the NYC Construction Codes and the following applicable provisions:
A. Design
1. FRCM system shall be designed in accordance with the ACI 549.4R-132 Guide for the Design and Construction of Externally Bonded Fabric-Reinforced Cementitious Matrix (FRCM) Systems for Repair and Strengthening Concrete and Masonry Structures with properties used for design obtained from tests performed in accordance with AC 434. Fire-resistance-rating and interior finish requirements shall be in accordance with the NYC Construction Codes, manufacturer's recommendations and the conditions of the required listing.

2. For repairs and upgrade achieved with unprotected external FRCM, the increase in flexural or shear strength provided by the external reinforcing system shall not exceed 50% of the existing structural capacity of the member prior to strengthening. This increase should be checked before applying the strength reduction factor.
3. Careful consideration should be given to determine reasonable strengthening limits. These limits are imposed to guard against collapse of the structure should bond or other failure of the FRCM system occur due to damage, vandalism, or other causes. The required strength of a structure without repair should be as specified in in accordance with ACI 562 *Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures* Section 5.5.

Recommendation – ACI, a professional technical society, has developed this ACI 562 in response to industry needs and to help assure minimum levels of life safety, health, and welfare for the public. For this reason and the other benefits identified in this reason statement, ACI recommends this code change proposal for committee approval as submitted.

Cost Impact: The use of this referenced standard should in many cases reduce the cost of repair. Too often in the process of repair, there is insufficient information to determine acceptance criteria that is amicable to both the owner and the building code official. The result is the determination that the repair must meet the latest building code requirements for new construction. This standard increases the options available for repair and provides the acceptance criteria necessary to permit these options. A case study that illustrates this point: "ACI 562 has been referenced in expert reports for litigation cases, resulting in significantly reduced financial settlements. Denver-based J. R. Harris & Company recently used the code as a standard in several litigation reports assessing damages in existing concrete structures. As an approved consensus standard, according to American National Standards Institute (ANSI) procedures, ACI 562-13 has been accepted as the source standard to use for damage assessment and repair on individual projects by Greenwood Village and Pikes Peak Regional Building Departments in Colorado. Based on this acceptance, the consulting engineer was able to cite the code in their recommendation for structural remediation and determination of damages. In one case involving rehabilitation work on four buildings with faulty construction, J.R. Harris was able to reduce the repair costs from $12 million to $3 million, with a repair plan based on the lesser of the demand-capacity ratio based on either the original or current building code per ACI 562."

S8162

Date Submitted	12/14/2018	**Section**	301.1	**Proponent**	Ann Russo4
Chapter	3	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No **Alternate Language** No

Related Modifications

Summary of Modification

This modification simply provides all the relevant references to the flood provisions found in the FEBC. This is a more comprehensive approach that will better address all methods in the FEBC

Rationale

This exception refers only the work area method for alterations in flood hazard areas. The prescriptive and performance methods have provisions similar to Section 701.3, so this exception should also refer to them

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity as this is already a code requirement

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners as this is already a code requirement

Impact to industry relative to the cost of compliance with code

No impact to industry as this is already a code requirement

Impact to small business relative to the cost of compliance with code

No impact to small businesses as this is already a code requirement

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by adding missing references that are of similar methods so this exception should also refer to them

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by adding missing references that are of similar methods so this exception should also refer to them

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against material, products, methods, or systems of construction of demonstrated capabilities, this is a current code requirement that does not limit material, products, methods, or systems of construction

Does not degrade the effectiveness of the code

Improves the effectiveness of the code

Revise as follows:

301.1 General. The *repair*, *alteration*, *change of occupancy*, *addition* or relocation of all *existing buildings* shall comply with one of the methods listed in Sections 301.1.1 through 301.1.3 as selected by the applicant. Sections 301.1.1 through 301.1.3 shall not be applied in combination with each other. Where this code requires consideration of the seismic force resisting system of an *existing building* subject to *repair*, *alteration*, *change of occupancy*, *addition* or relocation of *existing buildings,* the seismic evaluation and design shall be based on Section 301.1.4 regardless of which compliance method is used.

Exception: Subject to the approval of the *code official*, *alterations* complying with the laws in existence at the time the building or the affected portion of the building was built shall be considered in compliance with the provisions of this code unless the building is undergoing more than a limited structural *alteration* as defined in Section 907.4.4. New structural members added as part of the *alteration* shall comply with the *Florida Building Code*. ~~Alteration~~ *Alterations* of *existing buildings* in *flood hazard areas* shall comply with Section 403.2, 701.3 or 1401.3.3.

S8167

Date Submitted	12/14/2018	**Section**	301.1	**Proponent**	Ann Russo4
Chapter	3	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

Summary of Modification

This proposal retains the exception that allows the code official to waive certain architectural and other requirements that the FEBC would normally trigger in alteration projects. It removes that exception, however, regarding structural provisions.

Rationale

This proposal retains the exception that allows the code official to waive certain architectural and other requirements that the FEBC would normally trigger in alteration projects. It removes that exception, however, regarding structural provisions. The current exception already does not apply to alterations in flood hazard areas (which sometimes trigger structural improvements) or to substantial structural alterations. So the proposal does not change those cases at all.

Since the existing structural provisions for alterations are already measured, already allow reduced loads and alternative criteria in many cases, and already trigger structural improvements only in rare and severe cases, the proposed change to this exception should have little impact except to affirm that structural safety is fundamental to the code's intent.

By rolling back the blanket waiver for structural safety issues, the proposal helps code officials enforce the code as intended. It prevents the FEBC's basic structural requirements from being undermined by a permit applicant's pressure to receive a discretionary waiver.

As a secondary matter, it is worth noting that the existing exception is unclear. It refers to "laws in existence at the time the building ... was built." But if the intent is to waive requirements triggered by alterations, this language ignores, or forgets, the fact that older codes for a long time had alteration provisions that triggered structural upgrade -- often with requirements more onerous than those in the current FEBC. So does a permit applicant claiming compliance with the "laws in existence" a generation ago also intend to comply with those outdated triggers? This proposal removes that potential confusion.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity as this does not change any of the code's provisions, but only changes what was a discretionary waiver.

Impact to building and property owners relative to cost of compliance with code

This should have no impact with building and property owners as this proposal will not increase the cost of construction, but it could, hypothetically, limit the cases in which the code official could effectively reduce the cost of construction by waiving structural safety requirements

Impact to industry relative to the cost of compliance with code

This should have no impact with industry as this proposal will not increase the cost of construction, but it could, hypothetically, limit the cases in which the code official could effectively reduce the cost of construction by waiving structural safety requirements

Impact to small business relative to the cost of compliance with code

This should have no impact with small business as this proposal will not increase the cost of construction, but it could, hypothetically, limit the cases in which the code official could effectively reduce the cost of construction by waiving structural safety requirements

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by retaining exception allowing the code official to waive certain architectural and other requirements that the FEBC would trigger

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by and provides equivalent or better methods of construction by retaining exception allowing the code official to waive certain architectural and other requirements that the FEBC would trigger

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against material, products, methods, or systems of construction of demonstrated capabilities, this is a current code requirement that does not limit material, products, methods, or systems of construction

Does not degrade the effectiveness of the code

Improves the effectiveness of the code by retaining exception allowing the code official to waive certain architectural and other requirements that the FEBC would trigger

Revise as follows:

301.1 General. The *repair*, *alteration*, *change of occupancy*, *addition* or relocation of all *existing buildings*shallcomplywithoneofthemethodslistedinSections301.1.1through301.1.3asselectedby the applicant. Sections 301.1.1 through 301.1.3 shall not be applied in combination with eachother. Where this code requires consideration of the seismic force resisting system of an *existing building* subject to *repair*, *alteration*, *change of occupancy*, *addition* or relocation of *existing buildings,* the seismic evaluation and design shall be based on Section 301.1.4 regardless of which compliance method is used.

~~**Exception: Subject to the approval of the *code official*, *alterations* complying with the laws in existence at the time the building or the affected portion of the building was built shall be considered in compliance with the provisions of this code unless the building is undergoing more than a limited structural *alteration* as defined in Section 907.4.4. New structural members added as part of** the *alteration* shall comply with the *Florida Building Code*. *Alteration*s of *existing buildings* in *flood hazard areas* shall comply with Section 701.3.~~

Exception: Subject to the approval of the *code official, alterations* complying with the laws in existence at the time the building or the affected portion of the building was built shall be considered in compliance with the provisions of this code. New structural members added as part of the *alteration* shall comply with the *Florida Building Code*. This exception shall not apply to alterations that constitute substantial improvement in *flood hazard areas, which* shall comply with Section 701.3. This exception shall not apply to the structural provisions of Chapter 4 or to the structural provisions of Sections 707, 807, and 907.

S8169

Date Submitted	12/14/2018	**Section**	301.1	**Proponent**	Ann Russo4
Chapter	3	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

301.1.4 301.1.4.1
Table 301.1.1.4.1
301.1.4.2
Table 301.1.1.4.2
303(New)

Summary of Modification

Moves the seismic evaluation and design procedures out of the same section and code hierarchy as the three compliance methods and places it in its own section.

Rationale

The topic is separate and distinct, this modification moves it to a separate section to ensure it is independent of the compliance method choice by the applicant and will eliminate possible confusion

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity as this is already a code requirement

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners as this modification is only to clarify the existing code requirements through a relocation (reorganization) of code sections, so there is no intended increase or decrease expected by approving this proposal.

Impact to industry relative to the cost of compliance with code

No impact to industry as this is already a code requirement this is only to clarify the existing code requirements through a relocation (reorganization) of code sections, so there is no intended increase or decrease expected by approving this proposal.

Impact to small business relative to the cost of compliance with code

No impact to small business as this is already a code requirement this is only to clarify the existing code requirements through a relocation (reorganization) of code sections, so there is no intended increase or decrease expected by approving this proposal.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Doesn't change the health, safety, and welfare of the general public as is modification to move seismic evaluation and design procedures to its on section

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code because the format of the chapter will be clearer. Section 301 is intended to describe the three compliance methods. The seismic criteria are to be applied to all three methods where referenced and needed to located in a standalaone section

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against material, products, methods, or systems of construction of demonstrated capabilities, this is a current code requirement that does not limit material, products, methods, or systems of construction

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code it makes the format of the chapter will be clearer

SECTION
301
ADMINIS
TRATION

General. The *repair*, *alteration*, *change of occupancy*, *addition* or relocation of all *existing buildings* shall comply with one of the methods listed in Sections 301.1.1 through 301.1.3 as selected by the applicant. Sections 301.1.1 through 301.1.3 shall not be applied in combination with eachother. Where this code requires consideration of the seismic force resisting system of an *existing building* subject to *repair*, *alteration*, *change of occupancy*, *addition* or relocation of *existing buildings,* the seismic evaluation and design shall be based on Section ~~301.1.4~~ 303.1 regardless of which compliance method is used.

Exception: Subject to the approval of the *code official, alterations* complying with the laws in existence at the time the building or the affected portion of the building was built shall be considered in compliance with the provisions of this code unless the building is undergoing more than a limited structural *alteration* as defined in Section 907.4.4. New structural members added as part of the *alteration* shall comply with the *Florida Building Code*. *Alterations* of *existing buildings* in *flood hazard areas* shall comply with Section 701.3.

Prescriptive compliance method. *Repairs*, *alterations*, *additions* and *changes of occupancy*complyingwithChapter4ofthiscodeinbuildingscomplyingwiththe*Florida Fire Code* shall be considered in compliance with the provisions of thiscode.

Work area compliance method. *Repairs, alterations, additions, changes in occupancy and relocatedbuildingscomplyingwiththeapplicablerequirementsofChapters5through13ofthiscode shall be considered in compliance with the provisions of thiscode.*

Performancecompliancemethod.*Repairs,alterations,additions,*changesinoccupancyand relocated buildings complying with Chapter 14 of this code shall be considered in compliance with the provisions of this code.

Add new section as follows:

SECTION 303

SEISMIC EVALUATION AND DESIGN PROCEDURES

Renumber subsequent sections:

[BS] ~~301.1.4~~303.1~~Seismic evaluation and design procedures~~General. *(No change to text)*

[BS] ~~301.1.4.1~~303.1.1 Compliance with Florida Building Code-level seismic forces. *(No change to text)*

TABLE [BS] 3~~301.1.4.1~~ 303.1.1

PERFORMANCE OBJECTIVES FOR USE IN ASCE 41 FOR COMPLIANCE WITH FLORIDA BUILDING CODE-LEVEL SEISMIC FORCES

(No change to Table)

[BS] ~~301.1.4.2~~303.1.2 Compliance with reduced Florida Building Code-level seismic forces. ***(No change to text)***

TABLE [BS] ~~301.1.4.2~~ 303.1.2

PERFORMANCE OBJECTIVES FOR USE IN ASCE 41 FOR COMPLIANCE WITH REDUCED FLORIDA BUILDING CODE-LEVEL SEISMIC FORCES

S8189

Date Submitted	12/14/2018	**Section**	301.1.4.2	**Proponent**	Ann Russo4
Chapter	3	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Updates the FEBC to be consistent with the revised performance objective definitions and terminology used in ASCE 41-17. Tier 1 and 2 procedures are revised

Rationale

This proposal adds structural performance level requirements to the FEBC that are in line with the atest edition of ASCE 41. The modification uses clearer language in the new table notes

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity as this is updates the FEBC to be consistent with the revised performance objective definitions and terminology used in ASCE 41-17.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners as this is will not increase the cost of construction.

Impact to industry relative to the cost of compliance with code

No impact to industry as this is will not increase the cost of construction

Impact to small business relative to the cost of compliance with code

No impact to small business as this is will not increase the cost of construction

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by adding structural performance level requirements to the FEBC that are in line with the atest edition of ASCE 41. The modification uses clearer language in the new table notes.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by adding structural performance level requirements to the FEBC that are in line with the atest edition of ASCE 41. The modification uses clearer language in the new table notes.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against material, products, methods, or systems of construction of demonstrated capabilities, this is a current code requirement that does not limit material, products, methods, or systems of construction

Does not degrade the effectiveness of the code

Increase the effectiveness of the code

[BS] 301.1.4.2 Compliance with reduced Florida Building Code, Building-level seismic forces.

Where seismic evaluation and design is permitted to meet reduced *Florida Building Code, Building* seismic force

levels, the criteria used shall be in accordance with one of the following:

1. The *Florida Building Code, Building* using 75 percent of the prescribed forces. Values of *R*, Ω_0 and C_d used for analysis shall be as specified in Section 301.1.4.1 of this code.

2. Structures or portions of structures that comply with the requirements of the applicable chapter in Appendix A as specified in Items 2.1 through 2.5 and subject to the limitations of the respective Appendix A chapters shall be deemed to comply with this section.

2.1. The seismic evaluation and design of unreinforced masonry bearing wall buildings in Risk Category I or II are permitted to be based on the procedures specified in Appendix Chapter A1.

2.2. Seismic evaluation and design of the wall anchorage system in reinforced concrete and reinforced masonry wall buildings with flexible diaphragms in Risk Category I or II are permitted to be based on the procedures specified in Chapter A2.

2.3. Seismic evaluation and design of cripple walls and sill plate anchorage in residential

buildings of light-frame wood construction in Risk Category I or II are permitted to be based on the procedures

specified in Chapter A3.

2.4. Seismic evaluation and design of soft, weak, or open-front wall conditions in multiunit residential buildings of wood construction in Risk Category I or II are permitted to be based on the procedures

specified in Chapter A4.

2.5. Seismic evaluation and design of concrete buildings assigned to Risk Category I, II, or III are permitted to be based on the procedures specified in Chapter A5.

3. ASCE 41, using the performance objective in Table 301.1.4.2 for the applicable risk category.

[BS] TABLE 301.1.4.2

PERFORMANCE OBJECTIVES FOR USE IN ASCE 41 FOR COMPLIANCE WITH

REDUCED FLORIDA BUILDING CODE, BUILDING-LEVEL SEISMIC FORCES

RISK CATEGORY (Based on IBC Table 1604.5)	STRUCTURAL PERFORMANCE LEVEL FOR USE WITH BSE-1E EARTHQUAKE HAZARD LEVEL	STRUCTURAL PERFORMANCE LEVEL FOR USE WITH BSE-2E EARTHQUAKE HAZARD LEVEL
I	Life Safety (S-3). See Note a	Collapse Prevention (S-5)
II	Life Safety (S-3). See Note a	Collapse Prevention (S-5)
III	Damage Control (S-2). See Note a	Limited Safety (S-4). See Note b
IV	Immediate Occupancy (S-1)	Life Safety (S-3). See Note c

~~a. Tier 1 evaluation at the Damage Control performance level shall use the Tier 1 Life Safety checklists and Tier 1 Quick Check provisions midway between those specified for Life Safety and Immediate Occupancy performance.~~

Add Footnote:

For Risk Category I, II, and III buildings, the Tier 1 and Tier 2 procedures need not be considered for the BSE-1E earthquake hazard level.

For Risk Category III, the Tier 1 screening checklists shall be based on Collapse Prevention, except that checklist statements using the Quick Check provisions shall be based on the M_S–factors that checklist statements using the Quick Check provisions shall be based on M_S–factors that are the average of the values for Collapse Prevention and Life Safety.

For Risk Category IV, the Tier screening checklists shall be based on Collapse Prevention, except that checklist statements using the Quick Check provisions shall be based on M_S-factors for Life Safety.

S8389

Date Submitted	12/15/2018	**Section**	301.1	**Proponent**	Ann Russo8
Chapter	3	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

EB6-15

Summary of Modification

This exception refers only the work area method for alterations in flood hazard areas. The prescriptive and performance methods have provisions similar to Section 701.3, so this exception should also refer to them.

Rationale

This exception refers only the work area method for alterations in flood hazard areas. The prescriptive and performance methods have provisions similar to Section 701.3, so this exception should also refer to them.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This is a code clarification only and has no effect on enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This is a code clarification only and has no effect on the cost of construction.

Impact to industry relative to the cost of compliance with code

This is a code clarification only and has no effect on the cost of construction.

Impact to small business relative to the cost of compliance with code

This is a code clarification only and has no effect on the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This is a code clarification only and has no effect on enforcement of the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This is a code clarification only and has no effect on enforcement of the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This is a code clarification only and does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This is a code clarification only and does not degrade the effectiveness of the code.

Section: 301.1

Revise as follows:

301.1 General. The *repair*, *alteration*, *change of occupancy*, *addition* or relocation of all *existing buildings* shall comply with one of the methods listed in Sections 301.1.1 through 301.1.3 as selected by the applicant. Sections 301.1.1 through 301.1.3 shall not be applied in combination with each other. Where this code requires consideration of the seismic force resisting system of an *existing building* subject to *repair*, *alteration*, *change of occupancy*, *addition* or relocation of *existing buildings,* the seismic evaluation and design shall be based on Section 301.1.4 regardless of which compliance method is used.

Exception: Subject to the approval of the *code official*, *alterations* complying with the laws in existence at the time the building or the affected portion of the building was built shall be considered in compliance with the provisions of this code unless the building is undergoing more than a limited structural *alteration* as defined in Section 907.4.4. New structural members added as part of the *alteration* shall comply with the *International Building Code*. ~~Alteration~~ *Alterations* of *existing buildings* in *flood hazard areas* shall comply with Section 403.2, 701.3 or 1401.3.3.

S7970

Date Submitted	12/12/2018	**Section**	403.5	**Proponent**	Harold Barrineau
Chapter	4	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Existing Building Section 907.5 EB23-16

Summary of Modification

This proposal simplifies and clarifies the wording of corresponding proposals in the Work Area and Prescriptive methods.Current 403.4.1:•Renumber to 403.5.

Rationale

This proposal simplifies and clarifies the wording of corresponding proposals in the Work Area and Prescriptive methods.Current 403.4.1:•Renumber to 403.5. This can and should be a stand-alone provision, independent of the basic alteration check and 10% rule in 403.4.•Use the defined terms "work area" and "building area."•Replace the "75% of code" wording with the simpler call out for reduced seismic loads.•Omit the sentence about "new structural members and connections," as this is now covered by the general provisions in Chapter 3.Current 907.4.3:•Renumber to 907.5. Each of the lateral system provisions in 907.4 should be independent to avoid confusion over the exceptions in 907.4. A more complete reorganization of 907.4 is being proposed separately.•Simplify the call outfor reduced seismic loads.Note that the current Work Area provision triggers a wind evaluation/retrofit, while the Prescriptive provision does not. Because this is an editorial proposal, reconciliation, while recommended, will be left to a separate proposal.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity. This proposal is editorial, therefore there is no change in construction requirements.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners. This proposal is editorial, therefore there is no change in construction requirements.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction. This proposal is editorial, therefore there is no change in construction requirements.

Impact to small business relative to the cost of compliance with code

No impact to small business. This proposal is editorial, therefore there is no change in construction requirements.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by clarification of code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens and improves the code with clarification.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

Increases the effectiveness of the code with clarification.

[BS] ~~403.4.1~~403.5Seismic Design Category F.

Where the~~portion of the building undergoing the intended alteration~~ work area exceeds 50 percent of the ~~aggregate~~buildingarea~~of the building~~, and where the building is assigned to Seismic Design Category F, the structure of the altered building shall~~be shown to~~meet the~~earthquake design provisions~~requirements of~~theInternational Building Code. For purposes of this section, the earthquake loads need not be taken greater than 75 percent of those prescribed in~~ Section 1613 of theInternational Building Code~~for new buildings of similar occupancy, purpose and location.New structural members and connections required by this section~~

ReducedInternational Building Code-level seismic forcesshall~~comply with the detailing provisions of this code for new buildings of similar structure, purpose and location~~be permitted.

[BS]~~907.4.3~~ 907.5Seismic Design Category F.

Where the building is assigned to Seismic Design Category F, the~~evaluation and analysis shall demonstrate that the lateral load-resisting systemstructure~~of the altered building~~or structure complies with reduced~~shall meet the requirements of Sections 1609 and 1613 of theInternational Building Code. ReducedInternational Building Code-level seismic forces~~in accordance with Section 301.1.4.2 and with the wind provisions applicable to a limited structural alteration~~ shall be permitted.

[BS] ~~403.4.1~~ 403.5 Seismic Design Category F.
Where the ~~portion of the building undergoing the intended alteration~~ work area exceeds 50 percent of the ~~aggregate~~ building area ~~of the building~~, and where the building is assigned to Seismic Design Category F, the structure of the altered building shall ~~be shown to~~ meet the ~~earthquake design provisions~~ requirements of ~~the International Building Code. For purposes of this section, the earthquake loads need not be taken greater than 75 percent of those prescribed in~~ Section 1613 of the International Building Code ~~for new buildings of similar occupancy, purpose and location~~. ~~New structural members and connections required by this section~~
Reduced International Building Code-level seismic forces shall ~~comply with the detailing provisions of this code for new buildings of similar structure, purpose and location~~ be permitted.

[BS] ~~907.4.3~~ 907.5 Seismic Design Category F.
Where the building is assigned to Seismic Design Category F, the ~~evaluation and analysis shall demonstrate that the lateral load-resisting system structure~~ of the altered building ~~or structure complies with reduced~~ shall meet the requirements of Sections 1609 and 1613 of the International Building Code. Reduced International Building Code-level seismic forces ~~in accordance with Section 301.1.4.2 and with the wind provisions applicable to a limited structural alteration~~ shall be permitted.

S8016

Date Submitted	12/12/2018	**Section**	403.6	**Proponent**	Harold Barrineau
Chapter	4	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No **Alternate Language** No

Related Modifications

Section 907.4.5 EB27-16

Summary of Modification

[BS] 403.6 Wall anchorage for unreinforced masonry walls in major alterations. [BS] 907.4.5 Wall anchors for concrete and masonry buildings.

Rationale

This proposal extends the URM mitigation requirement for Level 3 alteration projects.Currently, Level 3 alterations trigger URM parapet bracing and anchors at the roof line in both the Work Area and Prescriptivemethods. However, experience in Christchurch and standard, feasible practice in Massachusetts and California indicate that URM walls should be anchored at floor levels as well, in order to achieve even basic collapse prevention performance. (IEBC AppendixA1 and ASCE 41 Chapter 15 say the same.)An alteration that already involves more than half of the building (a Level 3 Alteration in WAM terms) justifies this proactive mitigation, which not only protects the subject building and adjacent spaces and property, but also makes the essential parapet and roof level work more reliable.Note: A separate proposal would split 907.4.5 into two sections for editorial clarity. If that proposal is approved, this proposal can be effected simply by changing "roof line" to "floor and roof lines" in the new URM section, to match proposed 403.6 shown here.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will increase the cost of construction. A small additional cost with a high benefit-cost ratio for URM buildings with major alterations. No additional cost for lesser alterations.

Impact to building and property owners relative to cost of compliance with code

Will increase the cost of construction. A small additional cost with a high benefit-cost ratio for URM buildings with major alterations. No additional cost for lesser alterations.

Impact to industry relative to the cost of compliance with code

Will increase the cost of construction. A small additional cost with a high benefit-cost ratio for URM buildings with major alterations. No additional cost for lesser alterations.

Impact to small business relative to the cost of compliance with code

Will increase the cost of construction. A small additional cost with a high benefit-cost ratio for URM buildings with major alterations. No additional cost for lesser alterations.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by improving the performance of unreinforced masonry structures.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens or improves the code by improving the performance of unreinforced masonry structures.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials, products, methods, or systems of construction.

Does not degrade the effectiveness of the code

Increases the effectiveness of the code by improving the performance of unreinforced masonry structures.

[BS] 403.6 Wall anchorage for unreinforced masonry walls in major alterations.

Where the portion of the building undergoing the intended alteration exceeds 50 percent of the aggregate area of the building, the building is assigned to Seismic Design Category C, D, E or F, and the building's structural system includes unreinforced masonry walls, the alteration work shall include installation of wall anchors at the floor and roof ~~line~~ lines to resist seismic forces, unless an evaluation demonstrates compliance of existing wall anchorage. For purposes of this section, design seismic forces need not be taken greater than 75 percent of those that would be required for the design of new buildings of similar structure, purpose and location.

[BS] 907.4.5 Wall anchors for concrete and masonry buildings.

For any building assigned to Seismic Design Category D, E or F with a structural system consisting of concrete or reinforced masonry

walls with a flexible roof diaphragm and any building assigned to Seismic Design Category C, D, E or F with a structural system consisting of unreinforced masonry walls with any type of roof diaphragm, the alteration work shall include installation of wall anchors at the roof line of all subject buildings and at the floor lines of unreinforced masonry buildings to resist the reduced International Building Code-level seismic forces in accordance with Section 301.1.4.2, unless an evaluation demonstrates compliance of existing wall anchorage.

S8024

Date Submitted	12/12/2018	**Section**	403.6	**Proponent**	Harold Barrineau
Chapter	4	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Section 907.4.5

Summary of Modification

Modify Section Number 403.6 Wall Anchorage. New Section 403.6.1 Wall anchorage for unreinforced masonry walls in major alterations. New Section 403.6.2 Wall anchorage for concrete and reinforced masonry walls.

Rationale

This proposal resolves an inconsistency between the Work Area method and the Prescriptive method. Currently, the Work Area method has a sensible provision that requires roof-to-wall anchors in Level 3 Alterations for concrete and reinforced masonry walls as well as URM walls (907.4.5) but the Prescriptive method addresses only URM walls (403.6). This proposal adds a matching proposal for concrete and RM walls to the Prescriptive method.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement.

Impact to building and property owners relative to cost of compliance with code

Will increase the cost of construction.
For certain buildings, including vulnerable tilt-ups, undergoing major alterations. No change for other buildings or lesser alterations.

Impact to industry relative to the cost of compliance with code

Will increase the cost of construction.
For certain buildings, including vulnerable tilt-ups, undergoing major alterations. No change for other buildings or lesser alterations.

Impact to small business relative to the cost of compliance with code

Will increase the cost of construction.
For certain buildings, including vulnerable tilt-ups, undergoing major alterations. No change for other buildings or lesser alterations.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Concrete and masonry walls pose a hazard that needs to be addressed and this change will include the installation of wall anchors as part of required alterations. The health, safety, and welfare of the general public will be improved.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens or improves the code by providing provisions for anchorage for concrete and reinforced masonry walls.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

403.6 ~~Wall anchorage for unreinforced masonry walls in major alterations.~~ Wall Anchorage.

403.6.1 Wall anchorage for unreinforced masonry walls in major alterations.

Where the ~~portion of the building undergoing the intended alteration~~ work area exceeds exceeds 50 percent of the aggregate area of the building, the building is assigned to Seismic Design Category C, D, E or F, and the building's structural system includes unreinforced masonry walls, the alteration work shall include installation of wall anchors at the roof line to resist seismic forces, unless an evaluation demonstrates compliance of existing wall anchorage. For purposes of this section, design seismic forces need not be taken greater than 75 percent of those that would be required for the design of new buildings of similar structure, purpose and location.

403.6.2 Wall anchorage for concrete and reinforced masonry walls.

Where the work area exceeds 50 percent of the building area, the building is assigned to Seismic Design Category D, E or F, and the building's structural system includes concrete or reinforced masonry walls with a flexible roof diaphragm, the alteration work shall include installation of wall anchors at the roof line, unless an evaluation demonstrates compliance of existing wall anchorage. Use of reduced International Building Code-level seismic forces shall be permitted.

Date Submitted 12/13/2018
Chapter 4
Section 403.6
Affects HVHZ No
Proponent Harold Barrineau
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**   **Alternate Language** **No**

Related Modifications

Section 403.6.3 (New)
Section 907.4.7 (New)

Summary of Modification

403.6.3 Wall anchorage of unreinforced masonry partitions in major alterations. 907.4.7 Wall anchorage of unreinforced masonry partitions.

Rationale

This proposal adds a proactive mitigation trigger to address a common nonstructural falling hazard.
Currently, both the Prescriptive and Work Area methods include mitigation requirements for URM parapets and bearing walls, triggered by major (Level 3) alterations. A related hazard involves the failure of interior unreinforced masonry partitions, especially around stairwells and egress corridors.
Mitigation of this well-understood and common hazard is justified by a Level 3 alteration. Still, to avoid disproportionate impacts not associated with the intended work, the proposal would require the mitigation only within the work area and along egress paths from the work area to building exits. In many cases, an alteration project that involves 50 percent of a building's area will already have some partition removal or replacement in its scope.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

Will increase the cost of construction.
The cost increase is for URM partitions only, and only within the work area and egress paths. Where the intended work already involves partition alteration, there is no cost increase.

Impact to industry relative to the cost of compliance with code

Will increase the cost of construction.
The cost increase is for URM partitions only, and only within the work area and egress paths. Where the intended work already involves partition alteration, there is no cost increase.

Impact to small business relative to the cost of compliance with code

Will increase the cost of construction.
The cost increase is for URM partitions only, and only within the work area and egress paths. Where the intended work already involves partition alteration, there is no cost increase.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal addresses a significant potential hazard from unreinforced masonry partitions when major alterations are being performed.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal strengthens and improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capability.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Add new text as follows:

403.6.3 Wall anchorage of unreinforced masonry partitions in major alterations.

Where the work areaexceeds 50 percent of the building area, and where the building is assigned to Seismic Design Category C, D, E, or F, unreinforced masonry partitions and nonstructural walls within the work area and adjacent to egress paths from the work area shall be anchored, removed, or altered to resist out-of-plane seismic forces, unless an evaluation demonstrates compliance of such items. Use of reduced Florida Building Code-level seismic forces shall be permitted.

907.4.7 Wall anchorage of unreinforced masonry partitions.

Where the building is assigned to Seismic Design Category C, D, E, or F, unreinforced masonry partitions and nonstructural walls within the work area and adjacent to egress paths from the work area shall be anchored, removed, or altered to resist out-of-

plane seismic forces, unless an evaluation demonstrates compliance of such items. Use of reduced Florida Building Code-level seismic forces shall be permitted.

S8054

Date Submitted	12/13/2018	**Section**	403.4.2	**Proponent**	Harold Barrineau
Chapter	4	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No **Alternate Language** No

Related Modifications

Sections [BS] 907.4, [BS] 907.4.2.

Summary of Modification

403.4.2 Substantial structural alteration. [BS] 907.4 Existing structural elements resisting lateral loads. [BS] 907.4.2 Substantial structural alteration.

Rationale

This proposal reconciles a significant difference between the Prescriptive method and the Work Area method.
Currently, the Work Area method triggers a potential seismic upgrade for a Level 3 Alteration project whose intended scope includes a substantial alteration (as defined in 907.4.2). The Prescriptive method has no such trigger. This proposal adds the identical trigger to the prescriptive method.
Note the limited scope, to match the Work Area method provisions from 907.4 and 907.4.2:
• It applies only to a major (or Level 3) alteration, where the intended work area exceeds 50 percent of the building area.
• It applies only where the intended alteration already involves substantial structural scope.
• Reduced seismic forces are allowed.
• The entire trigger is waived for small residential buildings where the work complies with the IRC or light frame requirements.
•The entire trigger is waived above the first story when the intended alteration would affect only the first story. In addition, a few editorial clarifications to Sections 907.4 and 907.4.2 are proposed so that the provisions in the different methods will match. For example, Exception 2 omits the unnecessary phrase regarding change of occupancy; this phrase is meant to confirm that any change of occupancy requirements would override the exception, but such a statement is not needed because the FBC Existing applies requirements for multiple project types independently and cumulatively.
Finally, if the quasi-definition of a Substantial Structural Alteration from current 907.4.2 can be moved to the Chapter 2 definitions (as is being proposed separately), both 907.4.2 and proposed 403.8 can be simplified by simply using that defined term.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

Will increase the cost of construction.
For a major alteration with substantial structural alteration as part of its intended scope, the cost will increase as needed to do a seismic upgrade with reduced loads. The additional cost could be zero, or it could be more than zero.

Impact to industry relative to the cost of compliance with code

Will increase the cost of construction.
For a major alteration with substantial structural alteration as part of its intended scope, the cost will increase as needed to do a seismic upgrade with reduced loads. The additional cost could be zero, or it could be more than zero.

Impact to small business relative to the cost of compliance with code

Will increase the cost of construction.
For a major alteration with substantial structural alteration as part of its intended scope, the cost will increase as needed to do a seismic upgrade with reduced loads. The additional cost could be zero, or it could be more than zero.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal strengthens or improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Add new text as follows:

403.4.2 Substantial structural alteration.

Where the work area exceeds 50 percent of the building area and where more than 30 percent of the total floor and roof areas of the building or structure have been or are proposed to be involved in structural alteration within a 5-year period, the lateral load-resisting system of the altered building shall satisfy the requirements of Sections 1609 and 1613 of the Florida Building Code, Building. Reduce Florida Building Code-level seismic forces shall be permitted. The areas to be counted toward the 30 percent shall be those areas tributary to the vertical load-carrying components, such as joists, beams, columns, walls and other structural components that have been or will be removed, added or altered, as well as areas such as mezzanines, penthouses, roof structures and in-filled courts and shafts.

Exceptions:

1. Buildings of Group R occupancy with no more than five dwelling or sleeping units used solely for residential purposes that are altered based on the conventional light-frame construction methods of the Florida Building Code, Building or in compliance with the provisions of the Florida Building Code, Residential.
2. Where the intended alteration involves only the lowest story of a building, only the lateral load-resisting components in and below that story need comply with this section.

Revise as follows:

[BS] 907.4 Existing structural elements resisting lateral loads.

All existing elements of the lateral force-resisting system shall comply with this section.

Exceptions:

1. Buildings of Group R occupancy with no more than five dwelling or sleeping units used solely for residential purposes that are altered based on the conventional light-frame construction methods of the Florida Building Code, Building; or in compliance with the provisions of the Florida Building Code, Residential.
2. ~~Where such alterations involve only the lowest story of a building and the change of occupancy provisions of Chapter 10 do not apply, only the lateral force-resisting components in and below that story need comply with this section.~~
2. Where the intended alteration involves only the lowest story of a building, only the lateral load-resisting components in and below that story need comply with this section.

[BS] 907.4.2 Substantial structural alteration.

Where more than 30 percent of the total floor and roof

areas of the building or structure have been or are proposed to be involved in structural alteration within a 5-year period, ~~the evaluation and analysis shall demonstrate that the~~ lateral load-resisting system of the altered building ~~or structure complies with~~ shall satisfy the requirements of Sections 1609 and 1613 of the Florida Building Code, Building. ~~for wind loading and with reduced~~ Reduced Florida Building Code-level seismic forces ~~in accordance with Section 301.1.4.2~~ shall be permitted. The areas to be counted toward the 30 percent shall be those areas tributary to the vertical load-carrying components, such as joists, beams, columns, walls and other structural components that have been or will be removed, added or altered, as well as areas such as mezzanines, penthouses, roof structures and in-filled courts and shafts.

S8067

Date Submitted	12/13/2018	**Section**	403.9	**Proponent**	Harold Barrineau
Chapter	4	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Section [BS] 807.6

Summary of Modification

[BS] 403.9 Voluntary lateral force-resisting system alterations. [BS] 807.6 Voluntary lateral force-resisting system alterations.

Rationale

This proposal reconciles differences between the voluntary retrofit provisions in the Prescriptive and Work Area methods.
In general, since neither provision actually relieves a voluntary retrofit project from any other code requirements (for example regarding egress, accessibility, or fire safety), an argument can be made that these provisions are not even needed, as any of the work they contemplate should already be covered by more general provisions for alterations. However, these provisions are considered useful for encouraging this voluntary work.
The main purpose of the proposal is to provide identical wording in each method. To do this, the proposal simplifies the base provision in each case and borrows bits from each current provision, with two objectives:
•The work cannot make the building worse.
•New structural elements should meet IBC standards for materials and detailing, but not necessarily design force levels or drift limits.

Note that the current IEBC improperly shows the final sentence of 807.6 as part of list item 5. Both that list item (regarding dangerous conditions) and the final sentence (regarding the acceptability of IEBC Appendix A) are deleted by this proposal."

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal will have no impact to local entity relative to enforcement.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction.
This proposal is a clarification of intent, with editorial changes.
There is no change to construction requirements.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction.
This proposal is a clarification of intent, with editorial changes.
There is no change to construction requirements.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction.
This proposal is a clarification of intent, with editorial changes.
There is no change to construction requirements.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of he general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens or improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The proposal does not degrade the effectiveness of the code.

[BS] 403.9 Voluntary ~~seismic improvements~~ lateral force-resisting system alterations.

~~Alterations to existing structural elements or additions of new structural elements~~ Structural alterations that are intended exclusively to improve the lateral force-resisting system and are not ~~otherwise~~ required by other sections of this ~~chapter and are initiated for~~ code shall not be required to meet the ~~purpose~~ requirements of ~~improving the performance~~ Section 1609 or Section 1613 of the ~~seismic force-resisting system of an existing structure or the performance of seismic bracing or anchorage of existing nonstructural elements shall be permitted~~ International Building Code, provided that ~~an engineering analysis is submitted demonstrating the following:~~

> ~~1. The altered structure and the altered nonstructural elements are no less conforming to the provisions of the International Building Code with respect to earthquake design than they were prior to the alteration.~~
>
> ~~2. New structural elements are detailed as required for new construction.~~

1. The capacity of existing structural systems to resist forces is not reduced;

2.New structural elements are detailed and connected to existing or new structural elements as required by the International Building Code for new construction;

3. New or relocated nonstructural elements are detailed and connected to existing or new structural elements as required by the International Building Code for new construction~~.~~; and

4. The alterations do not create a structural irregularity as defined in ASCE 7 or make an existing structural irregularity more severe.

[BS] 807.6 Voluntary lateral force-resisting system alterations.

Structural ~~Alterations~~ alterations ~~of existing structural elements and additions of new structural elements~~ that are ~~initiated for the purpose of increasing~~ intended exclusively to improve the lateral force-resisting ~~strength or stiffness of an existing structure~~ system and ~~that~~ are not required by other sections of this code shall not be required to ~~be designed for forces conforming to~~ meet the requirements of Section 1609 or Section 1613 of the International Building Code, provided that ~~an engineering analysis is submitted to show that~~:

1. The capacity of existing structural ~~elements required~~ systems to resist forces is not reduced;

~~2. The lateral loading to existing structural elements is not increased either beyond its capacity or more than 10 percent;~~

2~~3~~. New structural elements are detailed and connected to the existing or new structural elements as required by the International Building Code for new construction;

3~~4~~. New or relocated nonstructural elements are detailed and connected to existing or new structural elements as required by the International Building Code for new construction; and

4.The alterations do not create a structural irregularity as defined in ASCE 7 or make an existing structural irregularity more severe.

~~5. A dangerous condition as defined in this code is not created.~~

~~Voluntary alterations to lateral force-resisting systems conducted in accordance with Appendix A and the referenced standards of this code shall be permitted.~~

S8075

Date Submitted	12/13/2018	**Section**	407.4	**Proponent**	Harold Barrineau
Chapter	4	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

Section: [BS] 1007.3.1

Summary of Modification

[BS] 407.4 Seismic force-resisting system. [BS] 1007.3.1 Seismic force-resisting system.

Rationale

This code change reconciles provisions of the prescriptive method with those of the work area method. Approval is consistent with actions on prior proposals.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal does not impact local entity relative to enforcement.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction.
By adding more exceptions to each method, the proposal will actually reduce the cost of construction.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction.
By adding more exceptions to each method, the proposal will actually reduce the cost of construction.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction.
By adding more exceptions to each method, the proposal will actually reduce the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal improves the heath, safety, and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal strengthens or improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

[BS] 407.4 ~~Structural~~ Seismic force-resisting system.

When a change of occupancy results in a ~~structure~~ building being ~~reclassified~~ assigned to a higher risk category, the ~~structure~~ building shall ~~conform to the seismic requirements for a new structure of the higher risk category. For purposes of this section, compliance with ASCE 41, using a Tier 3 procedure and the two-level performance objective in Table 301.1.4.1 for the applicable risk category, shall be deemed to meet~~ satisfy the requirements of Section 1613 of the International Building Code for the new risk category using International Building Code-level seismic forces.

Exceptions:

1. ~~Specific seismic detailing requirements of Section 1613 of the International Building Code for a new structure shall not be required to be met where the seismic performance is shown to be equivalent to that of a new structure. A demonstration of equivalence shall consider the regularity, overstrength, redundancy and ductility of the structure.~~ Where the area of the new occupancy is less than 10 percent of the building area and the new occupancy is not assigned to Risk Category IV, compliance with this section is not required. The cumulative effect of occupancy changes over time shall be considered.

2. When a change of use results in a ~~structure~~ building being reclassified from Risk Category I or II to Risk Category III and the ~~structure is located where the~~ seismic coefficient, ~~SDS~~ S_{DS},is less than 0.33, compliance with ~~the seismic requirements of Section 1613 of the International Building Code~~ this section is not required.

3. Unreinforced masonry bearing wall buildings assigned to Risk Category III, when assigned to Seismic Design Category A or B, shall be permitted to use Appendix Chapter A1 of this code.

[BS] 1007.3.1 ~~Compliance with International Building Code-level seismic forces.~~

Seismic force-resisting system.

~~Where~~ When a ~~building or portion thereof is subject to a~~ change of occupancy ~~that~~ results in ~~the~~ a building being assigned to a higher risk category ~~based on Table 1604.5 of the International Building Code~~, the building shall ~~comply with~~ satisfy the requirements ~~for~~ of Section 1613 of the International Building Code~~-level seismic forces as specified in Section 301.1.4.1~~ for the new risk category using International Building Code-level seismic forces

Exceptions:

1. ~~Where approved by the code official, specific detailing provisions required for a new structure are not required to be met where it can be shown that an equivalent level of performance and seismic safety is obtained for the applicable risk category based on the provision for reduced International Building Code-level seismic forces as specified in Section 301.1.4.2.~~ When a change of use results in a building being reclassified from Risk Category I or II to Risk Category III and the seismic coefficient, S_{DS}, is less than 0.33, compliance with this section is not required.

2. Where the area of the new occupancy ~~with a higher hazard category~~ is less than ~~or equal to~~ 10 percent of the ~~total~~ building ~~floor~~ area and the new occupancy is not ~~classified as assigned~~ to Risk Category IV~~. For the purposes of~~, compliance with this ~~exception, buildings occupied by two or more occupancies~~ section is not ~~included in the same risk category, shall be subject to the provisions of Section 1604.5.1 of the International Building Code~~ required. The cumulative effect of ~~the area of~~ occupancy changes over time shall be considered ~~for the purposes of this exception~~.

3. Unreinforced masonry bearing wall buildings ~~in~~ assigned to Risk Category III~~,~~ when assigned to Seismic Design Category A or B, shall be ~~allowed~~ permitted to ~~be strengthened to meet the requirements of~~ use Appendix Chapter A1 of this code ~~[Guidelines for the Seismic Retrofit of Existing Buildings (GSREB)]~~.

Date Submitted	12/14/2018	**Section**	301.1	**Proponent**	Ann Russo4
Chapter	4	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

301.2
301.1 301.1.1 301.1.2 301.1.3
401.1 401.1.1 401.2.2
404
501.1 501.1.1 502
1401.1 1401.1.1 1401.2.4

Summary of Modification

The purpose of this modification to remove the topic of repair from the three compliance methods and to move repair into one standalone chapter

Rationale

The purpose of this code change is to remove the topic of repair from the three compliance methods and to move repair into one standalone chapter.
The topic of repairs is fairly simple but the way the three methods handle the topic very differently:

- Prescriptive method- Specific requirements on structural repairs only, general statement on other topics with code official discretion on 'dangerous' situations
- Work area method- Specific requirements for structural (identical to prescriptive method), building materials, fire protection, accessibility, mechanical, plumbing, and electrical.
- Performance method- General requirements only and reference to the FBC for thresholds

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity as this is already a code requirement

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners as this is already a code requirement

Impact to industry relative to the cost of compliance with code

No impact to industry as this is already a code requirement

Impact to small business relative to the cost of compliance with code

No impact to small businesses as this is already a code requirement

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by moving Repairs to a stand alone chapter

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by moving Repairs to a stand alone chapter. Having a standalone chapter for repairs will make the code more clear.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against material, products, methods, or systems of construction of demonstrated capabilities, this is a current code requirement that does not limit material, products, methods, or systems of construction

Does not degrade the effectiveness of the code

improves the effectiveness of the code. This modification will make the repair provisions more consistent for each method. Repairs do not require several different methods of compliance. Having a standalone chapter for repairs will make the code more clear.

Relocate Chapter 6 as

follows: 6 4 REPAIRS
(Renumber Subsequent sections in this Chapter) (Renumber Chapters 4 and 5)

Revise as follows:

SECTION 301 ADMINISTRATION

General. The *repair, alteration, change of occupancy, addition* or relocation of all *existing buildings* shall comply with Section 301.2 or 301.3, asapplicable.

Repairs Repairs shall comply with the requirements of Chapter4.

~~301.1~~301.3 ~~General~~ Alteration, change of occupancy, addition or relocation. The ~~repair,~~ *alteration*, *change of occupancy*, *addition* or relocation of all *existing buildings* shall comply with one of the methods listed in Sections ~~301.1.1~~ 301.3.1 through ~~301.1.3~~ 301.3.3 as selected by the applicant. Sections ~~301.1.1~~ 301.3.1 through ~~301.1.3~~ 301.3.3 shall not be applied in combination with each other. Where this code requires consideration of the seismic forceresisting system of an *existing building* subject to ~~repair,~~ *alteration*, *change of occupancy*, *addition* or relocation of *existing buildings,* the seismic evaluation and design shall be based on Section ~~301.1.4~~ 301.3.4 regardless of which compliance method is used.

Exception: Subject to the approval of the *code official*, *alterations* complying with the laws in existence at the time the building or the affected portion of the building was built shall be considered in compliance with the provisions of this code unless the building is undergoing more than a limited structural *alteration* as defined in Section 907.4.4. New structural members added as part of the *alteration* shall comply with the *Florida Building Code*. *Alterations* of *existing buildings* in *flood hazard areas* shall comply with Section 701.3. This exception shall not apply to alterations that constitute substantial improvement in flood hazard areas which shall comply with Section 701.3. This exception shall not apply to the structural provisions of Chapter 4 or to the structural provisions of Sections 7047, 807, and 907.

301.1.~~1~~301.3.1 Prescriptive compliance method. ~~Repairs, alterations~~

Alterations, *additions* and *changes of occupancy* complying with Chapter 4~~5~~ of this code in buildings complying with the *Florida Fire Code* shall be considered in compliance with the provisions of this code.

301.1.~~2~~301.3.2 Work area compliance method.~~Repairs,alterations~~*Alterations,additions,changes in occupancy and relocated buildings complying with the applicable requirements of Chapters* ~~5~~ *6 through 13 of this code shall be considered in compliance with the provisions of this code.*

301.1.~~3~~301.3.3 Performance compliance method. ~~Repairs, alterations~~ *Alterations*, *additions*, changes in occupancy and relocated buildings complying with Chapter 14 of this code shall be considered in compliance with the provisions of this code.

(Renumber subsequent sections)

401.1 Scope. The provisions of this chapter shall control the *alteration*~~, repair,~~ *addition* and *change of occupancy* or relocation of *existing buildings* and structures, including *historic buildings* and structures as referenced in Section ~~301.1.1~~ 301.3.1.

> **Exception: Existing bleachers, grandstands and folding and telescopic seating shall comply with ICC 300.**

401.1.1 Compliance with other methods. *Alterations*~~, repairs~~, *additions* and *changes of occupancy* to or relocation of, *existing buildings* and structures shall comply with the provisions of this chapter or with one of the methods provided in Section ~~301.1~~ 301.3.

401.2.2 New and replacement materials. Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for ~~repairs and~~ *alterations*, provided no hazard to life, health or property is created. Hazardous materials shall not be used where the code for new construction would not permit their use in buildings of similar occupancy, purpose and location.

Delete without substitution:

~~SECTION 404~~
~~REPAIRS~~

~~**404.1 General.** Buildings and structures, and parts thereof, shall be repaired in compliance with Sections 401.2 and 404. Work on nondamaged components that is necessary for the required repair of damaged components shall be considered part of the repair and shall not be subject to therequirements for alterations in this chapter. Routine maintenance required by Section 401.2, ordinary repairs exempt from permitinaccordance withSection105.2,andabatementofwearduetonormalserviceconditions shall not be subject to the requirements for repairs in thissection.~~

~~**[BS] 404.2 Substantial structural damage to vertical elements of the lateral force-resisting system.** A building that has sustained substantial structural damage to the vertical elements of its lateral force-resisting system shall be evaluated and repaired in accordance with the applicable provisions of Sections 404.2.1 through 404.2.3.~~

~~Exceptions:~~

1. **~~Buildings assigned to Seismic Design Category A, B or C whose substantial structural damage was not caused by earthquake need not be evaluated or rehabilitated for load combinations that include earthquake effects.~~**

~~One-andtwo-familydwellingsneednotbeevaluated orrehabilitatedforloadcombinations that include earthquake effects.~~

[BS] 404.2.1 Evaluation. The building shall be evaluated by a registered design professional, and the evaluation findings shall be submitted to the building official. The evaluation shall establish whether the damaged building, if repaired to its predamage state, would comply with the provisions of the International Building Code for wind and earthquake loads.
Wind loads for this evaluation shall be those prescribed in Section 1609 of the Florida Building Code. Earthquake loads for this evaluation, if required, shall be permitted to be 75 percent of those prescribed in Section 1613 of the Florida Building Code. Alternatively, compliance with ASCE 41, using the performance objective in Table 301.1.4.2 for the applicable risk category, shall be deemed to meet the earthquake evaluation requirement.

[BS] 404.2.2 Extent of repair for compliant buildings. If the evaluation establishes compliance of the predamage building in accordance with Section 404.2.1, then repairs shall be permitted that restore the building to its predamage state.

[BS] 404.2.3 Extent of repair for noncompliant buildings. If the evaluation does not establish compliance of the predamage building in accordance with Section 404.2.1, then the building shall be rehabilitated to comply with applicable provisions of the Florida Building Code for load combinations that include wind or seismic loads. The wind loads for the repair shall be as required by the building code in effect at the time of original construction, unless the damage was caused by wind, in which case the wind loads shall be as required by the Florida Building Code. Earthquake loads for this rehabilitation design shall be those required for the design of the predamage building, but not less than 75 percent of those prescribed in Section 1613 of the FLorida Building Code. New structural members and connections required by this rehabilitation design shall comply with the detailing provisions of
the International Building Code for new buildings of similar structure, purpose and location. Alternatively, compliance with ASCE 41, using the performance objective in Table 301.1.4.2 for the applicable risk category, shall be deemed to meet the earthquake rehabilitation requirement.

[BS] 404.3 Substantial structural damage to gravity loadcarrying components. Gravity load-carrying components that have sustained substantial structural damage shall be rehabilitated to comply with the applicable provisions of the Florida Building Code for dead and live loads. Snow loads shall be considered if the substantial structural damage was caused by or related to snow load effects. Existing gravity load-carrying structural elements shall be permitted to be designed for live loads approved prior to the damage. If the approved live load is less than that required by Section 1607 of the Florida Building Code, the area designed for the nonconforming live load shall be posted with placards
of approved design indicating the approved live load. Nondamaged gravity load-carrying components that receive dead, live or snow loads from rehabilitated components shall also be rehabilitated or shown to have the capacity to carry the design loads of the rehabilitation design. New structural members and connections required by this rehabilitation design shall comply with the detailing provisions of

the Florida Building Code for new buildings of similar structure, purpose and location.

[BS] 404.3.1 Lateral force-resisting elements. Regardless of the level of damage to vertical elements of the lateral force-resisting system, if substantial structural damage to gravity load-carrying components was caused primarily by wind or earthquake effects, then the building shall be evaluated in accordance with Section 404.2.1 and, if noncompliant, rehabilitated in accordance with Section404.2.3.

Exceptions:

One-andtwo-familydwellingsneednotbeevaluated orrehabilitatedforloadcombinations that include earthquake effects.

2. Buildings assigned to Seismic Design Category A, B or C whose substantial structural damage was not caused by earthquake need not be evaluated or rehabilitated for load combinations that include earthquake effects.

[BS] 404.4 Less than substantial structural damage. For damage less than substantial structural damage, repairs shall be allowed that restore the building to its predamage state. New structural members and connections used for this repair shall comply with the detailing provisions of

the International Building Code for new buildings of similar structure, purpose and location.

[BS]404.5Floodhazardareas. Forbuildingsandstructuresinfloodhazardareasestablishedin Section 1612.3 of the International Building Code, or Section R322 of the Florida Residential Code, as applicable, any repair that constitutes substantial improvement or repair of substantial damage of the existing structure shall comply with the flood design requirements for new construction, and all aspects of the existing structure shall be brought into compliance with the requirements for new construction for flooddesign.

For buildings and structures in flood hazard areas established in Section 1612.3 of the Florida Building Code, or Section R322 of the Florida Residential Code, as applicable, any repairs that do not constitute substantial improvement or repair of substantial damage of the existing structure are not required to comply with the flood design requirements for new construction.

Revise as follows:

501.1 Scope. The provisions of this chapter shall be used in conjunction with Chapters 6 7 through 13 and shall apply to the *alteration*, repair, *addition* and *change of occupancy* of existing structures, including historic and moved structures, as referenced in Section 301.1.2. The work performed on an *existing building* shall be classified in accordance with this chapter.

501.1.1 Compliance with other alternatives. *Alterations*, repairs, *additions* and *changes of occupancy* to existing structures shallcomply with the provisions of Chapters 6 7 through 13 or with one of the alternatives provided in Section 301.1.

Delete without substitution:

SECTION 502 REPAIRS

Scope. Repairs, as defined in Chapter 2, include the patching or restoration or replacement of damagedmaterials,elements,equipmentorfixturesforthepurposeofmaintainingsuchcomponentsin good or sound condition with respect to existing loads or performancerequirements.

Application. Repairs shall comply with the provisions of Chapter6.

502.3 Related work. Work on nondamaged components that is necessary for the required repair of damagedcomponentsshallbeconsideredpartoftherepairandshallnotbesubjecttotheprovisionsof Chapter 7, 8, 9, 10 or 11.

Revise as follows:

1401.1 Scope. The provisions of this chapter shall apply to the *alteration*~~, repair~~, *addition* and *change of occupancy* of existing structures, including historic and moved structures, as referenced in **Section ~~301.1.3~~ 301.3.3. The provisions of this chapter are intended to maintain or increase the current degree of public safety, health and general welfare in *existing buildings* while** permitting ~~repair~~, *alteration*, *addition* and *change of occupancy* without requiring full compliance with Chapters ~~5~~ 6 through 13, except where compliance with other provisions of this code is specifically required in this chapter.

1401.1.1 Compliance with other methods. *Alterations,* ~~repairs~~*additions, and changes of occupancy* to existing structures shall comply with the provisions of this chapter or with one of the methods provided in Section ~~301.1~~ 301.3.

1401.2.4 Alterations and repairs. An *existing building* or portion thereof that does not comply with the requirements of this code for new construction shall not be altered or repaired in such a manner that results in the building being less safe or sanitary than such building is currently. If, in the *alteration* or *repair*, the current level of safety or sanitation is to be reduced, the portion altered or ~~repaired~~ shall conform to the requirements of Chapters 2 through 12 and Chapters 14 through 33 of the *Florida Building Code*.

S8225

Date Submitted	12/14/2018	**Section**	401.2.1	**Proponent**	Ann Russo4
Chapter	4	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

401.2.2
602.106.2.2

Summary of Modification

Deletes "Existing [Building} Materials" and "New and replacement Material sections from Chapter 4 ad 6 which have been inserted in Chapter 3

Rationale

This modification deletes the "Existing [Building] Materials" and "New and Replacement Materials" sections from Chapters 4 and 6 because they are already inserted in chapter 3. The content in
Chapter 3 applies to all methods in the FEBC so deleting these sections in the other method chapters reduces redundancy.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity as this is already a code requirement

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners as this is already a code requirement

Impact to industry relative to the cost of compliance with code

No impact to industry as this is already a code requirement

Impact to small business relative to the cost of compliance with code

No impact to small businesses as this is already a code requirement

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by removing wording that already is in Chapter 3

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by removing wording that already is in Chapter 3

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against material, products, methods, or systems of construction of demonstrated capabilities, this is a current code requirement that does not limit material, products, methods, or systems of construction

Does not degrade the effectiveness of the code

Increase the effectiveness of the code by removing wording that already is in Chapter 3

Delete without substitution:

~~**401.2.1 Existing materials.** Materials already in use in a building in compliance with requirements or approvals in effect at the time of their erection or installation shall be permitted to remain in use unless determined by the building official to be unsafe per Section 115.~~

~~**401.2.2 New and replacement materials.** Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for repairs and alterations, provided no hazard to life, health or property is created. Hazardous materials shall not be used where the code for new construction would not permit their use in buildings of similar occupancy, purpose and location.~~

602.1 Existing building materials. ~~Materials already in use in a building in compliance with requirements or approvals in effect at the time of their erection or installation shall be permitted to remain in use unless determined by the code official to render the building or structure unsafe or dangerous as defined in Chapter 2.~~ ~~**602.2**~~ **602.1 New and replacement materials.** Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for repairs and alterations, provided no dangerous or unsafe condition, as defined in Chapter 2, is created. Hazardous materials, such as asbestos and lead-based paint, shall not be used where the code for new construction would not permit their use in buildings of similar occupancy, purpose and location.

Exception: Repairs to a historic building shall be permitted using original or like materials. Materials shall comply with Sections 602.2, 602.3 and 602.4.

~~**602.3**~~**602.2 Glazing in hazardous locations.** Replacement glazing in hazardous locations shall comply with the safety glazing requirements of the Florida Building Code, Building or Florida Building Code, Residential as applicable.

Exception: Glass block walls, louvered windows, and jalousies repaired with like materials.

~~**602.4**~~**602.3 Replacement.** For repairs in an historic building, replacement or partial replacement of existing or missing features features hat match the original in configuration, height, size and original methods of construction shall be permitted.

Exception: Glazing in hazardous locations shall comply with Section ~~602.3~~602.2.

S8231

Date Submitted	12/14/2018	**Section**	401.2	**Proponent**	Ann Russo4
Chapter	4	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No | **Alternate Language** No

Related Modifications

401.2.1 401.2.2 401.2.3
403.1
404.1
602.1 602.2

Summary of Modification

Removes provisions from Sections 401.2,401.2.2,401.2.3,602.1 & 602.2 that wer already moved to Chapter 3 last cycle

Rationale

The modification removes provisions that were already moved to Chapter 3 in the last cycle. When they were moved, however, the remaining duplicate provisions addressed by this proposal could not be deleted because of Group assignments.
Sections 401.2.1, 401.2.2, 602.1, and 602.2 are now in Sections 302.3 and 302.4. Section 401.2.3 is now in Sections 301.1.4.1 and 301.1.4.2.
If 401.2.1 - 401.2.3 are deleted as proposed, the balance of 401.2 can be deleted as well.
Section 403.1 is revised accordingly to cite the existing sections that cover new and existing materials.
In Section 404.1, the two references to Section 401.2 are removed and not replaced because they are actually erroneous references that should have been removed in a previous cycle. Their
removal here is at most editorial, but could even be construed as errata. The reference to 401.2 used to match a provision in FBC Chapter 34 that referred to Section 3401.2 Maintenance, but that
section no longer exists in the FEBC in any of its compliance methods. The first instance could be revised to refer instead to 302.4, but it is frankly not needed, as 302.4 applies even without a direct reference. The second instance is clearly a mistaken reference to the old maintenance provision, not a reference to the current provisions about new and existing materials.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity as this is already a code requirement

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners as this is already a code requirement

Impact to industry relative to the cost of compliance with code

No impact to building and property owners as this is already a code requirement

Impact to small business relative to the cost of compliance with code

No impact to small businesses as this is already a code requirement

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by cleaning up duplicate language

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by cleaning up duplicate language

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against material, products, methods, or systems of construction of demonstrated capabilities, this is a current code requirement that does not limit material, products, methods, or systems of construction

Does not degrade the effectiveness of the code

Increases the effectiveness of the code by cleaning up duplicate language

Delete without substitution:

~~**401.2 Building materials and systems.** Building materials and systems shall comply with the requirements of this section.~~

~~**401.2.1 Existing materials.** Materials already in use in a building in compliance with requirements or approvals in effect at the time of their erection or installation shall be permitted to remain in use unless determined by the building official to be unsafe per Section 115.~~

~~**401.2.2 New and replacement materials.** Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for repairs and alterations, provided no hazard to life, health or property is created. Hazardous materials shall not be used where the code for new construction would not permit their use in buildings of similar occupancy, purpose and location.~~

~~**401.2.3 Existing seismic force-resisting systems.** Where the existing seismic force-resisting system is a type that can be designated ordinary, values of R, 0 and Cdfor the existing seismic force-resisting system shall be those specified by the International Building Code for an ordinary system unless it is demonstrated that the existing system will provide performance equivalent to that of a detailed, intermediate or special system.~~

Revise as follows:

403.1 General. Except as provided by ~~Section 401.2~~Sections 302.3, 302.4, or this section, *alterations* to any building or structure shall comply with the requirements of the *Florida Building Code* for new construction. *Alterations* shall be such that the existing building or structure is no less conforming to the provisions of the *Florida Building Code* than the *existing building* or structure was prior to the *alteration.*

Exceptions:

1. An existing stairway shall not be required to comply with the requirements of Section 1011 of the *Florida Building Code* where the existing space and construction does not allow a reduction in pitch or slope.

2. Handrails otherwise required to comply with Section 1011.11 of the *Florida Building Code* shall not be required to comply with the requirements of Section 1014.6 of the *Florida Building Code* regarding full extension of the handrails where such extensions would be hazardous due to plan configuration.

404.1 General. Buildings and structures, and parts thereof, shall be repaired in compliance with ~~Sections 401.2 and 404~~this section. Work on nondamaged components that is necessary for the required *repair* of damaged components shall be considered part of the *repair* and shall not be subject to the requirements for alterations in this chapter. ~~Routine maintenance required by Section 401.2~~Maintenance, ordinary repairs exempt from permit in accordance with Section 105.2, and abatement of wear due to normal service conditions shall not be subject to the requirements for repairs in this section.

Delete without substitution:

~~**602.1 Existing building materials.** Materials already in use in a building in compliance with requirements or approvals in effect at the time of their erection or installation shall be permitted to remain in use unless determined by the code *official* to render the building or structure *unsafe* or dangerous as defined in Chapter 2. **602.2 New and replacement materials.** Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for *repairs* and *alterations*, provided no *dangerous* or *unsafe conditio*n, as defined in Chapter 2, is created. Hazardous materials, such as~~

~~asbestos and lead-based paint, shall not be used where the code for new construction would not permit their use in buildings of similar occupancy, purpose and location.~~

S8232

Date Submitted	12/14/2018	**Section**	401.2.1	**Proponent**	Ann Russo4
Chapter	4	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** | **Alternate Language** **No**

Related Modifications

401.2.2
302.1 602.2

Summary of Modification

Deletes the "Existing [Building] Materials" and "New and Replacement Materials" sections from Chapters 4 and 6 because they are already inserted in chapter 3.

Rationale

This Modification deletes the "Existing [Building] Materials" and "New and Replacement Materials" sections from Chapters 4 and 6 because they are already inserted in chapter 3. The content in
Chapter 3 applies to all methods in the FEBC so deleting these sections in the other method chapters reduces redundancy.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity as this is already a code requirement

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners as this is already a code requirement

Impact to industry relative to the cost of compliance with code

No impact to industry as this is already a code requirement

Impact to small business relative to the cost of compliance with code

No impact to small businesses as this is already a code requirement

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by removing wording that already is in Chapter 3

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by removing wording that already is in Chapter 3

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Improves the health, safety, and welfare of the general public by removing wording that already is in Chapter 3

Does not degrade the effectiveness of the code

Improves the effectiveness of the code by removing wording that already is in Chapter 3

2015 International Existing Building Code

Delete without substitution:

~~**401.2.1 Existing materials.** Materials already in use in a building in compliance with requirements or approvals in effect at the time of their erection or installation shall be permitted to remain in use unless determined by the building official to be unsafe per Section 115.~~

~~**401.2.2 New and replacement materials.** Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for *repairs* and *alterations*, provided no hazard to life, health or property is created. Hazardous materials shall not be used where the code for new construction would not permit their use in buildings of similar occupancy, purpose and location.~~

S8241

Date Submitted	12/14/2018	**Section**	403.4	**Proponent**	Ann Russo4
Chapter	4	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

807.5

Summary of Modification

Makes editorial changes applying the preferred language from the two parallel sections: 403.4, the referencing 403.9, not 403.5.In 807.5 refer toSections 1609 and 1613.

Rationale

This modification makes corresponding sections of the Prescriptive and Work Area methods identical. It makes a number of editorial revisions (listed below) and one substantive change. The substantive change is this: Currently, for exactly the same situations, Section 807.5 allows the use of reduced seismic loads, while Section 403.4 does not. Reduced loads are appropriate in these cases, so the proposal revises 403.4 to match 807.5.

The editorial changes simply make the wording match, applying the preferred language from the two parallel sections:

- In 403.4, the reference to the section on voluntary retrofit should be to 403.9, not 403.5. This is errata.
- In 807.5, instead of referring to "wind and seismic provisions," the text should refer more specifically to Sections 1609 and 1613.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity as this is an editorial changes simply make the wording match, applying the preferred language from the two parallel sections

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners as this is an editorial changes simply make the wording match, applying the preferred language from the two parallel sections

Impact to industry relative to the cost of compliance with code

No impact to industry as this is an editorial changes simply make the wording match, applying the preferred language from the two parallel sections

Impact to small business relative to the cost of compliance with code

No impact to small business owners as this is an editorial changes simply make the wording match, applying the preferred language from the two parallel sections

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by cleaning up wording making wording match

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by cleaning up wording making wording match

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against material, products, methods, or systems of construction of demonstrated capabilities, this is a current code requirement that does not limit material, products, methods, or systems of construction

Does not degrade the effectiveness of the code

Improves the effectiveness of the code by cleaning up wording making wording match

Revise as follows:

[BS] 403.4 Existing structural elements carrying lateral load. Except as permitted by Section ~~403.5~~ 403.9, where the *alteration* increases design lateral loads ~~in accordance with Section 1609 or 1613 (the High-Velocity Hurricane Zone shall comply with Section 1620) of the *Florida Building Code*~~, or where the *alteration* results in a prohibited structural irregularity as defined in ASCE 7, or where the *alteration* decreases the capacity of any existing lateral load-carrying structural element, the structure of the altered building or structure shall ~~be shown to~~ meet the requirements of Sections 1609 and 1613 of the *Florida Building Code*. ~~For purposes of this section, compliance with ASCE 41, using a Tier 3 procedure and the two-level performance objective in Table 301.1.4.1 for the applicable risk category~~, Reduced Florida Building Code-level seismic forces shall be ~~deemed to meet the requirements of Section 1613(the HVHZ shall comply with Section 1620) of the Florida Building Code~~ permitted.

Exception: Any existing lateral load-carrying structural element whose demand-capacity ratio with the *alteration* considered is ~~no~~ not more than 10 percent greater than its demand-capacity ratio with the *alteration* ignored shall be permitted to remain unaltered. For purposes of calculating demand-capacity ratios, the demand shall consider applicable load combinations with design lateral loads or forces in accordance with Sections 1609 and 1613 (the HVHZ shall comply with Section 1620) of the *Florida Building Code*. Reduced Florida Building Code-level seismic forces shall be permitted. For purposes of this exception, comparisons of demand-capacity ratios and calculation of design lateral loads, forces, and capacities shall account for the cumulative effects of *additions* and *alterations* since original construction.

[BS] 807.5 Existing structural elements resisting lateral loads. Except as permitted by Section 807.6, where the alteration increases design lateral loads, or where the alteration results in prohibited structural irregularity as defined in ASCE 7, or where the alteration decreases the capacity of any existing lateral load-carrying structural element, the structure of the altered building or structure shall ~~be shown to~~ meet the ~~wind~~ requirements of Sections 1609 and ~~seismic provisions~~ 1613 of the *Florida Building Code*. Reduced *Florida Building Code*-level seismic forces ~~in accordance with Section 301.1.4.2~~ shall be permitted.

Exception: Any existing lateral load-carrying structural element whose demand-capacity ratio with the alteration considered is not more than 10 percent greater than its demand-capacity ratio with the alteration ignored shall be permitted to remain unaltered. For purposes of calculating demand-capacity ratios, the demand shall consider applicable load combinations with design lateral loads or forces in accordance with ~~*Florida Building Code*~~ Sections 1609 and 1613 of the *Florida Building Code*. Reduced *Florida Building Code* level seismic forces ~~in accordance with Section 301.1.4.2~~ shall be permitted. For purposes of this exception, comparisons of demand-capacity ratios and calculation of design lateral loads, forces, and capacities shall account for the cumulative effects of additions and alterations since original construction.

S8245

Date Submitted	12/14/2018	**Section**	403.4.1	**Proponent**	Ann Russo4
Chapter	4	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

403.6 403.7

Summary of Modification

Revises these provisions more consistent with the work area method which would only address alterations that have reconfigured space over 50% of the building. This proposal limits the area of alterations to the defined term; "work area"

Rationale

The modification revises the provisions more consistent with the work area method which would only address alterations that have reconfigured space over 50% of the building. This proposal limits the area of alterations to the defined term; "work area". This will prevent the inclusion of other areas, such as portions of the building where incidental work is being performed

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity as this is already a code requirement

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners as this is already a code requirement

Impact to industry relative to the cost of compliance with code

No impact to industry as this is already a code requirement

Impact to small business relative to the cost of compliance with code

No impact to small businesses as this is already a code requirement

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by making the provision more consistent with the work are method

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves by making the provision more consistent with the work are method

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against material, products, methods, or systems of construction of demonstrated capabilities, this is a current code requirement that does not limit material, products, methods, or systems of construction

Does not degrade the effectiveness of the code

Increases the effectiveness of the code by making the provision more consistent with the work are method

Revise as follows:

[BS] 403.4.1 Seismic Design Category F. Where the work area portion of the building undergoing the intended alteration exceeds 50 percent of the aggregate area of the building, and where the building is assigned to Seismic Design Category F, the structure of the altered building shall be shown to meet the earthquake design provisions of the *Florida Building Code*. For purposes of this section, the earthquake loads need not be taken greater than 75 percent of those prescribed in Section 1613 of the *Florida Building Code* for new buildings of similar occupancy, purpose and location. New structural members and connections required by this section shall comply with the detailing provisions of this code for new buildings of similar structure, purpose and location.

[BS] 403.6 Wall anchorage for unreinforced masonry walls in major alterations. Where the work area portion of the building undergoing the intended alteration exceeds 50 percent of the aggregate area of the building, the building is assigned to Seismic Design Category C, D, E or F, and the building's structural system includes unreinforced masonry walls, the alteration work shall include installation of wall anchors at the roof line to resist seismic forces, unless an evaluation demonstrates compliance of existing wall anchorage. For purposes of this section, design seismic forces need not be taken greater than 75 percent of those that would be required for the design of new buildings of similar structure, purpose and location.

[BS] 403.7 Bracing for unreinforced masonry parapets in major alterations. Where the work area portion of the building undergoing the intended alteration exceeds 50 percent of the aggregate area of the building, and where the building is assigned to Seismic Design Category C, D, E or F, parapets constructed of unreinforced masonry shall have bracing installed as needed to resist out-of-plane seismic forces, unless an evaluation demonstrates compliance of such items. For purposes of this section, design seismic forces need not be taken greater than 75 percent of those that would be required for the design of similar nonstructural components in new buildings of similar purpose and location.

S8248

Date Submitted	12/14/2018	**Section**	403.4.1	**Proponent**	Ann Russo4
Chapter	4	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No **Alternate Language** No

Related Modifications

403.6 403.7

Summary of Modification

This code change clarifies the work area method as it applies to alterations. The modification makes further simplifications and also substitutes the defined term, "building area".

Rationale

The modification revises these provisions more consistent with the work area method which would only address alterations that have reconfigured space over 50% of the building. This proposal limits the area of alterations to the defined term; "work area". This will prevent the inclusion of other areas, such as portions of the building where incidental work is being performed.The modification makes further simplifications and also substitutes the defined term, "building area".

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity as this is already a code requirement

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners as this is already a code requirement

Impact to industry relative to the cost of compliance with code

No impact to industry as this is already a code requirement

Impact to small business relative to the cost of compliance with code

No impact to small businesses as this is already a code requirement

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by making the provision more consistent with the work are method

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by making the provision more consistent with the work are method

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against material, products, methods, or systems of construction of demonstrated capabilities, this is a current code requirement that does not limit material, products, methods, or systems of construction

Does not degrade the effectiveness of the code

Improves the effectiveness of the code by making the provision more consistent with the work are method

Revise as follows:

[BS] 403.4.1 Seismic Design Category F. Where the work area ~~portion of the building undergoing the intended alteration~~ exceeds 50 percent of the ~~aggregate~~ building area ~~of the building~~, and where the building is assigned to Seismic Design Category F, the structure of the altered building shall be shown to meet the earthquake design provisions of the *Florida Building Code*. For purposes of this section, the earthquake loads need not be taken greater than 75 percent of those prescribed in Section 1613 of the *Florida Building Code* for new buildings of similar occupancy, purpose and location. New structural members and connections required by this section shall comply with the detailing provisions of this code for new buildings of similar structure, purpose andlocation.

[BS] 403.6 Wall anchorage for unreinforced masonry walls in major alterations. Where the work area ~~portion of the building~~ ~~undergoing the intended alteration~~ exceeds 50 percent of the ~~aggregate~~ building area ~~of the building~~, the building is assigned to Seismic Design Category C, D, E or F, and the building's structural system includes unreinforced masonry walls, the alteration work shall include installation of wall anchors at the roof line to resist seismic forces, unless an evaluation demonstrates compliance of existing wall anchorage. For purposes of this section, design seismic forces need not be taken greater than 75 percent of those that would be required for the design of new buildings of similar structure, purpose and location.

[BS] 403.7 Bracing for unreinforced masonry parapets in major alterations. Where the work area ~~portion of the building~~ ~~undergoing the intended alteration~~ exceeds 50 percent of the ~~aggregate~~ building area ~~of the building~~, and where the building is assigned to Seismic Design Category C, D, E or F, parapets constructed of unreinforced masonry shall have bracing installed as needed to resist out-of-plane seismic forces, unless an evaluation demonstrates compliance of such items. For purposes of this section, design seismic forces need not be taken greater than 75 percent of those that would be required for the design of similar nonstructural components in new buildings of similar purpose and location.

S8250

Date Submitted	12/14/2018	**Section**	403.4.1	**Proponent**	Ann Russo4
Chapter	4	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Reconciles a substantive difference between the Work Area and Prescriptive Method adding. It adds wind requirements. The Work Area method is preferred, and the Prescriptive method is revised to match.

Rationale

This proposal reconciles a substantive difference between the Work Area and Prescriptive methods.
Current section 403.4.1 already has a seismic evaluation/retrofit trigger that matches section 907.4.3, but 907.4.3 also has a wind requirement. This proposal adds a matching wind requirement to the Prescriptive provision.
Since the provision only applies in high seismic areas (SDC F), it is unlikely that a wind requirement will govern over the seismic requirement, but FEBC provisions traditionally treat wind and seismic together, so the Work Area method is preferred, and the Prescriptive method is revised to match.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will impact local entity only for SDC F buildings with high wind loads undergoing major alterations

Impact to building and property owners relative to cost of compliance with code

Will impact building and property owners. Will increase the cost of construction
Cost-beneficial cost increase, only for SDC F buildings with high wind loads undergoing major alterations

Impact to industry relative to the cost of compliance with code

Will impact Industry. Will increase the cost of construction
Cost-beneficial cost increase, only for SDC F buildings with high wind loads undergoing major alterations

Impact to small business relative to the cost of compliance with code

Will impact small business owners. Will increase the cost of construction
Cost-beneficial cost increase, only for SDC F buildings with high wind loads undergoing major alterations

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by reconciling a substantive difference between the Work Area and Prescriptive methods

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by reconciling a substantive difference between the Work Area and Prescriptive methods

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against material, products, methods, or systems of construction of demonstrated capabilities, this is a current code requirement that does not limit material, products, methods, or systems of construction

Does not degrade the effectiveness of the code

Improves the effectiveness of the code by reconciling a substantive difference between the Work Area and Prescriptive methods

Revise as follows:

[BS] 403.4.1 Seismic Design Category F. Where the portion of the building undergoing the intended alteration exceeds 50 percent of the aggregate area of the building, and where the building is assigned to Seismic Design Category F, the structure of the altered building shall ~~be shown to~~ meet the ~~earthquake design provisions~~ <u>requirements of Sections 1609 and 1613</u> of the *Florida Building Code*. For purposes of this section, the earthquake loads need not be taken greater than 75 percent of those prescribed in Section 1613 of the *Florida Building Code* for new buildings of similar occupancy, purpose and location. New structural members and connections required by this section shall comply with the detailing provisions of this code for new buildings of similar structure, purpose and location.

S8374

Date Submitted	12/15/2018	**Section**	401	**Proponent**	Ann Russo8
Chapter	4	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

EB14-15 and
EB26-15 CH 5

Summary of Modification

EB14-15 & EB26-15 Combined per Mo Madani. Replaces the word "maintaining" with "restoring," to avoid confusion. Replaces the phrase "good or sound" (removed elsewhere in past cycles) with "pre-damage," as used elsewhere in Chapters 4 and 6. etc.

Rationale

EB14-15 - This proposal cleans up repetitive language in Chapters 4 and 6 now found in Chapter 3.
EB26-15 - Replaces the word "maintaining" with "restoring," to avoid confusion between maintenance and repair. It replaces the phrase "good or sound" (removed elsewhere in past cycles) with "pre-damage," as used elsewhere in Chapters 4 and 6.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Code clarification only and has no effect on enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

Code clarification only and does not increase the cost of construction.

Impact to industry relative to the cost of compliance with code

Code clarification only and does not increase the cost of construction.

Impact to small business relative to the cost of compliance with code

Code clarification only and does not increase the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Code clarification only and has no effect on enforcement of the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Code clarification only and has no effect on the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Code clarification only. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not degrade the effectiveness of the code

Code clarification only. Does not degrade the effectiveness of the code.

ICC MOD's Combined per Mo Madani - EB14-15 & EB26-15 Section: 401.2, 401.2.1, 401.2.2, 401.2.3, 403.1, 404.1, 502.1, 602.1, 602.3

Delete without substitution:

~~**401.2 Building materials and systems.** Building materials and systems shall comply with the requirements of this section.~~

~~**401.2.1 Existing materials. Materials already in use in a building in compliance with requirements or approvals in effect at the time of their erection or installation shall be permitted to remain in use unless determined by the building official to be unsafe per Section 15.**~~

~~**401.2.2 New and replacement materials.** Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for *repairs* and *alterations*, provided no hazard to life, health or property is created. Hazardous materials shall not be used wherethecodefornewconstructionwouldnotpermittheiruseinbuildingsof similar occupancy, purpose and location.~~

~~401.2.3 **Existingseismicforce-resistingsystems.**Wheretheexistingseismicforce-resistingsystemis a type that can be designated ordinary, values of R, $_0$and $C_d$for the existing seismic force-resisting system shall be those specified by the *International Building Code* for an ordinary system unless it is demonstrated that the existing system will provide performance equivalent to that of a detailed, intermediate or specialsystem.~~

Revise as follows:

403.1 General. Except as provided by ~~Section 401.2~~ Sections 302.3, 302.4, or this section, *alterations* to any building or structure shall comply with the requirements of the *International Building Code* for new construction. *Alterations* shall be such that the *existing building* or structure is no less conforming to the provisions of the *International Building Code* than the *existing building* or structure was priorto the *alteration*.

Exceptions:

1. **Anexistingstairwayshallnotberequiredtocomplywiththerequirementsof Section1011of the *International Building Code* where the existing space and construction does not allow a reduction in pitch or slope.**
2. HandrailsotherwiserequiredtocomplywithSection1011.11ofthe*International Building Code* shall not be required to comply with the requirements of Section 1014.6of the *International Building Code* regarding full extension of the handrails where such extensions would be hazardous due to plan configuration.

404.1 General. Buildings and structures, and parts thereof, shall be repaired in compliance with ~~Sections 401.2 and 404~~ this section. Work on nondamaged components that is necessary for the required *repair* of damaged components shall be considered part of the *repair* and shall not be subject to the requirements for *alterations* in this chapter. ~~Routine maintenance required by Section 401.2~~ Maintenance, ordinary repairs exempt from permit in accordance with Section 105.2, and abatement of wear due to normal service conditions shall not be subject to the requirements for repairs in this section.

Delete without substitution:

~~602.1 Existing building materials. Materials already in use in a building in compliance with requirements or approvals in effect at the time of their erection or installation shall be permitted to remain in use unless determined by the *code official* to render the building or structure unsafe or *dangerous* as defined in Chapter 2.~~

~~602.3 New and replacement materials. Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for *repairs* and *alterations*, provided no *dangerous* or *unsafe* condition,as defined in Chapter 2, is created. Hazardous materials, such as asbestos and lead-based paint, shall not be used where the code for new construction would not permit their use in buildings of similar occupancy, purpose and location.~~

Section: 502.1

Revise as follows:

502.1 Scope. *Repairs,* as defined in Chapter 2, include the patching or restoration or replacement of damaged materials, elements, *equipment or fixtures* for the purpose of ~~maintaining such components in good or sound~~ restoring the pre-damage condition with respect to existing loads or performance requirements.

S8380

Date Submitted	12/15/2018	**Section**	602	**Proponent**	Ann Russo8
Chapter	6	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

EB14-15 CH 6
EB14-15 CH 4

Summary of Modification

The proposal removes provisions that were already moved to Chapter 3 in the last cycle. Sections 602.1, and 602.2 are now in Sections 302.3 and 302.4.

Rationale

The proposal removes provisions that were already moved to Chapter 3 in the last cycle. Sections 602.1, and 602.2 are now in Sections 302.3 and 302.4.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

The proposal removes provisions that were already moved to Chapter 3 in the last cycle so there is no impact on enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

The proposal removes provisions that were already moved to Chapter 3 in the last cycle and does not increase the cost of construction.

Impact to industry relative to the cost of compliance with code

The proposal removes provisions that were already moved to Chapter 3 in the last cycle and does not increase the cost of construction.

Impact to small business relative to the cost of compliance with code

The proposal removes provisions that were already moved to Chapter 3 in the last cycle and does not increase the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The proposal removes provisions that were already moved to Chapter 3 in the last cycle so there is no impact on enforcement of the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The proposal removes provisions that were already moved to Chapter 3 in the last cycle so there is no impact on enforcement of the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The proposal removes provisions that were already moved to Chapter 3 in the last cycle and does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The proposal removes provisions that were already moved to Chapter 3 in the last cycle and does not degrade the effectiveness of the code.

Sections: 602.1, 602.2

Delete without substitution:

~~**602.1 Existingbuildingmaterials.**Materialsalreadyinuseinabuildingincompliancewithrequirements or approvals in effect at the time of their erection or installation shall be permitted to remain in use unless determined by the *code official* to render the building or structure unsafe or *dangerous* as defined in Chapter2.~~

~~**602.2 New and replacement materials.** Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permittedfor*repairs*and*alterations*,providedno*dangerous*or*unsafe*condition,asdefinedinChapter2, is created. Hazardous materials, such as asbestos and lead-based paint, shall not be used where the code for new construction would not permit their use in buildings of similar occupancy, purpose and location.~~

Date Submitted	11/19/2018	**Section**	706	**Proponent**	Michael Silvers (FRSA)
Chapter	7	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Building Code Section 1511 Existing Roofing

Summary of Modification

This modification adds language to clarify that salvaged slate, clay and concrete roof tile of a like kind can be used in certain applications.

Rationale

There are several sections of the code that indicate that some reuse of these materials are permitted: 104.9., 602.1 and 1506.2.1 all at least suggest acceptance. Section 1511.5 states that existing material may be reinstalled. It is not clear on when existing material quantities can be augmented. FS 553.842 allows reuse if the product approval requirements haven't changed. But it's not clear if the particular material never had product approval or the approval has changed if it can be used. The proposed change clarifies when the reuse of slate, clay and concrete roof tile may be acceptable when current product approvals or notice of acceptance are not available.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification does not impact cost associated with enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This modification does not impact cost associated with enforcement of the code.

Impact to industry relative to the cost of compliance with code

This modification does not impact cost associated with compliance with the code.

Impact to small business relative to the cost of compliance with code

This modification does not impact cost associated with compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This modification will allow use of salvaged material that matches existing material. This will make maintenance and repair of existing tile roofs a good alternative to complete replacement.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This modification will allow use of salvaged material that matches existing material. This will make maintenance and repair of existing tile roofs a good alternative to complete replacement.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This modification does not discriminate against any materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This modification does not degrade the effectiveness of the code.

706.5 Reinstallation/Reuse of materials.

Existing or salvaged slate, clay or ~~cement~~ concrete tile shall be permitted for reinstallation or reuse, to repair an existing slate or tile roof, except that salvaged slate or tile shall be of like kind in both material and profile. D~~d~~amaged, cracked or broken slate or tile shall not be reinstalled. The building official may permit salvaged slate, clay and concrete tile to be installed on additions and new construction, when the tile is tested in compliance with the provisions of Section 1507 or 1523 (HVH shall comply with Section 1523) and installed in accordance with Section 1507 or 1518 (HVHZ shall comply with Section 1518). Existing vent flashing, metal edgings, drain outlets, collars and metal counterflashings shall not be reinstalled where rusted, damaged or deteriorated. Aggregate surfacing materials shall not be reinstalled. (High-Velocity Hurricane Zones shall comply with Sections 1512 through 1525 of the Florida Building Code, Building).

S7525

Date Submitted 11/29/2018
Chapter 7
Section 706
Affects HVHZ Yes
Proponent Michael Silvers (FRSA)
Attachments Yes
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments Yes

Alternate Language No

Related Modifications

Changes to Section 707 and 403.8 are also included and shouldn't be considered separately.

Summary of Modification

Expands 706.7 Mitigation by eliminating "single family residential" thereby covering all applicable site built structures. It removes the "roofing materials are removed" trigger and replaces it with prescriptive methods already in code.

Rationale

Engineers who can perform an evaluation can't agree when it applies, or what it requires. It states: "When roofing materials are removed from more than 50 percent of the roof diaphragm" which when you consider the 25% rule (Existing Building, 706.1.1) makes the 50% threshold actually 25%. It can be interpreted that during any roof replacement the structural evaluation and mitigation is required. The owner must commit to an open ended contract with a no idea of the potential cost, what the scope of work might be or how many trades may be involved. Some older deck types that proceed uplift testing are deemed unacceptable for use as a substrate. This could necessitate complete deck replacement as well as reworking or replacement of the roof to wall connections. If the building is occupied there is additional cost. The cost of this work could very well make continued use of the building nonviable. This would apply to a building that conformed to the building code when it was built. Expanding the current prescriptive methods in 706.7 Mitigation will provide a clear, consistent and familiar approach to improving the wind resistance of applicable structures. Changing the trigger from "Where roofing materials are removed from more than 50 percent of the roof diaphragm" to "Where more than 25 percent of the roof diaphragm is repaired or replaced" will properly place the requirement for a roof diaphragm and roof to wall connection evaluation and possible repair or replacement in the structural scope as opposed to part of the routine building maintenance of a roof covering replacement. The 25% threshold mirrors existing requirements to bring the balance of the work into compliance with the code. See 706.1.1. This approach will address recommendations outlined in the FBC funded University of Florida report titled Cost Impacts of 2017 FBC-EB 707.3.2 Roof Diaphragm Reroofing Requirements. (Portions attached)

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification provides cost savings by reducing enforcement of requirements of 707.3.2 on all applicable roof replacement projects and replacing them with prescriptive methods currently in the code.

Impact to building and property owners relative to cost of compliance with code

This modification provides cost savings. See Support File.

Impact to industry relative to the cost of compliance with code

This modification provides cost savings. See Support File

Impact to small business relative to the cost of compliance with code

This modification provides cost savings. See Support File.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This modification eliminates the extremely burdensome requirements and associated cost of 707.3.2 on all applicable roof replacements. The change clarifies when the required engineering evaluation and related work needs to be done.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

It will allow a simple roof covering replacement without the burdensome roof diaphragm engineering evaluation currently required. The current requirements are ambiguous which creates wide spread confusion for contractors, engineers and code enforcement officials.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This modification does not discriminate against any materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This modification does not degrade the effectiveness of the code. Current requirements of 707.3.2 are ambiguous and are typically ignored. The modification replaces the confusing and unenforced requirements with prescriptive requirements currently in the code for applicable structures

1st Comment Period History

S7525-G1

Proponent Gaspar Rodriguez **Submitted** 1/16/2019 **Attachments** No

Comment:

The code section referring to site-built single-family residential structure is derived from statutorily-mandated language. 553.844(2) (b) FS, specifically indicates "single-family residential structures." This proposed code mod will expand the statue, which I believe is beyond the scope of updating the code.

Also, the cost savings indicated on the support file only refers to the Cost Impact of Roof Diaphragm Reroofing Requirements. I would maintain that the cost impact of expanding FEBC 706.7 Mitigation Section, has an increase cost impact on enforcement cost.

1st Comment Period History

S7525-G2

Proponent	Mo Madani	**Submitted**	1/27/2019	**Attachments**	No

Comment:

Mitigation techniques and requirements of the 2017 FBC are consistent with section 553.844 FS.

706.7 Mitigation.

When a roof covering on an existing site-built ~~single-family residential~~ structure is removed and replaced, the following procedures shall be permitted to be performed by the roofing contractor:

(a) Roof-decking attachment shall be as required by Section 706.7.1.

(b) A secondary water barrier shall be provided as required by Section 706.7.2.

Exception: ~~Single-family residential~~ structures permitted subject to the Florida Building Code are not required to comply with this section.

706.7.1 Roof decking attachment for site-built ~~singlefamily residential~~ structures.

For site-built ~~single-family residential~~ structures the fastening shall be in accordance with Section 706.7.1.1 or 706.7.1.2 as appropriate for the existing construction. 8d nails shall be a minimum of 0.113 inch (2.9 mm) in diameter and shall be a minimum of $2^1/_4$ inches (57 mm) long to qualify for the provisions of this section for existing nails regardless of head shape or head diameter.

Remaining text unchanged.

706.7.2 Roof secondary water barrier for site-built ~~singlefamily residential~~ structures.

706.8

When a roof covering on an existing site-built ~~single family residential~~ structure is removed and replaced on a building that is located in the wind-borne debris region as defined in the Florida Building Code, Building and that has an insured value of $300,000 or more or, if the building is uninsured or for which documentation of insured value is not presented, has a just valuation for the structure for purposes of ad valorem taxation of $300,000 or more:

(a) Roof to wall connections shall be improved as required by Section 706.8.1.

(b) Mandated retrofits of the roof-to-wall connection shall not be required beyond a 15 percent increase in the cost of reroofing.

Exception: ~~Single-family residential~~ structures permitted subject to the Florida Building Code are not required to comply with this section.

706.8.1 Roof-to-wall connections for site-built ~~singlefamily residential~~ structures.

Remaining text unchanged.

SECTION 707
STRUCTURAL

707.3.2 Roof diaphragms resisting wind loads in high-wind regions.
Where ~~roofing materials are removed from~~ more than ~~50~~ 25 percent of the roof diaphragm ~~or section of~~ is repaired or replaced on a building located where the ultimate design wind speed, V_{ult}, is greater than 115 mph, as defined in Section 1609 (the HVHZ shall comply with Section 1620) of the *Florida Building Code, Building*, roof diaphragms, connections of the roof diaphragm to roof framing members, and roof-to-wall connections shall be evaluated for the wind loads specified in the *Florida Building Code, Building*, including wind uplift. If the diaphragms and connections in their current condition are not capable of resisting at least 75 percent of those wind loads, they shall be replaced or strengthened in accordance with the loads specified in the *Florida Building Code, Building*.

~~**Exceptions:**~~

~~1.This section does not apply to buildings permitted subject to the Florida Building Code.~~

~~2.This section does not apply to buildings permitted subject to the 1991 *Standard Building Code*, or later edition, or designed to the wind loading requirements of the ASCE 7-88 or later editions, where an evaluation is performed by a registered design professional to confirm the roof diaphragm, connections of the roof diaphragm to roof framing members, and roof-to-wall connections are in compliance with the wind loading requirements of either of these standards or later editions.~~

~~3.Buildings with steel or concrete moment resisting frames shall only be required to have the roof diaphragm panels and diaphragm connections to framing members evaluated for wind uplift.~~

~~4. This section does not apply to site-built singlefamily dwellings. Site-built single-family dwellings shall comply with Sections 706.7 and 706.8.~~

~~5. This section does not apply to buildings permitted within the HVHZ after January 1, 1994 subject to the 1994 South Florida Building Code, or later editions, or where the building's wind design is based on the wind loading requirements of ASCE 7-88 or later editions.~~

SECTION 403

ALTERATIONS

403.8 Roof diaphragms resisting wind loads in highwind regions.

Where ~~the intended alteration requires a permit for reroofing and involves removal of roofing materials from~~ more than ~~50~~<u>25</u> percent of the roof diaphragm <u>is repaired or replaced on </u>~~of a building or section of~~ a building located where the ultimate design wind speed is greater than 115 mph (51 m/s) in accordance with Figure 1609.3(1) of the Florida Building Code, Building as defined in Section 1609 (the HVHZ shall comply with Section 1620) of the Florida Building Code, Building, roof diaphragms, connections of the roof diaphragm to roof framing members, and roof-to-wall connections shall be evaluated for the wind loads specified in Section 1609 of the Florida Building Code, Building, including wind uplift. If the diaphragms and connections in their current condition are not capable of resisting at least 75 percent of those wind loads, they shall be replaced or strengthened in accordance with the loads specified in Section 1609 of the Florida Building Code, Building.

Remaining text unchanged.

Cost Impact of 2017 FBC-EB § 707.3.2 Roof Diaphragm Reroofing Requirements

RINKER-CR-2018-105

Final Report

1 June 2018

Submitted to

Mo Madani

Department of Business and Professional Regulation
1940 North Monroe Street
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Table 7. Bid Prices for A-F Roof type and A-C Repair Scenarios+*

Repair	LWC on Bar Joists	Wood Deck System	Metal on Steel Bar Joists	Gypsum on Spaced Joists	Tectum on Spaced Joists	LWEC Deck System
Base Bid (incl. in A-C Repair Scenarios)	**1:**$129,940 **2:**$109,688 **3:**$138,000	**1:** $128,540 **2:** $105,931 **3:** $139,000	**1:** $153,300 **2:** $128,773 **3:** $149,000	**1:**$129,940 **2:**$118,311 **3:**$143,000	**1:**$128,570 **2:**$118,311 **3:**$146,000	**1:**$128,540 **2:**$106,334 **3:**$141,000
Bid Line No.	1	1	1	1	1	1
A. Enhanced fastening of the roof deck	**1:**$134,440+ **2:**$157,556 **3:**$164,400	NA	**1:**$156,800+ **2:** $140,092 **3:** $163,425	NA	NA	**1:**$133,040+ **2:**$118,753 **3:**$155,900
Bid Line Nos.	1,2,3,4 & 8	---------	1,2,3,4 & 8	---------	---------	1,2,3,4,5 & 9
B. Roof-to-wall connections enhanced fastening	**1:**$146,940+* **2:**$128,208 **3:**$164,990	**1:** $131,040+ **2:** $123,631 **3:** $158,560	**1:** $169,300+* **2:** $147,293 **3:** $173,200	**1:**$145,940+ **2:**$134,231 **3:**$134,575	**1:** $144,570+ **2:** $134,231 **3:** $179,075	**1:**$145,540+* **2:**$125,954 **3:**$165,675
Bid Line Nos.	1,2, 4,5 & 8	1, 2, 3 & 7	1,2,4,5 & 8	1,2,3,4 & 7	1,2,3,4 & 7	1,2,3,5,6 & 9
C. Entire roof deck replacement	**1:**$284,440+ **2:**$265,188* **3:**$173,790	**1:** $158,540+ **2:** $148,431* **3:** $196,600	**1:** $231,800+ **2:** $219,273* **3:** $230,150	**1:**$293,440+ **2:**$226,211* **3:**$207,795	**1:**$282,070+ **2:**$226,211* **3:**$246,815	**1:**$283,040+ **2:**$252,934* **3:**$235,075
Bid Line Nos.	1,2,4,7 & 8	1, 2, 6 &7	1,2, 4,7 & 8	1,2,3,6 & 7	1,2,3,6 & 7	1,2,3,5,8 & 9

+ = No Bid Items; * = Condition/Exclusions

COST NOTES:

- For all 6 deck types the following cost items need to be also taken into consideration:
  - **1:** Cost for relocation if needed of occupants, contents, etc. (Depends on use)
  - **2:** Cost for loss of business (Depends on use)
  - **3:** Cost for isolating dust from occupied area if contents are not relocated (Depends on use)
  - **4:** Cost to repair or replacing ceilings (Depends on use)
  - **5:** Cost to keep temporarily watertight or phasing of work to do the same (Factored in Bid)
  - **6:** Cost of engineering for each protocol ($8,250).
- For deck types with rigid insulation for replacement (A, B, D, E & F) the Cost for the cover board that is required over the polyisocyanurate insulation is factored in bid and cost if replacement triggers energy code requirements would apply across the boards regardless of diaphragm frame.
- For light weight insulating concrete deck type (A) the cost for required tapered insulation for replacement of LWIC fill is factored in bid.
- For gypsum deck type (D) cost for relocation (mandatory) depends on building use type and the cost for removal and replacement of ceiling, ductwork, wiring etc. depends on building use type and cannot all be pinned on diaphragm roof type.

Table 8. Mean Bid Prices for A-F Roof type and A-B Repair Scenarios+*

Repair	LWC on Bar Joists	Wood Deck System	Metal on Steel Bar Joists	Gypsum on Spaced Joists	Tectum on Spaced Joists	LWEC Deck System
Base Bid (incl. in A-C Repair Scenarios)	**1:** $129,940	**1:** $128,540	**3:** $149,000	**1:** $129,940	**1:** $128,570	**1:** $128,540
A. Enhanced fastening of the roof deck	**2:** $157,556	NA	**3:** $163,425	NA	NA	**1:** $133,040+
% Cost Increase over Base Bid	21.3 %	----	9.7%	----	----	3.5%
B. Roof-to-wall connections enhanced fastening	**1:** $146,940+*	**1:** $131,040+	**3:** $173,200	**1:** $134,575	**1:** $144,570+	**1:** $145,540+*
% Cost Increase over Base Bid	13.1%	1.9%	16.2%	3.6%	12.4%	13.2%
C. Entire roof deck replacement	**2:** $265,188*	**1:** $158,540+	**3:** $230,150	**2:** $226,211*	**3:** $246,815	**2:** $252,934*
% Cost Increase over Base Bid	104.1%	23.3%	54.5%	74.1%	92.0%	96.8%

+ = No Bid Items; * = Condition/Exclusions

COST NOTES:

- For all 6 deck types the following cost items need to be also taken into consideration:
  - **7:** Cost for relocation if needed of occupants, contents, etc. (Depends on use)
  - **8:** Cost for loss of business (Depends on use)
  - **9:** Cost for isolating dust from occupied area if contents are not relocated (Depends on use)
  - **10:** Cost to repair or replacing ceilings (Depends on use)
  - **11:** Cost to keep temporarily watertight or phasing of work to do the same (Factored in Bid)
  - **12:** Cost of engineering for each protocol ($8,250).
- For deck types with rigid insulation for replacement (A, B, D, E & F) the Cost for the cover board that is required over the polyisocyanurate insulation is factored in bid and cost if replacement triggers energy code requirements would apply across the boards regardless of diaphragm frame.
- For light weight insulating concrete deck type (A) the cost for required tapered insulation for replacement of LWIC fill is factored in bid.
- For gypsum deck type (D) cost for relocation (mandatory) depends on building use type and the cost for removal and replacement of ceiling, ductwork, wiring etc. depends on building use type and cannot all be pinned on diaphragm roof type.

Conclusions

Roofing subcontractor bid data were collected for six roof types (A-F) covering the base bid and three repair scenarios (A-C). Unit costs were also collected for partial roof replacement options. The collected data was used to make cost comparisons between different replacement scenarios among three roofing subcontractors and determine mean base bid costs and repair/replacement costs for three scenarios: enhanced fastening of the roof deck; roof-to-wall connections enhanced fastening; and entire roof deck replacement. In general, based solely on the three bids received, the wood deck system was the least costly system to bring in compliance with 2017 FBC-EB § 707.3.2, while the LWC on bar joists was the most expensive

Future work should address the following:

a. Setting minimum deck attachment criteria (similar to wood decks) and standardizing this for all NOA/Product Approval tests. This will eliminate non-applicability of approved products for several field conditions and streamline the roofing permitting process.
b. On properties valued over a certain threshold (say $500,000), requiring scenario B (roof to wall connections and enhanced edge supports) up to a pre-set percentage (say 15%) of re-roofing cost.
c. Conducting a cost impact analysis for future code changes, before implementation, except in the case of life and/or fire safety requirements.

Date Submitted	11/29/2018	**Section**	707	**Proponent**	Michael Silvers (FRSA)
Chapter	7	**Affects HVHZ**	Yes	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Changes to Sections 403.8 and 202 Definitions are also included.

Summary of Modification

This modification changes the trigger from "where roofing materials are removed from more than 50% of the roof diaphragm" to a recognized trigger using a specific accumulated value of proposed work as a ratio of the value of the structure.

Rationale

Engineers who can perform an evaluation can't agree when it applies, or what it requires. It states: "When roofing materials are removed from more than 50 percent of the roof diaphragm" which when you consider the 25% rule (Existing Building, 706.1.1) makes the 50% threshold actually 25%. It can be interpreted that during any roof replacement the structural The existing language in 707.2.3 is ambiguous as it pertains to the "roof diaphragm". Engineers who can perform an evaluation can't agree when it applies, or what it requires. It states: "When roofing materials are removed from more than 50 percent of the roof diaphragm or section of a building" which when you consider the 25% rule (Existing Building, 706.11) makes the 50% threshold actually 25%. It can be interpreted that during any roof replacement the structural evaluation and mitigation is required. The building owner must commit to an open ended contract with absolutely no idea of the potential cost, what the scope of work might be or how many trades may be involved. Some older deck types that proceed uplift testing are deemed unacceptable for use as a substrate for roof replacement. This would necessitate complete deck replacement as well as reworking or replacement of the roof to wall connections. If the building is occupied there is additional cost. The cost of this work could very well make continued use of the building unviable. This could easily apply to a building that conforms to the building code that was applicable when it was built. Using a trigger of "30 percent of the assessed value of the structure" as a cost threshold before requiring this work to be done aligns with other sections of the code. This basic method is currently used for energy and envelope improvements as well as certain improvements in coastal flood zones.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification provides cost savings by reducing enforcement of requirements of 707.3.2 on all applicable roof replacement projects and replacing them with prescriptive methods currently in the code.

Impact to building and property owners relative to cost of compliance with code

This modification provides cost savings. See Support File.

Impact to industry relative to the cost of compliance with code

This modification provides cost savings. See Support File

Impact to small business relative to the cost of compliance with code

This modification provides cost savings. See Support File

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Eliminates the burdensome requirements and excessive cost of 707.3.2. The change clarifies when the required evaluation needs to be done. It removes the current roof replacement trigger and uses an existing definition that triggers certain work to be done when a project reaches the 30% threshold.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the requirements for a roof diaphragm evaluation. This change will allow roof covering replacement without the burdensome engineering evaluation currently required. The current ambiguous requirements creates confusion for contractors, engineers and code enforcement officials.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This modification does not discriminate against any materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This modification does not degrade the effectiveness of the code. Current requirements of 707.3.2 are ambiguous and are typically ignored. The modification replaces the confusing and unenforced requirements with prescriptive requirements currently in the code for applicable structures

SECTION 707
STRUCTURAL

707.3.2 Roof diaphragms resisting wind loads in high-wind regions.

Where a renovated building alteration includes roof replacement ~~roofing materials are removed from more than 50 percent of the roof diaphragm or section of a building located~~ where the ultimate design wind speed, V_{ult}, determined in accordance with Figure 1609.3(1) of the Florida Building Code, Building, is greater than 115 mph (51 m/s), as defined in Section 1609 (the High-Velocity Hurricane Zone be evaluated for the wind loads specified in the Florida Building Code, Building, including shall comply with Section 1620) of the Florida Building Code, Building, roof diaphragms, connections of the roof diaphragm to roof framing members, and roof-to-wall connections shall wind uplift. If the diaphragms and connections in their current condition are not capable of resisting at least 75 percent of those wind loads, they shall be replaced or strengthened in accordance with the loads specified in the Florida Building Code, Building

Remaining text unchanged.

403.8 Roof diaphragms resisting wind loads in highwind regions.

Where ~~the intended~~ a renovated building alteration requires a permit for reroofing ~~and involves removal of roofing materials from more than 50 percent of the roof diaphragm of a building or section of a building located~~ where the ultimate design wind speed is greater than 115 mph (51 m/s) in accordance with Figure 1609.3(1) of the Florida Building Code, Building as defined in Section 1609 (the HVHZ shall comply with Section 1620) of the Florida Building Code, Building, roof diaphragms, connections of the roof diaphragm to roof framing members, and roof-to-wall connections shall be evaluated for the wind loads specified in Section 1609 of the Florida Building Code, Building, including wind uplift. If the diaphragms and connections in their current condition are not capable of resisting at least 75 percent of those wind loads, they shall be replaced or strengthened in accordance with the loads specified in Section 1609 of the Florida Building Code, Building.

Remaining text unchanged.

CHAPTER 2

DEFINITIONS

SECTION 202
GENERAL DEFINITIONS

RENOVATED BUILDING. A residential or nonresidential building undergoing alteration that varies or changes insulation, HVAC systems, water heating systems or exterior envelope conditions, provided the estimated cost of renovation exceeds 30 percent of the assessed value of the structure

Cost Impact of 2017 FBC-EB § 707.3.2 Roof Diaphragm Reroofing Requirements

RINKER-CR-2018-105

Final Report

1 June 2018

Submitted to

Mo Madani

Department of Business and Professional Regulation
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Table 7. Bid Prices for A-F Roof type and A-C Repair Scenarios+*

Repair	LWC on Bar Joists	Wood Deck System	Metal on Steel Bar Joists	Gypsum on Spaced Joists	Tectum on Spaced Joists	LWEC Deck System
Base Bid (incl. in A-C Repair Scenarios)	**1:**$129,940 **2:**$109,688 **3:**$138,000	**1:** $128,540 **2:** $105,931 **3:** $139,000	**1:** $153,300 **2:** $128,773 **3:** $149,000	**1:**$129,940 **2:**$118,311 **3:**$143,000	**1:**$128,570 **2:**$118,311 **3:**$146,000	**1:**$128,540 **2:**$106,334 **3:**$141,000
Bid Line No.	1	1	1	1	1	1
A. Enhanced fastening of the roof deck	**1:**$134,440+ **2:**$157,556 **3:**$164,400	NA	**1:**$156,800+ **2:** $140,092 **3:** $163,425	NA	NA	**1:**$133,040+ **2:**$118,753 **3:**$155,900
Bid Line Nos.	1,2,3,4 & 8	---------	1,2,3,4 & 8	---------	---------	1,2,3,4,5 & 9
B. Roof-to-wall connections enhanced fastening	**1:**$146,940+* **2:**$128,208 **3:**$164,990	**1:** $131,040+ **2:** $123,631 **3:** $158,560	**1:** $169,300+* **2:** $147,293 **3:** $173,200	**1:**$145,940+ **2:**$134,231 **3:**$134,575	**1:**$144,570+ **2:**$134,231 **3:**$179,075	**1:**$145,540+* **2:**$125,954 **3:**$165,675
Bid Line Nos.	1,2, 4,5 & 8	1, 2, 3 & 7	1,2,4,5 & 8	1,2,3,4 & 7	1,2,3,4 & 7	1,2,3,5,6 & 9
C. Entire roof deck replacement	**1:**$284,440+ **2:**$265,188* **3:**$173,790	**1:** $158,540+ **2:** $148,431* **3:** $196,600	**1:** $231,800+ **2:** $219,273* **3:** $230,150	**1:**$293,440+ **2:**$226,211* **3:**$207,795	**1:**$282,070+ **2:**$226,211* **3:**$246,815	**1:**$283,040+ **2:**$252,934* **3:**$235,075
Bid Line Nos.	1,2,4,7 & 8	1, 2, 6 &7	1,2, 4,7 & 8	1,2,3,6 & 7	1,2,3,6 & 7	1,2,3,5,8 & 9

+ = No Bid Items; * = Condition/Exclusions

COST NOTES:

- For all 6 deck types the following cost items need to be also taken into consideration:
  - **1:** Cost for relocation if needed of occupants, contents, etc. (Depends on use)
  - **2:** Cost for loss of business (Depends on use)
  - **3:** Cost for isolating dust from occupied area if contents are not relocated (Depends on use)
  - **4:** Cost to repair or replacing ceilings (Depends on use)
  - **5:** Cost to keep temporarily watertight or phasing of work to do the same (Factored in Bid)
  - **6:** Cost of engineering for each protocol ($8,250).
- For deck types with rigid insulation for replacement (A, B, D, E & F) the Cost for the cover board that is required over the polyisocyanurate insulation is factored in bid and cost if replacement triggers energy code requirements would apply across the boards regardless of diaphragm frame.
- For light weight insulating concrete deck type (A) the cost for required tapered insulation for replacement of LWIC fill is factored in bid.
- For gypsum deck type (D) cost for relocation (mandatory) depends on building use type and the cost for removal and replacement of ceiling, ductwork, wiring etc. depends on building use type and cannot all be pinned on diaphragm roof type.

Table 8. Mean Bid Prices for A-F Roof type and A-B Repair Scenarios+*

Repair	LWC on Bar Joists	Wood Deck System	Metal on Steel Bar Joists	Gypsum on Spaced Joists	Tectum on Spaced Joists	LWEC Deck System
Base Bid (incl. in A-C Repair Scenarios)	**1:** $129,940	**1:** $128,540	**3:** $149,000	**1:** $129,940	**1:** $128,570	**1:** $128,540
A. Enhanced fastening of the roof deck	**2:** $157,556	NA	**3:** $163,425	NA	NA	**1:** $133,040+
% Cost Increase over Base Bid	21.3 %	----	9.7%	----	----	3.5%
B. Roof-to-wall connections enhanced fastening	**1:** $146,940+*	**1:** $131,040+	**3:** $173,200	**1:** $134,575	**1:** $144,570+	**1:** $145,540+*
% Cost Increase over Base Bid	13.1%	1.9%	16.2%	3.6%	12.4%	13.2%
C. Entire roof deck replacement	**2:** $265,188*	**1:** $158,540+	**3:** $230,150	**2:** $226,211*	**3:** $246,815	**2:** $252,934*
% Cost Increase over Base Bid	104.1%	23.3%	54.5%	74.1%	92.0%	96.8%

+ = No Bid Items; * = Condition/Exclusions

COST NOTES:

- For all 6 deck types the following cost items need to be also taken into consideration:
  - **7:** Cost for relocation if needed of occupants, contents, etc. (Depends on use)
  - **8:** Cost for loss of business (Depends on use)
  - **9:** Cost for isolating dust from occupied area if contents are not relocated (Depends on use)
  - **10:** Cost to repair or replacing ceilings (Depends on use)
  - **11:** Cost to keep temporarily watertight or phasing of work to do the same (Factored in Bid)
  - **12:** Cost of engineering for each protocol ($8,250).
- For deck types with rigid insulation for replacement (A, B, D, E & F) the Cost for the cover board that is required over the polyisocyanurate insulation is factored in bid and cost if replacement triggers energy code requirements would apply across the boards regardless of diaphragm frame.
- For light weight insulating concrete deck type (A) the cost for required tapered insulation for replacement of LWIC fill is factored in bid.
- For gypsum deck type (D) cost for relocation (mandatory) depends on building use type and the cost for removal and replacement of ceiling, ductwork, wiring etc. depends on building use type and cannot all be pinned on diaphragm roof type.

Conclusions

Roofing subcontractor bid data were collected for six roof types (A-F) covering the base bid and three repair scenarios (A-C). Unit costs were also collected for partial roof replacement options. The collected data was used to make cost comparisons between different replacement scenarios among three roofing subcontractors and determine mean base bid costs and repair/replacement costs for three scenarios: enhanced fastening of the roof deck; roof-to-wall connections enhanced fastening; and entire roof deck replacement. In general, based solely on the three bids received, the wood deck system was the least costly system to bring in compliance with 2017 FBC-EB § 707.3.2, while the LWC on bar joists was the most expensive

Future work should address the following:

a. Setting minimum deck attachment criteria (similar to wood decks) and standardizing this for all NOA/Product Approval tests. This will eliminate non-applicability of approved products for several field conditions and streamline the roofing permitting process.
b. On properties valued over a certain threshold (say $500,000), requiring scenario B (roof to wall connections and enhanced edge supports) up to a pre-set percentage (say 15%) of re-roofing cost.
c. Conducting a cost impact analysis for future code changes, before implementation, except in the case of life and/or fire safety requirements.

S7960

Date Submitted	12/13/2018	**Section**	707.3.2	**Proponent**	Gaspar Rodriguez
Chapter	7	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Section 403.8 also modified.

Summary of Modification

Resolves the issue of a routine maintenance activity (i.e. reroofing) establishing a burdensome requirement that is contemplated in Chapter 9 of the Florida Building Code Existing Building, when an Alteration Level Three is reached.

Rationale

Resolves the issue of a routine maintenance activity (i.e. reroofing) establishing a burdensome requirement that is contemplated in Chapter 9 of the Florida Building Code Existing Building, when an Alteration Level Three is reached. Realizes that quite often removal of roof covering does not expose the structural attachment of all existing elements of the lateral force-resisting system.

Section 907.4, FBCEB, indicates the requirements for an engineering evaluation and analysis when more than 30 percent of the roof area is involved in a structural alteration. Removal of roof covering should be considered non-structural alteration.

Provide clarity that it is the structural alteration that initiates when an engineering evaluation and analysis is required.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Reduces the burden of enforcement, by properly placing the condition of this requirement at the more proper level of alteration.

Impact to building and property owners relative to cost of compliance with code

Will save cost by eliminating the excessive cost of evaluating a structure during a routine reroof. The evaluation should occur during a more extensive alteration.

Impact to industry relative to the cost of compliance with code

Will save cost by eliminating the excessive cost of evaluating a structure during a routine reroof. The evaluation should occur during a more extensive alteration.

Impact to small business relative to the cost of compliance with code

Will save cost by eliminating the excessive cost of evaluating a structure during a routine reroof. The evaluation should occur during a more extensive alteration.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The welfare of the public will benefit with the cost savings from eliminating the excessive cost of evaluating a structure during a routine reroof. The evaluation should occur during a more extensive alteration.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Provides equivalent protection by focusing the enforcement of the code on buildings that are being altered at an alteration level where the evaluation is warranted.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This modification does not discriminate against any materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This modification does not degrade the effectiveness of the code. Could be argued that it makes the code more effective by focusing the enforcement of the code on buildings that are being altered at an alteration level where the evaluation is warranted.

707.3.2 Roof diaphragms resisting wind loads in high-wind regions.

Where ~~roofing materials are~~the structural roof deck is removed from more than ~~50~~30 percent of the ~~roof~~structural diaphragm of a building or section of a building located where the ultimate design wind speed, V_{ult}, determined in accordance with Figure 1609.3(1) of the Florida Building Code, Building, is greater than 115 mph (51 m/s), as defined in Section 1609(the High-Velocity Hurricane Zone shall comply with Section 1620) of the Florida Building Code, Building, roof diaphragms, connections of the roof diaphragm to roof framing members, and roof-to-wall connections shall be evaluated for the wind loads specified in the Florida Building Code, Building, including wind uplift. If the diaphragms and connections in their current condition are not capable of resisting at least 75 percent of those wind loads, they shall be replaced or strengthened in accordance with the loads specified in the Florida Building Code, Building.

~~Exceptions:~~

1. ~~This section does not apply to buildings permitted subject to the Florida Building Code.~~
2. ~~This section does not apply to buildings permitted subject to the 1991 Standard Building Code, or later edition, or designed to the wind loading requirements of the ASCE 7-88 or later editions, where an evaluation is performed by a registered design professional to confirm the roof diaphragm, connections of the roof diaphragm to roof framing members, and roof-to-wall connections are in compliance with the wind loading requirements of either of these standards or later editions.~~
3. ~~Buildings with steel or concrete moment resisting frames shall only be required to have the roof diaphragm panels and diaphragm connections to framing members evaluated for wind uplift.~~
4. ~~This section does not apply to site-built singlefamily dwellings. Site-built single-family dwellings shall comply with Sections 706.7 and 706.8.~~
5. ~~This section does not apply to buildings permitted within the HVHZ after January 1, 1994 subject to the 1994 South Florida Building Code, or later editions, or where the building's wind design is based on the wind loading requirements of ASCE 7-88 or later editions.~~

403.8 Roof diaphragms resisting wind loads in high-wind regions.

Where the ~~intended alteration requires a permit for reroofing and involves removal of roofing materials~~structural roof deck is removedfrom more than~~50~~30 percent of the~~roof~~structural diaphragm of a building or section of a building located where the ultimate design wind speed is greater than 115 mph (51 m/s) in accordance with Figure 1609.3(1) of theFlorida Building Code, Building as defined in Section 1609 (the HVHZ shall comply with Section 1620) of the Florida Building Code, Building, roof diaphragms, connections of the roof diaphragm to roof framing members, and roof-to-wall connections shall be evaluated for the wind loads specified in Section 1609 of the Florida Building Code, Building, including wind uplift. If the diaphragms and connections in their current condition are not capable of resisting at least 75 percent of those wind loads, they shall be replaced or strengthened in accordance with the loads specified in Section 1609 of the Florida Building Code, Building.

~~**Exceptions:**~~

1. ~~This section does not apply to buildings permitted subject to the Florida Building Code.~~
2. ~~This section does not apply to buildings permitted subject to the 1991 Standard Building Code, or later edition, or designed to the wind loading requirements of the ASCE 7-88 or later editions, where an evaluation is performed by a registered design professional to confirm the roof diaphragm, connections of the roof diaphragm to roof framing members, and roof-to-wall connections are in compliance with the wind loading requirements of either of these standards or later editions.~~
3. ~~Buildings with steel or concrete moment resisting frames shall only be required to have the roof diaphragm panels and diaphragm connections to framing members evaluated for wind uplift.~~
4. ~~This section does not apply to site-built single-family dwellings. Site-built single-family dwellings shall comply with Sections 706.7 and 706.8.~~

5. ~~This section does not apply to buildings permitted within the HVHZ after January 1, 1994 subject to the 1994 South Florida Building Code, or later editions, or where the building's wind design is based on the wind loading requirements of ASCE 7-88 or later editions.~~

S8079

Date Submitted 12/13/2018
Chapter 7
Section 606.2.1
Affects HVHZ No
Proponent Harold Barrineau
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**
Alternate Language **No**

Related Modifications

[BS] 606.2.1.1

Summary of Modification

[BS] 606.2.1 Repairs for less than substantial structural damage. 606.2.1.1 Snow damage.

Rationale

This proposal adds a limited and minor upgrade requirement for structural damage caused by snow.
Instead of allowing repair to the predamage condition, the proposal would require any repaired or replaced elements --but not any other similar elements that escaped damage --to be designed for the requirements for new construction.
This requirement is justified because snow loads, especially with the effects of climate change, are different from dead, live, earthquake, and wind loads that are otherwise addressed in Chapter 6. Existing framing carrying dead and live loads generally does not require upgrade even when it's non-conforming because it has a history of adequate service. Design level snow loads don't have that history. And unlike wind or earthquake loads, snow loads at damaging or design levels are likely to occur again within a few years. Thus, it is folly to allow deficient components to be repaired only to the state in which we can expect them to be damaged again next winter.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal does not impact local entity relative to enforcement.

Impact to building and property owners relative to cost of compliance with code

Will increase the cost of construction.
There will be a slight increase in the cost of construction, but only the damaged elements.

Impact to industry relative to the cost of compliance with code

Will increase the cost of construction.
There will be a slight increase in the cost of construction, but only the damaged elements.

Impact to small business relative to the cost of compliance with code

Will increase the cost of construction.
There will be a slight increase in the cost of construction, but only the damaged elements.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This code change introduces a common sense approach to repairing structural components damaged by snow loading. This proposal improves the health, safety, and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal strengthens or improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

[BS] 606.2.1 Repairs for less than substantial structural damage.

~~For~~ Unless otherwise required by this section, for damage less thansubstantial structural damage,the damaged elements shall be permitted to be restored to their predamage condition.

606.2.1.1 Snow damage.

Structural components whose damage was cause by or related to snow load effects shall be repaired, replaced, or altered to satisfy the requirements of Section 1608 of the International Building Code.

S8088

Date Submitted	12/13/2018	**Section**	1007.1	**Proponent**	Harold Barrineau
Chapter	10	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Section: 202 (New), [BS] 1007.2, [BS] 1007.3.2

Summary of Modification

Add new definition as follows: RISK CATEGORY [BS] 1007.1 Live loads. [BS] 1007.2 Snow and wind loads. [BS] 1007.3.2 Access to Risk Category IV.

Rationale

This proposal makes editorial changes for consistency, clarity, and simplification. The revisions use the preferred wording and logic approved for other sections in recent code cycles, so as to make the structural provisions more uniformly understandable and enforceable throughout the IEBC.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

These changes, which are primarily editorial, make the IEBC provisions more understandable and enforceable.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction

This is an editorial change, so there will be no change to construction requirements.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction

This is an editorial change, so there will be no change to construction requirements.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction

This is an editorial change, so there will be no change to construction requirements.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal improves the health, safety, and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal strengthens or improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Add new definition as follows:

RISK CATEGORY. A categorization of buildings and other structures for determination of flood, wind, snow, ice and earthquake loads based on the risk associated with unacceptable performance, as provided in Section 1604.5 of the International Building Code.

Revise as follows:

[BS] 1007.1 ~~Gravity~~ Live loads. ~~Buildings or portions thereof subject to~~ structural elements carrying tributary live loads from an area with a change of occupancy ~~where such change in~~ shall satisfy the ~~nature~~ requirements of ~~occupancy results in higher uniform or concentrated loads based on the Florida Building Code, Building, Table 1607.1 shall comply with the gravity load provisions~~ Section 1607 of the Florida Building Code, Building. Design live loads for areas of new occupancy shall be based on Section 1607 of the Florida Building Code, Building. Design live loads for other areas shall be permitted to use previously approved design live loads.

> **Exception:** ~~Structural elements whose stress is not increased by more than 5 percent.~~Structural elements whose demand-capacity ratio considering the change of occupancy is not more than 5 percent greater than the demand-capacity ratio based on previously approved live loads need not comply with this section.

[BS] 1007.2 Snow and wind loads. ~~Buildings and structures subject to~~ When a ~~change of occupancy where such~~ change ~~in the nature~~ of occupancy results in a structure being assigned to a higher ~~wind or snow~~ risk ~~categories based on the Florida Building Code, Building Table 1604.5.~~ category, the structure shall satisfy the requirements of Sections 1608 and 1609 of the Florida Building Code, Building ~~shall be analyzed and shall comply with~~ for the ~~applicable wind or snow load provisions of the Florida Building Code, Building~~ new risk category. (High-Velocity Hurricane Zones shall comply with Section 1620) shall be analyzed and shall comply with the applicable wind or snow load provisions of the Florida Building Code, Building.

Exception: ~~Where the new occupancy with a higher risk category is less than or equal to 10 percent of the total building floor area. The cumulative effect of the area of occupancy changes shall be considered for the purposes of this exception.~~ Where the area of the new occupancy is less than 10 percent of the building area, compliance with this section is not required. The cumulative effect of occupancy changes over time shall be considered.

[BS] 1007.3.2 Access to Risk Category IV. ~~Where a change of occupancy is such~~ Any structure that ~~compliance with Section 1007.3.1 is required and the building is~~ provides operational access to an adjacent structure assigned to Risk Category IV, as the ~~operational access to the building result of a change of occupancy~~ shall ~~not be through an adjacent structure, unless that structure conforms to~~ itself satisfy the requirements of Section 1613 of the Florida Building Code, Building for Risk Category IV structures using Florida Building Code-level seismic forces. Where operational access to the Risk Category IV structure is less than 10 feet (3048 mm) from either an interior lot line or from another structure, access protection from potential falling debris shall be provided ~~by the owner of the Risk Category IV structure~~.

S8090

Date Submitted	12/13/2018	**Section**	1007.2	**Proponent**	Harold Barrineau
Chapter	10	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

None

Summary of Modification

[BS] 1007.2 Snow and wind loads.

Rationale

Table 1604.5 of the FBC is not about wind or snow categories; it is entitled "Risk Category". To say that a change in the nature of the occupancy results in a higher wind or snow category is inaccurate, so this proposal deletes that language.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal does not impact local entity relative to enforcement.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction.
The proposed modification does not change the requirement, so cost is not impacted.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction.
The proposed modification does not change the requirement, so cost is not impacted.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction.
The proposed modification does not change the requirement, so cost is not impacted.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal improves the health, safety, and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal strengthens or improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Revise as follows:

[BS] 1007.2 Snow and wind loads. Buildings and structures subject to achange of occupancywhere such change in the nature of occupancy results in higher~~wind or snow~~ risk categories based on of theFlorida Building Code, BuildingTable 1604.5~~.~~ shall be analyzed and shall comply with the applicable wind or snow load provisions of theFlorida Building Code, Building. (High-Velocity Hurricane Zones shall comply with Section 1620) shall be analyzed and shall comply with the applicable wind or snow load provisions of the Florida Building Code, Building.

Exception: Where the new occupancy with a higher risk category is less than or equal to 10 percent of the total building floor area. The cumulative effect of the area of occupancy changes shall be considered for the purposes of this exception.

Date Submitted 12/15/2018
Chapter 10
Section 1007.2
Affects HVHZ No
Proponent Kimberly Gilliam
Attachments Yes
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**
Alternate Language **No**

Related Modifications

Summary of Modification

Corrects a mistake in the current reference to risk categories referencing wind or snow categories.

Rationale

Corrects a mistake in the current reference to risk categories referencing wind or snow categories. Table 1604.5 of the FBC, Building is entitled "Risk Categories of Buildings and Other Structures", and does not reference wind or snow.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None. The proposed modification does not change the requirement. It is simply a correction of erroneous language.

Impact to building and property owners relative to cost of compliance with code

None. The proposed modification does not change the requirement. It is simply a correction of erroneous language.

Impact to industry relative to the cost of compliance with code

None. The proposed modification does not change the requirement. It is simply a correction of erroneous language.

Impact to small business relative to the cost of compliance with code

None. The proposed modification does not change the requirement. It is simply a correction of erroneous language.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

No, the proposed modification does not change the requirement. It is simply a correction of erroneous language.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, the proposed modification improves the clarification and coordination of code language.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

No, it improves the effectiveness of the code by providing clarification and better coordination of code language.

[BS] 1007.2 Snow and wind loads.

Buildings and structures subject to a *change of occupancy* where such change in the nature of occupancy results in higher ~~wind or snow~~ risk categories based on the Florida Building Code, Building Table 1604.5, (High-Velocity Hurricane Zones shall comply with Section 1620) shall be analyzed and shall comply with the applicable wind or snow load provisions of the Florida Building Code, Building.

Exception: Where the new occupancy with a higher risk category is less than or equal to 10 percent of the total building floor area. The cumulative effect of the area of occupancy changes shall be considered for the purposes of this exception.

Code Change No: EB51-16

Original Proposal

Section: [BS] 1007.2

Proponent: Kathleen Petrie, representing City of Seattle, Department of Planning and Development (kathleen.petrie@seattle.gov)

THIS CODE CHANGE WILL BE HEARD BY THE IBC-STRUCTURAL CODE COMMITTEE. SEE THE TENTATIVE HEARING ORDER FOR THIS COMMITTEE.

Revise as follows:

[BS] 1007.2 Snow and wind loads. Buildings and structures subject to a *change of occupancy* where such change in the nature of occupancy results in higher ~~wind or snow~~ risk categories based on Table 1604.5 of the *International Building Code* shall be analyzed and shall comply with the applicable wind or snow load provisions of the *International Building Code*.

> **Exception:** Where the new occupancy with a higher risk category is less than or equal to 10 percent of the total building floor area. The cumulative effect of the area of occupancy changes shall be considered for the purposes of this exception.

Reason: Table 1604.5 of the IBC is not about wind or snow categories; it is entitled "Risk Category of Buildings and Other Structures". To say that a change in the nature of the occupancy results in a higher wind or snow category is inaccurate, so this proposal deletes that language.

Cost Impact: Will not increase the cost of construction
The proposed modification does not change the requirement, so cost is not impacted

Report of Committee Action Hearings

Committee Action: **Approved as Submitted**

Committee Reason: The proposal corrects a mistake in the current reference to risk categories.

Assembly Action: **None**

Final Action Results

EB51-16	**AS**

Date Submitted 12/14/2018
Chapter Appendix A
Section 501
Affects HVHZ No
Proponent Ann Russo4
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No

Alternate Language No

Related Modifications

301.1.4.2
502
503
504
505
506
507

Summary of Modification

Deletion of Chapter PART 5 EARTHQUAKE HAZARD REDUCTION IN EXISTING CONCRETE BUILDINGS

Rationale

Recent revisions to both Chapter A5 and ASCE 41 make this appendix chapter no longer needed and provides no benefit relative to the procedures in ASCE 41 that are already allowed by the FEBC

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity as this is removes a redundant reference standard

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners as this is will not increase the cost of construction

Impact to industry relative to the cost of compliance with code

No impact to industry as this is will not increase the cost of construction

Impact to small business relative to the cost of compliance with code

No impact to small business as this is will not increase the cost of construction

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by cleaning up redundancy with reference standards.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by cleaning up redundancy with reference standards.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against material, products, methods, or systems of construction of demonstrated capabilities, this is a current code requirement that does not limit material, products, methods, or systems of construction

Does not degrade the effectiveness of the code

Increase the effectiveness of code by cleaning up redundancy with reference standards.

Mod 8178

Revise as Follows:

[BS] 301.1.4.2 Compliance with reduced Florida Building Code, Building-level seismic forces. Where seismic evaluation and design is permitted to meet reduced Florida Building Code, Building seismic force levels, the criteria used shall be in accordance with one of the following:

1. The Florida Building Code, Building using 75 percent of the prescribed forces. Values of R, O0 and Cd used for analysis shall be as specified in Section 301.1.4.1 of this code.
2. Structures or portions of structures that comply with the requirements of the applicable chapter in Appendix A as specified in Items 2.1 through ~~2.5~~ 2.4 and subject to the limitations of the respective Appendix A chapters shall be deemed to comply with this section.
2.1. The seismic evaluation and design of unreinforced masonry bearing wall buildings in Risk Category I or II are permitted to be based on the procedures specified in Appendix Chapter A1.
2.2. Seismic evaluation and design of the wall anchorage system in reinforced concrete and reinforced masonry wall buildings with flexible diaphragms in Risk Category I or II are permitted to be based on the procedures specified in Chapter A2.
2.3. Seismic evaluation and design of cripple walls and sill plate anchorage in residential buildings of light-frame wood construction in Risk Category I or II are permitted to be based on the procedures specified in Chapter A3.
2.4. Seismic evaluation and design of soft, weak, or open-front wall conditions in multiunit residential buildings of wood construction in Risk Category I or II are permitted to be based on the procedures specified in Chapter A4.
2.5. ~~Seismic evaluation and design of concrete buildings assigned to Risk Category I, II or III are permitted to be based on the procedures specified in Chapter A5.~~
3. ASCE 41, using the performance objective in Table 301.1.4.2 for the applicable risk category.

APPENDIX A Guidlines for the Seismic Retrofit of Exisiting Buildings

Delete without subsitiution:

CHAPTER PART ~~A5-EARTHQUAKE HAZARD REDUCTION IN EXISTING CONCRETE BUILDINGS~~

~~SECTION A501~~
~~PURPOSE~~

~~SECTION A502~~
~~SCOPE~~

~~SECTION A503~~
~~GENERAL REQUIREMENTS~~

~~SECTION A504~~
~~SITE GROUND MOTION~~

~~SECTIONS A505~~
~~TIER 1 ANALYSIS PROCEDURE~~

~~SECTION A506~~
~~TIER 2 ANALYSIS PROCEDURE~~

~~SECTION A507~~
~~TIER 3 ANALYSIS PROCEDURE~~

Date Submitted	12/15/2018	**Section**	301.2	**Proponent**	Harold Barrineau
Chapter	Appendix A	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No   **Alternate Language** No

Related Modifications

None

Summary of Modification

[BS] A301.2 Scope.

Rationale

The purpose of this code change is to coordinate the exceptions to Section A303 with the Group R occupancies and uses in the IBC. The original scope of this appendix in the UBC was limited to single-family homes, duplexes, and other small congregate residences. Proposal EB78-04/05 modified the scope and exception to replace the reference to UBC Group R, Division 1 with the what was intended to be the appropriate Group R categories in the IBC. The modification was not quite correct.

Detached small group homes/congregate residences are equivalent to single family homes, Thus, the exception needs to be modified to remove the limitation on Group R-4 buildings. These facilities should be able to use this appendix.

In addition, the language regarding number of dwelling units typically does not apply to Group R-1, but more typically to Group R-2 and R-3. It is noted the UBC originally excluded all multifamily occupancies and other Group R, Division 1 occupancies and uses from the appendix. Thus the limiting language is split between transient lodging (Group R-1) and facilities with dwelling units (all Group R).

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal does not impact local entity relative to enforcement.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction.
The original intent was for the provisions of Appendix A3 to apply to single family homes, including small group homes, for reasons of public health and safety. This proposal restores that intent.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction.
The original intent was for the provisions of Appendix A3 to apply to single family homes, including small group homes, for reasons of public health and safety. This proposal restores that intent.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction.
The original intent was for the provisions of Appendix A3 to apply to single family homes, including small group homes, for reasons of public health and safety. This proposal restores that intent.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal improves the health, safety, and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal strengthens or improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Revise as follows:

[BS] A301.2 Scope. The provisions of this chapter apply to residential buildings of light-frame wood construction containing one or more of the structural weaknesses specified in Section A303.

Exception:

The provisions of this chapter do not apply to the buildings, or elements thereof, listed below. These buildings or elements require analysis by a registered design professional in

accordance with Section A301.3 to determine appropriate strengthening:

1. Group R-1.
2. Group ~~R-1, R-2 or R-4 occupancies~~ R with more than four dwelling units.
3. Buildings with a lateral force-resisting system using poles or columns embedded in the ground.
4. Cripple walls that exceed 4 feet (1219 mm) in height.
5. Buildings exceeding three stories in height and any three-story building with cripple wall studs exceeding 14 inches (356 mm) in height.
6. Buildings where the code official determines that conditions exist that are beyond the scope of the prescriptive requirements of this chapter.
7. Buildings or portions thereof constructed on concrete slabs on grade.

Sub Code: Residential

S7214

192

Date Submitted	11/21/2018	**Section**	202	**Proponent**	Joseph Crum
Chapter	2	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

G9-16 Part II

Summary of Modification

This proposal revises the definitions of fenestration and vertical fenestration in the FBC and FBCR, for consistency with the FBCECC, and each other

Rationale

This proposal revises the definitions of fenestration and vertical fenestration in the FBC and IRC, for consistency with the IECC, and each other. It places the most distinguishing characteristics of fenestration in the main definition of that product type, and further distinguishes between vertical fenestration, and skylights and sloped glazing.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

The code change proposal is simply a clarification for consistency between the FBCB, FBCR and FBCEC

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction

The code change proposal will not change the cost of construction and is simply a clarification for consistency between the FBCB, FBCR and FBCEC

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction

The code change proposal will not change the cost of construction and is simply a clarification for consistency between the FBCB, FBCR and FBCEC

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction

The code change proposal will not change the cost of construction and is simply a clarification for consistency between the FBCB, FBCR and FBCEC

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The code change proposal is simply a clarification for consistency between the FBCB, FBCR and FBCEC

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The code change proposal is simply a clarification for consistency between the FBCB, FBCR and FBCEC

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The code change proposal is simply a clarification for consistency between the FBCB, FBCR and FBCEC

Does not degrade the effectiveness of the code

The code change proposal is simply a clarification for consistency between the FBCB, FBCR and FBCEC

FBCR SECTION R202

~~[RE]FENESTRATION. Skylights, roof windows, vertical windows (whether fixed or moveable); opaque doors; glazed doors; glass block; and combination opaque and glazed doors.~~

~~See Section R202 of the Florida Building Code, Energy Conservation.~~

FENESTRATION. Products classified as either vertical fenestration or skylights.

Skylight. Glass or other transparent or translucent glazing material installed at a slope of less than 60 degrees (1.05 rad) from horizontal~~. Glazing materials in skylights~~, including unit skylights, tubular daylighting devices, and glazing materials in solariums, sunrooms, roofs and sloped walls. ~~are included in this definition~~.

Vertical fenestration. Windows (fixed or moveable), opaque doors, glazed doors, glazed block and combination opaque/glazed doors composed of glass or other transparent or translucent glazing materials and installed at a slope of at least 60 degrees (1.05 rad) from horizontal.

S7382

Date Submitted	11/21/2018	**Section**	202	**Proponent**	Joseph Crum
Chapter	2	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **Yes** **Alternate Language** **No**

Related Modifications

Summary of Modification

This proposal revises the definitions of fenestration and vertical fenestration in the FBCB and FBCR, for consistency with the FBCEC, and each other.

Rationale

This proposal revises the definitions of fenestration and vertical fenestration in the FBCB and FBCR, for consistency with the FBCEC, and each other. It places the most distinguishing characteristics of fenestration in the main definition of that product type, and further distinguishes between vertical fenestration, and skylights and sloped glazing.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

The code change proposal is simply a clarification for consistency between the FBCB, FBCR and FBCEC.

Impact to building and property owners relative to cost of compliance with code

The code change proposal will not change the cost of construction and is simply a clarification for consistency between the FBCB, FBCR and FBCEC.

Impact to industry relative to the cost of compliance with code

The code change proposal will not change the cost of construction and is simply a clarification for consistency between the FBCB, FBCR and FBCEC.

Impact to small business relative to the cost of compliance with code

The code change proposal will not change the cost of construction and is simply a clarification for consistency between the FBCB, FBCR and FBCEC.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The code change proposal is simply a clarification for consistency between the FBCB, FBCR and FBCEC.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The code change proposal is simply a clarification for consistency between the FBCB, FBCR and FBCEC.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The code change proposal is simply a clarification for consistency between the FBCB, FBCR and FBCEC. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The code change proposal is simply a clarification for consistency between the FBCB, FBCR and FBCEC. Does not degrade the effectiveness of the code.

1st Comment Period History

S7382-G1

Proponent Roger LeBrun **Submitted** 2/1/2019 **Attachments** No

Comment:

This mod (and the companion S7381) proposes language that directly contradicts other definitions for skylights in the same chapter. I strongly urge the TAC to disapprove, since the proponent did not address the conflict or provide any reason for the contradiction to exist.

FBCR SECTION 202

Delete existing and replace with the new definition.

- [RE]~~**FENESTRATION.** Skylights, roof windows, vertical windows (whether fixed or moveable); opaque doors; glazed doors; glass block; and combination opaque and glazed doors.~~

FENESTRATION. Products classified as either vertical fenestration or skylights.

Skylight. Glass or other transparent or translucent glazing material installed at a slope of less than 60 degrees (1.05 rad) from horizontal, including unit skylights, tubular daylighting devices, and glazing materials in solariums, sunrooms, roofs and sloped walls..

Vertical fenestration. Windows (fixed or moveable), opaque doors, glazed doors, glazed block and combination opaque/glazed doors composed of glass or other transparent or translucent glazing materials and installed at a slope of at least 60 degrees (1.05 rad) from horizontal.

S7478

Date Submitted	12/14/2018	**Section**	202	**Proponent**	Joseph Crum
Chapter	2	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No **Alternate Language** No

Related Modifications

G2-16 PART II

Summary of Modification

This proposal simply revises the definition to state that Light- Frame is a "method" of construction and should not be confused with the different "Types of Construction" specified in Chapter 6.

Rationale

The wording of this definition has often caused confusion among code users when determining the type of construction of a building. Chapter 6 of the FBC describes and provides the requirements for the different types of construction ranging from Type IA to VB. Light wood frame is not considered a type of construction. This proposal simply revises the definition to state that Light- Frame is a "method" of construction and should not be confused with the different "Types of Construction" specified in Chapter 6.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification will simplify the definition and make enforcement easier.

Impact to building and property owners relative to cost of compliance with code

There is no increase in the cost of construction due to this change as it is only intended to clarify the existing code provisions.

Impact to industry relative to the cost of compliance with code

There is no increase in the cost of construction due to this change as it is only intended to clarify the existing code provisions.

Impact to small business relative to the cost of compliance with code

There is no increase in the cost of construction due to this change as it is only intended to clarify the existing code provisions.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the code by clarification of the definition and makes enforcement easier.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by clarification of the definition.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This change as it is only intended to clarify the existing code provisions so does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities .

Does not degrade the effectiveness of the code

This change as it is only intended to clarify the existing code provisions so does not degrade the effectiveness of the code

Section: R202

Modify as follows:
[RB]LIGHT-FRAME CONSTRUCTION. ~~A type of c~~ Construction ~~with~~ whose vertical and horizontal structural elements ~~that~~ are primarily ~~formed by~~ a system of repetitive wood or cold-formed steel framing members.

S7486

Date Submitted	11/28/2018	**Section**	202	**Proponent**	Joseph Crum
Chapter	2	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

G2-16 Part II

Summary of Modification

This proposal simply revises the definition to state that Light- Frame is a "method" of construction and should not be confused with the different "Types of Construction" specified in Chapter 6.

Rationale

The wording of this definition has often caused confusion among code users when determining the type of construction of a building. Chapter 6 of the FBC describes and provides the requirements for the different types of construction ranging from Type IA to VB. Light wood frame is not considered a type of construction. This proposal simply revises the definition to state that Light- Frame is a "method" of construction and should not be confused with the different "Types of Construction" specified in Chapter 6.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This change as it is only intended to clarify the existing code provisions.

Impact to building and property owners relative to cost of compliance with code

There is no increase in the cost of construction due to this change as it is only intended to clarify the existing code provisions.

Impact to industry relative to the cost of compliance with code

There is no increase in the cost of construction due to this change as it is only intended to clarify the existing code provisions.

Impact to small business relative to the cost of compliance with code

There is no increase in the cost of construction due to this change as it is only intended to clarify the existing code provisions.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the code by clarification of the definition and makes enforcement easier.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by clarification of the definition.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This change is only intended to clarify the existing code provisions therefore does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This change is only intended to clarify the existing code provisions therefore it does not degrade the effectiveness of the code.

Section: R202

Modify as follows:

[RB]LIGHT-FRAME CONSTRUCTION.~~A type of c~~ Construction with vertical and horizontal structural elements that are primarily ~~formed by~~ a system of repetitive wood or cold-formed steel framing members.

S7504

Date Submitted	11/28/2018	**Section**	202	**Proponent**	Ann Russo5
Chapter	2	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

This proposal revises the definitions of fenestration and vertical fenestration for consistency. It places the most distinguishing characteristics of fenestration in the main definition of that product type, and further distinguishes between vertical fenestration, and skylights and sloped glazing.

Rationale

The definition of fenestration, skylights, sloped glazing, unit skylights and tubular daylighting devices was revised and reformatted from the earlier Code editions. This proposal revises the definitions of fenestration and vertical fenestration with each other. It places the most distinguishing characteristics of fenestration in the main definition of that product type, and further distinguishes between vertical fenestration, and skylights and sloped glazing.

Although fenestration is an opening in the building envelope, it is to be designed and installed in such a manner as to preserve the integrity of the building envelope component in which it is installed. Fenestration products typically consist of assemblies that are glazed with glass or other transparent or translucent materials. This proposal places both of these characteristics into the main definition of fenestration.

Although similar, the performance characteristics for skylights and sloped glazing are different than for vertical fenestration. This proposal maintains the measurement of 15 degrees from vertical as the point at which fenestration products go from being vertical fenestration installed in a wall, to skylights or sloped glazing. Although earlier definitions set this threshold at 30 degrees from vertical, AAMA strongly feels that this is an erroneous point at which to draw this distinction. The design of products to be weather resistant, particularly with regards to water penetration and related loads, is quite different for products installed at any slope at all in comparison to products installed in a completely vertical position. 15 degrees from vertical has been the accepted threshold for this distinction for many years. It should not be increased.

The change will increase reliability and safety while not materially impacting costs.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No material impact as product approval and related information would be consulted in the normal process of plan review and inspection

Impact to building and property owners relative to cost of compliance with code

Cost impact would be minimal and would increase value and reliability to the property owners with regards to life safety and service life

Impact to industry relative to the cost of compliance with code

None foreseen as this is an adopted industry standard as well as practice

Impact to small business relative to the cost of compliance with code

None foreseen

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Increases safety and welfare of the owner and occupants due to reduced probability of infiltration which reduces risk of mold and other contaminants

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the quality of construction and end product, the building, for benefit of owner and occupants of the structure

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The change will not impact products, just increase their effectiveness as part of the building envelope

Does not degrade the effectiveness of the code

It increases the base effectiveness and benefit to the building's owner and occupants

Delete:

~~**FENESTRATION.** Skylights, roof windows, vertical windows (fixed or moveable), opaque doors, glazed doors, glazed block and combination opaque/glazed doors. Fenestration includes products with glass and nonglass glazing materials.~~

Replace with:

FENESTRATION. Products classified as either vertical fenestration or skylights and sloped glazing, installed in such a manner as to preserve the weather resistant barrier of the wall or roof in which they are installed. Fenestration includes products with glass or other transparent or translucent materials.

Add new definition as follows:

FENESTRATION, VERTICAL. Windows that are fixed or movable, opaque doors, glazed doors, glazed block and combination opaque and glazed doors installed in a wall at less than 15 degrees from vertical.

S7605

Date Submitted 11/30/2018
Chapter 2
Section 202
Affects HVHZ No
Proponent Ann Russo5
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**
Alternate Language **No**

Related Modifications

Summary of Modification

To distinguish drilled shaft from augercast piles (reference to removing drilling equipment), and coordinate with definitions under Building Code

Rationale

The purpose of the proposed code change is to include this definition in the Residential Code so as to properly coordinate with the Building Code as this type of foundation element is being employed in select projects due to site conditions.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Better defines process and clarifies options available and improves possible safety aspects

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves understanding and options for piles and methofs

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not

Does not degrade the effectiveness of the code

Does not

Add:

[BS]DRILLEDSHAFT. A cast-in-place deep foundation element ,also referred to as caisson, drilled pier, and bored pile, constructed by drilling a hole (with or without permanent casing or drilling fluid) into soil or rock and filling it with fluid concrete after the drilling equipment isremoved.

-

Socketed drilled shaft. A drilled shaft with a permanent pipe or tube casing that extends down to bedrock and an uncased socket drilled into the bedrock.

S7709

Date Submitted 12/6/2018
Chapter 2
Section 202
Affects HVHZ No
Proponent Borrone Jeanette
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

FBC R401.4 & R801.3
new definitions: COLLAPSIBLE SOILS, COMPRESSIBLE SOILS, EXPANSIVE SOILS

Summary of Modification

add new definitions: COLLAPSIBLE SOILS, COMPRESSIBLE SOILS, EXPANSIVE SOILS Revise R401.4 Soil tests & R801.3 Roof drainage

Rationale

There is currently no definition for collapsible soils to provide guidance to design professionals and building officials on identification and design procedures to address these soils. These terms are used in IRC Section R401.4 and R801.3.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will not impact local entity

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction The change is for clarification so there is not change to construction requirements

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction The change is for clarification so there is not change to construction requirements

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction The change is for clarification so there is not change to construction requirements

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by adding needed definitions for these soils and provides clarification to the code text

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by adding needed definitions for these soils and provides clarification to the code text

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials, products, methods, or systems of construction adding needed definitions for these soils and provides clarification to the code text

Does not degrade the effectiveness of the code

Increases the effectiveness of the code by adding needed definitions for these soils and provides clarification to the code text

Add new definitions:

COLLAPSIBLE SOILS.

Soils that exhibit volumetric reduction in response to partial or full wetting under load.

COMPRESSIBLE SOILS

Soils that exhibit volumetric reduction in response to the application of load even in the absence of wetting or drying.

EXPANSIVE SOILS.

Soils that exhibit volumetric increase or decrease (swelling or shrinking) in response to partial or full wetting or drying under load.

Revise as follows:

R401.4 Soil tests.

Where quantifiable data created by accepted soil science methodologies indicate *expansive* soils, *compressible soils*, shifting or other questionable soil characteristics are likely to be present, the *building official* shall determine whether to require a soil test to determine the soil's characteristics at a particular location. This test shall be done by an *approved agency* using an *approved* method.

R801.3 Roof drainage.

In areas where *expansive* soils *or collapsible soils* are known to exist, all *dwellings* shall have a controlled method of water disposal from roofs that will collect and discharge roof drainage to the ground surface not less than 5 feet (1524 mm) from foundation walls or to an *approved* drainage system.

Date Submitted	12/11/2018	**Section**	202	**Proponent**	Joseph Hetzel
Chapter	2	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation	Pending Review
Commission Action	Pending Review

Comments

General Comments	**No**	**Alternate Language**	**No**

Related Modifications

Summary of Modification

Adding a definition of "opaque door".

Rationale

Provides a missing definition for a term used in the code, such as in the Fenestration definition

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact.

Impact to building and property owners relative to cost of compliance with code

No impact.

Impact to industry relative to the cost of compliance with code

No impact.

Impact to small business relative to the cost of compliance with code

No impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Upholds the health, safety, and welfare by clarifying the definition of "opaque door" as used in the code..

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens and improves the code by clarifying the definition of "opaque door" as used in the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No discrimination.

Does not degrade the effectiveness of the code

Improves the effectiveness of the code by clarifying the definition of "opaque door" as used in the code.

OPAQUE DOOR. A door that is not less than 50 percent opaque in surface area.

S7937

Date Submitted	12/11/2018	**Section**	202	**Proponent**	Joseph Hetzel
Chapter	2	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No | **Alternate Language** No

Related Modifications

Summary of Modification

Relocate the definitions of Skylight and Vertical Fenestration.

Rationale

The purpose of this proposed code modification is to format the Fenestration, Skylights and Vertical Fenestration definitions found in R202 in the same manner as found in C202. In C202, Skylights and Vertical Fenestration are shown as sub-definitions to Fenestration. With the relocation, there is also minor wording changes for consistency with the C202 provisions. The proposal was submitted to the ICC as CE11-16 Part 2 (Residential) where it was approved as modified by public comment, reflected in the language shown in this proposed code modification. See Code Modification 7915 for a coordinated proposal for Commercial.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact.

Impact to building and property owners relative to cost of compliance with code

No impact.

Impact to industry relative to the cost of compliance with code

No impact.

Impact to small business relative to the cost of compliance with code

No impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

No adverse effect on health, safety, and welfare, since it is simply a definitions relocation.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens and improves the code through a logical definitions relocation.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No discrimination.

Does not degrade the effectiveness of the code

Improves the effectiveness of the code through a logical definitions relocation.

FENESTRATION. Products classified as either skylights or vertical fenestration.

Skylights. Glass or other transparent or translucent glazing material installed at a slope of less than 60 degrees (1.05 rad) from horizontal.

Vertical fenestration. Windows (fixed or operable), opaque doors, glazed doors, glazed block and combination opaque/glazed doors composed of glass or other transparent or translucent glazing materials and installed at a slope of at least 60 degrees (1.05 rad) from horizontal.

Delete without substitution in R202:
~~SKYLIGHT. Glass or other transparent or translucent glazing material installed at a slope of less than 60 degrees (1.05 rad) from horizontal.~~

Delete without substitution in R202:
~~VERTICAL FENESTRATION. Windows (fixed or moveable), opaque doors, glazed doors, glazed block and combination opaque/glazed doors composed of glass or other transparent or translucent glazing materials and installed at a slope of a least 60 degrees (1.05 rad) from horizontal.~~

S8124

Date Submitted	12/14/2018	**Section**	202	**Proponent**	Andy Williams
Chapter	2	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No **Alternate Language** No

Related Modifications

None

Summary of Modification

Include definition of Post Frame Building System

Rationale

Post frame design and construction has long been recognized in the Florida Building Code under Section 2306, Allowable Stress Design, where each of the EP's are referenced. The material and labor advantages are more often now being recognized in residential construction. Post frame design is an engineered construction method that often requires significant design in the areas of isolated foundations; nail lamination of wood elements to create columns and headers; and diaphragm design to transfer wind load throughout the structure. This definition specifically identifies to the reader that there are code recognized standards to be followed to ensure proper design.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This definition will clarify post frame design and the required standards to allow enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This definition will provide clarity to property owners however it should not increase cost of compliance with the code.

Impact to industry relative to the cost of compliance with code

This definition will provide clarity however it should not increase cost of compliance with the code.

Impact to small business relative to the cost of compliance with code

This definition will provide clarity however it should not increase cost of compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

A proper understanding of what is Post Frame design and the requirements should increase safety and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This definition improves the code by showing the design principles used to support Post Frame design and construction.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against other types of design or design materials.

Does not degrade the effectiveness of the code

If anything, this proposal helps to clarify the code on what is included in a Post Frame design.

Add text as follows

POST FRAME BUILDING SYSTEM. A building system designed in accordance with NDS and, as required, utilizing ASABE Engineering Practice EP 484 (Diaphragm Design), EP 486 (Shallow Pier and Post Foundation Design), and EP 559 (Mechanically Laminated Wood Assemblies) as recognized in the Florida Building Code. The building is characterized by primary structural frames of wood posts as columns to support floors and trusses or rafters as roof framing. Roof framing is attached to the posts, either directly or indirectly through girders. Posts are embedded in the soil and supported on isolated footings, or are attached to the top of piers, concrete or masonry walls, or slabs-on-grade. Secondary framing members, purlins in the roof and girts in the walls, are attached to the primary members to provide lateral support and to transfer sheathing loads, both in-plane and out-of-plane, to the posts and roof framing.

S8177

Date Submitted	12/14/2018	**Section**	202	**Proponent**	Ann Russo1
Chapter	2	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No

Alternate Language No

Related Modifications

Summary of Modification

Add definition to the building-integrated photovoltaic roof panel

Rationale

This proposal adds definition and will provide clarity to the application of this type of roof covering.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal adds another type of roof covering and will provide clarity to the enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal has reasonable and substantial connection with the health, safety and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal will improve the application of the code and will provide equivalent or better products, methods and systems of construction.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal will not discriminate against materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This proposal will not degrade the effectiveness of the code.

Add text as follows:

SECTION 202

DEFINITIONS

BUILDING-INTEGRATED PHOTOVOLTAIC ROOF PANEL. A photovoltaic panel that functions as a component of the building envelope.

S8383

Date Submitted	12/15/2018	**Section**	202	**Proponent**	Craig Conner
Chapter	2	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

806.5

Summary of Modification

This adds definition of moisture diffusion port.

Rationale

This definition supports change in 806.5.2. The rationale is at modification number 8378.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

none

Impact to building and property owners relative to cost of compliance with code

potentially lower cost because of additional options with less expensive materials

Impact to industry relative to the cost of compliance with code

potentially lower cost because of additional options with less expensive materials

Impact to small business relative to the cost of compliance with code

Supports an additional option which can use less expensive materials.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

yes proven to mitigate moisture build up and rot in attic cavities

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Provides a potentially less expensive option and reduces moisture condensation and problems. Improves code because it uses a better method of controlling moisture buildup.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Allows construction with additional materials, instead of restricting practical application to one material.

Does not degrade the effectiveness of the code

Providing usable options improves the code.

VAPOR DIFFUSION PORT. A passageway for conveying water vapor from an unvented attic to the outside atmosphere.

Date Submitted	11/14/2018	**Section**	301.2	**Proponent**	T Stafford
Chapter	3	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Updates the simplified component and cladding loads in Tables R301.2(2) and R301.2(3) and Figure R301.2(7) for consistency with ASCE 7-16.

Rationale

This code change correlates the simplified component and cladding loads in Tables R301.2(2) and R301.2(3) and Figure R301.2(7) with the newly referenced ASCE 7-16. During Phase I of the 2020 update of the FBC, the Commission voted to update ASCE 7 from the 2010 edition to the 2016 edition (ASCE 7-16). In ASCE 7-16, the component and cladding loads and roof zones for roofs with a MRH of 60 feet and less have changed. Additionally the height and exposure coefficients for Exposure B for MRH less than 30 feet have also changed. This code change simply makes the necessary updates to the body of the code for correlation with ASCE 7-16.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners. While there may be cost impacts for certain buildings due to the adoption of ASCE 7-16, this code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to industry relative to the cost of compliance with code

No impact to industry. While there may be cost impacts for certain buildings due to the adoption of ASCE 7-16, this code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to small business relative to the cost of compliance with code

No impact to small business. While there may be cost impacts for certain buildings due to the adoption of ASCE 7-16, this code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This code change correlates the code with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This code change improves the code by providing correlation with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This code change dos not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This code change does not degrade the effectiveness of the code.

Mod 7262

Delete Table R301.2(2) in its entirety:

~~TABLE R301.2(2)~~
~~COMPONENT AND CLADDING LOADS FOR A BUILDING WITH A MEAN ROOF HEIGHT OF 30 FEET LOCATED IN EXPOSURE B (ASD) (psf)~~[a, b, c, d, e, f]

(table values not shown for brevity)

~~For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m2, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa.~~

~~a. The effective wind area shall be equal to the span length multiplied by an effective width. This width shall be permitted to be not less than one-third the span length. For cladding fasteners, the effective wind area shall not be greater than the area that is tributary to an individual fastener.~~

~~b. For effective areas between those given, the load shall be interpolated or the load associated with the lower effective area shall be used.~~

~~c. Table values shall be adjusted for height and exposure by multiplying by the adjustment coefficient in Table R301.2(3).~~

~~d. See Figure R301.2(7) for location of zones.~~

~~e. Plus and minus signs signify pressures acting toward and away from the building surfaces.~~

~~f. Table values have been multiplied by 0.6 to convert component and cladding pressures to ASD.~~

Add new Table R301.2(2) as follows:

TABLE R301.2(2)

COMPONENT AND CLADDING LOADS FOR A BUILDING WITH A MEAN ROOF HEIGHT OF 30 FEET LOCATED IN EXPOSURE B (ASD) (psf)[a, b, c, d, e, f]

	Zone	Effective Wind Area (ft²)	Ultimate Design Wind Speed, V_{ult} (mph) 115 Pos	115 Neg	120 Pos	120 Neg	130 Pos	130 Neg	140 Pos	140 Neg	150 Pos	150 Neg	160 Pos	160 Neg	170 Pos	170 Neg	180 Pos	180 Neg
Gable Roof 0 to 7 degrees	1,1e	10	10.0	-22.7	10.0	-24.8	10.0	-29.1	10.0	-33.7	10.0	-38.7	11.2	-44.0	12.7	-49.7	14.2	-55.7
	1,1e	20	10.0	20.2	10.0	22.0	10.0	25.8	10.0	29.9	10.0	34.4	10.5	39.1	11.9	44.1	13.3	49.5
	1,1e	50	10.0	-16.8	10.0	-18.3	10.0	-21.5	10.0	-24.9	10.0	-28.6	-29.9	-32.5	10.8	-36.7	12.2	-41.2
	1,1e	100	10.0	-14.3	10.0	-15.5	10.0	-18.2	10.0	-21.2	10.0	-24.3	-29.9	-27.6	10.0	-31.2	11.3	-35.0
	2	10	10.0	-30.0	10.0	-32.7	10.0	-38.3	10.0	-44.5	10.0	-51.0	11.2	-58.1	12.7	-65.6	14.2	-73.5
	2	20	10.0	26.7	10.0	29.1	10.0	34.2	10.0	39.6	10.0	45.5	10.5	51.8	11.9	58.4	13.3	65.5
	2	50	10.0	-22.4	10.0	-24.4	10.0	-28.6	10.0	-33.2	10.0	-38.1	-29.9	-43.3	10.8	-48.9	12.2	-54.8
	2	100	10.0	-19.1	10.0	-20.8	10.0	-24.4	10.0	-28.3	10.0	-32.5	10.0	-37.0	10.0	-41.8	11.3	-46.8
	3	10	10.0	-40.9	10.0	44.5	10.0	-52.2	10.0	-60.6	10.0	-69.6	11.2	-79.1	12.7	89.4	14.2	-100.2
	3	20	10.0	-34.4	10.0	-37.4	10.0	-43.9	10.0	-50.9	10.0	-58.4	10.5	-66.5	11.9	-75.1	13.3	-84.2
	3	50	10.0	-25.6	10.0	-27.9	10.0	-32.8	10.0	-38.0	10.0	-43.6	10.0	-49.6	10.8	-56.0	12.2	-62.8
	3	100	10.0	-19.1	10.0	-20.8	10.0	-24.4	10.0	-28.3	10.0	-32.5	10.0	-37.0	10.0	-41.8	11.3	-46.8
Gable Roof >7 to 20 degrees	1, 2e	10	10.6	26.4	11.6	28.7	13.6	33.7	15.8	39.1	18.1	44.9	20.6	51.0	23.3	57.6	26.1	64.6
	1, 2e	20	10.0	-26.4	10.0	-28.7	11.7	-33.7	13.6	-39.1	15.6	-44.9	17.8	-51.0	20.1	-57.6	22.5	-64.6
	1, 2e	50	10.0	-16.1	10.0	-17.5	10.0	-20.6	10.8	-23.8	12.3	-27.4	14.0	-31.1	15.9	-35.2	17.8	-39.4
	1, 2e	100	10.0	-8.2	10.0	-9.0	10.0	-10.5	10.0	-12.2	10.0	-14.0	11.2	-15.9	12.7	-18.0	14.2	-20.2
	2n,2r,3e	10	10.6	38.5	11.6	41.9	13.6	49.2	15.8	57.0	18.1	65.4	20.6	74.5	23.3	84.1	26.1	94.2
	2n,2r,3e	20	10.0	-33.2	10.0	-36.2	11.7	-42.4	13.6	-49.2	15.6	-56.5	17.8	-64.3	20.1	-72.6	22.5	-81.4
	2n,2r,3e	50	10.0	-26.2	10.0	-28.5	10.0	-33.5	10.8	-38.8	12.3	-44.6	14.0	-50.7	15.9	-57.2	17.8	-64.2
	2n,2r,3e	100	10.0	-20.9	10.0	-22.8	10.0	-26.7	10.0	-31.0	10.0	-35.6	11.2	-40.5	12.7	-45.7	14.2	-51.3
	3r	10	10.6	45.7	11.6	49.8	13.6	58.4	15.8	67.8	18.1	77.8	20.6	88.5	23.3	99.9	26.1	112.0
	3r	20	10.0	-39.2	10.0	-42.7	11.7	-50.1	13.6	-58.1	15.6	-66.7	17.8	-75.9	20.1	-85.6	22.5	-96.0
	3r	50	10.0	-30.5	10.0	-33.2	10.0	-39.0	10.8	-45.2	12.3	-51.9	14.0	-59.0	15.9	-66.6	17.8	-74.7
	3r	100	10.0	-24.0	10.0	-26.1	10.0	-30.6	10.0	-35.5	10.0	-40.8	11.2	-46.4	12.7	-52.3	14.2	58.7
Gable Roof >20 to 27 degrees	1, 2e	10	10.6	-20.3	11.6	-22.1	13.6	-26.0	15.8	-30.1	18.1	-34.6	20.6	-39.3	23.3	-44.4	26.1	-49.8
	1, 2e	20	10.0	-20.3	10.0	-22.1	11.7	-26.0	13.6	-30.1	15.6	-34.6	17.8	-39.3	20.1	-44.4	22.5	-49.8
	1, 2e	50	10.0	-17.3	10.0	-18.8	10.0	-22.1	10.8	-25.6	12.3	-29.4	14.0	-33.5	15.9	-37.8	17.8	-42.4
	1, 2e	100	10.0	14.9	10.0	16.2	10.0	19.0	10.0	22.1	10.0	25.3	11.2	28.8	12.7	32.5	14.2	36.5
	2n,2r,3e	10	10.6	-32.4	11.6	-35.3	13.6	-41.4	15.8	-48.0	18.1	-55.2	20.6	-62.8	23.3	-70.8	26.1	-79.4
	2n,2r,3e	20	10.0	-28.4	10.0	-31.0	11.7	-36.3	13.6	-42.1	15.6	-48.4	17.8	-55.0	20.1	-62.1	22.5	-69.6
	2n,2r,3e	50	10.0	-23.1	10.0	-25.2	10.0	-29.5	10.8	-34.2	12.3	-39.3	14.0	-44.7	15.9	-50.5	17.8	-56.6
	2n,2r,3e	100	10.0	19.1	10.0	20.8	10.0	24.4	10.0	28.3	10.0	32.5	11.2	37.0	12.7	41.8	14.2	46.8
	3r	10	10.6	-38.5	11.6	-41.9	13.6	-49.2	15.8	-57.0	18.1	-65.4	20.6	-74.5	23.3	-84.1	26.1	-94.2
	3r	20	10.0	-32.4	10.0	-35.3	11.7	-41.4	13.6	-48.0	15.6	-55.2	17.8	-62.8	20.1	-70.8	22.5	-79.4
	3r	50	10.0	-24.0	10.0	-26.1	10.0	-30.6	10.8	-35.5	12.3	-40.8	14.0	-46.4	15.9	-52.3	17.8	-58.7
	3r	100	10.0	24.0	10.0	26.1	10.0	30.6	10.0	35.5	10.0	40.8	11.2	46.4	12.7	52.3	14.2	58.7
Gable Roof >27 to 45 degrees	1,2e,2r	10	13.1	-24.0	14.2	-26.1	16.7	-30.6	19.4	-35.5	22.2	-40.8	25.3	-46.4	28.5	-52.3	32.0	-58.7
	1,2e,2r	20	11.6	-20.3	12.6	-22.1	14.8	-26.0	17.2	-30.1	19.8	-34.6	22.5	-39.3	25.4	-44.4	28.5	-49.8
	1,2e,2r	50	10.0	-15.5	10.5	-16.9	12.4	-19.8	14.3	-22.9	16.5	-26.3	18.7	-30.0	21.1	-33.8	23.7	-37.9
	1,2e,2r	100	10.0	-11.9	10.0	-12.9	10.5	-15.1	12.2	-17.6	14.0	-20.2	15.9	-22.9	18.0	-25.9	20.2	-29.0
	2n, 3r	10	13.1	-26.4	14.2	-28.7	16.7	-33.7	19.4	-39.1	22.2	-44.9	25.3	-51.0	28.5	-57.6	32.0	-64.6
	2n, 3r	20	11.6	-23.6	12.6	-25.7	14.8	-30.1	17.2	-34.9	19.8	-40.1	22.5	-45.6	25.4	-51.5	28.5	-57.8
	2n, 3r	50	10.0	19.9	10.5	21.6	12.4	25.4	14.3	29.4	16.5	33.8	18.7	38.4	21.1	43.4	23.7	48.6
	2n, 3r	100	10.0	-17.1	10.0	-18.6	10.5	-21.8	12.2	-25.3	14.0	-29.0	15.9	-33.0	18.0	-37.3	20.2	-41.8
	3e	10	13.1	-32.4	14.2	-35.3	16.7	-41.4	19.4	-48.0	22.2	-55.2	25.3	-62.8	28.5	-70.8	32.0	-79.4
	3e	20	11.6	-28.8	12.6	-31.3	14.8	-36.8	17.2	-42.7	19.8	-49.0	22.5	-55.7	25.4	-62.9	28.5	-70.5
	3e	50	10.0	24.0	10.5	26.1	12.4	30.6	14.3	35.5	16.5	40.8	18.7	46.4	21.1	52.3	23.7	58.7
	3e	100	10.0	-20.3	10.0	-22.1	10.5	-26.0	12.2	-30.1	14.0	-34.6	15.9	-39.3	18.0	-44.4	20.2	-49.8

Hip Roof 7 to 20 degrees[1]	1	10	10.6	-24.0	11.6	-26.1	13.6	-30.6	15.8	-35.5	18.1	-40.8	20.6	-46.4	23.3	-52.3	26.1	-58.7
	1	20	10.0	-24.0	10.0	-26.1	11.7	-30.6	13.6	-35.5	15.6	-40.8	17.8	-46.4	20.1	-52.3	22.5	-58.7
	1	50	10.0	18.5	10.0	20.2	10.0	23.7	10.8	27.4	12.3	31.5	14.0	35.8	15.9	40.4	17.8	[illegible]
	1	100	10.0	-14.3	10.0	-15.5	10.0	-18.2	10.0	-21.2	10.0	-24.3	11.2	-27.6	12.7	-31.2	14.2	[illegible]
	2r	10	10.6	-31.2	11.6	-34.0	13.6	-39.9	15.8	-46.3	18.1	-53.1	20.6	-60.4	23.3	-68.2	26.1	[illegible]
	2r	20	10.0	-28.1	10.0	-30.6	11.7	-35.9	13.6	-41.7	15.6	-47.9	17.8	-54.4	20.1	61.5	22.5	[illegible]
	2r	50	10.0	24.0	10.0	26.1	10.0	30.7	10.8	35.6	12.3	40.9	14.0	46.5	15.9	52.5	17.8	58.8
	2r	100	10.0	-20.9	10.0	-22.8	10.0	-26.7	10.0	-31.0	10.0	-35.6	11.2	-40.5	12.7	-45.7	14.2	-51.3
	2e, 3	10	10.6	-33.6	11.6	-36.6	13.6	-43.0	15.8	-49.8	18.1	-57.2	20.6	-65.1	23.3	-73.5	26.1	-82.4
	2e, 3	20	10.0	30.3	10.0	32.9	11.7	38.7	13.6	44.8	15.6	51.5	17.8	58.6	20.1	66.1	22.5	74.1
	2e, 3	50	10.0	-25.8	10.0	-28.0	10.0	-32.9	10.8	-38.2	12.3	-43.8	14.0	-49.9	15.9	-56.3	17.8	-63.1
	2e, 3	100	10.0	-22.4	10.0	-24.4	10.0	-28.6	10.0	-33.2	10.0	-38.1	11.2	-43.3	12.7	-48.9	14.2	[illegible]
Hip Roof >20 to 27 degrees	1	10	10.6	-19.1	11.6	-20.8	13.6	-24.4	15.8	-28.3	18.1	-32.5	20.6	-37.0	23.3	-41.8	26.1	[illegible]
	1	20	10.0	16.9	10.0	18.4	11.7	21.6	13.6	25.1	15.6	28.8	17.8	32.8	20.1	37.0	22.5	[illegible]
	1	50	10.0	-14.0	10.0	-15.3	10.0	-17.9	10.8	-20.8	12.3	-23.9	14.0	-27.2	15.9	-30.7	17.8	-34.4
	1	100	10.0	-11.9	10.0	-12.9	10.0	-15.1	10.0	-17.6	10.0	-20.2	11.2	-22.9	12.7	-25.9	14.2	-29.0
	2e,2r,3	10	10.6	-26.4	11.6	-28.7	13.6	-33.7	15.8	-39.1	18.1	-44.9	20.6	-51.0	23.3	-57.6	26.1	-64.6
	2e,2r,3	20	10.0	23.6	10.0	25.7	11.7	30.1	13.6	34.9	15.6	40.1	17.8	45.6	20.1	51.5	22.5	57.8
	2e,2r,3	50	10.0	-19.9	10.0	-21.6	10.0	-25.4	10.8	-29.4	12.3	-33.8	14.0	-38.4	15.9	-43.4	17.8	-48.6
	2e,2r,3	100	10.0	-17.1	10.0	-18.6	10.0	-21.8	10.0	-25.3	10.0	-29.0	11.2	-33.0	12.7	-37.3	14.2	-41.8
Hip Roof >27 to 45 degrees	1	10	10.2	-20.3	11.1	-22.1	13.0	-26.0	15.1	-30.1	17.3	-34.6	19.7	-39.3	22.2	-44.4	24.9	-49.8
	1	20	10.0	-18.0	10.0	-19.6	11.3	-23.0	13.1	-26.7	15.1	-30.7	17.1	-34.9	19.4	-39.4	21.7	-44.2
	1	50	10.0	-15.0	10.0	-16.3	10.0	-19.2	10.5	-22.2	12.1	-25.5	13.8	-29.0	15.5	-32.8	17.4	-36.7
	1	100	10.0	-12.7	10.0	-13.8	10.0	-16.2	10.0	-18.8	10.0	-21.6	11.2	-24.6	12.7	-27.8	14.2	-31.1
	2e	10	10.2	24.2	11.1	26.3	13.0	30.9	15.1	35.9	17.3	41.2	19.7	46.8	22.2	52.9	24.9	59.3
	2e	20	10.0	-19.1	10.0	-20.8	11.3	-24.4	13.1	-28.3	15.1	-32.5	17.1	-37.0	19.4	-41.8	21.7	-46.8
	2e	50	10.0	-11.9	10.0	-12.9	10.0	-15.1	10.5	-17.6	12.1	-20.2	13.8	-22.9	15.5	-25.9	17.4	-29.0
	2e	100	10.0	-11.9	10.0	-12.9	10.0	-15.1	10.0	-17.6	10.0	-20.2	11.2	-22.9	12.7	-25.9	14.2	-29.0
	2r	10	10.2	30.6	11.1	33.3	13.0	39.1	15.1	45.4	17.3	52.1	19.7	59.2	22.2	66.9	24.9	75.0
	2r	20	10.0	-25.7	10.0	-28.0	11.3	-32.8	13.1	-38.1	15.1	-43.7	17.1	-49.8	19.4	-56.2	21.7	-63.0
	2r	50	10.0	-19.2	10.0	-20.9	10.0	-24.5	10.5	-28.4	12.1	-32.6	13.8	-37.1	15.5	-41.9	17.4	-47.0
	2r	100	10.0	-14.3	10.0	-15.5	10.0	-18.2	10.0	-21.2	10.0	-24.3	11.2	-27.6	12.7	-31.2	14.2	-35.0
	3	10	10.2	32.7	11.1	35.6	13.0	41.7	15.1	48.4	17.3	55.6	19.7	63.2	22.2	71.4	24.9	80.0
	3	20	10.0	-24.6	10.0	-26.7	11.3	-31.4	13.1	-36.4	15.1	-41.8	17.1	-47.5	19.4	-53.7	21.7	-60.2
	3	50	10.0	-14.3	10.0	-15.5	10.0	-18.2	10.5	-21.2	12.1	-24.3	13.8	-27.6	15.5	-31.2	17.4	-35.0
	3	100	10.0	-14.3	10.0	-15.5	10.0	-18.2	10.0	-21.2	10.0	-24.3	11.2	-27.6	12.7	-31.2	14.2	-35.0
Walls	4	10	14.3	-15.5	15.5	-16.9	18.2	-19.8	21.2	-22.9	24.3	-26.3	27.6	-30.0	31.2	-33.8	35.0	-37.9
	4	20	13.6	-14.8	14.8	-16.1	17.4	-19.0	20.2	-22.0	23.2	-25.2	26.4	-28.7	29.8	-32.4	33.4	-36.3
	4	50	12.8	-14.0	13.9	-15.2	16.3	-17.9	19.0	-20.7	21.8	-23.8	24.8	-27.1	27.9	-30.6	31.3	-34.3
	4	100	12.1	13.3	13.2	14.5	15.5	17.1	18.0	19.8	20.6	22.7	23.5	25.8	26.5	29.2	29.7	32.7
	4	500	10.6	-11.9	11.6	-12.9	13.6	-15.1	15.8	-17.6	18.1	-20.2	20.6	-22.9	23.3	-25.9	26.1	-29.0
	5	10	14.3	-19.1	15.5	-20.8	18.2	-24.4	21.2	-28.3	24.3	-32.5	27.6	-37.0	31.2	-41.8	35.0	-46.8
	5	20	13.6	-17.8	14.8	-19.4	17.4	-22.8	20.2	-26.4	23.2	-30.3	26.4	-34.5	29.8	-38.9	33.4	-43.6
	5	50	12.8	16.1	13.9	17.6	16.3	20.6	19.0	23.9	21.8	27.5	24.8	31.2	27.9	35.3	31.3	39.5
	5	100	12.1	-14.8	13.2	-16.1	15.5	-19.0	18.0	-22.0	20.6	-25.2	23.5	-28.7	26.5	-32.4	29.7	-36.3
	5	500	10.6	-11.9	11.6	-12.9	13.6	-15.1	15.8	-17.6	18.1	-20.2	20.6	-22.9	23.3	-25.9	26.1	-29.0

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m2, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa.

a. The effective wind area shall be equal to the span length multiplied by an effective width. This width shall be permitted to be not less than one-third the span length. For cladding fasteners, the effective wind area shall not be greater than the area that is tributary to an individual fastener.

b. For effective areas between those given, the load shall be interpolated or the load associated with the lower effective area shall be used.

c. Table values shall be adjusted for height and exposure by multiplying by the adjustment coefficient in Table R301.2(3).

d. See Figure R301.2(7) for location of zones.

e. Plus and minus signs signify pressures acting toward and away from the building surfaces.

f. Table values have multiplied by 0.6 to convert component and cladding pressures to ASD.

g. Loads in Zone 1' are permitted to be determined in accordance with ASCE 7.

h. Where the ratio of the building mean roof height to length or width is less than 0.8, uplift loads are permitted to be determined in accordance with ASCE 7.

TABLE R301.2(3)

HEIGHT AND EXPOSURE ADJUSTMENT COEFFICIENTS FOR TABLE R301.2(2)

MEAN ROOF HEIGHT (ft)	EXPOSURE CATEGORY		
	B	C	D
15	0.82 ~~1.00~~	1.21	1.47
20	0.89 ~~1.00~~	1.29	1.55
25	0.94 ~~1.00~~	1.35	1.61
30	1.00	1.40	1.66
35	1.05	1.45	1.70
40	1.09	1.49	1.74
45	1.12	1.53	1.78
50	1.16	1.56	1.81
55	1.19	1.59	1.84
60	1.22	1.62	1.97

Delete Figure R301.2(7) in its entirety:

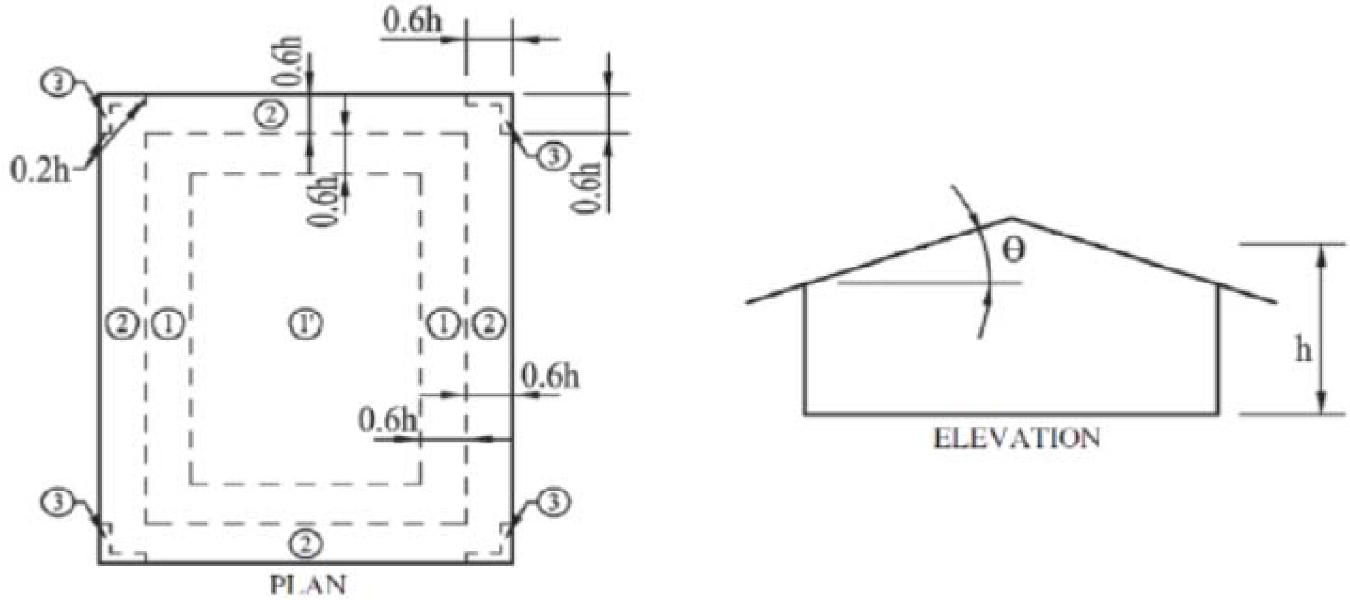
(figure not shown for brevity)

~~For SI: 1 foot = 304.8 mm, 1 degree = 0.0175 rad.~~
~~**Note:** a = 4 feet in all cases.~~

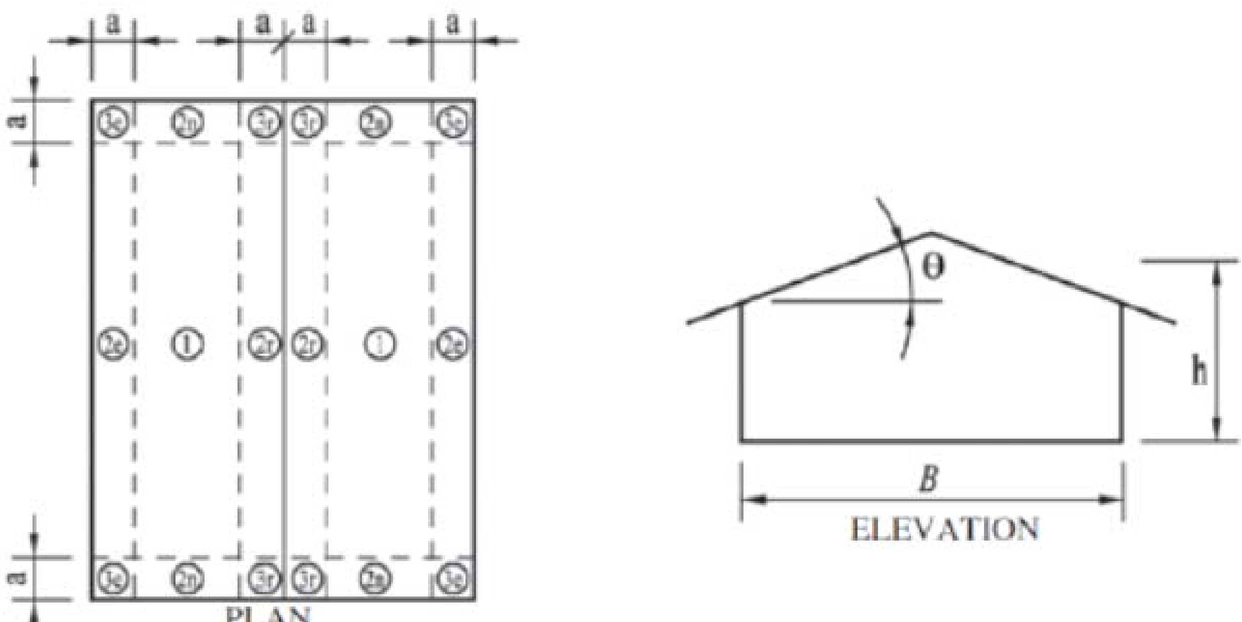
~~**FIGURE R301.2(7)**~~

~~**COMPONENT AND CLADDING PRESSURE ZONES**~~

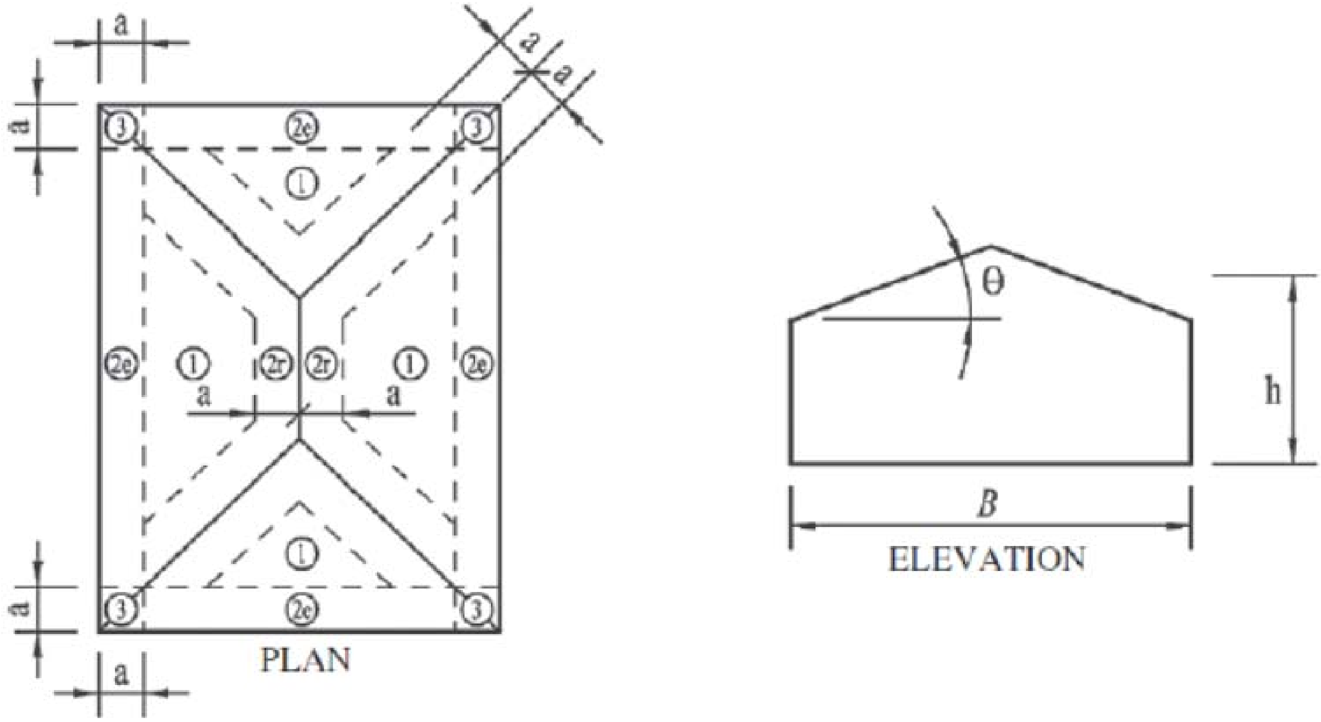
Add new Figure R301.2(7) as follows:



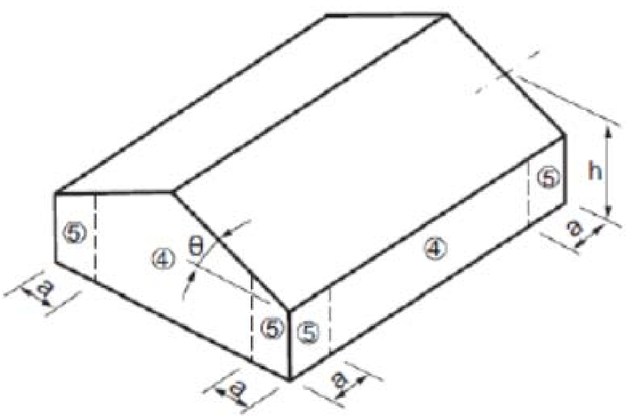
Gable and Flat Roofs $\theta \leq 7^0$



Gable Roofs $7^0 < \theta \leq 45^0$



Hip Roofs $7^0 < \theta \leq 45^0$



Walls

For SI: 1 foot = 304.8 mm, 1 degree = 0.0175 rad.
Note: a = 4 feet in all cases.

FIGURE R301.2(7)
COMPONENT AND CLADDING PRESSURE ZONES

Date Submitted	11/28/2018	**Section**	324.4.1	**Proponent**	Michael Savage
Chapter	3	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No | **Alternate Language** No

Related Modifications

None.

Summary of Modification

This proposal is intended to clarify and correct the requirements for design loads for roofs with PV panels.The text is technically incorrect because it implies the PV panels themselves would be considered as live load.

Rationale

We believe the proposed code change more clearly and completely states the intended requirement. It is to be noted that Section R324.4 does not contain the wind load requirement for PV panels, although it references Section R907, which does.
The text is technically incorrect because it implies the PV panels themselves would be considered as live load. This is inconsistent with how ASCE 7 and other portions of the IRC treat fixed equipment (see Section R301.4 and the definition of "Dead Load" in Section R202).

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

There will not be an increase in the cost of construction or inspection enforcement. This proposal merely clarifies how loads are to be applied to the roof structure, so no change in cost or construction is anticipated.

Impact to building and property owners relative to cost of compliance with code

There will not be an increase in the cost of construction or inspection enforcement. This proposal merely clarifies how loads are to be applied to the roof structure, so no change in cost or construction is anticipated.

Impact to industry relative to the cost of compliance with code

There will not be an increase in the cost of construction or inspection enforcement. This proposal merely clarifies how loads are to be applied to the roof structure, so no change in cost or construction is anticipated.

Impact to small business relative to the cost of compliance with code

There will not be an increase in the cost of construction or inspection enforcement. This proposal merely clarifies how loads are to be applied to the roof structure, so no change in cost or construction is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety and welfare to the public by addressing the issues with dead and live load calculation issues with regard to this solar component.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Provides better consistency with how ASCE 7 and other portions of the IRC treat fixed equipment (see Section R301.4 and the definition of "Dead Load" in Section R202).

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Improves the health, safety and welfare to the public by addressing the issues with dead and live load calculation issues with regard to this solar component and provides better consistency with ASCE 7 and other portions of the IRC while not discriminating against any know products or manufacturers.

Does not degrade the effectiveness of the code

Provides better consistency with how ASCE 7 and other portions of the IRC treat fixed equipment (see Section R301.4 and the definition of "Dead Load" in Section R202).

~~R324.4.1Roof live load. Roof structures that provide support for photovoltaic panel systems shall be designed for applicable roof live load. The design of roof structures need not include roof live load in the areas covered by photovoltaic panel systems. Portions of roof structures not covered by photovoltaic panels shall be designed for roof live load. Roof structures that provide support for photovoltaic panel systems shall be designed for live load, LR, for the load case where the photovoltaic panel system is not present.~~

Portions of roof structures not covered with photovoltaic panel systems shall be designed for dead loads and roof loads in accordance with Sections R301.4 and R301.6. Portions of roof structures covered with photovoltaic panel systems shall be designed for the following load cases:

1.

1. Dead load (including photovoltaic panel weight) plus snow load in accordance with Table R301.2(1).

2.

2. Dead load (excluding photovoltaic panel weight) plus roof live load or snow load, whichever is greater, in accordance with Section R301.6.

S7616

Date Submitted	11/30/2018	**Section**	301	**Proponent**	Joseph Hetzel
Chapter	3	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

Summary of Modification

Establishes a minimum positive wind load of 10 PSF, and a minimum negative wind load of 10 PSF, when using Table R301.2(4).

Rationale

Per ASCE 7-16 Section 30.2.2, design wind loads for components and cladding of buildings shall not be less than 16 PSF, which is ultimate design strength based. Converting to allowable stress design, which the values in Table R301.2(4) are based on, minimum positive and negative design wind loads shall be multiplied by the 0.6 load reduction factor resulting in +/- 10 PSF rounded up from the calculated value of +/- 9.6 PSF.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Cost increase would be minimal overall, since the tabulated values are being increased a relatively minimal amount. The cost increase is offset by the public benefit since the code is strengthened through implementing an ASCE 7-16 requirement.

Impact to building and property owners relative to cost of compliance with code

Cost increase would be minimal overall, since the tabulated values are being increased a relatively minimal amount. The cost increase is offset by the public benefit since the code is strengthened through implementing an ASCE 7-16 requirement.

Impact to industry relative to the cost of compliance with code

Cost increase would be minimal overall, since the tabulated values are being increased a relatively minimal amount. The cost increase is offset by the public benefit since the code is strengthened through implementing an ASCE 7-16 requirement.

Impact to small business relative to the cost of compliance with code

Cost increase would be minimal overall, since the tabulated values are being increased a relatively minimal amount. The cost increase is offset by the public benefit since the code is strengthened through implementing an ASCE 7-16 requirement.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The public will benefit by the code being strengthened, through implementing an ASCE 7-16 requirement.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The code is strengthened through implementing an ASCE 7-16 requirement.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The proposal is neutral with respect to materials, products, methods, or systems.

Does not degrade the effectiveness of the code

The code is strengthened through implementing an ASCE 7-16 requirement.

Mod 7616

TABLE R301.2(4)
NOMINAL (ASD) GARAGE DOOR WIND LOADS FOR A BUILDING WITH A MEAN ROOF HEIGHT OF 30 FEET LOCATED IN EXPOSURE B (PSF) 1,2,3,4,5

Door Size		**ULTIMATE DESIGN WIND SPEED (V*ult*) DETERMINED IN ACCORDANCE WITH SECTION R301.2.1 (MPH-3 SECOND GUST)**																					
Width(ft)	**Height(ft)**	**100 mph**		**110 mph**		**120 mph**		**130 mph**		**140 mph**		**150 mph**		**160 mph**		**170 mph**		**180 mph**		**190 mph**		**200 mph**	
9	7	~~+9.6~~ 10.0	-10.9	+11.4	-12.9	+13.7	-15.5	+16.1	-18.2	+18.5	-20.9	+21.3	-24.1	+24.3	-27.5	+27.6	-31.2	+30.6	-34.6	+34.2	-38.6	+38.0	-43.0
16	7	~~+9.2~~ 10.0	-10.3	+10.9	-12.2	+13.1	-14.6	+15.5	-17.2	+17.7	-19.7	+20.4	-22.7	+23.3	-26.0	+26.4	-29.4	+29.3	-32.6	+32.7	-36.5	+36.4	-40.6
78 mph		85 mph		93 mph		101 mph		108 mph		116 mph		124 mph		132 mph		139 mph		147 mph		155 mph			
Nominal Design Wind Speed (V*asd*) converted from V*ult* per Section R301.2.1.3																							

For SI: 1 foot = 304.8 mm, 1 mile per hour = 1.609 km/h, 1 psf = 47.88 N/m2.

1.For door sizes or wind speeds between those given above the load may be interpolated, otherwise use the load associated with the lower door size.

2.Table values shall be adjusted for height and exposure by multiplying by the adjustment coefficient in Table R301.2(3). Minimum positive wind load shall be 10 PSF and minimum negative wind load shall be 10 PSF.

3.Plus and minus signs signify pressures acting toward and away from the building surfaces.

4.Negative pressures assume door has 2 feet of width in building's end zone.

5.Table values include the 0.6 load reduction factor.

Date Submitted	12/2/2018	**Section**	317.3	**Proponent**	Ann Russo8
Chapter	3	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

S275-16 Part II

Summary of Modification

The intention of this proposal is to better integrate staples into the code so that the provisions for small diameter fasteners (nail and timber rivets) also are explicitly extended to staples where applicable.

Rationale

This proposal is to specifically limit staples to stainless steel where exposed to high corrosion environments. The thin wire gauges used in staple fasteners (16ga – 14ga) are much thinner than those used in nails, and are consequentially more susceptible to corrosion. Also, according to ICC ESR-1539 report for power-drive staples and nails, currently stainless steel staples are the only available option for staples to meet the increased corrosion resistance requirements of sections 2304.10.5.1 and R317.3.1. By specifically specifying staples as requiring stainless steel this avoids confusion and possible misuse of other types of staples in increased corrosion risk applications.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

By specifically specifying staples as requiring stainless steel this avoids confusion and possible misuse of other types of staples in increased corrosion risk applications.

Impact to building and property owners relative to cost of compliance with code

Clarification for the use of staples only. There should be no cost impact.

Impact to industry relative to the cost of compliance with code

Clarification for the use of staples only. There should be no cost impact.

Impact to small business relative to the cost of compliance with code

Clarification for the use of staples only. There should be no cost impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

By specifically specifying staples as requiring stainless steel this avoids confusion and possible misuse of other types of staples in increased corrosion risk applications.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by specifically specifying staples as requiring stainless steel this avoids confusion and possible misuse of other types of staples in increased corrosion risk applications.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Clarification for the use of staples only. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not degrade the effectiveness of the code

Clarification for the use of staples only. Does not degrade the effectiveness of the code but improves the effectiveness of the code.

Revise as follows:

R317.3.1 Fasteners for preservative-treated wood. Fasteners, including nuts and washers, for preservative-treated wood shall be of hot-dipped, zinc-coated galvanized steel, stainless steel, silicon bronze or copper. Staples shall be of stainless steel. Coating types and weights for connectors in contact with preservative-treated wood shall be in accordance with the connector manufacturer's recommendations. In the absence of manufacturer's recommendations, a minimum of ASTM A 653 type G185 zinc-coated galvanized steel, or equivalent, shall be used.

Exceptions:

1. one/two (1/2)-inch-diameter (12.7 mm) or greater steelbolts.

2. Fasteners other than nails, staples, and timber rivets shall be permitted to be of mechanically deposited zinc-coated steel with coating weights in accordance with ASTM B 695, Class 55 minimum.
3. Plain carbon steel fasteners in SBX/DOT and zinc borate preservative-treated wood in an interior, dry environment shall bepermitted.

R317.3.3 Fasteners for fire-retardant-treated wood used in exterior applications or wet or damp locations. Fasteners, including nuts and washers, for fire-retardant-treated wood used in exterior applications or wet or damp locations shall be of hot-dipped, zinc-coated galvanized steel, stainless steel, silicon bronze or copper. Fasteners other than nails, staples, and timber rivets shall be permitted to be of mechanically deposited zinc-coated steel with coating weights in accordance with ASTM B 695, Class 55 minimum.

S7631

Date Submitted	12/2/2018	**Section**	324.4.1.1	**Proponent**	Ann Russo8
Chapter	3	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

RB165-16

Summary of Modification

This proposal is intended to clarify and correct the requirements for design loads for roofs with PV panels.

Rationale

This proposal is intended to clarify and correct the requirements for design loads for roofs with PV panels. The current code text is confusing, incomplete, and technically incorrect.

- The text is confusing because the fourth sentence appears to contradict the second sentence. In addition, the term LR is not used in the FBCR so it is unclear how this is to be applied.
- The text is incomplete because it does not appear to include snow load on top of the PV panels as a load case for roof design.
- The text is technically incorrect because it implies the PV panels themselves would be considered as live load. This is inconsistent with how ASCE 7 and other portions of the FBCR treat fixed equipment (see Section R301.4 and the definition of "Dead Load" in Section R202).

We believe the proposed code change more clearly and completely states the intended requirement.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal merely clarifies how loads are to be applied to the roof structure. This change will help with the interpretation and enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This proposal merely clarifies how loads are to be applied to the roof structure.
Properly-designed roof structures should have been using the load cases in this proposal, so no change in cost or construction is anticipated

Impact to industry relative to the cost of compliance with code

This proposal merely clarifies how loads are to be applied to the roof structure.
Properly-designed roof structures should have been using the load cases in this proposal, so no change in cost or construction is anticipated

Impact to small business relative to the cost of compliance with code

This proposal merely clarifies how loads are to be applied to the roof structure.
Properly-designed roof structures should have been using the load cases in this proposal, so no change in cost or construction is anticipated

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal merely clarifies how loads are to be applied to the roof structure. This change will help with the interpretation and enforcement of the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal merely clarifies how loads are to be applied to the roof structure. Improves the code by clarification and providing correct information.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal merely clarifies how loads are to be applied to the roof structure. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not degrade the effectiveness of the code

This proposal merely clarifies how loads are to be applied to the roof structure. Does not degrade the effectiveness of the code rather enhances the code with the clarification.

Delete and substitute as follows:

R324.4.1.1 Roof ~~live~~ load. ~~Roof structures that provide support for photovoltaic panel systems shall be designed for applicable roof live load. The design of roof structures need not include roof live load in the areas covered by photovoltaic panel systems. Portions of roof structures not covered by photovoltaic panels shall be designed for roof live load. Roof structures that provide support for photovoltaic panel systems shall be designed for live load, LR, for the load case where the photovoltaic panel system is not present.~~

Portions of roof structures not covered with photovoltaic panel systems shall be designed for dead loads and roof loads in accordance with Sections R301.4 and R301.6. Portions of roof structures covered with photovoltaic panel systems shall be designed for the following load cases:

1. Dead load (including photovoltaic panel weight) plus snow load in accordance withTable R301.2(1).
2. Dead load (excluding photovoltaic panel weight) plus roof live load or snowload, whichever is greater, in accordance with Section R301.6.

S7645

Date Submitted	12/3/2018	**Section**	324	**Proponent**	John Hall
Chapter	3	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments Yes | **Alternate Language** No

Related Modifications

The location and numbering of this modification will be dependent upon any action taken on modification #7475.

Summary of Modification

The modification provides for solar ready features to facilitate the instalation of solar PV and solar thermal systems without resort to destructive methods.

Rationale

Solar photovoltaic and solar thermal systems are becoming more cost competitive in the marketplace. Adoption of this technology has many societal benefits. A serious hindrance to the adoption of solar technology is the destructive means required to install them on existing structures. This mod seeks to overcome this hindrance.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

There will be no cost impact relative to enforcement of the code due to this proposed modification. The inspection activity will be performed during already required inspections that are regularly scheduled.

Impact to building and property owners relative to cost of compliance with code

There will be a cost impact to building and property owners for compliance. The requirements are minimal and the associated cost is negligible.

Impact to industry relative to the cost of compliance with code

There will be no cost impact to industry for compliance. The modification is only applicable to one- and two-family dwellings and townhouses.

Impact to small business relative to the cost of compliance with code

There will be no cost impact to small business for compliance. The modification is only applicable to one- and two-family dwellings and townhouses.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The proposed modification has a reasonable and substantial connection with the health, safety, and welfare of the general public by fostering adoption of solar technology that will reduce harmful emissions from use of fossil fuels.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The proposed modification improves the code by making provision for non-destructive installation of solar systems on existing structures.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The proposed modification does not discriminate against any materials, products, methods, or systems of construction as none are specified. The modification allows use of any existing code approved methods and materials for compliance.

Does not degrade the effectiveness of the code

The proposed modification does not degrade the effectiveness of the code. The implementation of the code is enhanced through the provision of features that simplify addition of solar systems to existing structures.

1st Comment Period History

S7645-G1

Proponent Stevie Freeman-Monte **Submitted** 1/29/2019 **Attachments** No

Comment:

I support this proposed code modification.

SECTION 324

SOLAR ENERGY SYSTEMS

R324.1 General. Solar energy systems shall comply with the provisions of this section.

R324.2 Solar thermal systems. Solar thermal systems shall be designed and installed in accordance with Chapter 23 and the *Florida Fire Prevention Code.*

R324.3 Photovoltaic systems. Photovoltaic systems shall be designed and installed in accordance with Sections R324.3.1 through R324.7.1, NFPA 70 and the manufacturer's installation instructions.

R324.3.1 Equipment listings. Photovoltaic panels and modules shall be listed and labeled in accordance with UL 1703. Inverters shall be *listed* and *labeled* in accordance with UL 1741. Systems connected to the utility grid shall use inverters *listed* for utility interaction.

R324.4 Rooftop-mounted photovoltaic systems. Rooftop-mounted *photovoltaic panel systems* installed on or above the roof covering shall be designed and installed in accordance with this section.

R324.4.1 Structural requirements. Rooftop-mounted *photovoltaic panel systems* shall be designed to structurally support the system and withstand applicable gravity loads in accordance with Chapter 3. The roof on which these systems are installed shall be designed and constructed to support loads imposed by such systems in accordance with Chapter 8.

R324.5 Building-integrated photovoltaic systems. Building-integrated photovoltaic systems that serve as roof coverings shall be designed and installed in accordance with Section R905.

R324.5.1 Photovoltaic shingles. Photovoltaic shingles shall comply with Section R905.16.

R324.5.2 Fire Classification. *Building-integrated photovoltaic systems* shall have a fire classification in accordance with Section R902.3.

R324.6 Ground-mounted photovoltaic systems. Groundmounted photovoltaic systems shall be designed and installed in accordance with Section R301.

R324.6.1 Fire separation distances.

Ground-mounted photovoltaic systems shall be subject to the *fire separation distance* requirements determined by the local *jurisdiction*.

<u>**R324.7 Solar-ready zone.** New detached one- and two-family dwellings, and townhouses with not less than 600 square feet (55.74 m2) of roof area oriented between 90 degrees and 270 degrees of true north shall comply with Sections R324.9 through R324.17.</u>

<u>**Exceptions:**</u>

New residential buildings with a permanently installed on-site renewable energy system.

A building where all areas of the roof that would otherwise meet the requirements of Section R324.8 are in full or partial shade for more than 70 percent of daylight hours annually.

Solar-ready zone. A section or sections of the roof or building overhang designated and reserved for the future installation of a solar photovoltaic or solar thermal system.

R324.7.1 Construction document requirements for solar ready zone. Construction documents shall indicate the solar-ready zone.

R324.7.2 Solar-ready zone area. The total solar ready zone area shall be not less than 300 square feet (27.87m2) exclusive of mandatory access or set back areas as required by the *Florida Fire Prevention Code*. New townhouses three stories or less in height above grade plane shall have a solar-ready zone area of not less than 150 square feet (13.94 m2). The solar-ready zone shall be composed of areas not less than 5 feet (1524 mm) in width and not less than 80 square feet (7.44 m2) exclusive of access or set back areas as required by the *Florida Fire Prevention Code*.

R324.7.3 Obstructions. Solar-ready zones shall be free from obstructions, including but not limited to vents, chimneys, and roof-mounted equipment.

R324.7.4 Shading. The solar-ready zone shall be set back from any existing or new, permanently affixed object on the building or site that is located south, east or west of the solar zone a distance not less than two times the object's height above the nearest point on the roof surface. Such objects include, but are not limited to, taller portions of the building itself, parapets, chimneys, antennas, signage, rooftop equipment, trees and roof plantings.

R324.7.5 Capped roof penetration sleeve. A capped roof penetration sleeve shall be provided adjacent to a solar-ready zone. The capped roof penetration sleeve shall be sized to accommodate the future photovoltaic system conduit, but shall have an inside diameter of not less than 11/4 inches (32 mm).

R324.7.6 Roof load documentation. The structural design loads for roof dead load and roof live load shall be clearly indicated on the construction documents.

R324.7.7 Interconnection pathway. Construction documents shall indicate pathways for routing of conduit or plumbing from the solar-ready zone to the electrical service panel or service hot water system.

R324.7.8 Electrical service reserved space. The main electrical service panel shall have a reserved space to allow installation of a dual pole circuit breaker for future solar electric installation and shall be labeled "For Future Solar Electric." The reserved space shall be positioned at the opposite (load) end from the input feeder location or main circuit breaker location.

> **Exception.** A listed enclosure on the supply side of the electrical service main disconnecting means providing access for future interconnection of a solar photovoltaic power production source shall be permitted. The listed enclosure shall be labeled "For Future Solar Electric." The label shall comply with NFPA 70 110.21(B).

R324.7.9 Construction documentation certificate. A permanent certificate, indicating the solar-ready zone and other requirements of this section, shall be posted near the electrical distribution panel, water heater or other conspicuous location by the builder or registered design professional.

Fiscal Impact Assumptions Mod 7645

1. Electrical inspections will be required during the course of construction of a new dwelling. The inspections required by this modification will be performed during the regularly scheduled rough inspection.
2. The modification will result in negligible cost to the owner. The modification requires only three physical items to be installed, a capped roof penetration sleeve of a minimum inside diameter of 1.25 inches, a two pole space in the electrical panel, and labels indicating the location of the solar ready roof zone and the electrical panel space or supply side enclosure if provided.
3. The space in the electrical panel can be substituted with a listed enclosure on the supply side of the service main disconnecting means. This option would eliminate the need for additional space in the electrical panel.
4. All remaining requirements are for location of items to allow clear space on the roof for the system.

LUND UNIVERSITY

Residential solar photovoltaics deployment: barriers and drivers in space

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2017

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List of abbreviations:

IRR = Internal rate of return

PPA = Power purchase agreement

PV = (Solar) photovoltaics

TGC = tradable green certificates

TIS = Technological innovation system

TPO = Third-party ownership

Keywords: Solar photovoltaics (PV), renewable energy, sustainability transitions, technology deployment, diffusion of innovations, barriers, drivers, space, technological innovation system (TIS), technology adoption, business model, peer effects

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Abstract

In order to support a sustainability transition in the energy sector, actors need knowledge about barriers and drivers to the deployment of clean energy technologies. Solar photovoltaics (PV) is a renewable energy technology that is technically mature and on the verge of becoming economically competitive in numerous regions around the world. Not least in the residential segment, PV has considerable potential. Even after residential PV has reached economic competitiveness, however, the technology might still face important barriers in the sociotechnical system in which it is to be deployed.

This thesis aims at adding knowledge about barriers and drivers to the deployment of residential PV systems. The research takes a sociotechnical systems perspective and demonstrates how the *technological innovation systems* (TIS) framework can be amended by the *business models* and the *diffusion of innovations* frameworks to study the deployment of a mature technology in a catching-up market, treating technology development and production as a 'black box'. The research is largely based on case studies and uses various modes of data collection and analysis. The bulk of the research was performed in Swedish settings on the national and local levels, although the United States, Germany and Japan were also studied. Studying these different contexts, the thesis builds knowledge about barriers and drivers on different spatial scales. The researched focused on the period between 2009 and 2014.

The results highlight various barriers and drivers in the studied contexts. On the national level, the Swedish sociotechnical system for PV deployment has been immature and infested by various institutional barriers. Swedish subsidies for PV deployment have been flawed with uncertainties, complexities and discontinuations, and there have been important uncertainties regarding the future development of the institutional set-up. The results also demonstrate how barriers in different national contexts have been decisive for what kinds of business models for PV deployment that have been viable. On the local level in Sweden, the results show how actors such as local electric utilities and private individuals have influenced homeowners to adopt PV through information dissemination and social influence (peer effects). The results can inform policymakers, firms and other actors as to how to support PV deployment.

Populärvetenskaplig sammanfattning

Klimatförändringarna är en av vår tids största utmaningar. För att utsläppen av koldioxid ska minska behöver teknologier för förnybar energi snabbt ersätta energi baserad på fossila bränslen. För att olika aktörer – såsom lagstiftare, företag, ideella organisationer och privatpersoner – ska kunna stödja en sådan omställning behövs kunskap om olika hinder och drivkrafter som motverkar respektive främjar (eller skulle kunna främja) spridningen av teknologi för förnybar energi.

Denna avhandling handlar om spridning av *solceller*. Avhandlingens mål är att identifiera och utvärdera hinder och drivkrafter som påverkar hur mycket solceller som installeras. Fokus ligger främst på solcellsanläggningar för privatpersoner i Sverige, vilket i regel innebär solceller placerade på villatak. Trots Sveriges geografiska läge på förhållandevis solfattiga breddgrader finns god potential för användning av solceller även i Sverige. Avhandlingen tar ett sociotekniskt systemperspektiv och analyserar samtida hinder och drivkrafter relaterade till regelverk, styrmedel, affärsmodeller, social påverkan och ekonomi. En rad fallstudier genomfördes, och data samlades in genom bland annat enkäter och intervjuer med nyckelaktörer. Genom fallstudier fokuserade på såväl det nationella som det lokala planet bygger avhandlingen kunskap om hinder och drivkrafter på olika geografiska nivåer.

Arbetet genomfördes som fyra delstudier, vilka har publicerats (eller ska publiceras) i vetenskapliga tidskrifter. Den första delstudien tog ett helhetsperspektiv på hinder och drivkrafter på nationell nivå i Sverige. Analysen återger ett underutvecklat sociotekniskt system för byggnadsanknutna solceller i Sverige och pekar på en rad problem vad gäller den institutionella stabiliteten. Brister i de ekonomiska styrmedlen har medfört osäkerheter och försämrad investeringsvilja inom installatörsbranschen samt en lång kö för privatpersoner att få ansökningar om bidrag beviljade. Stora osäkerheter har rått vad gäller den framtida utformningen av styrmedel och skatteregler. I vissa fall har det varit oklart hur befintliga regler ska tillämpas då dessa inte varit anpassade för mikroproduktion av elektricitet utan utvecklats för centraliserad storskalig elproduktion.

I den andra delstudien analyserades olika typer av affärsmodeller som nått framgång på tre stora solcellsmarknader (USA, Tyskland och Japan). En affärsmodell är det sätt på vilket företag skapar värde åt sig själva och sina kunder. Studien gick ut på att identifiera faktorer som skiljer sig åt mellan marknaderna och som skulle kunna förklara varför en viss affärsmodell nått framgång på en marknad men inte på en annan. De studerade marknaderna skiljer sig åt markant vad gäller vilka typer av affärsmodeller som nått framgång. Till exempel har leasing av solcellssystem varit mycket populärt i USA men nästintill obefintligt i Tyskland och Japan. Resultaten visade på att faktorer som husägares tillgång till kapital, sparkvoter, flyttmönster, egenskaper hos den nationella byggsektorn samt utformning av bidragssystem kan ha ett stort förklaringsvärde. Resultaten kan användas för att stödja spridning av solceller i Sverige och annorstädes, t.ex. genom att informera lagstiftare om hur institutionella hinder mot vissa typer av affärsmodeller kan avlägsnas, eller genom att informera entreprenörer om hur affärsmodeller kan anpassas för olika nationella kontexter.

Den tredje delstudien gick ut på att förklara skillnader i antalet solcellsinstallationer per capita mellan svenska kommuner. Intervjuer med lokala aktörer samt en enkät skickad till personer som skaffat solceller användes för att identifiera lokala faktorer i fem kommuner med särskilt hög solcellstäthet (antal installationer per capita). Resultaten pekar på att den troligen enskilt viktigaste förklaringen till den höga solcellstätheten i de studerade kommunerna är att lokala aktörer aktivt främjat solceller. Framförallt verkar lokala elnätsbolag som marknadsfört och spridit information kring solceller ha haft en stor effekt.

Den fjärde delstudien handlade om social påverkan mellan privatpersoner. En rad utländska studier har tidigare visat att varje ny solcellsinstallation ökar sannolikheten för ytterligare installationer i dess absoluta närhet, vilket indikerar att grannar påverkar varandra att skaffa solceller. Kunskapen om *hur* denna påverkan gått till har dock varit låg. En enkät skickades till solcellsägare, och uppföljande intervjuer genomfördes med utvalda respondenter. Resultaten tydde på att påverkan främst skett genom förhållandevis nära sociala nätverk (mellan släkt och vänner snarare än mellan grannar utan någon närmare relation), samt att den information som förmedlats och som ansetts viktig främst varit en *bekräftelse* på att anläggningen är enkel att använda, levererar elektricitet som förväntat och är driftsäker, samt att inga obehagliga överraskningar är att vänta. Kontakt mellan privatpersoner har således fungerat som ett komplement till professionell rådgivning, där solcellsägande privatpersoner förmedlat en trygghet som ökat deltagarnas benägenhet att skaffa solceller trots att de saknat proffsens detaljkunskaper.

I sin helhet visar avhandlingen på en rad viktiga hinder och drivkrafter för spridning av solceller. Dessa hinder och drivkrafter kopplar till såväl nationella styrmedel och regelverk som till lokala informationsinsatser och social påverkan. Genom att öka kunskaperna om hinder och drivkrafter på olika geografiska nivåer bidrar avhandlingen till bättre förutsättningar för olika aktörer att underlätta spridning av solceller.

List of papers

This thesis is based on the following four research papers (articles). The full papers can be found at the end of the thesis.

Paper 1:

Palm, A., 2015. An emerging innovation system for deployment of building-sited solar photovoltaics in Sweden. Environmental Innovation and Societal Transitions 15, 140-157.

Paper 2:

Strupeit, L., Palm, A., 2016. Overcoming barriers to renewable energy diffusion: business models for customer-sited solar photovoltaics in Japan, Germany and the United States. Journal of Cleaner Production 123, 124-136.

This paper was produced by my colleague Lars Strupeit and me in close collaboration. As regards research design, the credit goes mainly to Lars. Data collection was split between us, with me responsible for one case (Japan) and Lars for the other two cases. The literature review, data analysis and writing were performed by the two of us in close collaboration.

Paper 3:

Palm, A., 2016. Local factors driving the diffusion of solar photovoltaics in Sweden: A case study of five municipalities in an early market. Energy Research & Social Science 14, 1-12.

Paper 4:

Palm, A., 2016. Peer effects in residential solar photovoltaics adoption – a mixed methods study of Swedish users. Submitted to Energy Research & Social Science.

Content

1. Introduction

To cope with the challenge of climate change, the need for a transition to a low-carbon energy system is urgent (IPCC, 2014). Such a transition is likely to not only involve the introduction of new energy technologies, but also changes of a more social character, involving institutions, consumption behaviour, knowledge and business models (Geels, 2002; Grübler, 2003; IPCC, 2014; Kemp et al., 1998). Sociotechnical transitions of this kind have occurred several times throughout history in different sectors, but they normally take decades (Grübler, 1996), not only because of the time required to develop and refine new technological artefacts, but also because of various barriers in the sociotechnical environment in which the technology is to be deployed. Not least in the energy sector, such barriers are often severe (Unruh, 2000).

Common barriers to the dissemination of new technology include high costs, technical flaws and poor compatibility with existing infrastructure (Geels, 2002; Grübler, 1996; Kemp et al., 1998). Key reasons that new technology tends to be expensive are that production typically takes place on a relatively small scale, and that processes of learning regarding efficient production are yet to occur (Grübler, 2003; Kemp and Soete, 1992). Long periods of experimentation and learning are typically required to bring down costs and refine the performance of a new technology (Grübler, 2012; Kemp and Soete, 1992; Rosenberg, 1994).

Even after a new technology has reached economic and technical competitiveness, important barriers of a more social character typically remain, obstructing deployment of the technology. Organisational and institutional support for new energy technologies is often lacking, while existing (competing) technologies have built up such support over a long period (Bergek et al., 2008a; Geels, 2002; Grübler, 2012; Hekkert et al., 2007; Unruh, 2000). Existing institutions are often poorly aligned to new, radical innovations as the institutions were often adapted for another technological regime, and incumbent companies with vested interests in preserving the status quo will often use their (superior) financial resources and networks to hold new competitors back, e.g. through lobbying (Unruh, 2000). Besides, consumers tend to be somewhat suspicious of new technologies, and complexities and uncertainties (perceived or real, technical or institutional) can often deter potential adopters (Kemp et al., 1998; Rogers, 1983).

There is also an important spatial dimension to the dissemination of innovations. Understanding the preconditions for a transition requires an understanding of how different phenomena relate to geographical places and scales (Coenen et al., 2012; Hansen and Coenen, 2015). The spatial dimension of sustainability transitions has, nevertheless, remained underexplored (Coenen et al., 2012; Hansen and Coenen, 2015). For example, local aspects related to consumers and market formation have only been sporadically considered in the transitions literature (Hansen and Coenen, 2015).

There are various strategies that different actors can use to facilitate a transition. Various policy interventions can be used, based on economic instruments, regulatory approaches or information dissemination (IPCC, 2014). Firms can develop innovative business models that fit certain characteristics of a new technology (Bocken et al., 2014; Boons and Lüdeke-Freund, 2013). Information campaigns and lobbying can be run by non-profit organisations or others. Individuals can influence each other through social networks. Such activities can make a new technology disseminate more quickly. To enable different actors to facilitate a transition in an informed manner, a thorough understanding of the sociotechnical system in which the technology is to be deployed is needed.

This thesis is about the deployment of one specific renewable energy technology, namely *solar photovoltaics* (PV). The aim is to identify and assess *barriers* and *drivers* that obstruct and facilitate PV deployment. The thesis takes the *spatial* dimension into consideration, recognising that geographical place and scale might matter in different ways for different barriers and drivers. The scope is limited to the residential sector, i.e. to PV systems situated on the premises of private homeowners. Only grid-connected applications are considered. The thesis adopts a systemic, sociotechnical view of technology deployment, recognising that deployment depends on an interplay between aspects such as institutions, perceptions, social influence, economy infrastructure and artefacts (Bergek et al., 2008a; Geels, 2002; Grübler, 2003; Hekkert et al., 2007; Hughes, 1993; Markard et al., 2012; Unruh, 2000).

The research behind the thesis has been presented to the research community in four papers. Three of them have been published in different peer-reviewed academic journals, and the fourth is under revision. The papers are summarised one by one in section 3, and the full papers are provided as appendices.

Box 1. Background: PV technology

What is a PV system?

A PV system consists of a number of PV modules and any necessary mounting device, wiring, power inverters etc. Each module consists of a series of solar cells encapsulated into a weather-resistant shell with a transparent surface. PV systems take advantage of the photovoltaic effect, which occurs as the semiconductive material of solar cells is exposed to sunlight.

PV development and dissemination: a brief history

After its invention in the mid-1900s, PV technology found its first significant commercial market in the space industry, where the then high cost of PV was of minor concern. Subsequent niche markets include pocket calculators, early mobile phones, remote transmission stations, parking meters and holiday cottages. As a result of cost reductions and subsidies, the residential rooftop segment gained relevance in the 1990s. Global PV installations came to be dominated by a handful of countries with ambitious subsidy schemes, including Japan, Germany and the United States. In the most recent years, the global PV market has become increasingly geographically diverse.

Technical benefits and challenges of PV

Rooftop PV systems allow adopters to produce and use their own electricity. As the production is close to the user, transmission losses are kept at a minimum. PV technology is highly modular, and PV can feasibly be applied on vastly different scales (from pocket calculators to ground-mounted solar parks). A challenge of PV is intermittency (electricity is produced only when the sun shines), and an increasing share of PV in the power systems might eventually increase the need for load management.

The efficiency of most commercial PV modules in converting solar energy into electricity is around 15%, a figure that has gradually increased from around 6% in the earliest years of PV technology. This figure might not appear too impressive at first glance, but, considering the large amounts of solar energy entering the Earth, it is more than enough from a technical perspective. The global technical potential for electricity generation is several times larger for PV than for biomass or wind power (de Vries et al., 2007).

Although solar cells can be made from a variety of different materials, the world market has been dominated by cells made of silicon, which is the Earth's second most abundant element. The lifecycle greenhouse gas emissions and other externalities of PV systems are normally small in comparison to fossil fuel based electricity generation systems. The energy payback time of silicon-based PV systems under average United States and Southern European conditions is typically around two to three years (Fthenakis and Kim, 2011), and the lifetime of PV modules can be assumed to be 25 years or more (Bazilian et al., 2013).

1.1. PV deployment: barriers, drivers and space – previous knowledge and gaps in the literature

1.1.1. Barriers and drivers to PV deployment

Residential PV deployment faces substantial challenges, including issues that are general to the deployment of new technologies as well as issues that are more specific to PV, the electricity system and the built environment. While barriers are present throughout the PV value chain, this thesis focuses on barriers at work in the *deployment* phase. Deployment is defined here as the process of putting the technology into use, involving activities occurring at and around the very end of the value chain (see section 1.3 for a more detailed definition).

From a purely technical point of view, PV has been a rather mature technology for decades, performing well in various applications (Jacobsson et al., 2004). However, PV is a radical innovation in the context of national electricity systems and the built environment (Awerbuch, 2000; Schleicher-Tappeser, 2012). Compared to established electricity generation technologies, PV is a disruptive technology as it (a) can be distributed at many points in the electrical grid rather than concentrated to a few large plants, (b) can be located at the user side of the electricity meter, and (c) produces electricity intermittently (only when the sun shines). As a radical technology that requires compatibility with other systems, PV can be expected to face substantial challenges regarding compatibility with existing institutions, practices and infrastructures when deployed in a new context (cf. Kemp et al., 1998). Although there is a fair amount of literature on barriers and drivers to PV deployment, there are various relevant research gaps, of which this thesis addresses a few.

Historically, high costs of PV-generated electricity compared to electricity bought from the grid have been a dominant barrier to residential PV and other grid-connected PV applications (Arvizu et al., 2011; Jacobsson et al., 2004). Only recently have costs of PV technology become low enough for PV to compete in grid-connected applications without subsidies. These cost reductions have largely been the result of learning and economies of scale in the production of solar cells, including input materials (Candelise et al., 2013; de La Tour et al., 2013; Jacobsson et al., 2004; Neij, 2008; Nemet, 2006; Zheng and Kammen, 2014). However, this thesis mainly studies a context (Sweden) in which limited economic profitability has remained a substantial barrier.

To overcome the cost barrier, subsidies to deployment have been a common strategy and an important driver. However, not only the sheer size of subsidies is important, but also various other design aspects. For example, the remuneration can be based on the electricity production, total cost or installed capacity of a PV system, creating somewhat different incentive structures (Haas, 2003). Regardless of which strategy is chosen, the literature stresses the importance of keeping subsidies predictable (to reduce uncertainty), user-friendly (to reduce complexity) and dynamic (to be adaptable to external changes). It is crucial to keep the economic profitability (measured for example as the ***internal rate of return***, IRR) of investing in a PV system predictable. Remuneration levels should thus be continuously monitored and adapted to changing prices of PV systems (Haas, 2004, 2003; Sandén, 2005). Throughout Europe, insufficient guarantees regarding the continuation of subsidies have been a common problem (Dusonchet and Telaretti, 2010). The potential of subsidies for PV adoption to drive down costs of PV technology has also been stressed, as the subsidies provide the industry with a market in which it can sell its products and thus learn how to produce and deploy PV more efficiently (Jacobsson et al., 2004; Sandén, 2005). There has, however, been a large variation in how subsidies for PV deployment have actually been designed.

An economic barrier that is particularly tangible for PV is the relatively high ***upfront*** cost. That is, the total lifecycle cost of PV systems is typically highly concentrated to the initial investment. The 'fuel' is free and maintenance costs are low, and although a PV system might be a beneficial long-term investment, prospective adopters might not be able to purchase a PV system due to difficulties in raising the necessary capital (Rosoff and Sinclair, 2009; Yang, 2010). This issue can also deter potential adopters that use a high (explicit or implicit) discount rate.

As costs of PV systems have decreased over time, other barriers than poor economic profitability have gained in relative importance. For example, various complexities and uncertainties (institutional, financial, technical) will often deter potential PV adopters (Karteris and Papadopoulos, 2012; Rai et al., 2016; Rosoff and Sinclair, 2009; Shih and Chou, 2011; Simpson and Clifton, 2015). Examples of specific institutional barriers to PV deployment that have been pinpointed in the literature are a lack of reliable installer certification and standards for technical components and grid-connection (Shrimali and Jenner, 2013; Simpson and Clifton, 2015; Zhang et al., 2015), and long turnaround times and high fees in permitting (Dong and Wiser, 2013; Li and Yi, 2014). Incumbent actors in the electricity sector that have seen their revenues being threatened by the dissemination of residential PV have often tried to influence institutions to counteract PV dissemination, with some (albeit limited) success (Hess, 2016).

Barriers to PV deployment may often be rooted in the electricity and housing systems. Barriers to new technologies tend to be most severe for "systemic technologies that require change in the outside world" (Kemp et al., 1998). For PV to achieve compatibility with buildings and electricity systems, technical and institutional change in these systems might be required. Housing and energy are also typically highly regulated, meaning that various legislative barriers might be present (cf. Unruh, 2000). Systems for electricity generation and distribution can be understood as 'large technical systems' of high complexity and inertia (Hughes, 1993). In such systems, existing institutions and infrastructures often interact to obstruct the deployment of new technologies. Legislation and other institutions in the electricity sector have typically been adapted for a technological regime (cf. Geels, 2002) of centralised large-scale facilities (Unruh, 2000). Current energy systems can be understood as being in a state of 'carbon lock-in' caused by "technological and institutional co-evolution driven by path-dependent increasing returns to scale" (Unruh, 2000), impeding radical innovation in the energy sector and conserving the status quo. Furthermore, technological change is typically slower in sectors of long-lived structures (Grübler, 1996). Only rarely does new energy technology replace existing technology through the premature retiring of existing capital stock; thus, the longevity of plants and infrastructures in incumbent energy systems holds back the dissemination of new energy technologies (Grübler, 2012).

In understanding barriers and drivers to PV deployment, it is important to understand the motives for adopting a residential PV system. In developed countries, motives have mainly related to electricity bill savings, reduced environmental impact, energy independence and a general interest in new technology (Rai et al., 2016; Schelly, 2014; Zhai and Williams, 2012). In markets where PV adoption has been a poor economic investment, concern for the environment and an interest in the technology have often been important driving forces for those few adopting PV (e.g. Palm and Tengvard, 2011).

It is recognised that business model innovation (the development of new business models or the adaptation of existing ones) could serve to overcome certain barriers to PV deployment. For example, third-party ownership (TPO) business models can address the high upfront cost of PV systems, bureaucratic hassle and concerns related to operation and maintenance (Overholm, 2015). Research on how different business models for PV deployment relate to different contextual factors has, however, been scarce.

1.1.2. The spatial dimension of PV deployment

Barriers and drivers to PV deployment can be rooted in different places and extend over different geographical scales. The production of PV system components has mainly taken place in other parts of the world than where the technology has been deployed (Huang et al., 2016; Quitzow, 2015), and the part of the value chain where development and production occur has been more global by nature than have processes of deployment. Processes occurring 'upstream' in the PV value chain, such as silicon purification and wafer production, are technologically advanced and take place in a global arena. In this part of the value chain, skilled staff has been recruited from around the world and production equipment and produced goods have been traded internationally (de la Tour et al., 2011; Huang et al., 2016). The development of institutions governing the global PV industry has been shaped by an interplay between governments and firms across national borders (Bohnsack et al., 2016). Although the actual production of PV system components and input materials has been concentrated to certain places, the sociotechnical system for the generation of PV system components has thus been rather global by nature. At the subsequent steps down the value chain too, solar cells and modules are traded globally nearly as commodities. As a consequence, cost reduction and technological improvements of PV system components have been globally pervasive, thus directly reducing barriers to PV deployment around the world.

PV deployment is an inherently more local process. Installations must be performed on-site, and the geographical focus of the actors involved typically range from the local to the national scale. Deployment in any given place is typically strongly dependent on formal institutions applying to a limited geographical area (Dewald and Fromhold-Eisebith, 2015; Quitzow, 2015), including subsidies, tax rules, building permits and rules for grid-connection.

The cost and technical performance of PV technology have thus been determined to a great extent by factors beyond the deployment context, operating at other geographical places and scales.

Although PV system installation is in itself a rather straightforward procedure, PV deployment is a complex and systemic procedure involving interaction between various actors, institutions and artefacts (Quitzow, 2015). PV deployment and production could indeed be understood as being different sociotechnical systems with different spatial characteristics, interconnected through certain linkages (cf. Bergek et al., 2015; Markard et al., 2015; Quitzow, 2015; Sandén et al., 2008). For small national deployment markets, the global PV industry could be seen as an 'external force' (cf. Sandén et al., 2008). Deployment could thus be characterised as taking place in sociotechnical 'sub-systems' (national or regional PV markets) to a global sociotechnical system for PV technology. The geographical reach of these sub-systems is presumably defined to a great extent by national borders, as the nation state is a natural upholder and enforcer of formal institutions. Although the aggregate of these sub-systems is what fuels (and is fuelled by) the global production system for PV system components, the individual sub-systems are often too small to substantially influence the global system (a counterexample is the domination of the German PV market on global demand in the early 2000s (Quitzow, 2015)).

Conventional methods for analysing technological transitions have suffered from a lack of attention to geographical aspects of the kinds described above (Coenen et al., 2012; Raven et al., 2012). The most widely used sociotechnical system approaches to understanding sustainability transitions are *technological innovation systems* (TIS) and the *multi-level perspective* (MLP) (Coenen et al., 2012; Coenen and Díaz López, 2010; Markard et al., 2012; Markard and Truffer, 2008; Weber and Rohracher, 2012). These approaches have been developed and conventionally applied to consider processes of technology development and deployment together as belonging to one and the same system. However, neither of them has been very explicit on how to deal with spatial division of labour of the kind occurring in the PV value chain (Coenen et al., 2012), although some development has occurred in this regard in parallel to the work with this thesis (Hansen and Coenen, 2015).

As stated, PV technology is mature regarding technical performance, and is reaching cost competitiveness in an increasing number of regions. Meanwhile, there are numerous potential national and regional markets around the world where PV penetration is (still) very low. These markets can be seen as potential catching-up markets, into which PV technology could be imported and deployed relatively swiftly if their internal barriers to deployment are not too severe. The potential global aggregate for PV uptake in such markets is huge, and it is thus important to understand barriers and drivers to deployment in these markets. Research on barriers and drivers to PV deployment in catching-up markets has, however, been scarce.

Various factors of a more local nature have been found to influence PV adoption rates, such as local variations in solar insolation, electricity prices (Kwan, 2012) and rules and procedures for permits, grants and grid-connection (Brudermann et al., 2013; Dong and Wiser, 2013). There is also some evidence that local organisations can overcome barriers to deployment by promoting PV through campaigns, information provision, lobbying or demonstration projects (Brudermann et al., 2013; Dewald and Truffer, 2012; Noll et al., 2014; Owen et al., 2014). As argued by Noll et al. (2014), such local initiatives are likely to have the largest impact on PV adoption rates if residential PV adoption is neither highly profitable nor clearly unprofitable. As financial aspects are neither the dominant driver nor a major barrier in such situations, the argument goes, there is more opportunity for information campaigns or seminars to make a relative difference in driving adoption rates. However, the understanding of what factors can explain local variation in PV adoption rates has been limited.

A driver with an often inherently large local component is social influence between peers, also referred to as *peer effects*. Positive word of mouth often plays an important role in overcoming barriers to the diffusion of innovations (Rogers, 1983). This is particularly true in situations where the support of a strong brand or strong marketing resources are lacking, which is often the case for small companies marketing radical innovations (Mazzarol, 2011). A number of recent studies have attempted to quantify local peer effects in terms of increased probability of additional nearby PV adoptions following previous adoptions (Bollinger and Gillingham, 2012; Graziano and Atkinson, 2014; Graziano and Gillingham, 2014; Müller and Rode, 2013; Rai and Robinson, 2013; L.-L. Richter, 2013; Rode and Weber, 2013). The results indicate that peer effects are stronger down to the zip code or street level (e.g. Bollinger and Gillingham, 2012). Some early attempts have also been made to separate *active* (through direct interpersonal contact) and *passive* (through passively observing PV systems) peer effects, although the results have remained rather inconclusive (e.g. Rai and Robinson, 2013). Pre-existing research on peer effects in PV adoption has focused on estimating the sheer magnitude of the effects, and the qualitative perspective has been lacking. The actual mechanisms underlying the peer effects have thus remained poorly understood.

There is some evidence that local organisations can take advantage of peer effects to reduce barriers to adoption. The findings of Noll et al. (2014) suggest that local non-profit organisations promoting residential PV in the U.S. have managed to leverage the impact of their activities through peer effects by engaging local individuals. A better understanding of how peer effects actually work could potentially inform organisations in how to exploit peer effects to boost PV uptake.

1.2. Objective

The objective of this thesis is to advance the knowledge on *the deployment of residential PV systems*. More specifically, the thesis aims at identifying and assessing *barriers* and *drivers* that obstruct or facilitate PV deployment in different geographical settings, taking the spatial dimension into account. Barriers include any factors in the sociotechnical system surrounding PV deployment that obstruct the deployment process, thus reducing the rate of PV adoptions. Correspondingly, drivers are sociotechnical factors that facilitate PV deployment, thus increasing adoption rates. Such barriers and drivers may relate to for example institutions, firms, economy, human behaviour, infrastructure or technology. Studying different national and local contexts, the thesis aims at building knowledge on barriers and drivers on different spatial scales. The thesis aims at answering four different research questions, one for each paper:

- RQ1 (paper 1): What barriers are present in the Swedish sociotechnical system for residential PV deployment?

- RQ2 (paper 2): How have different kinds of business models been successfully designed by firms to overcome country-specific barriers to residential PV deployment in different national contexts?
- RQ3 (paper 3): What local factors can explain geographically uneven adoption rates (as measured on the municipal level) of residential PV systems within Sweden?
- RQ4 (paper 4): How has social influence between peers (peer effects) reduced barriers to PV adoption among Swedish homeowners?

The thesis is largely based on case study methodology. Important modes of data collection were interviews and surveys, although data were gathered in various other ways as well. Both qualitative and quantitative methods were used.

The target audience includes actors that might have an interest in stimulating PV dissemination. These include policymakers, firms and non-profit organisations.

1.3. Scope

This thesis focuses on a particular part of the PV value chain, namely on *deployment*. Deployment is defined here as the process of putting the technology into use, and involves various activities taking place at and around the very end of the PV value chain, such as PV system marketing, sales, installation and adoption decision making among (potential) users. Deployment is thus the last set of processes in a series of events that lead to a PV system being commissioned. Processes taking place further upstream in the value chain, such as technology production and development, are outside the scope.

Although the terms ‘deployment’ and ‘dissemination’ are often used interchangeably, ‘deployment’ is in this thesis used to signal that it is activities at the end of the value chain that are alluded to. The term ‘dissemination’ is used here to describe the increased uptake of an innovation (e.g. the number of PV systems per capita) without alluding to any particular part(s) of the value chain. Dissemination is thus regarded here as an outcome of the combination of technology development, production and deployment.

With a focus on deployment, there is little reason to delimit the scope to PV systems based on any particular kind of solar cells. Although crystalline silicon solar cells dominate PV markets worldwide, other kinds of solar cells are in principle not excluded from the analysis. Other cell types can be produced with very different methods using different materials, but once encapsulated into modules they can typically be treated more or less as equivalents for residential applications. The deployment focus thus allows the researcher to regard PV modules as 'black boxes' converting sunlight into electricity regardless of the characteristics of its internal processes.

As regards different applications, the focus is on the *residential* segment, i.e. on systems situated in connection to and providing electricity to a particular household. Thus, larger ground-mounted installations, industrial applications and most applications on multi-family dwellings are not considered. Although people renting their homes are in principle not excluded, the current state of affairs in PV markets around the world (including the studied contexts) implies that the adopter category of interest is that of private homeowners.

Regarding *geography*, most of the research focused on Sweden, either the whole country (paper 1) or more local entities (papers 3 and 4). Only in paper 2 was the focus on markets outside Sweden, namely Germany, Japan and the United States. Paper 2 does, nevertheless, provide important lessons for Swedish actors regarding the future development of the Swedish market as this paper studies more developed markets. Papers 3 and 4 differ from the other papers in that they have a *local* focus. All research was conducted in developed countries only. Practically all households in the studied contexts are connected to the electrical grid, and the thesis thus considers grid-connected PV applications only.

Sweden was chosen as the main setting for three key reasons. First, residential PV as an investment in Sweden has been neither clearly unprofitable nor very profitable in recent years. When PV adoption offers limited (but not too poor) prospects of economic gains, various non-economic factors are presumably more likely to have a relatively high impact on adoption rates (cf. Noll et al., 2014), which makes such factors more easily observable. This makes Sweden a potentially fruitful case for studying non-economic barriers to deployment. Second, there has been a lack of research on barriers to PV deployment in catching-up markets. The aggregate of (potential) catching-up PV markets around the world offers a huge potential for PV uptake, and understanding barriers in such contexts is thus of utmost importance. Third, data for Sweden were relatively accessible as the researcher was based there and is a native speaker of the language. Paper 2 went outside the Swedish context because there was not enough empirical data to be found on the topic of interest (business models for PV deployment) within Sweden. A better understanding of business models can nevertheless be useful to support PV deployment in Sweden and other catching-up markets.

Regarding *time*, the research focuses mainly on phenomena that occurred between 2009 (when a subsidy for residential PV was launched in Sweden) and 2014. During that period and up until the time of writing this chapeau (late 2016), the studied PV markets, as well as other PV markets around the world and the global PV industry, have developed substantially. There is, nevertheless, little reason to believe that the findings of this thesis (with perhaps some minor exceptions) are less relevant at the time of finishing the thesis than a few years earlier. First, as observed by the researcher, most of the barriers to deployment in Sweden identified throughout the research remain at the time of finishing the thesis and are thus still relevant targets for policy. Second, even if the studied contexts have changed, there are numerous markets around the world that will likely face challenges similar to those encountered in the studied cases, and that can learn important lessons from them.

All papers except paper 4 adopt a systemic perspective in their respective context, considering a variety of interacting factors in PV deployment. Paper 4, being narrower in scope, focuses exclusively on social influence between peers in PV adoption.

1.4. Limitations

Some limitations of this thesis need to be recognised. First, the generalisability (external validity) of the findings is limited by the fact that the bulk of the research was focused on the Swedish context. Generalisability might be largest to similar cases, e.g. to developed countries with PV markets that are in an early stage of development and where the economic profitability of adopting a PV system is limited.

Second, the perspectives of all relevant actors are not always present. Due to restrictions in time available to the researcher, primary data could not be collected through interviews or surveys for all actors but were collected only from actors that were deemed the most relevant. In paper 1, the actors interviewed were general experts, installers and electricity companies, while primary data were not gathered for adopters and policymakers. In paper 2, primary data were obtained from companies using the business models of interest and from industry experts, but not from the companies' customers or from companies using other business models. Also in paper 3, a deeper understanding could possibly have been obtained through interviews with adopters that responded to the survey.

Third, the number of cases in the comparative case studies (papers 2 and 3) was constrained by limitations in the amount of time available to the researcher rather than by theoretical saturation (cf. Glaser and Strauss, 1967). With more cases added, the internal and external validity could have been increased, and additional insights could potentially have been reached.

Fourth, data could have been gathered to support more elaborate statistical analyses. For paper 3, data could have been collected to perform statistical analyses comparing a larger number of municipalities with regard to how various aspects correlate with PV adoption rates. For paper 4, a larger sample with secured representativeness would have made more elaborate statistical analyses possible.

2. Methodology

This section starts with a description of three theoretical frameworks that were used to guide the research. Then, the overall research design, which is based on case studies and various methods for data collection and analysis, is presented. Lastly, the interdisciplinary nature of the research is discussed briefly.

2.1. Theoretical frameworks

The research conducted for this thesis was guided by a variety of theoretical frameworks and concepts. However, three theoretical frameworks were particularly important. The rationale for choosing these frameworks is described below, after which the frameworks are outlined one by one.

As the thesis aims at identifying barriers and drivers throughout sociotechnical systems for PV deployment, the theoretical framework, or set of frameworks, used must reflect the 'whole' system. There are existing frameworks that fit this purpose quite well. In particular, the *technological innovation systems* (TIS) framework (e.g. Bergek et al., 2008a; Hekkert et al., 2007) and the *multi-level perspective* (MLP) (e.g. Geels, 2002) have been developed to analyse the development and deployment of new technologies from a sociotechnical systems perspective. These two frameworks have become dominant as analytical tools to understand (various barriers and drivers to) sustainability transitions, and, even though they have been developed rather independently of each other, they are largely focused on the same real-world phenomena and share several key concepts (Coenen et al., 2012; Markard and Truffer, 2008). Although these frameworks were not developed for any particular technology or sector, they have very often been applied to renewable technologies in the energy sector (Markard et al., 2012; Markard and Truffer, 2008).

Yet, there are differences between these two frameworks. The TIS framework is apt for studying barriers and drivers at different stages of a technology's development (Bergek et al., 2015, 2008a; Markard et al., 2012), while the MLP framework is relatively more focused on niche applications *or* regimes and less so on intermediate stages of development (Markard and Truffer, 2008). The MLP framework is more apt to explain broader transformative changes than the TIS framework, which is more focused on technology-specific matters (Markard et al., 2015; Weber and Rohracher, 2012). These differences hint that the TIS framework might be a more appropriate choice for the purpose of studying the deployment of a mature technology (PV) in an application that is not to be considered a niche (the residential application) but that has become mainstream in other geographical contexts and is expected to become mainstream also in the country or region of interest. Thus, the thesis uses the TIS framework as a starting point to analyse barriers to PV deployment (paper 1).

The wide scope of the TIS framework implies that it is not as detailed in all parts of the studied sociotechnical system. To further understand barriers and drivers to PV deployment, papers 2-4 analyse specific parts of the deployment systems. The research designs of papers 2-4 thus required the identification of the most relevant parts of these systems, as well as the identification or construction of theoretical frameworks that zoomed in on these parts.

Ideally, the TIS framework would provide adequate guidance to other frameworks that could be applied when studying certain phenomena in greater depth. This is the case for some phenomena that are within the scope of the TIS framework; for example, the TIS framework assigns significant importance to institutions, and accordingly the TIS literature refers to central literature on institutional theory, particularly to literature that deals with relationships between institutions and technological change. However, when it comes to other phenomena that occur in the TIS framework, such as the different actors involved in technology deployment and some of the 'functions' (key processes), the TIS literature does not connect as well to other literature streams. Neither does it provide guidance to any subsystems that might be analysed.

A useful analysis has, nevertheless, been performed by Foxon (2011), who identified a set of key coevolving systems relevant when analysing sustainability transitions, namely *ecosystems*, *technologies*, *institutions*, *business strategies* and *user practices*. Of these systems, *ecosystems* are regarded as external in this thesis. Also *technologies* are largely regarded as an external force, as the focus is on the deployment of artefacts that are in themselves technically mature and imported from another system. *Institutions* are crucial to a systemic analysis of barriers to deployment but are, as stated, quite well covered by the TIS framework, and paper 1 accordingly provides a thorough institutional analysis. Thus, potential areas for further studies remaining after the completion of paper 1 are *business strategies* and *user practices*. Business strategies have also been identified as crucial in bringing sustainable products to the market within the *business models* literature (Bocken et al., 2014; Boons and Lüdeke-Freund, 2013; Mont et al., 2006; Reim et al., 2015; Tukker, 2004). Furthermore, Schot et al. (2016) have made a strong case for dealing in greater depth with the role of users in the technological transitions literature.

Suitable frameworks for studying business strategies and user practices are the *business models framework* (Amit and Zott, 2001; Shafer et al., 2005) and Rogers' (1983) *diffusion of innovations* framework, respectively. Thus, these frameworks were used for papers 2-4. These frameworks fit within the scope of the TIS framework as they zoom in on real-world phenomena covered by the TIS literature. Both frameworks could be positioned relatively easily within the TIS literature as they clearly relate to core TIS concepts. What the TIS framework intends to capture by stressing the importance of firms and the function 'entrepreneurial experimentation' has a large overlap with what is described in the business models literature. The business models literature, being solely devoted to this topic, is nevertheless much more detailed on the phenomena of interest. In a similar manner, the role of users and the functions 'legitimation', 'knowledge development and diffusion' and 'market formation' of the TIS framework have a large overlap with what is dealt with in Rogers' diffusion of innovations framework.

2.1.1. Framework 1: Technological innovation systems (TIS)

The technological innovation systems (TIS) framework was developed to analyse the development, production and deployment of new technologies from a sociotechnical systems perspective (Bergek et al., 2008a; Hekkert et al., 2007). Its most common application has been to identify and assess barriers and drivers to technology dissemination in order to derive policy recommendations, often with the purpose of understanding how increased uptake of renewable energy technologies could be supported (e.g. Dewald and Truffer, 2011; Dewald and Fromhold-Eisebith, 2015; Jacobsson and Bergek, 2011; Quitzow, 2015; Sandén et al., 2008; Suurs, 2009; Suurs and Hekkert, 2009).

The TIS literature is a branch of a wider innovation systems literature, including other innovation systems approaches such as *national*, *regional* and *sectoral* innovation systems. An innovation system belonging to any of these categories can be understood as a complex system of actors and institutions involved in the development, production and deployment of new technology. Originally, the innovation systems literature focused on *national* innovation systems, which are not restricted to one particular technology but deal with the general innovative capability of a country (Lundvall, 2010). Subsequently, literature emerged on sector-specific innovation systems (Malerba, 2009) and, narrowing down, on innovation systems for specific technologies – that is, on TISs. The innovation systems literature emerged largely as a result of a frustration among certain scholars regarding how (mainstream) economics dealt with economic development; the argument was that it neglected processes of learning, institutions and technological change, and wrongfully assumed a static equilibrium (Sharif, 2006).

The rate and direction of technological change can be understood as being determined more by competition between innovation systems than between technologies (Hekkert et al., 2007). A major external force of a TIS for PV deployment is the incumbent system for electricity production, which could be understood as a sectoral innovation system, or as a sociotechnical *regime* (Geels, 2002). As stated, such incumbent systems/regimes could be expected to be locked in through various technological and institutional mechanisms, making it difficult for new and competing technologies to gain ground (Unruh, 2000).

In this thesis (paper 1), the TIS approach was used somewhat differently than in most previous TIS studies as it was applied to the *deployment* phase exclusively. Earlier TIS studies (as most other innovation system studies) have been predominantly used to study processes of development, production and deployment together as occurring in one and the same system, or they have paid less attention to deployment than to development and production (Dewald and Truffer, 2011). However, due to spatially different characteristics between different parts of the PV value chain (see section 1.1.2), a pure deployment focus was deemed the most appropriate for the present research (see also section 2.1.1.3).

In recent (post-2007/2008) TIS literature (Bergek et al., 2008a; Hekkert et al., 2007), a TIS is normally divided into one 'structural' and one 'functional' (more dynamic) part. These are outlined below, and it is briefly explained how they may relate to technology deployment. A brief account of how to think about geographical system boundaries in relation to the value chain follows, as this was an important issue in paper 1.

2.1.1.1. The structure of a TIS

The 'structure' of a TIS is normally thought of in terms of the following three categories of elements:

- *Actors*: Any organisations or individuals relevant for the development or deployment of the technology. With a deployment focus, core actors include, for example, installers and suppliers of turnkey systems and components, policymakers and (potential) adopters.
- *Networks*: Linkages between actors through which information is exchanged. In deployment, associations for installers and suppliers are frequently of high importance, as well as informal networks between adopters. Advocacy coalitions may attempt to influence policy though political networks (Bergek et al., 2008b).
- *Institutions:* Any humanly devised rules (formal or informal) affecting the development or deployment of the technology, such as laws, standards, practices or collective mind frames. For deployment, technology standards

(Ma, 2010) and popular perceptions (legitimacy) (Jacobsson and Bergek, 2004) are examples of institutions that are often important. Although institutions often facilitate deployment, pre-existing institutions may also prohibit or complicate the deployment of a new technology, often unintentionally.

While a TIS is in its early stages, the institutional set-up is usually badly aligned to the emerging technology as institutions are either not in place or are maladapted to the technology. The alignment of institutions to new technology is, however, notoriously an arduous process (Unruh, 2000), further complicated by the fact that firms "compete not only in the market but also over the nature of the institutional set-up" (Bergek et al., 2008a), a competition in which incumbent firms are often in a stronger position than the small newcomers that might represent the new technology. Furthermore, key actors might be missing or might not have gained the relevant knowledge, and networks are often lacking.

With a focus on deployment, these three categories of structural components are all likely to be as important as when the TIS framework is used to study development and deployment together. However, the deployment focus allows the researcher to focus his or her resources on those actors, networks and institutions that are the most relevant for deployment, thus creating room for a more in-depth analysis of those elements.

2.1.1.2. Functions of a TIS

Functions represent key processes that should occur in a TIS in order for the system to perform well. Functions have been described as constituting "an intermediate level between the components of a [TIS] and the performance of the system" (Jacobsson and Bergek, 2004) and as "emergent properties of the interplay between actors and institutions" (Markard and Truffer, 2008). The exact number of functions that should occur is somewhat arbitrary, and various sets of functions have been presented. The following set has (with some variation) gained recognition in the recent TIS literature (Bergek et al., 2008a; Hekkert et al., 2007):

- *Knowledge development and diffusion*, encompassing different processes of learning among key actors. As regards deployment, firms, policy makers and (potential) adopters need to gain an understanding of how to install, market, regulate, support and use the technology.
- *Guidance of the search*, capturing incentives for firms and other organisations to enter and participate in the TIS. The strength of this function is to a great extent determined by present and future *market formation* (see below) as perceived by relevant actors, not least when it comes to the deployment phase.

- *Entrepreneurial experimentation*, including various creative activities of firms. As regards deployment, innovation and variation regarding what applications and business models are employed can be important indicators of the strength of this function.
- *Market formation*, referring to activities that contribute to the creation of demand for the technology. Market formation is a crucial part of the deployment process and a prerequisite for dissemination. Barriers to market formation are often found in the institutional set-up (for example as a lack of standards or misaligned legislation) or in a poor price/performance.
- *Legitimation*, referring to changes in the social acceptance of a technology, or how good or desirable the technology is perceived to be. Legitimation through lobbying performed by activists and interest organisations was decisive for the implementation of deployment supporting schemes for PV in Germany (Bergek et al., 2008a; Jacobsson and Lauber, 2006).
- *Resource mobilisation*, reflecting the availability of human and financial capital necessary for the TIS to perform well. As regards the deployment of renewable energy technologies, the mobilisation of capital for subsidy schemes has often been crucial.

By identifying and strengthening poorly performing functions, policy interventions can facilitate the dissemination of a desirable technology (e.g. a renewable energy technology). This can be achieved by strengthening or adding drivers, or by weakening or removing barriers (Bergek et al., 2008a).

The functions have often been used to study feedback loops between production and deployment. When the TIS framework is applied to the deployment phase exclusively, such feedback loops will not be made visible. With a deployment focus, there is also a possibility that the relative importance between functions might differ from when the TIS framework is applied to a larger part of the value chain, as some functions might be more directly related to earlier stages of the value chain and others to deployment processes (e.g. 'market formation').

2.1.1.3. The spatial dimension and the case for deployment-focused TIS studies

Setting spatial system boundaries in TIS studies can be more or less complicated depending on the case at hand. While some technologies have their value chain assembled more or less entirely within one single country, others have their value chain distributed over different geographical places and scales. As stated by Hekkert et al. (2007), a technology is "hardly ever embedded in just the institutional infrastructure of a single nation or region, since – especially in modern society – the relevant knowledge base for most technologies originates from various geographical areas all over the world". The question of what part(s) of the value chain that are in focus thus has implications for the choice of spatial scope of the study.

A need for more elaborate approaches to geographical system boundary setting and spatial differentiation in TIS studies has been identified in recent publications (Binz et al., 2014; Coenen et al., 2012). The general trend towards increased global division of labour and specialisation in value chains (Antràs et al., 2012; Baldwin and Robert-Nicoud, 2014; Hummels et al., 2001; Los et al., 2015; Timmer et al., 2013) suggests that this need, if anything, will increase as technologies increasingly have their value chains distributed over different geographical places and scales. In parallel to the work with this thesis, empirical and conceptual work has been carried out by other scholars to make the TIS framework more elaborate regarding spatial differentiation (Bergek et al., 2015; Binz et al., 2014; Dewald and Fromhold-Eisebith, 2015; Gosens et al., 2015; Huang et al., 2016; Quitzow, 2015; Wieczorek et al., 2015). Empirical studies using geographically differentiated TIS approaches have been performed for PV (Dewald and Fromhold-Eisebith, 2015; Quitzow, 2015), membrane bioreactors (Binz et al., 2014) and wind power (Wieczorek et al., 2015). A spatially differentiated TIS analysis, in which deployment and production are treated as (partly) different sociotechnical systems between which linkages exist, has been proposed in recent publications (Bergek et al., 2015; Dewald and Fromhold-Eisebith, 2015; Quitzow, 2015). Such analyses could often be useful, but they are resource-intensive as the researcher has to gather and analyse data from different contexts. It is thus important that the researcher knows what to focus his or her resources on and what can be left out of the analysis. Thus, there is a case for elaborating upon whether and under what circumstances the TIS framework can be applied to deployment exclusively, treating technology development and production as a 'black box'.

PV is an example of a technology whose whole value chain does not naturally fit into one and the same geographically defined TIS. As described in section 1.1.2, the development and production of PV system components take place in a global arena, and this part of the value chain is thus better understood as pertaining to a global TIS (although it might, for pragmatic reasons, make sense to define a national TIS for these processes if the purpose is to derive policy recommendations for a particular government), while the deployment of PV is an inherently much more local activity. This can make it somewhat problematic to attempt to squeeze development, production and deployment of PV into one and the same TIS, although the TIS framework is originally intended to study all these processes together. In paper 1, this dilemma was elaborated upon, and it was demonstrated that the TIS framework is useful to study deployment separately in cases where it does not make sense to include more upstream parts of the value chain in the same TIS as deployment.

Two macro trends hint that TIS analyses focused on deployment will be increasingly needed. First, an increasing global division of labour and specialisation suggests that the production and trade of artefacts will increasingly take place in a global arena, while processes of deployment may remain more localised (which has been the case for PV, see section 1.1.2). In those cases, individual end user markets will often be small in relation to the global production system, and a pure deployment focus in TIS studies may be feasible. Second, there is an increasing availability of mature renewable energy technologies that can be deployed in new regions. This availability creates a case for more deployment-focused TIS analyses to study barriers and drivers in these catching-up markets, thus informing actors in how to facilitate a sustainability transition. Furthermore, as technologies mature, their global production systems are likely to increase in size in both absolute terms and in relation to more localised deployment systems, in which case it can be feasible to treat technology development and production as a 'black box' in relation to deployment.

2.1.2. Framework 2: Business models

In order for a technological transition to take place, not only technical but also organisational innovation is required. Not least *firms*, who are usually key actors in technology deployment, might need new strategies to overcome barriers to the deployment of radical innovations. In order to profit from a new technology, firms will often need new strategies for how to provide value for their customers and capture value for themselves – that is, new ***business models*** are needed. In paper 2, an analysis was made of why different kinds of business models for PV deployment have reached success in different national contexts.

A business model is, simply put, a representation of how firms create value for themselves and their customers. Customers may be private individuals, other firms or other organisations, and value may be provided in the form of services, products or a combination of both. In two widely cited papers, business models have been described as "the design of transaction content, structure, and governance so as to create value through the exploitation of business opportunities" (Amit and Zott, 2001), and the "firm's underlying core logic and strategic choices for creating and capturing value within a value network" (Shafer et al., 2005). The business models concept became prevalent around the mid-1990s in connection with the rise of the Internet (Shafer et al., 2005; Zott et al., 2011). A deployment focus is common in business model analyses, although focus can equally well be on products that are to be further processed before a finished product can be deployed.

Although there is no precise, agreed definition of a business model, the following elements are central to most definitions (M. Richter, 2013):

- *Value proposition:* the products or services offered to customers.
- *Customer interface:* the overall interaction with customers, including customer relations, customer segmentation and distribution channels.
- *Infrastructure:* the company's inner structure for value creation, including assets, know-how and partnerships.
- *Revenue model:* the relationship between the costs and revenues of the value proposition.

It is recognised in the literature that business model innovation (the development of new business models or the adaptation of existing ones) can facilitate the deployment of new technologies (Boons and Lüdeke-Freund, 2013). A new technology might not only come with some inherent attributes that call for a new or changed business model, but also the newness in itself might entail barriers that could be addressed through business model innovation. Uncertainties and incompatibilities with existing institutions could potentially be addressed through business models designed to transfer risks and transaction costs from the customer to the company, or to neutralise particular institutional barriers.

In the present thesis (paper 2), the analysis went beyond the conventional business models framework to also consider various contextual country-specific factors. This allowed the research to identify how various barriers have influenced the viability of different business models for PV deployment in different geographical contexts.

2.1.3. Framework 3: Diffusion of innovations

In the *diffusion of innovations* literature, the (potential) adopters are in focus, as well as those influencing or trying to influence their decision to adopt or reject an innovation. Thus, this framework is deployment-focused by nature, although it does not capture the full set of actors (or other factors) relevant for deployment. This section outlines the diffusion of innovations framework as presented by Rogers (1983). Rogers' framework gathers insights from a broad set of literature and has gained wide recognition. His main contribution was to put existing research together into a comprehensible yet robust package. The framework is by no means restricted to sustainability innovations or innovations in the energy sector, but is general to innovations that are or can be adopted by individuals. Elements of the diffusion of innovations framework were used throughout this thesis, particularly in papers 3 and 4.

Rogers (1983, p. 5) defined diffusion as *"the process by which an innovation is communicated through certain channels over time among the members of a social system"*. The framework focuses on processes of decision making, how different personality types relate to the inclination to adopt an innovation, and how different attributes of innovations might influence their adoption rates. Rogers used the terms ‘diffusion’ and ‘dissemination’ interchangeably. In this thesis, ‘dissemination’ is used as a general term for the uptake of an innovation (e.g. in terms of adoption rates), while ‘diffusion’ is used for processes more specifically related to communication or exchange of ideas, or to signal adherence to the work of Rogers. In this thesis, ‘diffusion’ differs from ‘deployment’ in that ‘deployment’ involves more aspects than just interpersonal communication (the difference between ‘dissemination’ and ‘deployment’ has been accounted for in section 1.3).

A key feature of the framework is the categorisation of potential adopters by some key characteristics and their role in diffusion processes. Rogers promotes a categorisation of potential adopters into five ideal types (although he concedes that in reality there are no sharp boundaries between these groups):

- *Innovators* are the first to adopt innovations. The innovator is venturesome and eager to try new ideas, leading him or her to seek social relationships with other like-minded outside their local peer group. Innovators are often seen upon with some suspicion by their peers, being perceived as ‘too’ innovative, but they can still facilitate the diffusion process by bringing new ideas into their social system.
- *Early adopters* are somewhat less innovative than innovators. They are more integrated into their local social system than innovators, and are more influential on the attitudes of their local peers. Being both relatively respected and innovative (but not *too* innovative), they are effective role models and have the highest level of *opinion leadership* (see below) among the categories.
- The *early majority* adopts innovations just slightly earlier than the average individual. This group is an important link between early and late adopters, providing interconnectedness supporting the diffusion process. Once a person belonging to this category has started contemplating adoption, his or her decision period is longer than that of earlier adopters.
- The *late majority* adopts innovations slightly later than the average individual. Adoption often comes as the result of economic necessity or social pressure. Persons in this category tend to maintain a sceptical attitude towards new ideas in general, and practically all uncertainty about the innovation must have disappeared before they choose to adopt.
- *Laggards* are the last to adopt an innovation. They are suspicious of new ideas, and their attitudes are often aligned with the practices of previous generations. Often, however, a precarious economic situation is a partial reason for the late adoption.

The decision to adopt (and keep using) an innovation is described by Rogers as an *innovation-decision process* consisting of the following five stages:

- *Knowledge,* in which awareness of the existence of the innovation and understanding of how it works are gained.
- *Persuasion*, in which a favourable or unfavourable attitude towards the innovation is formed.
- *Decision*, involving activities leading to a choice regarding whether to adopt or reject the innovation.
- *Implementation*, in which the innovation is put into use.
- *Confirmation*, in which reinforcement of an earlier adoption decision is sought, sometimes leading to a reversal of the adoption.

Innovations have different *attributes*, which are highly influential on the rate at which they diffuse in a social system. Attributes can be generalised into the following five categories, which, according to Rogers, taken together normally explain most of the variance in the rate of adoption between innovations:

- *Relative advantage* as compared to existing alternatives. In the case of residential PV, the existing alternative would for most prospective adopters be electricity from another source or another financial investment.
- *Compatibility* with for example norms, beliefs and infrastructure. As an example, residential PV benefits from a widespread belief in the perils of climate change, but may be in conflict with permitting or tax rules.
- *Complexity* as perceived by potential adopters. Although residential PV systems are typically relatively easy to acquire and use (at least from a technical point of view), potential adopters might perceive adoption and use as potentially complicated.
- *Trialability*, reflecting the possibility of testing the technology before adopting it. Residential PV suffers from low trialability, as a PV system cannot easily be installed and uninstalled for testing on a rooftop.
- *Observability*, being the extent to which members of a social system can observe the results of an adoption. While residential PV has a high observability in terms of *awareness* (neighbours will normally notice when someone has installed a rooftop PV system), lower observability of the actual results of PV adoption (production, economy, reliability) might be a disadvantage.

A key concept in papers 3 and 4 is that of 'peer effects', which captures social influence between peers (e.g. neighbours, co-workers or friends) in the adoption decision process. Although Rogers did not use this particular term, much of his framework is, as should be evident from the above account, dedicated to this topic. Peer effects can be *active* (occurring through direct communication between peers) or *passive* (occurring without direct communication, for example when someone observes a new PV installation in their neighbourhood) (e.g. Rai and Robinson, 2013). Peer effects have been observed in the adoption of a variety of technologies, such as menstrual cups among Nepalese adolescents (Oster and Thornton, 2009), electric vehicles (Axsen et al., 2009), information and communication technologies (e.g. Stewart, 2007), housing renovation (Helms, 2012) and various kinds of farming equipment (Rogers, 1983). Peer effects are often highly localised (Rode and Weber, 2013), and local peer effects for residential PV systems have been quantified in a number of recent studies (Bollinger and Gillingham, 2012; Graziano and Atkinson, 2014; Graziano and Gillingham, 2014; Müller and Rode, 2013; Rai and Robinson, 2013; L.-L. Richter, 2013; Rode and Weber, 2013). There has, nevertheless, been a lack of qualitative research on peer effects in PV adoption, and consequently the understanding of the underlying mechanisms of peer effects in PV adoption has remained poor. This gap was addressed in paper 4.

2.2. Research design

The research was mainly based on case studies carried out using qualitative methods. Data were collected through a variety of methods, including interviews (all papers), surveys (papers 3 and 4) and comprehensive internet searches (all papers). Both primary and secondary data (academic and non-academic) were used (secondary data were relatively more important for papers 1 and 2). In this section, the case study approach(es) adopted and the methods for data collection and analysis are outlined. (For a more detailed account of the research designs of each paper, see section 3 or the appended papers.)

2.2.1. Case studies

The thesis is largely based on *case studies*, i.e. empirical in-depth inquiries in single settings (Eisenhardt, 1989; Yin, 2009). Case studies are suitable to shed light on 'how'- or 'why'-questions regarding contemporary phenomena over which the researcher has little or no control (Yin, 2009). Case studies can be based on qualitative or quantitative methods, or a combination of both, and they normally make use of a variety of evidence, including documents, artefacts, interviews, and observations (Eisenhardt, 1989; Yin, 2009). Case studies are generalisable to theoretical propositions rather than to populations, and one of their important strengths is to explain causal links in complex situations (Yin, 2009).

Case studies can be based on one or more cases, which should be selected on the basis of their expected ability to provide useful information rather than to provide a representative sample of a larger universe (Eisenhardt, 1989; Yin, 2009). If the number of candidates for cases to study exceeds about a dozen, quantitative data should be collected about the cases and pre-defined criteria should be specified to select a smaller number (Yin, 2009). This strategy was adopted for paper 3.

For papers 1-3, a clear-cut case study approach was adopted, while paper 4 employed elements of case study methodology. Paper 1 was carried out as a single-case study to identify and assess barriers and drivers within one particular setting (Sweden as a whole). Papers 2 and 3, on the other hand, used multiple-case approaches to support generalisations by means of comparison between different settings.

2.2.2. Data collection and analysis

In line with the interdisciplinary nature of the research and with case study methodology, data were collected and analysed using a variety of sources and methods (Table 1). This allowed for knowledge to be added regarding various aspects of the posed research questions. The variety also allowed for triangulation, i.e. for increasing the internal validity of the findings using evidence derived from different datasets and methods (Richards, 2007). While papers 1 and 2 were exclusively qualitative, papers 3 and 4 used a mix of qualitative and quantitative methods. Paper 4 used a narrower set of data sources than the other papers. Both primary and secondary data were used. Primary data were collected mainly from interviews and surveys. See Table 1, section 3 or the appended papers for more detailed information on the data used for each paper.

Participants (interviewees and survey respondents) were selected through *purposeful sampling,* i.e. they were selected based on their expected ability to provide useful information rather than to achieve a representative sample of a larger population. Purposeful sampling is generally adequate in qualitative research (Maxwell, 2008).

Interviews were carried out in a semi-structured manner, meaning that a set of questions (an interview guide) was prepared in advance but was not necessarily followed strictly. Thus, any unforeseen and interesting matters surging during the interview could be addressed. In total, 59 interviews were performed. In addition, numerous shorter or less structured communications were performed with various actors, mainly through telephone or email. The main function of these shorter contacts was to guide the research towards relevant data sources or topics.

The interviews were analysed differently between the papers, mostly depending on their relative importance for the respective paper. For papers 1-3, interviews were not recorded but notes were taken during the interviews. For paper 4, in which interviews were relatively more important, not only notes were taken but the interviews were also recorded and (whenever the notes were not considered detailed enough) revisited and partly transcribed. Simple coding techniques were used to analyse the interviews, through which themes were identified and put into categories. This allowed the researcher to keep track of how many interviewees had made certain statements or expressed certain considerations. Some degree of interview coding was performed for all papers, although it was done most systematically for paper 4.

Two surveys were performed to collect data for papers 3 and 4, respectively. Questionnaires (see appendices A and B) were sent by postal mail to Swedish PV adopters. The response rates were 74-80% (which is to be regarded as high) and in total 130 valid responses were obtained. The data obtained through the surveys were used mainly for descriptive statistics and to guide the further research, although some inferential statistics were also performed.

Table 1. Data systematically collected for the four papers, by type and quantity. In addition to what is shown in this table, systematic Internet searches were important for papers 1-3, leading to the use of various secondary data.

Paper	Data		
	Type	Actor/source	Quantity
1	Interviews (duration 0.5-1 h)	PV installers	9
		Electricity companies	9
		Experts	4
2	Interviews, marketing material	Companies (Japan)	5
	Websites	Companies (U.S, Germany)	70
3	Survey questionnaire (appendix A)	Adopters	65 valid responses (80% response rate)
	Interviews (duration 0.25-0.5 h)	Local actors (e.g. PV installers, electric utilities, municipal energy advisers)	16
4	Survey questionnaire (appendix B)	PV adopters	65 valid responses (74% response rate)
	Interviews (appendix C) (duration 0.25-0.75 h)	PV adopters	16

Secondary data were collected from various sources. Documents such as industry reports, academic publications, newspaper articles and the websites of firms and other organisations were used. For papers 1-3, comprehensive Internet searches were an important tool to identify and gather data. An important data source and tool was the Swedish Energy Agency's register of applications and approvals for an investment subsidy scheme that has been available to PV adopters since 2009. The names and addresses of PV adopters obtained from this register allowed for analysis of geographical differences in PV adoption rates within Sweden, and made it possible for the researcher to contact adopters for the surveys and interviews. This register was used for papers 3 and 4.

When feasible, data were collected until theoretical saturation (Glaser and Strauss, 1967) was approached, i.e. until the marginal gain in insights obtained through additional data collection was not large enough to motivate the effort of collecting more data. There were, nevertheless, restrictions regarding the extent to which theoretical saturation could be applied (see section 1.4).

2.3. Interdisciplinarity

The research behind this thesis is *interdisciplinary* by nature. Interdisciplinarity is the combination and (partial) integration of elements from two or more academic disciplines (Boden, 1999; Klein, 2010, 1990). A broad scope alone does not necessarily imply interdisciplinarity, and neither does the mere juxtaposition of different disciplines (Klein, 1990). For interdisciplinarity to be meaningful, the strengths of different disciplines should contribute to address one and the same issue and, ideally, the disciplines should enrich each other (Boden, 1999). Although interdisciplinarity is often confused with *multidisciplinarity*, the latter term refers to the juxtaposition of disciplines without any requirements on integration (Klein, 1990). Distinctions between different branches of social science are to a large extent arbitrary and historically forged (Calhoun and Rhoten, 2010), meaning that that interdisciplinary approaches are often no more intrinsically wide-scoped or integrative than research within established disciplines.

Interdisciplinary approaches are often useful to study phenomena that are complex or that do not fit into one particular discipline (Calhoun and Rhoten, 2010; Klein, 1990; Krohn, 2010), including many policy challenges facing humanity, such as climate change and sustainability transitions in the energy sector (Bhaskar et al., 2010; Miller, 2010). The present research made use of two theoretical frameworks (TIS and business models) that are in themselves pronouncedly interdisciplinary (Pateli and Giaglis, 2007; Sharif, 2006). In addition, theories originating in sociology (the diffusion of innovations framework) were used to understand the role of adopters in PV deployment. Although these three frameworks were used largely in parallel rather than integrated with each other in the four papers, this chapeau ties the findings more closely together, thus strengthening the interdisciplinarity of the research.

3. Key findings organised by papers

The four papers studied barriers and drivers to PV deployment in different geographical contexts and using different approaches. In paper 1, a sociotechnical systems approach was used to identify and assess various barriers and drivers to PV deployment in Sweden. In paper 2, business models for PV deployment that have been successful in three important PV markets (the United States, Germany and Japan) were analysed regarding their ability to overcome country-specific barriers. In paper 3, drivers that could explain the relatively high adoption rates observed in certain Swedish municipalities were identified and assessed using a multiple-case study approach. In paper 4, social influence between peers (peer effects) was studied regarding how Swedish PV adopters have increased the willingness of their peers to adopt PV. In the following, the four papers are summarised one by one.

3.1. Paper 1 – Systems perspective on barriers and drivers to PV deployment (Sweden)

3.1.1. Background

The Swedish government has an outspoken ambition to increase the share of solar energy and other renewables in the country's energy system, and subsidies for PV deployment have been available for a number of years. As previously stated, the deployment of radical energy technologies is however a complex process that may encounter several unforeseen barriers. This calls for a systematic review of the overall conditions for PV deployment within the country. Such an analysis has previously been performed by Sandén et al. (2008), who included not only deployment but also development and production in their study. This thesis provides an updated study devoted solely to the deployment phase.

3.1.2. Objective and approach

The objective of this paper was to identify and assess barriers and drivers to the deployment of residential PV systems in Sweden. Such an analysis could result in information useful to policymakers. A technological innovation systems (TIS) approach was adopted, which is a sociotechnical systems perspective developed to analyse the dynamics of technology development, production and deployment, and to identify and assess barriers and drivers throughout a technology's value chain (see section 2.1.1). In the present thesis, however, the TIS framework was applied to the deployment phase exclusively, allowing for a more robust analysis of this phase.

Methods for data collection were comprehensive Internet searches, 22 interviews with experts, installation firms and electricity companies, as well as a number of brief communications with various actors. A large amount of secondary data, mainly identified through the Internet searches, was reviewed, including legislative texts, debate articles, organisations' websites, statistics from governmental organisations, governmental reports, etc.

The Swedish national borders were set as the geographical system boundary because they coincide with the reach of several important institutions and because a purpose of the study was to inform Swedish policymakers. Timewise, the study focused on the early 2010s.

3.1.3. Results

The analysis revealed that the Swedish TIS for PV deployment was small and underdeveloped, although the market was (in relative terms) in a state of rapid growth. Commercial actors involved in PV deployment were largely restricted to small installation companies, although electric utilities[1] and electricity retailers had also shown an increasing interest in PV systems sales and trade in solar electricity. Installation firms were typically small and with a local focus. They were often not exclusively devoted to PV technology, thus lacking the benefit of specialisation. Potentially important actors such as architects or construction companies were not

[1] In this thesis, an *electric utility* is defined as an organisation that operates an electrical distribution grid. Although the legal entity that is most directly responsible for operating the grid is not allowed by Swedish law to trade in electricity or appliances such as PV systems, a grid-operating entity and an electricity-trading entity can be (and are often) gathered within the same group of companies. The group of companies can then sell PV systems though the electricity-trading entity, while it runs the grid through its grid-operating entity. In this thesis, the term *utility* may refer to such groups of entities or to pure grid-operators. For companies engaged in electricity-trading but not in grid-operation, the term *electricity retailer* will be used.

engaged in PV deployment more than marginally. PV systems were almost exclusively purchased by the adopters, meaning that third-party ownership business models that have been common in some more developed markets were practically non-existent in Sweden. This lack of alternative business models could be a barrier to some potential adopters who would prefer to adopt PV without purchasing a system.

Overall, the most important barrier to PV deployment was found to be the poor economic profitability of investing in a PV system. This was not only because of expensive PV systems and relatively low amounts of solar influx, but also because electricity prices in Sweden have generally been relatively low by international standards. Thus, the Swedish PV market had been created and upheld by subsidies. However, the subsidy schemes in place were sub-optimally designed, impaired by uncertainties and complexities.

The most important subsidy for PV deployment has been an investment subsidy scheme available for residential PV since 2009. Through this subsidy, adopters have been reimbursed for a fixed share of their expenses for purchasing a PV system. The scheme has repeatedly reached its budget cap, after which no more applications have been approved until more funding has been added through political decisions. As the PV market was very dependent on this subsidy scheme, the reaching of the cap has led to discontinuations not only in the scheme but in the whole PV market. This has created severe problems for installation firms that have suddenly and repeatedly lost their source of revenue. It has most often been unknown to the actors if and when new funding was to be added to the scheme. The interviews revealed that, as a result of these uncertainties, installation firms have often postponed decisions regarding the recruitment of new employees, purchasing of equipment or acquiring of a more appropriate office.

Furthermore, whenever the cap had been reached, additional applications were placed in a queue to be considered if and when new funding was added through political decisions. This led to waiting times for getting applications approved gradually increasing to more than a year, creating complications not only for adopters but also for firms. The delays have resulted in extra transaction costs for installers who have often had the feeling that they have been forced to 'sell the PV system twice', once when the adopter contacts them before filing an application for the subsidy and again after the application has been approved.

In parallel to the investment subsidy scheme, a tradable green certificates (TGC) scheme has been in place since 2003. Through the TGC scheme, owners of PV systems and a number of other renewable electricity technologies have been granted tradable certificates for their electricity production (one certificate per megawatt-hour). Certificates have been sellable on a 'free' market, demand being created by legal obligations on other actors to acquire certificates in proportion to their production or use of electricity.

The TGC scheme was launched as the main Swedish policy instrument to support renewable electricity, and an important feature was its alleged ‘technology neutrality’. It has been an important driver of the dissemination of renewable electricity technologies, mainly for wind power (Swedenergy, 2012). The scheme has, however, been poorly adapted for micro-generation of electricity (e.g. in residential PV systems). Trading small quantities of certificates has been complicated, and although PV owners have formally been entitled certificates corresponding to their whole production, hassle and extra costs have made it unattractive to acquire certificates for the self-consumed part of the production. Perhaps most importantly, expensive metering equipment has had to be installed by the PV owner for certificates to be granted for self-consumed electricity. The misalignment of the TGC scheme to micro-generation is illustrated by the fact that only a fraction of the Swedish PV adopters had found it worthwhile to apply for TGCs at the time of the study. For example, by the end of 2012 a mere 10% of all grid-connected PV systems in Sweden were benefiting from the scheme (Stridh et al., 2013).

As regards the institutional set-up beyond subsidies, existing institutions were found to be fairly well-aligned to residential PV deployment in the sense that no particular barriers of prohibitive magnitude could be identified. An important barrier was removed in 2010 when PV adopters were given the legal right to connect their system to the grid at no cost. Building permits for PV systems have usually been granted without prohibitive costs or hassle, and even though there has been some variation between municipalities’ building permit policies, national regulation has kept these costs and restrictions within certain limits.

There have, however, been some barriers related to tax rules. Most of the existing tax rules of relevance were designed decades ago for a regime of centralised large-scale electricity generation, and have not always been straightforwardly applicable to micro-generation. For example, there have been uncertainties regarding whether micro-producers selling their surplus electricity to an electricity retailer are to be regarded as ‘professional’ and thereby subject to extra taxation and paper work. According to the tax agency, tax rules on the EU and Swedish levels have also prohibited net metering (the practice of subtracting any electricity fed into the grid from the consumption before applying taxes), although the tax agency’s interpretation of the rules on this point has been opposed by some actors.

A large problem has been uncertainties regarding the future development of the institutional set-up. Most importantly, future taxes and subsidies have been unpredictable, both regarding their design and at what times they would be in operation. Apart from the aforementioned uncertainties regarding the investment subsidy, there were important uncertainties regarding the planned introduction of a tax reduction scheme for PV owners[2], for example regarding the compatibility of the tax reduction with existing tax rules.

The functional analysis revealed a linear chain reaction driving deployment. 'Legitimation' had been necessary for 'resource mobilisation' of the funding used for the investment subsidy scheme. This caused 'market formation' to take off, which in turn provided 'guidance of the search' for entrepreneurs to get involved in the PV installation business. The functions not mentioned in this chain reaction ('knowledge development and diffusion' and 'entrepreneurial experimentation') were excluded because little evidence was found that these functions operated on more than a basic level. Most installation had taken place in a rather traditional manner both technically and organisationally, and the experimentation of electric utilities and other commercial actors had remained a rather marginal phenomenon. The knowledge employed by actors involved in PV deployment was rather basic (add-on PV installation is in itself not a very complicated process), and the awareness of consumers necessary for their propensity to adopt PV was rather captured by the legitimation function. Because of the deployment focus, functional feedback mechanisms from deployment to production that are often analysed in TIS studies were not made visible in this case. However, the Swedish PV market was too small to significantly affect the global PV production system and such feedback mechanisms could thus be neglected.

3.2. Paper 2 – Business models for PV deployment (Germany, United States, Japan)

3.2.1. Background

In overcoming barriers to PV deployment, firms may play an important role through organisational innovation. The development and adaptation of new and existing business models have historically often been crucial in technological transitions. As PV is a radical technology in the electricity and housing sectors, business model innovation will most likely be key to coping with various barriers. Barriers, not least related to these sectors, can vary substantially between different geographical contexts, and there is thus a need to analyse how different business models can address barriers in different PV markets. Insights into how business models can

[2] After the publication of the paper, the tax reduction has been implemented in parallel to the other schemes, meaning that there are now (December 2016) three overlapping subsidy schemes.

counteract barriers to PV deployment could be useful to support deployment in Sweden and other emerging PV markets around the world. As revealed in paper 1, the TIS function 'entrepreneurial experimentation' was rather weak in Swedish PV deployment as practically all installation companies offered the same basic sales of turnkey PV systems. In other markets around the world, however, a variety of PV business models with rather different characteristics has emerged lately. Thus, paper 2 went beyond the Swedish setting to find empirical evidence on alternative business models.

3.2.2. Objective and approach

This study aimed at analysing how different business models for PV deployment can overcome barriers in different national contexts, and how different barriers and other contextual factors affect which kind of business models that will emerge and succeed in different settings. The study compared three distinctively different business models for PV deployment that have achieved success in three important PV markets, namely in Japan, Germany and the United States. In Germany, PV systems have been purchased and owned by the user as a financial investment. In the United States, third-party ownership (TPO) business models have proliferated. In Japan, the building industry has taken a leading role by integrating PV systems into prefabricated homes. An in-depth analysis was performed regarding the characteristics of each business model and the national contexts in which they thrive. How context has mattered for the success of the different business models, and implications for policymakers and firms, were then elaborated upon.

Based on theoretical sampling (Eisenhardt, 1989), the cases were selected for three key reasons. First, distinctively different business models have succeeded in the three countries, which allows for the identification of contextual factors that might explain why a certain business model thrives in a certain context. Second, the three countries together accounted for about 45% of the cumulative global installed PV capacity at the time of the study being performed (REN 21, 2014), making them important cases to learn from regarding successful PV deployment. Third, the extensive experience of PV deployment in the three countries was instrumental for data access.

Key data sources included firms' own material, such as websites, marketing material and annual reports. Also, legislative texts, standards, research reports, academic literature, trade journals etc. were used. In the case of Japan, the possibilities to use secondary data were more restricted due to the language barrier, and interviews were thus carried out with five companies in the prefabricated housing sector and with a number of experts, using an interpreter.

3.2.3. Results

Below, a case-by-case account of the different business models and their respective contexts is given. The conclusions are then accounted for.

3.2.3.1. United States

In the United States, business models based on third-party ownership (TPO) have been highly successful, accounting for 70-90% of residential installations in important sub-markets such as California, Arizona and Colorado. In these business models, the adopter is not the owner of the PV system. Instead, the system is owned by a firm providing a full-service solution including planning, installation and maintenance. Financing is obtained through an arrangement in which firms package several projects into funds that are sold to investors.

TPO models are commonly based on either a power purchase agreement (PPA) or a lease. In a PPA, adopters purchase the electricity that the PV system generates. Certain criteria are set for the price so that it is highly predictable over a period of 15-20 years. At the end of this term, the adopter can purchase the PV system, have it removed by the PPA provider or renew the agreement. In a lease, the adopter instead pays a time-based fee for using the system, and gets to use the produced electricity without additional payments. PV leasing has been common in states in which PPA has not been allowed.

The TPO models used in the United States have successfully addressed several common barriers to PV adoption. First, they have minimised consumer transaction costs. The adopter's only point of contact has typically been the firm providing the TPO model, rather than numerous actors such as installation and maintenance firms, banks, insurers and government agencies. The TPO firm has also taken care of any administrative tasks related to subsidies, permits and grid-connection. Second, risks related to the ownership have been shifted from the adopter towards the firm. Third, the adopter has not had to raise capital to finance the system.

TPO models have addressed barriers that have been particularly prevalent in the Unites States. Homeowners in the United States have had lower savings rates than homeowners in Japan or Germany, and potential adopters in the United States have thus been less likely to be able to finance a PV system upfront without a mortgage. Furthermore, access to home equity loans has been severely restricted in the wake of the financial crisis of 2008, which has left many homeowners 'underwater' (their home mortgage being larger than the value of their home), further restricting potential adopters' ability to finance a PV system purchase. People in the United States also tend to move relatively frequently, which for many potential adopters has likely increased the relative attractiveness of immediate electricity bill savings compared to a long-term investment in their home. Lastly, transaction costs in PV deployment have been higher in the United States than in Japan or Germany, which has made it more attractive for adopters to impose them on a third party.

3.2.3.2. Germany

In Germany, PV systems have mainly been financed and owned by the adopters themselves. In the business model dominating German PV deployment, the value proposition has been based on PV adoption as a low-risk financial investment fully competitive with other investment alternatives. Adopters have been guaranteed stable revenues for 20-21 years through a feed-in tariff scheme backed up by national legislation. Policymakers have regularly monitored the cost development of PV systems and adapted the feed-in tariffs to keep the IRR of PV adoption at around 7%.

Transaction costs in PV deployment have been relatively low in Germany. Institutional alignment and local learning among practitioners since the early 1990s have led to a relatively smooth deployment process, and legal-administrative processes related to PV deployment have become among the least complicated in Europe. The absence of high transaction costs has made the third-party owner somewhat redundant as a key function of a third-party owner is otherwise to absorb transaction costs. This is likely a partial explanation for German PV adopters' preference for purchasing and owning PV systems without the involvement of a third-party owner.

As German adopters have fully financed the upfront cost, the German business model has benefited from the availability of low-interest loans especially dedicated to PV. These loans have been provided through a government-owned bank since 1999. The loans have often been supplemented by equity from the customers, and the relatively high savings rates of German homeowners have thus facilitated the business model.

Just like firms in the United States, German firms have been offering a variety of services and features to reduce uncertainties and complexity. These include comprehensive insurance packages, long-term warranties for durability and performance, as well as certification of PV system components and installers through reputable organisations.

3.2.3.3. Japan

In Japan, the cross-selling of PV systems together with other products has been widespread, particularly in the construction sector. The *prefabricated homes industry* has been leading in this regard and, as early as 2011, about 60% of all new prefabricated homes came with a PV system. The prefabricated homes sector has held around 20% of the market for new homes and 10-15% of the residential PV market. The prefabrication of homes has been dominated by around ten large companies.

The value proposition has had several advantages compared to value propositions based on add-on PV systems. PV systems sold with new homes have been less expensive for the adopter than add-on systems, and roof integration has allowed for aesthetically appealing solutions. As the adopter has already established a contact with the supplier for the purpose of purchasing a home, transaction costs have been reduced for both parties. In Japan, PV adopters who have purchased their PV system together with a new home have typically been more satisfied with the adoption than have other PV adopters (Mukai et al., 2011).

The expenses for the PV system have generally been integrated into the home mortgage, reducing transaction costs and interest rates. As a mortgage needs to be issued for the home in any case, it has been easy to expand this loan to include the PV system. From the perspective of the financial institution issuing the loan, the income generated through the PV system has enhanced the adopter's creditworthiness. Building-integration has also been a benefit in this regard as a system physically integrated into the roof cannot as easily come adrift.

A key contextual factor explaining the success of this business model is the pre-existence of a highly industrialised prefabrication sector. Built upon large volumes, automation and advanced logistics systems, Japan's prefabrication industry has seemingly been the most industrialised house-building industry in the world. Industrialisation has brought about a high degree of standardisation, benefitting PV integration. The high level of industrialisation has, in turn, sprung out of a 'scrap and rebuild' culture in which almost 90% of all homes sold have been newly produced. Homes in Japan have typically depreciated very rapidly as they have increased in age.

Unlike in Western countries, prefabricated homes in Japan have been considered to be of higher quality than site-built homes, and they have typically been more expensive and equipped with more features. The cost savings achieved through industrialisation and mass-production have generally been used to add more features to the homes rather than to reduce consumer prices. Through this so called *mass customisation*, consumers have been offered a wide variety of choices between mass-produced components, including energy devices such as batteries, fuel cells, heat pumps and home energy management systems. PV systems have neatly fitted into this pattern.

Another relevant contextual factor has been the domestic PV industry, which has been dominated by large electronics companies keeping large parts of the PV value chain within their own organisation. The Japanese PV industry has played a key role in making prefabricated PV homes become common in Japan by marketing their products intensely towards the prefabrication industry rather than directly to consumers. They have also been seeking collaboration with prefabrication companies, something that, as revealed by the interviews, the prefabrication companies have often perceived as valuable and helpful. The interviews also revealed that house producers have tended to prioritise stable long-term partnerships with PV module suppliers over lower prices or higher efficiency of the modules. Although Japanese modules have been substantially more expensive than for example Chinese modules, all house producers interviewed used Japanese modules. They motivated this choice by explaining that communication with and reliability of the module producer and its products are crucial when modules are to be customised to fit the roofs.

Also, assurances of the national government that subsidies were to be present for an extended period have been important for the prefabrication industry to work with PV integration. Changing production lines is expensive, and the house-building industry has preferred certainty that PV systems were to remain attractive for their customers before making such investments.

3.2.3.4. Conclusions

In all three cases, the studied business models for PV deployment have enabled firms to overcome typical barriers faced by prospective PV adopters, such as complexity, transaction costs, risks and access to finance. Yet, the business models have been distinctively different. The analysis suggests that the differences between them have to a large extent been the result of differences in the national contexts in which they have occurred. The importance of context implies that business models for PV deployment cannot necessarily be viably transferred from one setting to another. (For example, recent attempts to implement TPO business models in Germany have not been very successful.)

The strong presence of TPO models in the United States and their absence in Germany and Japan is not likely to only be the result of differences in consumer preferences, but also of other contextual factors. TPO models have effectively addressed issues that have been particularly prevalent in the Unites States, such as low savings rates, restricted access to capital, high mobility on the housing market and high transaction costs. In Germany and Japan, on the other hand, higher savings rates, better access to low-interest loans, lower mobility on the housing market and lower transaction costs have made PV adopters more prone to purchase and finance the PV systems themselves.

TPO models for PV deployment may gradually lose their relevance for most adopters as PV markets mature. Market maturation usually entails a reduction in transaction costs and risks, which might make it more attractive for adopters to finance and own PV systems themselves. As TPO models require more middle-men capturing their share of the lifecycle economic gains of a PV system, business models based on self-ownership have the potential to become more financially beneficial for adopters. Once other barriers disappear, self-ownership could thus become the most viable option for most adopters also in markets such as the United States. A high proliferation of TPO models could perhaps even serve as an indicator for policymakers that there are barriers that should be dealt with. TPO models could, however, still prevail in mature markets to serve certain market segments, as some adopters might value the simplicity of TPO models more than the prospects of higher long-term financial gains.

3.3. Paper 3 – Local factors and information channels influencing PV deployment (Sweden)

3.3.1. Background

On the surface, the conditions for PV deployment seem to be rather homogenous throughout Sweden, as economic and institutional conditions do not differ much between different parts of the country. Yet, PV adoption rates vary between municipalities to an extent that is beyond what could be explained by local factors such as building stock characteristics, solar influx or average income. This raises the question of whether there are unknown local drivers present in these high-dissemination municipalities that have increased local adoption rates.

3.3.2. Objective and approach

This paper aimed at identifying and assessing factors that could explain high localised adoption rates of residential PV systems in Swedish municipalities. An explorative multiple-case study approach was used (Yin, 2009). Five municipalities that stood out in terms of high PV adoption rates were studied in depth. These main cases were then compared to 50 municipalities with low PV adoption rates, which were studied in less depth. Triangulation of quantitative and qualitative methods and different data sources was used to enhance the robustness of the findings.

The main cases were selected as follows. All Swedish municipalities were ranked by their per capita PV density and by their PV density in terms of number of PV systems per detached home. Those five municipalities that occurred in the top ten in *both* these rankings were selected. As comparison cases, the 50 municipalities with the lowest per capita PV adoption rates were selected (except for one municipality that was excluded because it had very few detached homes). The case selection was thus a combination of replication (cases with the same outcome on a key variable) and a 'two tail' design (cases on either extreme of a key variable) (Yin, 2009).

Data were collected by three main methods. First, a survey questionnaire (see appendix A) was sent by postal mail to all presumed PV adopters that could be identified in the five main case municipalities. The survey yielded 65 valid responses at a response rate of 80%. The aim of the survey was to assess various local information channels that might have affected the respondents' decision to adopt PV. Second, 16 interviews, as well as a number of shorter communications, were performed with local installers, electric utilities and other key actors. Third, comprehensive Internet searches were performed to identify actors and gather other relevant information about the cases.

The data necessary to estimate municipalities' adoption rates and to contact adopters were obtained from the Swedish Energy Agency. More specifically, a register of applications and approvals for the national investment subsidy scheme (this scheme has been described in section 3.1.3) was used, containing the names and addresses of adopters. Since few PV systems had been installed outside this scheme, these data were assumed to provide a good representation of the actual number of installations.

3.3.3. Results

The results pointed to local actors promoting PV as an important explanatory factor behind the relatively high adoption rates in the five main case municipalities. This finding was corroborated through triangulation, as the three main sources of data (survey, interviews and Internet searches) pointed largely to the same explanatory factors. Common to the five municipalities was the presence of local organisations promoting solar energy from an early stage, mainly electric utilities and installation firms selling PV systems and disseminating information. The survey respondents recognised that they had been influenced to a substantial extent by these activities. Overall, the respondents rated local information channels as slightly more influential than common non-local information channels such as nation-wide media, websites with a non-local focus and non-local acquaintances. The survey results indicated that the local factors had not only *raised the respondents' interest* in PV but also *influenced their final decision* to adopt, suggesting that these factors operated throughout a substantial portion of the innovation-decision process (cf. Rogers, 1983).

The relative importance of different factors varied between the studied municipalities. Regarding this variation, the survey results were largely in line with the results obtained through the interviews and Internet searches (factors that were found to be of high relative importance in a municipality using one method were also found to be of high relative importance using the other methods). For instance, in the two municipalities with the most active local utilities, the respondents regarded utilities as more important than respondents in the other three main case municipalities did. In one municipality where installations had been largely concentrated to one zip code area in which an installation company was based, peer effects and PV installers were recognised by the respondents as relatively important. In another municipality, where a local association has realised a number of larger ground-mounted PV installations, the presence of ground-mounted PV was recognised by the respondents as important in inspiring them to adopt PV.

Local electric utilities supporting PV appeared to have been a particularly important driver elevating local PV adoption rates. Local utilities promoting PV during the period studied were found in four of the five main case municipalities, while none of the local utilities in the 50 comparison municipalities were found to have engaged in PV promotion during or before the period studied. The local utilities supporting PV in the main case municipalities had started their promotion of PV *before* the PV market started taking off, indicating causation in the direction from utilities towards increased adoption rates. The importance of utilities was also recognised by the survey respondents. Seminars attended by the respondents had (as reported by the respondents) been arranged mainly by local utilities, and 54% and 24% of the respondents agreed that their final decision to adopt PV had to some or to a large extent, respectively, been due to their utility purchasing PV electricity.

The results also indicated some causality going in the other direction. During the interviews, some representatives of PV-promoting utilities acknowledged that their organisations had been influenced to some extent by customers adopting PV or contacting them for information on grid-connection of PV, thus pushing them towards developing strategies for PV. This reveals the presence of a positive feedback loop: customers influence their utilities, which in turn influence other customers to adopt. The interviews also revealed that the utilities' engagement in PV promotion had in most cases started largely as the result of one devoted staff member (usually the CEO). These persons had, for one reason or the other, adopted a positive attitude towards PV, and had had the personal drive to win their organisation over to promoting PV.

Lastly, respondents in all municipalities recognised having been influenced by PV adopters in their proximity (peer effects), both through direct communication with adopters and by observing PV systems in their neighbourhood. These findings were strengthened by the interviews with installation companies, which largely agreed that after installing a PV system at a particular place, they would often shortly thereafter get additional requests from homeowners in the same area. These homeowners had, according to the interviewees, often been inspired by the first installation. On average, the survey respondents considered local acquaintances to have been about as influential on their adoption decision as installation firms. However, local peers whom the respondents categorised as 'neighbours' were seen as having had a rather minor influence, indicating that the peer effects had been mediated through other kinds of social relations than those between people regarding each other primarily as neighbours.

3.4. Paper 4 – Peer effects in PV adoption (Sweden)

3.4.1. Background

The results of paper 3 suggested that peer effects (social influence between peers) have been a factor in reducing barriers to PV adoption in Sweden. A number of previous studies have also quantified peer effects in PV adoption in other settings, mainly Germany and the United States (Bollinger and Gillingham, 2012; Graziano and Atkinson, 2014; Graziano and Gillingham, 2014; Müller and Rode, 2013; Rai and Robinson, 2013; L.-L. Richter, 2013; Rode and Weber, 2013). This research has mainly been concerned with estimating the increased probability of PV adoptions occurring within a small geographical area as the result of previous adoptions in the vicinity. Little, however, has been known about the inner workings of peer effects in PV adoption. Thus, in paper 4, a closer look was taken at the role of peer effects among Swedish PV adopters.

3.4.2. Objective and approach

The study took a mixed-methods approach (combining quantitative and qualitative methods) to add knowledge of the inner workings of peer effects among Swedish PV adopters. More specifically, the research aimed at shedding light on what kinds of social relations mediate peer effects, what kind of information is transferred between the peers and what emotions are evoked leading to the adoption of a PV system.

Data were collected through a survey questionnaire (see appendix B) and interviews (see appendix C) with selected survey respondents. The survey was sent by postal mail to Swedish PV adopters. To maximise the occurrence of peer effects among the respondents, adopters living in zip code areas with high adoption rates were targeted. Just like for paper 3, data for estimating local adoption rates and addresses of adopters were obtained from the Swedish Energy Agency's register of applications and approvals for the national investment subsidy scheme. All Swedish zip code areas were ranked by their number of PV systems per capita, and the survey was sent to all 92 individuals that had had their applications for the subsidy approved in the 25 zip code areas with the highest adoption rates (except for five areas that were located in the municipalities studied in paper 3, which were excluded because the adopters on those areas had recently been sent a similar questionnaire). The survey yielded 65 valid responses at a response rate of 74% (four presumed adopters returned the questionnaire informing that they had in fact not adopted). The survey was mainly built upon five-point rating scales of both unipolar and Likert type, in which the respondents were asked to rate how they perceived that seeing PV systems or talking to PV adopters in or outside their neighbourhood had influenced their perceptions of PV technology.

Telephone interviews were performed with selected survey respondents. Those 22 respondents who reported having been in contact with at least one PV adopter in their neighbourhood prior to taking a final decision to adopt (and who had provided their telephone number) were selected, and full interviews were carried out with 16 of them. The interviews were recorded, and whenever the notes taken during the interviews were not considered detailed enough, the recordings were used to complement the notes. Key data were coded in a spreadsheet.

Considering that people tend to consistently underestimate the impact of social influence on their decision making (Nolan et al., 2008), the risk of overestimating peer effects using the chosen methodology, which relied on participants' self-estimation, was assumed to be small.

3.4.3. Results

As in paper 3, the presence of peer effects was widely recognised by the participating PV adopters. Among the survey respondents, 38% reported that contact with a peer (local or non-local) had been highly important ("4" or "5" in the rating scales) for raising their interest in PV. The corresponding figure for the final decision to adopt was 35%. Among respondents who had been in contact with an adopter in their neighbourhood before they decided to adopt (28 respondents), half agreed that the contact had been highly important for raising their interest in PV, and almost half did so regarding their final decision to adopt.

The interviews revealed that the contacts had almost exclusively occurred through pre-existing and rather close social networks, such as friends and family. Contacts with PV-using neighbours to whom the respondent had no deeper relationship had been rare and of minor importance (this was also suggested by the survey carried out for paper 3). This contrasts somewhat to what has been previously believed about peer effects in PV adoption, where the role of neighbour relations has (more or less implicitly) been assumed to be important. Furthermore, even though the sample was selected based on a presumed high occurrence of *local* peer effects, almost as many respondents reported having been highly influenced ("4" or "5" in the rating scales) by someone living *outside* as *inside* their neighbourhood.

The main function of the peer effects appears to have been a confirmation that PV works as intended and without hassle, rather than the procreation of unexpected insights or the provision of more advanced information. The confirmation was strengthened by the trustworthiness of the peers, who (apart from being known by the participants) as private homeowners were in a situation similar to that of the participants, and who (as opposed to PV installers) lacked economic incentives to recommend PV adoption. The information transferred had generally not been of a very advanced character, and had mainly related to ease of use and economic performance – that PV systems worked as intended and without hassle, and that they delivered as much electricity as expected. This information had, nevertheless, been perceived as useful by the interviewees; it had contributed to reducing a general uncertainty about PV as a new and 'unknown' technology, and had increased the participants' determination to adopt. Overall, few of the contact persons had recommended PV adoption outright – rather, they had provided more 'neutral' accounts of their experiences as adopters. Almost all interviewees had seriously contemplated PV adoption and acquired some knowledge of PV before any contact with previous adopters took place, and the contacts did thus not evoke much unexpected insight.

When it comes to the role of *passive* peer effects (influence of *seeing* PV), the results indicated that these had been of minor importance. As in the survey carried out for paper 3, seeing PV systems was regarded as a relatively important influential factor. However, a closer look at the data revealed that respondents who had seen a PV system in their neighbourhood tended to regard this as influential only if they had also been in contact with an adopter. The interviews confirmed that it was when a PV system had been seen in connection with adopter contact that it had been influential, for example when visiting a PV owner that demonstrated his or her PV system.

Contacts between the interviewees and previous adopters had come about in two principal ways: either the interviewee had approached the PV adopter with the purpose of acquiring information from him or her, or the topic had come up as they had met for another purpose. Only in one case had the interviewee experienced being approached by an adopter (other than a salesperson) who appeared to have had the purpose of talking about PV. In the previous literature, it has sometimes been assumed that seeing local PV systems tend to induce people to contact the systems' owners to get more information. However, the findings of the present study did not support that such an order of events had been common in the studied setting, as almost no contacts had come about as the result (partly or fully) of the interviewee first seeing the contact person's PV system.

4. Concluding discussion

In this section, a synthesis of the findings of the four papers will first be presented. The methodological contributions of the thesis will then be discussed. Based on the findings, some recommendations for policy will also be provided, both specific advice for reforms of Swedish policy and more general advice. Lastly, some pathways for further research will be suggested.

4.1. Synthesis of findings

The objective of this thesis was to identify and assess barriers and drivers to residential PV deployment in different geographical settings, taking the spatial dimension into account. The findings of each paper have been accounted for separately in section 3. The added value of this synthesis is that it builds a larger and more coherent picture of barriers and drivers on different spatial levels, thus contributing to an improved understanding of the geography of sustainability transitions (cf. Coenen et al., 2012; Hansen and Coenen, 2015).

While the price and performance of PV technology have been largely determined on the international level, the thesis goes into depth with barriers and drivers rooted in national and local settings. By studying altogether four national PV markets, papers 1 and 2 identify and assess barriers and drivers mainly rooted on the national level, providing various examples of how institutions, industry, culture and financial aspects have affected PV deployment. On the local level, papers 3 and 4 show how local organisations and private individuals have driven PV deployment through information provision and social influence. Together, barriers and drivers rooted on all these levels determine the conditions for PV deployment at any given location. Thus, an understanding of barriers and drivers on all levels is important.

Paper 1 took a systemic perspective to identify and assess barriers and drivers in Sweden. The analysis was facilitated by the technological innovation systems (TIS) framework, which guided the research to relevant actors, networks, institutions and processes. The analysis depicts a small, underdeveloped Swedish TIS for PV deployment, albeit in rapid growth in relative terms. Limited economic profitability in PV adoption was a crucial barrier during the period studied (also including subsidies). The results reveal that the Swedish policy environment has been uncertain and complex, creating problems for different actors. The institutional barriers in Swedish PV deployment (which have been described in more detail in section 3.1.3) could be coarsely summarised as follows: First, the fact that more than one subsidy scheme for PV deployment have been running in parallel is a complexity in itself. Second, there have been uncertainties regarding when different subsidies were to be available, and on what conditions. Third, important rules, mainly related to taxes, have been unpredictable.

Even though the institutions affecting PV deployment in Sweden have mainly been national, they have not always been fully controlled by the national government. For example, Swedish rules for taxes and building permits affecting PV deployment have partly been determined on the EU and the municipal levels, respectively. Paper 1 reveals that institutions on the EU level have restricted the ability of the Swedish government to adapt rules to PV and other micro-generation technologies, resulting in institutional rigidity that has contributed to a lock-in of the incumbent energy system (cf. Unruh, 2000).

The thesis also demonstrates that country-specific characteristics of a domestic industrial sector can be important for PV deployment. Paper 2 reveals that certain characteristics of the Japanese construction sector, such as a high degree of industrialisation and standardisation, have been important for the physical and organisational integration of PV into the construction of new buildings in Japan. Those factors are rather unique to the Japanese construction sector compared to other domestic construction sectors around the world. This is likely an important explanation of why the Japanese construction sector has been highly involved in PV deployment as compared to construction sectors in other important PV markets.

The thesis also identifies barriers and drivers that vary between countries but are less confined to administrative borders. Such factors include cultural and behavioural aspects such as savings rates, homeowner mobility (how often people move), accustomedness to TPO business models (not only for PV) and priorities regarding long-term versus immediate cost savings. As suggested by paper 2, these aspects will influence what kind of business models will be most viable within a certain context, as different business models are suited to overcome different barriers to deployment. Perhaps most importantly, this relates to the ability of potential adopters to raise capital and to their preferences regarding whether to own the PV system or consult a TPO firm. Another example is real estate prices, which have developed rather differently between countries and regions, influencing homeowners' ability to finance a PV system. If the value of a home substantially exceeds the mortgage for the same home, the homeowner can often quite easily get a home equity loan to finance a PV system. This will be the situation for most homeowners in regions where the prices of homes have increased substantially in recent years. On the other hand, there are many regions around the world in which the values of homes have decreased dramatically in the wake of the financial crisis of 2008. In these regions, homeowners will typically have less opportunity of getting a home equity loan, and many of them will be 'underwater', meaning that the value of their home is lower than their mortgage. These homeowners will often find it difficult to finance a PV system, and TPO business models might then be a viable option. As argued in paper 2, this is likely a contributing factor to the success of TPO business models in California, where housing prices declined substantially after the financial crisis.

Paper 2 illustrates that certain business models can successfully overcome complexities and uncertainties faced by prospective PV adopters on the national level. It is thus noteworthy that Sweden, with its complex and uncertain policy environment, has (as was found in paper 1) lacked alternative business models such as TPO even though these have been successful in addressing complexities and uncertainties in other countries. As argued in paper 2, a lack of alternative business models (such as TPO) could be a barrier for some categories of potential adopters, and trying to explain the absence of TPO models in Sweden is thus justified. Drawing on papers 1 and 2, this synthesis allows for some remarks in this regard. A first reason for the absence of TPO models in Sweden could be the low economic profitability of PV investments; TPO models require a middle-man taking a share of the life cycle economic gains of a PV system, and the total economic gains might simply have been too small in Sweden for TPO to be viable. Second, the small size of the Swedish PV market might have decreased the likelihood of TPO models occurring as they require a higher level of organisational sophistication. Third, the Swedish institutional uncertainties have created risks of events that would affect all installations simultaneously. This contrasts to risks of events that occur independently of one another for each installation. While TPO models do not address the former kind of risk (events affecting all installations simultaneously could ruin a TPO firm), they successfully address the latter kind by spreading the risks over a large number of installations. Fourth, the Swedish housing market has withstood the global financial crisis remarkably well from an international perspective, and the prices of homes have increased rather consistently during the last decade, which has made it easier for Swedish homeowners in general to finance PV systems themselves without the need for a TPO model.

When it comes to the local level, papers 3 and 4 point to local sources of information as being an important driver of PV deployment. Local information seminars organised by electric utilities seem to have had a substantial effect in increasing adoption rates in Swedish municipalities (paper 3), and basic information transferred between peers appears to have been important in convincing Swedish homeowners to adopt PV (paper 4). Even though information channels operating on a higher geographical level, such as websites directed towards a national or international audience and media with a national coverage, were important for the decision making of the participating adopters, the findings of paper 3 suggest that local sources of information were of equal or higher importance. A substantial function of the information appears to have related to raising the interest in PV among potential adopters, indicating a lack of basic awareness.

Even though the geographical entity studied in paper 3 was the municipality, the findings point to another geographical entity of relevance, namely the area covered by the electrical grid operated by a certain utility. Different utilities have developed different strategies and attitudes regarding PV, and the results of paper 3 strongly suggest that a local utility's supportive attitude can substantially increase local PV adoption rates. Even though these effects are surely not strictly confined to the area covered by the utility's grid, the reach of the grid is likely to be of significant importance as everyone connected to the grid is a customer of the utility and thus subject to its communication. While utilities might have different roles in different countries, previous research on local sources of market formation (Dewald and Truffer, 2012) has not acknowledged the role of utilities, which might be relevant in some (though likely not all) other countries as well.

A driver with an inherently large local component is *peer effects* (social influence between peers resulting in PV adoptions). Previous research has identified substantial localised peer effects in PV deployment using quantitative research methods (Bollinger and Gillingham, 2012; Graziano and Atkinson, 2014; Graziano and Gillingham, 2014; Müller and Rode, 2013; Rai and Robinson, 2013; L.-L. Richter, 2013; Rode and Weber, 2013). Little has been known, however, about the inner workings of peer effects in PV deployment. Together, papers 3 and 4 contribute to deepening the understanding of peer effects by surveying in total 130 PV adopters and interviewing 16 of them, thus introducing a qualitative perspective that has been lacking in the previous research. Paper 3 confirms that peer effects in PV adoption also exist in the Swedish setting, and the paper provides some tentative findings regarding their underlying mechanisms. In paper 4, the mechanisms behind the peer effects were investigated more deeply. The two papers used data from different sets of participants (one set for each paper) and, as some survey items were identical or very similar for the sets, they together provide a larger sample on some aspects.

Paper 4 suggests that the main function of the peer effects was a *confirmation* from a trustworthy source that PV adoption would be a sound choice. The information transferred was generally not of a very advanced character, and related mainly to ease of use and economic performance – that the technology worked as intended and without hassle, and that it delivered as much electricity as expected. This information was perceived as useful by the interviewees, and it contributed to reducing a general uncertainty regarding PV as a new and 'unknown' technology, thus reducing barriers to adoption. Paper 4 was unique not only to the Swedish context, but also globally, as peer effects in PV adoption had not previously been studied through interviews with adopters.

The results of papers 3 and 4 suggest that the main reason (at least in the studied setting) for peer effects having a large local component is that people who are family and friends tend to live close to one another, rather than people influencing one another through more superficial neighbour relations. Both papers reveal that relations with people who the adopters perceived as ‘neighbours’ were perceived to have been of minor importance – instead, the influence had taken place through closer and more established social networks. The high degree of localisation in peer effects has led to an assumption in the previous literature that neighbour relations and passive influence (through passively observing neighbours’ PV systems) have been important mediators of peer effects. However, paper 4 suggests that passive peer effects played but a minor role in the studied context. One implication of these results relates to the fruitfulness of different computational models of peer effects in PV deployment. Two different approaches to such models are based on social networks and geography, respectively (Bale et al., 2013; Rode and Weber, 2013). The results of this thesis indicate that the former approach might more accurately reflect the underlying processes at work.

Lastly, the thesis demonstrates how the local nature of PV deployment can create inefficiencies, at least in a small and early market such as the Swedish one. Paper 1 reveals that the installation of PV systems in Sweden has been dominated by small, local firms that have often not been exclusively devoted to PV technology, thus lacking the benefit of specialisation. This can be seen as a consequence of the fact that PV systems need to be installed on-site by the firm’s staff, in combination with a small market size. Several of the installers interviewed for paper 1 expressed the ambition to become more specialised, claiming that the small market size within their catchment area would not support specialisation. With limited demand for PV systems within a reasonable travelling distance, a full-time job cannot be sustained by the demand for PV installations only. This leads to poor economies of scale on the local level, and to a lack of competition as the number of installers offering their services in any given place will be limited.

4.2. Methodological contribution

The thesis makes some contributions regarding research methodology, which will be discussed below. A first contribution relates to the application of the TIS framework. In paper 1, this framework was used to study PV deployment separately from processes occurring earlier in the PV value chain. Paper 1 demonstrates that it is meaningful to apply the TIS framework to study deployment separately in order to identify and assess barriers and drivers, and that deployment taken on its own is a complex and systemic process that motivates the use of a holistic analysis tool such as the TIS framework. The thesis argues that in cases where a mature technology is to be deployed in a catching-up market that is small in relation to the international production system for the technology in question, a pure deployment focus is motivated in TIS analyses. The value of this contribution is made evident by the fact that a pure deployment focus allows the researcher to focus his or her resources on the deployment phase, thus avoiding spending valuable time studying technology development and production, and saving him or her the effort of doing an international and spatially differentiated TIS analysis. Furthermore, increasing global specialisation and division of labour, as well as an increasing availability of mature renewable energy technologies that can be deployed in new regions, can be expected to create an increasing need for deployment-focused TIS studies (see section 2.1.1.3).

The thesis also demonstrates how the TIS framework, the business models framework and Rogers' diffusion of innovations framework can be combined to study technology deployment (see section 2.1). The latter two frameworks fit within the scope of the TIS framework and are appropriate choices when zooming in on selected parts of a TIS that relate to technology deployment. The thesis argues that the latter frameworks connect well to certain phenomena described in the TIS literature, such as certain categories of actors and the functions 'entrepreneurial experimentation', 'knowledge development and diffusion', 'legitimation' and 'market formation'. Thus, the latter frameworks could well be positioned within the TIS framework – the very concept of a 'business model', as well as various core concepts within both the frameworks, could be incorporated into the TIS framework, in some cases perhaps by replacing existing terminology. This would, nevertheless, require a deeper analysis, which is beyond the scope of the present thesis.

Another methodological contribution relates more directly to the application of the business models framework. In paper 2, the viability of different business models for PV deployment in different countries was studied. Previous literature on business models had elaborated upon how business model innovation can bring new (sustainable) technologies to the market (Bocken et al., 2014; Boons and Lüdeke-

Freund, 2013; Mont et al., 2006; Reim et al., 2015; Tukker, 2004) and upon the role of the wider sociotechnical context for shaping business models (Birkin et al., 2009; Budde Christensen et al., 2012; Casper and Kettler, 2001; Linder and Cantrell, 2000; Provance et al., 2011). The methodological uniqueness of paper 2 was that it combined the business models framework with a comparative case study approach to pinpoint contextual factors in different geographical settings. This had not previously been done for PV technology and, to the best knowledge of the authors, it had not been done for the deployment of any other technology either. The approach proved useful in understanding how different business models can overcome contextual barriers (see section 3.2.3) to technology deployment and thereby create value for adopters and firms.

Also some contributions regarding methodology to study local variations in PV adoption rates were made. For paper 3, an approach based on comparative case studies was developed to identify and assess local drivers in Swedish municipalities. A combination of a replication and a 'two tail' design (Yin, 2009) was used. Five 'main cases' (municipalities with the highest adoption rates) and 50 'comparison cases' (municipalities with the lowest adoption rates) were studied. The number of comparison cases was larger because data were scarcer for this category. The comparative element of the approach was two-fold. First, the main cases were compared to one another. Second, the two categories of cases were compared to each other. The method proved useful to pinpoint local drivers that could explain why certain municipalities have stood out in terms of high PV adoption rates. To the best knowledge of the author, there has not previously been any research on local variations in technology adoption rates using an approach including the elements described above.

Furthermore, paper 3 introduced a novel approach for dealing with differences in building stock when selecting cases for comparative case studies of geographical differences in PV adoption rates. There is often a need to take building stock into consideration when studying causal factors behind PV adoption rates, as the characteristics of the built environment (e.g. the share of detached homes) may otherwise become an important confounding variable. For paper 3, all Swedish municipalities were ranked by their PV-density using two measures: the number of PV systems *per capita* and *per detached home*. Municipalities that occurred at the top or bottom of *both* these rankings were selected. The inclusion of the latter criteria served as a control mechanism, reducing the risk of local building stock characteristics confounding the selection process (see section 3.3.2).

Lastly, for paper 4, a mixed-methods approach was developed to study peer effects in PV adoption, combining qualitative and quantitative research methods through a survey and follow-up interviews with selected respondents. Thus, a qualitative perspective that had hitherto been lacking in studies of peer effects in PV adoption was introduced. As peer effects are by nature closely related to the adopters' own thoughts and emotions, survey data arguably need to be complemented with interviews – particularly in a stage where the understanding of the effects is limited – to make sure that the survey data have been interpreted correctly and to increase the chances of identifying any important matters not identified through the survey. The method proved useful to nuance the previous understanding of peer effects in PV adoption, and continued research using this or similar approaches may be fruitful in achieving a deeper understanding of peer effects in the adoption of PV or other technologies.

4.3. Implications for policymakers, firms and others

Based on the findings of this thesis, some recommendations can be derived for policymakers, firms and other actors aiming to support PV dissemination. Below, a set of general advice will first be provided. Then, a number of more specific recommendations for reforms of existing Swedish policy will follow.

A first set of advice relates to *business models* for PV deployment (paper 2). The findings regarding the relationship between business models and their surrounding context may be useful to both policymakers and firms. Even though the research on business models was not carried out in Sweden (as was the rest of the research), the findings might prove useful to overcome barriers in Sweden and other catching-up markets.

One piece of advice for policymakers is to remove any institutional barriers that might obstruct the use of certain business models, or to provide enabling legislation for business models that have proven viable in other contexts. Preferences vary between consumer groups, and a variety of business models for prospective adopters to choose from could thus increase the overall adoption rates by satisfying the preferences of a larger number of consumers. Furthermore, a substantial number of the potential adopters will, in many contexts, find it difficult to finance and own a PV system even if a purchase would be their first choice. Any institutions hindering TPO business models may thus impose a barrier to PV deployment. This does not necessarily mean that policy has failed if all business models that have proven successful in other markets are not present in the market of interest, as it might simply be the case that the market has selected against certain business models due to differences in consumer preferences or other contextual differences that are beyond the direct control of policymakers.

When it comes to firms, the findings on business models could be informative when planning to enter new markets or targeting certain consumer segments. The findings could also guide firms in how to respond to a changing context.

A second set of advice relates to *electric utilities* (organisations operating electrical grids). Paper 3 strongly suggests that local utilities can elevate PV uptake in their area by supporting PV. Policymakers could exploit this by influencing utilities to take a supportive attitude towards residential PV. Such influence could be exercised by informing utilities about PV technology and about how other organisations have worked with PV, for instance by offering utilities' staff training as to how to best support PV deployment. A web-based platform for the provision and exchange of information directed towards utilities could be implemented (perhaps as part of a larger platform for PV information directed to a broader audience). Educating utilities might both increase the chance of them choosing to support PV deployment, and make utilities perform better in providing their customers with relevant information. In cases where a government owns a utility (Swedish utilities are, for example, often owned by local governments), the government could steer the utility towards promoting PV. Utilities could also be regulated to take a more active role in PV deployment.

Another piece of advice is to arrange *information seminars* targeting private homeowners. Such seminars could be arranged by any actor (such as utilities, non-profit organisations, local governments and installation firms) interested in supporting PV deployment. Paper 3 suggests that local information seminars have been an effective strategy to convince homeowners to adopt PV in Sweden. The effectiveness of seminars might, nevertheless, depend on context-specific factors. Two key characteristics of the Swedish PV market are that it is in an early stage of development and that there is limited economic profitability in residential PV adoption. As convincingly argued by Noll et al. (2014), there are reasons to believe that information provision has the highest prospects of being effective in markets where PV is neither very profitable nor clearly unprofitable. Awareness of PV might also be lower in early markets, in which case there is a higher need for information dissemination. The generalisability this advice might thus be more or less limited to markets that are similar to Sweden in these respects.

A last piece of advice relates to *peer effects* (papers 3 and 4). Actors with a goal to increase PV uptake could seek to make use of peer effects by involving existing PV adopters in information campaigns or marketing. This might prove a cost-effective strategy for policy and businesses even if the existing adopters are economically compensated for their involvement.

Paper 4 reveals that information obtained from peers plays a partly different and complementary role compared to other information sources, such as the advice of professionals. Peers (at least in the context studied) seem to convince each other to adopt PV by giving reassurance that adoption is indeed a sound choice, rather than through the provision of more factual information (which can be found in written sources or obtained through professional advisers). Trust is not only gained through established social relations, but also through peers being in a similar situation (as private homeowners), having actual experience as adopters, and (as opposed to firms) lacking economic incentives to portray PV in an excessively positive manner. The participation of PV adopters in information campaigns or marketing could thus be effective as a complement to other means of information provision.

There are various conceivable strategies for making use of peer effects. One suggestion is to include sessions in information seminars where visitors get the opportunity to talk to adopters, for example in Q&A sessions or group discussions. Study visits could also be organised by firms or policymakers to the premises of adopters to let attendants see their PV system and talk to them. Another option would be to have local energy advisors provide citizens with contact information to local adopters. Policymakers might even want to target certain individuals to become PV adopters if these individuals could be expected to be particularly likely to create further adoptions through peer effects. If so, the findings of paper 4 suggest that socially well-connected individuals should be targeted rather than individuals who have the most visible rooftops.

4.3.1. Reforms of existing Swedish policy

A substantial portion of the research behind this thesis relates to existing Swedish institutions, and the results thus lend themselves to some Sweden-specific policy advice. This advice does not involve increased subsidisation, but rather changes in the design of existing subsidy schemes or other advice that does not require increased public spending. The advice relates to issues that were identified in the research *and* that are still present at the time of finishing the thesis (December 2016), which includes the majority of the issues identified in the research.

Paper 1 points to several uncertainties and complexities in the Swedish policy framework that could be addressed. First, the circumstance that more than one subsidy schemes for PV deployment have been running in parallel is an unnecessary complication that creates extra administration and transaction costs for adopters, installation firms and authorities, and that makes it more difficult for (potential) adopters to estimate the economic consequences of PV adoption. At the time of writing (December 2016), three subsidy schemes are running in parallel, as the proposed tax reduction was implemented after the completion of paper 1. Second, it was – and still is – unclear for how long the different subsidy schemes will run. The total budget for PV within these schemes should thus preferably be gathered within one coherent long-term strategy with high predictability and transparency.

The most important Swedish subsidy scheme for PV deployment – the investment subsidy launched in 2009 – has been flawed with uncertainties. This issue could be addressed through some relatively straightforward reforms. First, the scheme's duration and future remuneration levels should be planned and made transparent. This could be done through the setting of certain conditions to determine the future development of the scheme. For example, it could be decided that investing in a residential PV should yield a certain economic profitability, e.g. an IRR of around 5%. Factors that influence this figure (most importantly the cost development of PV systems) should then be monitored continuously so that remuneration levels can be adapted to keep the profitability at the desired level. Once the profitability reaches the desired level without the need for subsidies, the scheme has served its purpose and should be terminated. Second, measures should be taken to mitigate the long queue of applications awaiting approval. Even though the remuneration level has been reduced to 20% since paper 1 was finished while a substantial amount of long-term funding has been added, the long queue has persisted, resulting in waiting times of up to two years as of November 2016 (Svensk Solenergi, 2016). As regards the market fluctuations caused by discontinuations in the scheme, this problem appears to have been resolved. Even if new discontinuations in the scheme would occur, the current remuneration level of only 20% in combination with reduced prices of PV systems have induced an increased share of the new adopters to purchase the system *before* their application is approved, hoping to get the subsidy retroactively. This secures a more evenly distributed demand for PV systems regardless of any discontinuations in the scheme.

Paper 1 also shows that the tradable green certificates (TGC) scheme, which has been available for PV and other renewables since 2003, has been poorly adapted to residential PV and other modes of micro-production of electricity. To adapt this scheme, the selling of small quantities of certificates could be made easier. This could be achieved for example through the provision of a user-friendly web-based trading platform, or by authorities purchasing certificates at market rates from micro-producers using an automated system (the authorities could then re-sell the certificates in bulk to other actors). Another issue is the high cost for micro-producers of acquiring certificates for self-consumed electricity, as this requires the installation of additional metering equipment. This could – if the TGC scheme is to be intended for micro-producers in the future – be solved through for example relaxed requirements on metering, certificates for self-consumption being granted on the basis of a template, or by providing PV adopters with free metering equipment. However, a burning issue is whether the TGC scheme should be intended at all for micro-production. If so, the scheme should be adapted accordingly. If not, micro-production should be formally excluded from the TGC system (any subsidisation should then be carried out by other means).

The building permit system could also be reformed. To reduce complexity, rules could be standardised between municipalities. Building permits for residential PV could also be abolished if certain criteria are fulfilled (e.g. that the panels follow the inclination of the roof). Fees could be abolished, or only be due once a permit has been approved (thus reducing uncertainty and risk for prospective adopters). Information on building permits regarding fees, requirements, administration time etc. could be provided on municipalities' websites.

As regards uncertainties regarding tax rules, it was recently (after the completion of paper 1) established that residential PV adopters are under most circumstances indeed not subject to extra taxation and related administration. Any remaining uncertainties could be mitigated by adaptation of rules in a planned, transparent manner, by clear and official statements regarding the intended direction of future reform, or by clarifying official statements regarding how existing rules should be applied.

4.4. Suggestions for further research

In this section, some possible lines of research that could be addressed subsequent to this thesis will be identified. Four potential areas of research will be discussed, one following each paper.

4.4.1. Technological innovation systems (TIS)

As argued in this thesis, there will likely be an increasing need for TIS studies focusing exclusively on the deployment phase of PV (as was done in paper 1) and other technologies. Although this thesis makes some methodological contributions in how to perform such studies (see section 4.2), further methodological development is needed. For example, methods need to be developed regarding how to set system boundaries for geography and value chain based on what phenomena interact in a systemic manner and how different phenomena relate to space. A deployment focus is also likely to have implications regarding the functional dynamics of TISs. The relative importance of different functions might change in some generalisable ways and there might be differences in which functions are important on different geographical scales. New empirical research, or re-analysis of existing TIS literature with a 'new lens', might shed light on these issues.

Conceptual work could also be done regarding how the TIS framework connects to other streams of literature. As observed in this thesis (see section 2.1), the business models framework as well as Rogers' diffusion of innovations framework both fit within the scope of the TIS framework and are useful when zooming in on certain key parts of a TIS. These, and perhaps other, frameworks could be more elaborately positioned within the TIS framework in future conceptual work.

4.4.2. Business models and their context

Paper 2 served as a first step in analysing how business models for PV deployment depend on barriers and other contextual factors in different geographical settings. The findings pointed towards a number of factors that appeared to have influenced the success of different business models in the studied markets. However, more research is needed in order to gain a deeper understanding of how and to what extent these and other factors influence the viability of different business models. As an increasing number of PV markets become mature enough to host more elaborate business models, there will be more potential cases to study. Paper 2 could also be complemented through data collection from adopters (surveys, interviews) in the studied markets or in other markets. This could shed light on adopters' motives for preferring a certain business model, and on whether any particular contextual factors influenced their preferences. Furthermore, business models for the deployment of other technologies than PV could be studied in relation to their context. This could yield valuable technology-specific as well as generalisable knowledge regarding the relationship between business models and their context.

4.4.3. Local barriers and drivers

Paper 3 was and early attempt to identify causes of locally elevated adoption rates of residential PV. There are several ways to continue this line of research. First, the adopter perspective could be further explored, e.g. through interviews with adopters in municipalities with high adoption rates. This way, a deeper understanding of factors influencing the different stages of their adoption decision process could be gained. Approaches similar to that developed for paper 3 could also be used to study other settings than the Swedish one. This could reveal to what extent the findings of paper 3 are generalisable; for example, the findings might be specific for early PV markets or for some other characteristic that Sweden shares with certain other settings. Another possibility would be to use statistical regression analyses to compare municipalities or other geographical entities with each other, using PV adoption rates as the dependent variable. This could reveal correlations not visible through case study methodology.

One finding of paper 3 was that local electric utilities supporting PV appeared to have had a substantial positive effect on adoption rates. This could be further explored in different ways. For example, it could be investigated why some utilities choose to engage in PV promotion and sales. From a purely economic perspective, promoting PV might appear as a bad decision for utilities as increased PV penetration undermines their source of revenue. Furthermore, PV sales are arguably beyond their core business. Research on incumbent companies in the offshore oil and gas sector that have diversified into wind power suggests that a key reason for this diversification has been to attract the most talented staff for use in their core business (Hansen and Steen, 2015). However, there is as yet little research on the reasons for energy incumbents to engage in renewables, and on whether and under what circumstances such engagement might be economically rational for such organisations.

Furthermore, the role (current and potential) of utilities might differ between countries. For example, utilities are typically highly regulated on the national level, which might create rather different opportunities for utilities in different countries to act beyond their core tasks (and thus to support PV). This could be researched.

Lastly, more research could be done on the role of local information in increasing PV adoption rates. The findings of paper 3 indicated that information seminars have been important in the cases studied, but little is known about what defines successful information dissemination on the local level (e.g. how an information seminar should be designed in order to spur PV adoptions). As information dissemination can be a low-cost intervention, it can (if effective) be a cost-effective way to increase PV uptake. For example, it has been argued that information dissemination has the highest potential to be effective in early markets in which PV is neither very profitable nor clearly unprofitable (Noll et al., 2014), but there is currently little empirical evidence to support this.

4.4.4. Peer effects

This thesis offers an initial attempt to understand the inner workings of peer effects in PV adoption. To build a more solid understanding of the mechanisms behind these peer effects, more qualitative empirical research is needed. Using the approach developed for paper 4 or a similar methodology combining survey and interviews appears to be a fruitful way of moving this research forward. Data could be collected from adopters, non-adopters, or potential adopters in different settings.

Depending on the exact research question and on the expected occurrence of useful information among adopters, representative or purposeful sampling could be used. For example, peer effects could often be expected to be more common in areas with high adoption rates. Thus, any given sample size could yield more useful information through purposeful sampling in such areas. As large samples are costly to manage, purposeful sampling could be beneficial in situations where a representative sample is not necessary. Future research could in those cases imitate or be inspired by the sampling strategy developed for the present thesis.

Research could also be done to find out whether and how the characteristics of peer effects vary between different contexts, such as between early and more mature markets. For example, as early adopters are generally more cosmopolite than later adopters (Rogers, 1983), peer effects might be less localised in early markets (as was the case in the studied Swedish early market).

The findings of this thesis raise some doubt as to the role of passive peer effects in PV adoption. In previous literature, these have often been assumed to be an important part of the 'total' peer effects. The importance of the passive component could be assessed by investigating the impact of PV systems' visibility. If, for example, rooftop PV systems facing roads generate substantially larger increases in local adoption rates than PV systems facing backyards, this could indicate a large passive component.

Lastly, the possibilities of utilising peer effects in campaigns could be explored. Is, for example, information provision (e.g. seminars) more effective when adopters are involved? How should they be engaged to make the highest impact: should they give lectures, be available for Q&A sessions, or take part in conversation groups? (As anecdotal evidence, small conversation groups among seminar participants were described as a very important influential factor by one of the interviewees.) Would it be cost-effective to pay them to participate? Are organised study visits to PV adopters' premises a viable strategy? Such alternatives could be investigated, for example through experiments.

5. Conclusions

This thesis identifies and assesses various barriers and drivers to the deployment of residential PV systems in different geographical contexts. Using a sociotechnical systems approach, the thesis demonstrates how the *technological innovation systems* TIS framework can be amended by the *business models* and the *diffusion of innovations* frameworks to study the deployment of a mature technology (in this case PV) in a catching-up market, treating the development and production of the technology as a 'black box'. On the national level, the analysis shows that the Swedish sociotechnical system for residential PV deployment has been immature and infested by various institutional barriers. Most notably, the Swedish subsidy schemes for PV deployment have been flawed with uncertainties and complexities, and there have been important uncertainties regarding the future development of the Swedish institutional set-up. The results also demonstrate how barriers in different national contexts have affected what kinds of business models for PV deployment that have been viable. On the local level, the results demonstrate how actors such as local electric utilities and private individuals have influenced homeowners to adopt PV through information dissemination and social influence (peer effects). The findings can inform policymakers, firms and other actors as to how to better support PV deployment.

6. References

Amit, R., Zott, C., 2001. Value creation in E-business. Strateg. Manag. J. 22, 493–520. doi:10.1002/smj.187

Antràs, P., Chor, D., Fally, T., Hillberry, R., 2012. Measuring the Upstreamness of Production and Trade Flows. Am. Econ. Rev. 412.

Arvizu, D., Balaya, P., Cabeza, L.F., Hollands, K.G.T., Jäger-Waldau, A., Kondo, M., Konseibo, C., Meleshko, V., Stein, W., Tamaura, Y., Xu, H., Zilles, R., 2011. Direct Solar Energy, in: IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (Eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Awerbuch, S., 2000. Investing in photovoltaics: risk, accounting and the value of new technology. Energy Policy, The viability of solar photovoltaics 28, 1023–1035. doi:10.1016/S0301-4215(00)00089-6

Axsen, J., Mountain, D.C., Jaccard, M., 2009. Combining stated and revealed choice research to simulate the neighbor effect: The case of hybrid-electric vehicles. Resour. Energy Econ. 31, 221–238. doi:10.1016/j.reseneeco.2009.02.001

Baldwin, R., Robert-Nicoud, F., 2014. Trade-in-goods and trade-in-tasks: An integrating framework. J. Int. Econ. 92, 51–62. doi:10.1016/j.jinteco.2013.10.002

Bale, C.S.E., McCullen, N.J., Foxon, T.J., Rucklidge, A.M., Gale, W.F., 2013. Harnessing social networks for promoting adoption of energy technologies in the domestic sector. Energy Policy 63, 833–844. doi:10.1016/j.enpol.2013.09.033

Bergek, A., Hekkert, M., Jacobsson, S., Markard, J., Sandén, B., Truffer, B., 2015. Technological innovation systems in contexts: Conceptualizing contextual structures and interaction dynamics. Environ. Innov. Soc. Transit. 16, 51–64. doi:10.1016/j.eist.2015.07.003

Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S., Rickne, A., 2008a. Analyzing the functional dynamics of technological innovation systems: A scheme of analysis. Res. Policy 37, 407–429. doi:10.1016/j.respol.2007.12.003

Bergek, A., Jacobsson, S., Sandén, B., 2008b. Legitimation and development of positive externalities: Two key processes in the formation phase of technological innovation systems. Technol. Anal. Strateg. Manag.

Bhaskar, R., Frank, C., Høyer, K.G., Naess, P., Parker, J. (Eds.), 2010. Interdisciplinarity and Climate Change: Transforming Knowledge and Practice for Our Global Future, 1 edition. ed. Routledge, London; New York.

S7680

Date Submitted	12/4/2018	**Section**	322.1.6	**Proponent**	Kari Hebrank
Chapter	3	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **Yes** **Alternate Language** **Yes**

Related Modifications

Summary of Modification

This modification specifies the location, anchoring and safety requirements to resist flood forces and prevent flotation for equipment for pools, spas and water features located within a floodplain.

Rationale

This revision provides relief for homeowners located within floodplains so that they may safely install a pool. Currently, pool builders are being asked to elevate pool equipment to heights in excess of their design specifications. To illustrate, pumps will lose prime at 3' or above water level. Every time the pump shuts down, the wet end of the pump and elevated piping will likely drain to the pool water level. When a pump loses prime it must manually be restarted. If this happens and the operator / homeowner is not aware, the pump will fail, causing overheating, melting of the plumbing, and burning out the motor and seals. In addition, pool water could sit stagnant for a period of time. In Florida's extreme heat temperatures, if a pool is not circulating it could result in the development of an algae bloom and harmful bacteria requiring more chemical and labor expense to restore the water quality, in addition to replacing the pump. Also, if equipment is located at an elevation which is unsafe, homeowners may be at risk for injury.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

There could potentially be costs-savings by ensuring pool equipment is located and anchored to ensure safety and design functionality, thus preventing equipment malfunction.

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This revision will help ensure that safe pools continue to be built within floodplains.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The revision will provide equivalent protection through the use of branch circuits that have ground-fault circuit interrupter protection. Further, with the equipment being located near the ground, there is less chance of falling injuries to homeowners and contractors.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This revision does not discriminate against materials, products, methods or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This revision does not degrade the effectiveness of the code.

Alternate Language

1st Comment Period History

7680-A1

Proponent Gregory Wilson **Submitted** 2/13/2019 **Attachments** Yes

Rationale

The proposed amendment is not consistent with published FEMA guidance. This proposed change to further modify the R322.1.6 exception makes it consistent with National Flood Insurance Program Guidance which advises pool equipment should be fully elevated where possible, but if elevation would result in problems with pump function and performance, equipment is to be elevated as high as possible while allowing safe functioning. Reference FEMA P-348 Protecting Building Utilities From Flood Damage. There are other places in the code where judgement to determine practicality is required.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

Some may have costs for partial elevation.

Impact to industry relative to the cost of compliance with code

None

Impact to Small Business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Allows safe functioning while reducing exposure to flooding.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, consistent with NFIP guidance

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Modification does not discriminate against materials, products or methods of systems of construction

Does not degrade the effectiveness of the code

Modification does not degrade effectiveness of the code.

1st Comment Period History

S7680-G1

Proponent Kari Hebrank **Submitted** 2/13/2019 **Attachments** No

Comment:

The Florida Swimming Pool Association SUPPORTS this code modification which specifies the location, anchoring and safety requirements to resist flood forces and prevent flotation for equipment for pools, spas and water features located within a floodplain. Furthermore, it will ensure pool equipment is installed to ensure maximum efficiency.

R322.1.6Protection of mechanical, plumbing and electrical systems.

Electrical systems, *equipment* and components; heating, ventilating, air conditioning; plumbing *appliances* and plumbing fixtures; *duct systems*; and other service *equipment* shall be located at or above the elevation required in Section R322.2 or R322.3. If replaced as part of a substantial improvement, electrical systems, *equipment* and components; heating, ventilating, air conditioning and plumbing *appliances* and plumbing fixtures; *duct systems*; and other service *equipment* shall meet the requirements of this section. Systems, fixtures, and *equipment* and components shall not be mounted on or penetrate through walls intended to break away under flood loads.

Exception: Locating electrical systems, *equipment* and components; heating, ventilating, air conditioning; plumbing *appliances* and plumbing fixtures; *duct systems*; and other service *equipment* is permitted below the elevation required in Section R322.2 or R322.3 provided that they are designed and installed to prevent water from entering or accumulating within the components and to resist hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the design flood elevation in accordance with ASCE 24. Equipment for pools, spas and water features shall be permitted below the elevation required in Section R322.2 or R322.3 provided it is anchored to prevent floatation and resist flood forces and is supplied by branch circuits that have ground-fault circuit interrupter protection. Electrical wiring systems are permitted to be located below the required elevation provided that they conform to the provisions of the electrical part of this code for wet locations.

Exception: Locating electrical systems, equipment and components; heating, ventilating, air conditioning; plumbing appliances and plumbing fixtures; duct systems; and other service equipment is permitted below the elevation required in Section R322.2 or R322.3 provided that they are designed and installed to prevent water from entering or accumulating within the components and to resist hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the design flood elevation in accordance with ASCE 24. Equipment for pools, spas and water features shall be permitted below the elevation required in Section R322.2 or R322.3 provided it is elevated to the extent practical and is anchored to prevent floatation and resist flood forces and is supplied by branch circuits that have ground-fault circuit interrupter protection. Electrical wiring systems are permitted to be located below the required elevation provided that they conform to the provisions of the electrical part of this code for wet locations.

S7737

Date Submitted	12/6/2018	**Section**	317.1	**Proponent**	Scott McAdam
Chapter	3	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

RB154-16
R317.1, R402.1.2, R504.3,

Summary of Modification

The existing text was outdated, requiring clarification and updates to current AWPA section numbering.

Rationale

The existing text was outdated, requiring clarification and updates to current AWPA section numbering.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

clarification with wording of standard no impact

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction
These changes merely clarify and update the existing text without any impact on the required specifications for materials used.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction
These changes merely clarify and update the existing text without any impact on the required specifications for materials used.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction
These changes merely clarify and update the existing text without any impact on the required specifications for materials used.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

clarification

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

clarifies

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

does not discriminate

Does not degrade the effectiveness of the code

no effect

R317.1 Location required. Protection of wood and wood- based products from decay shall be provided in the following locations by the use of naturally durable wood or wood that is preservative-treated in accordance with AWPA U1 ~~for the species, product, preservative and end use. Preservatives shall be listed in Section 4 of AWPA U1.~~

"Remaining text unchanged"

_**R402.1.2 Wood treatment.** All lumber and plywood shall be pressure-preservative treated and dried after treatment in accordance with AWPA U1 (Commodity Specification A, ~~Use Category 4B and Section 5.2~~ Special Requirement 4.2)~~,~~ and shall bear the *label* of an accredited agency. Where lumber and/or plywood is cut or drilled after treatment, the treated surface shall be field treated with copper naphthenate, the concentration of which shall contain a minimum of 2-percent copper metal, by repeated brushing, dipping or soaking until the wood absorbs no more preservative.

_**R504.3 Materials.** Framing materials, including sleepers, joists, blocking and plywood subflooring, shall be pressure-preservative treated and dried after treatment in accordance with AWPA U1 (Commodity Specification A, ~~Use Category 4B and Section 5.2~~ Special Requirement 4.2), and shall bear the *label* of an accredited agency.

S7831

Date Submitted 12/10/2018
Chapter 3
Section 308.6
Affects HVHZ No
Proponent Roger LeBrun
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

7825

Summary of Modification

Clarify the exceptions and other language dealing with broken glass retention.

Rationale

The current language that states when screens are required below unit skylights glazing has frequently been difficult to interpret by jurisdictions, causing consumers and others concern when they are incorrectly told they need to install a glass retention screen below conforming laminated glass. Skylight manufacturers are asked to intervene far too frequently to ensure that unsightly, unnecessary screens are not installed in these instances. Furthermore, it is believed that many times an optional skylight installation is removed from submitted plans due to misinterpretation at the plan check stage, where the supplier may never know that the issue was raised because the permit applicant chooses to surrender rather than appeal.

The current code language addresses qualifying laminated glass by simple omission from the sections dealing with screens. It is this omission that seems to create the confusion within the industry. The proposed additional sentence in Section R308.6.5 states directly that permitted laminated glass does not require screens. This should reduce the frequency of misinterpretations that have been experienced.

Adding the modifier, “broken glass retention” fully describes the screen’s purpose. This is to ensure readers do not confuse them with insect screens or fall protection screens, which are physically different and will not serve as effective retention screens.

Section R308.6.7 is further clarified to be consistent with the language in IBC Section 2405.3.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Reduced confusion about the screening provisions.

Impact to building and property owners relative to cost of compliance with code

Smoother approval of plans, and less chance of failing inspections.

Impact to industry relative to the cost of compliance with code

Fewer requests for intervention due to misinterpretation of current language.

Impact to small business relative to the cost of compliance with code

No significant impact

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Provides protection from falling glass only when needed.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Less ambiguous language

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Yes

Does not degrade the effectiveness of the code

Yes

R308.6 Skylights and sloped glazing.

Skylights and sloped glazing shall comply with the following sections.

R308.6.1 Definitions.

The following terms are defined in Chapter 2:

SKYLIGHT, UNIT.
SKYLIGHTS AND SLOPED GLAZING.
TUBULAR DAYLIGHTING DEVICE (TDD).

R308.6.2 Materials.

The following types of glazing shall be permitted to be used:

1. 1.Laminated glass with not less than a 0.015-inch (0.38 mm) polyvinyl butyral interlayer for glass panes 16 square feet (1.5 m^2) or less in area located such that the highest point of the glass is not more than 12 feet (3658 mm) above a walking surface or other accessible area; for higher or larger sizes, the interlayer thickness shall be not less than 0.030 inch (0.76 mm).
2. 2.Fully tempered glass.
3. 3.Heat-strengthened glass.
4. 4.Wired glass.
5. 5.*Approved* rigid plastics.

R308.6.3 Screens, general.

For fully tempered or heat-strengthened glass, a ~~retaining~~ broken glass retention screen meeting the requirements of Section R308.6.7 shall be installed below the full area of the glass, except for fully tempered glass that meets ~~either~~ condition (1) or (2) listed in Section R308.6.5.

R308.6.4 Screens with multiple glazing.

Where the inboard pane is fully tempered, heat-strengthened or wired glass, a broken glass retention ~~retaining~~ screen meeting the requirements of Section R308.6.7 shall be installed below the full area of the glass, except for condition (1) or (2) listed in Section R308.6.5. Other panes in the multiple glazing shall be of any type listed in Section R308.6.2.

R308.6.5 Screens not required.

Screens shall not be required where laminated glass complying with item (1) of Section R308.6.2 is used as single glazing or the inboard pane in multiple glazing.

Screens shall not be required where fully tempered glass is used as single glazing or the inboard pane in multiple glazing and either of the following conditions are met:

1. 1.Glass area 16 square feet (1.49 m^2) or less. Highest point of glass not more than 12 feet (3658 mm) above a walking surface or other accessible area, nominal glass thickness not more than $^3/_{16}$ inch (4.8 mm), and (for multiple glazing only) the other pane or panes fully tempered, laminated or wired glass.
2. 2.Glass area greater than 16 square feet (1.49 m^2). Glass sloped 30 degrees (0.52 rad) or less from vertical, and highest point of glass not more than 10 feet (3048 mm) above a walking surface or other accessible area.

R308.6.6 Glass in greenhouses.

Any glazing material is permitted to be installed without screening in the sloped areas of greenhouses, provided that the greenhouse height at the ridge does not exceed 20 feet (6096 mm) above *grade*.

R308.6.7 Screen characteristics.

The screen and its fastenings shall be capable of supporting twice the weight of the glazing, be firmly and substantially fastened to the framing members, be installed within 4 inches (102 mm) of the glass and have a mesh opening of not more than 1 inch by 1 inch (25 mm by 25 mm).

S8052

Date Submitted	12/13/2018	**Section**	322	**Proponent**	Rebecca Quinn obo FL Dept Emerg Mg
Chapter	3	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Adjust section numbers of Commission approved flood provisions in R322.3 to put them in the correct order.

Rationale

Three proposals to the flood provisions in IRC Section R322.3 were approved by the Commission (RB160-16, RB161-16, and RB162-16). This proposal simply shows how to properly include those proposals into Sec. R322.3 with the correct section numbers, while adjusting the numbers of the existing subsections from the 5th edition (2017). The proposed order matches the order of provisions in 2018 IRC Sec. 322.3.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact due to adjusting section number.

Impact to building and property owners relative to cost of compliance with code

No impact due to adjusting section number.

Impact to industry relative to the cost of compliance with code

No impact due to adjusting section number.

Impact to small business relative to the cost of compliance with code

No impact due to adjusting section number.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

No change to flood protection of the code caused by adjusting section numbers.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

No change to flood protection of the code caused by adjusting section numbers.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No change to flood protection of the code caused by adjusting section numbers.

Does not degrade the effectiveness of the code

No change to flood protection of the code caused by adjusting section numbers.

~~R322.3.4~~ <u>R322.3.5</u> **Walls below design flood elevation.** Walls and partitions are permitted below the elevated floor, provided that such walls and partitions are not part of the structural support of the building or structure and:

1. Electrical, mechanical and plumbing system components are not to be mounted on or penetrate through walls that are designed to break away under flood loads; and
2. Are constructed with insect screening or open lattice; or
3. Are designed to break away or collapse without causing collapse, displacement or other structural damage to the elevated portion of the building or supporting foundation system. Such walls, framing and connections shall have a resistance of not less than 10 (479 Pa) and not more than 20 pounds per square foot (958 Pa) as determined using allowable stress design; or
4. Where wind loading values of this code exceed 20 pounds per square foot (958 Pa), as determined using allowable stress design, the *construction documents* shall include documentation prepared and sealed by a registered *design professional* that:
   4.1 The walls and partitions below the design flood elevation have been designed to collapse from a water load less than that which would occur during the base flood.
   4.2 The elevated portion of the building and supporting foundation system have been designed to withstand the effects of wind and flood loads acting simultaneously on structural and nonstructural building components. Water-loading values used shall be those associated with the design flood. Wind-loading values shall be those required by this code.
5. Walls intended to break away under flood loads as specified in Item 3 or 4 have flood openings that meet the criteria in Section R322.2.2, Item 2.

~~R322.3.5~~ <u>R322.3.6</u> **Enclosed areas below design flood elevation.** Enclosed areas below the design flood elevation shall be used solely for parking vehicles, building access or storage.

~~R322.3.5.1~~ <u>R322.3.6.1</u> **Protection of building envelope.** An exterior door that meets the requirements of Section R609 shall be installed at the top of stairs that provide access to the building and that are enclosed with walls designed to break away in accordance with Section 322.3.5.

~~R322.3.6~~ <u>R322.3.7</u> **Stairways and ramps.** Stairways and ramps that are located below the lowest floor elevations specified in Section R322.3.2 shall comply with one or more of the following:

1. Be designed and constructed with open or partially open risers and guards.
2. Stairways and ramps not part of the required means of egress shall be designed and constructed to break away during design flood conditions without causing damage to the building or structure, including foundation.
3. Be retractable, or able to be raised to or above the lowest floor elevation, provided that the ability to be retracted or raised prior to the onset of flooding is not contrary to the means of egress requirements of the code.
4. Be designed and constructed to resist flood loads and minimize transfer of flood loads to the building or structure, including foundation.

Areas below stairways and ramps shall not be enclosed with walls below the design flood elevation unless such walls are constructed in accordance with Section R322.3.5.

~~R322.3.6~~ <u>R322.3.8</u> **Decks and porches.** Attached decks and porches shall meet the elevation requirements of Section R322.3.2 and shall either meet the foundation requirements of this section or shall be cantilevered from or knee braced to the building or structure. Self-supporting decks and porches that are below the elevation required in Section R322.3.2 shall not be enclosed by solid, rigid walls, including walls designed to break away. Self-supporting decks and porches shall be designed and constructed to remain in place during base flood conditions or shall be frangible and break away under base flood conditions.

~~R322.3.6~~ R322.3.9 **Construction documents.** The *construction documents* shall include documentation that is prepared and sealed by a registered *design professional* that the design and methods of construction to be used meet the applicable criteria of this section.

~~R322.3.7~~ R322.3.10 **Tanks.** Underground tanks shall be anchored to prevent flotation, collapse and lateral movement under conditions of the base flood. Above-ground tanks shall be installed at or above the elevation required in Section R322.3.2. Where elevated on platforms, the platforms shall be cantilevered from or knee braced to the building or shall be supported on foundations that conform to the requirements of Section R322.3.

Proposal #8052

Proponent: Rebecca Quinn, on behalf of the Florida Division of Emergency Management

NOTE: The base text shown below is the published 2018 IRC. ICC's tech editors do a little work, which accounts for the slight, non-substantive differences between this and the working documents based on the results of the code hearing cycle.

R322.3.4 Concrete slabs Concrete slabs used for parking, floors of enclosures, landings, decks, walkways, patios and similar uses that are located beneath structures, or slabs that are located such that if undermined or displaced during base flood conditions could cause structural damage to the building foundation, shall be designed and constructed in accordance with one of the following:

1. To be structurally independent of the foundation system of the structure, to not transfer flood loads to the main structure, and to be frangible and break away under flood conditions prior to base flood conditions. Slabs shall be a maximum of 4 inches (102 mm) thick, shall not have turned-down edges, shall not contain reinforcing, shall have isolation joints at pilings and columns, and shall have control or construction joints in both directions spaced not more than 4 feet (1219 mm) apart.
2. To be self-supporting, structural slabs capable of remaining intact and functional under base flood conditions, including erosion and local scour, and the main structure shall be capable of resisting any added flood loads and effects of local scour caused by the presence of the slabs.

Commented [RQ1]: RB160 proposed this as R322.3.4. Therefore, this section will not show in the proposal to adjust section numbering to match how they got combined in the 2018 IRC

~~**R322.3.4**~~ **R322.3.5 Walls below design flood elevation.** Walls and partitions are permitted below the elevated floor, provided that such walls and partitions are not part of the structural support of the building or structure and:

1. Electrical, mechanical and plumbing system components are not to be mounted on or penetrate through walls that are designed to break away under flood loads; and
2. Are constructed with insect screening or open lattice; or
3. Are designed to break away or collapse without causing collapse, displacement or other structural damage to the elevated portion of the building or supporting foundation system. Such walls, framing and connections shall have a resistance of not less than 10 (479 Pa) and not more than 20 pounds per square foot (958 Pa) as determined using allowable stress design; or
4. Where wind loading values of this code exceed 20 pounds per square foot (958 Pa), as determined using allowable stress design, the *construction documents* shall include documentation prepared and sealed by a registered *design professional* that:

4.1 The walls and partitions below the design flood elevation have been designed to collapse from a water load less than that which would occur during the base flood.
4.2 The elevated portion of the building and supporting foundation system have been designed to withstand the effects of wind and flood loads acting simultaneously on structural and nonstructural building components. Water-loading values used shall be those associated with the design flood. Wind-loading values shall be those required by this code.

5. Walls intended to break away under flood loads as specified in Item 3 or 4 have flood openings that meet the criteria in Section R322.2.2, Item 2.

~~R322.3.5~~ R322.3.6 **Enclosed areas below design flood elevation.** Enclosed areas below the design flood elevation shall be used solely for parking vehicles, building access or storage.

~~R322.3.5.1~~ R322.3.6.1 **Protection of building envelope.** An exterior door that meets the requirements of Section R609 shall be installed at the top of stairs that provide access to the building and that are enclosed with walls designed to break away in accordance with Section 322.3.5.

~~R322.3.6~~ R322.3.7 **Stairways and ramps.** Stairways and ramps that are located below the lowest floor elevations specified in Section R322.3.2 shall comply with one or more of the following:

1. Be designed and constructed with open or partially open risers and guards.
2. Stairways and ramps not part of the required means of egress shall be designed and constructed to break away during design flood conditions without causing damage to the building or structure, including foundation.
3. Be retractable, or able to be raised to or above the lowest floor elevation, provided that the ability to be retracted or raised prior to the onset of flooding is not contrary to the means of egress requirements of the code.
4. Be designed and constructed to resist flood loads and minimize transfer of flood loads to the building or structure, including foundation.

Areas below stairways and ramps shall not be enclosed with walls below the design flood elevation unless such walls are constructed in accordance with Section R322.3.5.

Commented [RQ2]: RB161 proposed this as R322.3.6, so now have to "amend" to assign the right section number

~~R322.3.6~~ R322.3.8 **Decks and porches.** Attached decks and porches shall meet the elevation requirements of Section R322.3.2 and shall either meet the foundation requirements of this section or shall be cantilevered from or knee braced to the building or structure. Self-supporting decks and porches that are below the elevation required in Section R322.3.2 shall not be enclosed by solid, rigid walls, including walls designed to break away. Self-supporting decks and porches shall be designed and constructed to

Commented [RQ3]: RB162 proposed this as R322.3.6, so now have to "amend" to assign the right section number remain in place during base flood conditions or shall be frangible and break away under base flood conditions.

~~R322.3.6~~ R322.3.9 **Construction documents.** The *construction documents* shall include documentation that is prepared and sealed by a registered *design professional* that the design and methods of construction to be used meet the applicable criteria of this section.

~~R322.3.7~~ R322.3.10 **Tanks.** Underground tanks shall be anchored to prevent flotation, collapse and lateral movement under conditions of the base flood. Above-ground tanks shall be installed at or above the elevation required in Section R322.3.2. Where elevated on platforms, the platforms shall be cantilevered from or knee braced to the building or shall be supported on foundations that conform to the requirements of Section R322.3.

Summary of Mod

Adjust section numbers of Commission approved flood provisions in R322.3 to put them in the correct order.

Rationale

Three proposals to the flood provisions in IRC Section R322.3 were approved by the Commission (RB160-16, RB161-16, and RB162-16). This proposal simply shows how to properly include those proposals into Sec. R322.3 with the correct section numbers, while adjusting the numbers of the existing subsections from the 5th edition (2017). The proposed order matches the order of provisions in 2018 IRC Sec. 322.3.

Fiscal Impact:

Impact to local entity relative to enforcement of code (553.73(9)(b),F.S.)*

No impact due to adjusting section number.

Impact to building and property owners relative to cost of compliance with code (553.73(9)(b),F.S.)*

No impact due to adjusting section number.

Impact to industry relative to the cost of compliance with code (553.73(9)(b),F.S.)*

No impact due to adjusting section number.

Impact to small business relative to the cost of compliance with code (553.73(9)(b),F.S.)*

No impact due to adjusting section number.

REQUIREMENTS

Has a reasonable and substantial connection with the health, safety, and welfare of the general public (553.73(9)(a)2,F.S.)

No change to flood protection of the code caused by adjusting section number.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction (553.73(9)(a)3,F.S.)

No change to flood protection of the code caused by adjusting section number.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities (553.73(9)(a)4,F.S.)

No change to flood protection of the code caused by adjusting section number.

Does not degrade the effectiveness of the code (553.73(9)(a)5,F.S.)

No change to flood protection of the code caused by adjusting section number

Date Submitted	12/14/2018	**Section**	301.2.1	**Proponent**	T Stafford
Chapter	3	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

This proposal is intended to clarify the limits for using the prescriptive (non-high) wind criteria that's been carried forward in the FBCR from the IRC.

Rationale

This proposal is intended to clarify the applicability of the prescriptive criteria in the FBCR for wood, masonry, concrete and steel buildings. Since the first edition, the FBCR has limited the use of the prescriptive criteria that has been carried forward from the IRC. With the adoption of ASCE 7-10 in the 2010 FBCR, the prescriptive provisions have not been permitted to be used in any area of Florida. Recent editions of the FBCR have simply deleted this criteria. During the last cycle, language was added to specifically address the limits but was not as comprehensive as in previous editions. This proposal simply provides additional clarification. In addition, during Phase I of the 2020 update of the FBC, the Commission voted to update ASCE 7 from the 2010 edition to the 2016 edition (ASCE 7-16). ICC 600 has not been updated to ASCE 7-16. This proposal also makes it clear that masonry and concrete wall design is permitted in accordance with ICC 600, but wood roof framing would have to comply with the WFCM or be designed to comply with ASCE 7-16.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with the code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to cost of compliance with the code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to cost of compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal clarifies requirements for wind design of buildings within the scope of the FBCR.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code by clarifying the wind design requirements of buildings within the scope of the FBCR.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

R301.2.1.1Wind ~~limitations and wind~~ design required. ~~The prescriptive provisions of this code for wood construction, cold-formed steel light-frame construction, and masonry construction shall not apply to the design of buildings where the ultimate design wind speed, V_{ult}, from Figure R301.2(4) equals or exceeds 115 miles per hour (51 m/s). The prescriptive provisions of this code include the sizing and attachment requirements specified in Sections R502, R503, R505, R602, R603, R606, R802 and R804.~~

-

~~**Exceptions:**~~

~~1.For concrete construction, the wind provisions of this code shall apply in accordance with the limitations of Sections R401, R402, R404 and R608.~~
~~2.For structural insulated panels, the wind provisions of this code shall apply in accordance with the limitations of Section R610.~~
~~3.Roof sheathing shall be installed in accordance with Section R803.~~

In regions where the ultimate design wind speed, V_{ult}, from Figure R301.2(4) equals or exceeds 115 miles per hour (51 m/s), the design of concrete, masonry, wood, and steel buildings for wind loads shall be in accordance with one or more of the following methods:

1. AF&PA *Wood Frame Construction Manual* (WFCM).
2. Concrete and masonry walls are permitted to be designed in accordance with ICC *Standard for Residential Construction in High-Wind Regions* (ICC 600).
3. ASCE *Minimum Design Loads for Buildings and Other Structures* (ASCE 7).
4. AISI *Standard for Cold-Formed Steel Framing— Prescriptive Method For One- and Two-Family Dwellings* (AISI S230.
5. *Florida Building Code, Building*; or
6. The MAF *Guide to Concrete Masonry Residential Construction in High Wind Areas* shall be permitted for applicable concrete masonry buildings for a basic wind speed of 130 mph (58 m/s) or less in Exposure B and 110 mph (49 m/s) or less in Exposure C in accordance with Figure R301.2(4) as converted in accordance with R301.2.1.3.

Exceptions:

1. Footings and foundations shall comply with Chapter 4.
2. Exterior windows and doors shall comply with Section R609.
3. For structural insulated panels, the provisions of this code apply in accordance with the limitations of Section R610.
4. Exterior wall coverings and soffits shall comply with Chapter 7
5. Roof sheathing shall be attached in accordance with Section R803.
6. Roof coverings shall comply with Chapter 9.

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The elements of design not addressed by the methods in Items 1 through 6 shall be in accordance with the provisions of this code.

S8393

Date Submitted	12/15/2018	**Section**	317.3.1	**Proponent**	Randall Shackelford
Chapter	3	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

8354

Summary of Modification

Requires staples used for treated wood to be stainless steel.

Rationale

The purpose of this proposal is to specifically limit staples to stainless steel where exposed to high corrosion environments. The thin wire gages used in staple fasteners (16ga – 14ga) are much thinner than those used in nails, and are consequentially more susceptible to corrosion, as well as being harder to coat with a corrosion-resistant coating. Also, according to ICC ESR-1539 report for power-driven staples and nails, currently stainless steel staples are the only available option for staples to meet the increased corrosion resistance requirements of sections 2304.10.5.1 and R317.3.1. By specifically specifying staples as requiring stainless steel this avoids confusion and possible misuse of other types of staples in increased corrosion risk applications.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Small. Staples are not that commonly used as fasteners for treated wood. But if they were, they would need to be corrosion-resistant.

Impact to building and property owners relative to cost of compliance with code

Small. Staples are not that commonly used as fasteners for treated wood. But if they were, they would need to be corrosion-resistant.

Impact to industry relative to the cost of compliance with code

Small. Staples are not that commonly used as fasteners for treated wood. But if they were, they would need to be corrosion-resistant.

Impact to small business relative to the cost of compliance with code

Small. Staples are not that commonly used as fasteners for treated wood. But if they were, they would need to be corrosion-resistant.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Ensures that connections made with staples in treated wood will be effective and will last. New treated wood formulations have been found to be corrosive to steel fasteners.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens code by ensuring that connections made with staples in treated wood will be effective and will last. New treated wood formulations have been found to be corrosive to steel fasteners.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

I am not aware of other materials that would be acceptable for staples in treated wood.

Does not degrade the effectiveness of the code

Does not degrade the code.

R317.3.1 Fasteners for preservative-treated wood.

Fasteners, including nuts and washers, for preservative-treated wood shall be of hot-dipped, zinc-coated galvanized steel, stainless steel,silicon bronze or copper. Staples shall be of stainless steel. Coating types and weights for connectors in contact with preservative-treated wood shall be in accordance with the connectormanufacturer's recommendations. In the absence of manufacturer's recommendations, a minimum of ASTM A 653 type G185 zinc-coated galvanized steel, or equivalent, shall be used.

Exceptions:

1. one half (1/2)-inch-diameter (12.7 mm) or greater steel bolts.

2. Fasteners other than nails, staples, and timber rivets shall be permitted to be of mechanically deposited zinc-coated steel with coating weights in accordance with ASTM B 695, Class 55 minimum.

3. Plain carbon steel fasteners in SBX/DOT and zinc borate preservative-treated wood in an interior, dry environment shall be permitted.

R317.3.3 Fasteners for fire-retardant-treated wood used in exterior applications or wet or damp locations. **Fasteners, including nuts and washers, for fire-retardant-treated wood used in exterior applications or wet or damp locations shall be of hot-dipped, zinc-coated galvanizedsteel, stainless steel, silicon bronze or copper. Fasteners other than nails, staples, and timber rivets shall be permitted to be of mechanically deposited zinc-coated steel with coating weights in accordance with ASTM B 695, Class 55 minimum.**

S7434

Date Submitted	11/26/2018	**Section**	401.2	**Proponent**	Hill Kevin
Chapter	4	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Clarify for all foundation soils, not just fill soils, should be designed, installed, compacted and tested.

Rationale

Clarification that all foundation soils (not just fill soils) should be designed, installed, compacted and tested.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves safety by requiring that all foundation soils be properly designed, compacted and tested.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by requiring that all foundation soils (not just fill soils) be properly designed, compacted and tested.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the code.

R401.2Requirements.

Foundations shall be capable of resisting all loads from roof uplift and building overturn. Foundation uplift for light-frame wood or steel buildings shall be calculated or determined from Table R401.1. Masonry buildings within the dimensional scope of Table R401.1 shall be assumed to be of adequate weight so as not to require uplift resistance greater than that provided by the structure and any normal foundation. Foundation construction shall also be capable of accommodating all gravity loads in accordance with Section R301 and of transmitting the resulting loads to the supporting soil. ~~Fill s~~Soils that support footings and foundations shall be designed, installed/compacted and tested in accordance with accepted engineering practice. Gravel fill used as footings for wood and precast concrete foundations shall comply with Section R403.

S7435

Date Submitted	11/26/2018	**Section**	401.4	**Proponent**	Hill Kevin
Chapter	4	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No **Alternate Language** No

Related Modifications

7398, 7396, 7404

Summary of Modification

Adding highly organic soils to expansive soils to require testing, reducing presumptive load-bearing values for sandy soils from 2000 to 1500psf (same as proposed change in Building Ch.18, Mod 7398) and defining what complete organic removal is (same as mod 7404 for Building).

Rationale

Highly organic soil should have the same consideration as expansive soil for foundation design. Florida sands should not have a 2000psf presumptive bearing pressure as there are footing widths and water table depth combinations that have nearly zero safety factor in such cases. 1500psf is more commonly used for design on Florida sands.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Very little impact. Building official may now more easily require soil testing if highly organic soils are present.

Impact to building and property owners relative to cost of compliance with code

Should not impact. Likely none.

Impact to industry relative to the cost of compliance with code

Likely none.

Impact to small business relative to the cost of compliance with code

Likely none.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves safety by increasing safety factor against bearing failure, which was too low for certain conditions under current code. Also improves safety by requiring testing if highly organic soils are present.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by increasing safety factor against bearing failure, which was too low for certain conditions under current code. Also improves the code by requiring testing if highly organic soils are present and defining what highly organic soils are and what complete removal is.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

R401.4Soil tests.

Where quantifiable data created by accepted soil science methodologies indicate expansive, highly organic, compressible, shifting or other questionable soil characteristics are likely to be present, the *building official* shall determine whether to require a soil test to determine the soil's characteristics at a particular location. This test shall be done by an *approved agency* using an *approved* method. Soils shall be considered highly organic if the Organic Content by weight, determined in accordance with ASTM D2974, is greater than 8 percent and the total thickness of organic layer(s) is greater than 12 inches.

R401.4.1Geotechnical evaluation.

In lieu of a complete geotechnical evaluation, the load-bearing values in Table R401.4.1shall be assumed.

TABLE R401.4.1

PRESUMPTIVE LOAD-BEARING VALUES OF FOUNDATION MATERIALS[a]

CLASS OF MATERIAL	LOAD-BEARINGPRESSURE(pounds per square foot)
Crystalline bedrock	12,000
Sedimentary and foliated rock	4,000
Sandy gravel and/or gravel (GW and GP)	3,000
~~Sand, silty sand, clayey sand, s~~Silty gravel and clayey gravel (~~SW, SP, SM, SC,~~ GM and GC)	2,000
Sand, silty sand, clayey sand, ~~C~~Clay, sandy, silty clay, clayey silt, silt and sandy siltclay (SW, SP, SM, SC, CL, ML, MH and CH)	1,500[b]

For SI: 1 pound per square foot = 0.0479 kPa.

1. a.Where soil tests are required by Section R401.4, the allowable bearing capacities of the soil shall be part of the recommendations.
2. b.Where the building official determines that in-place soils with an allowable bearing capacity of less than 1,500 psf are likely to be present at the site, the allowable bearing capacity shall be determined by a soils investigation.

R401.4.2Compressible, highly organic or shifting soil.

Instead of a complete geotechnical evaluation, where top or subsoils are compressible, highly organic or shifting, they shall be removed to a depth and width sufficient to ensure stable moisture content in each active zone and shall not be used as fill or stabilized within each active zone by chemical, dewatering or presaturation. Removal of highly organic soil shall be considered complete when the total thickness of all organic layers remaining in the soil is less than 12 inches thick and organic content of the remaining soil is less than 8 percent by weight. If highly organic soil is to be treated rather than removed, an approved geotechnical report shall be required that includes design of such treatment and recommendations for construction.

Designation: D2974 – 14

Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils[1]

This standard is issued under the fixed designation D2974; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 These test methods cover the measurement of moisture content, ash content, and organic matter in peats and other organic soils, such as organic clays, silts, and mucks. Test Method D2216 provides an alternative method for determining moisture content in mineral soils and rock.

1.1.1 *Test Method A*—Moisture is determined by drying peat or organic sample at 110 ± 5°C.

1.1.2 *Test Method B*—Alternative moisture method which removes the total moisture in two steps: (*1*) evaporation of moisture at room temperature, (*2*) subsequent oven drying of air dried sample at 110 ± 5°C. This method is used when the peat is to be used as fuel.

1.1.3 *Test Method C*—Ash content of a peat or organic soil sample, for general purposes, is determined by igniting oven dried sample from moisture content determination in a furnace at 440 ± 40°C.

1.1.4 *Test Method D*—Ash content of a peat or organic soil sample, for materials used for fuel, is determined by igniting oven dried sample from moisture content determination in a furnace at 750 ± 38°C.

1.2 Test Method A should be used for general classification, except for use of the peat as a fuel. Test Method B should be used when peats are being evaluated for use as a fuel

1.3 The values stated in SI units are to be regarded as the standard. No other units of measurement are included in this standard.

1.4 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026.

1.4.1 The procedures used to specify how data are collected/recorded or calculated in this standard are regarded as the industry standard. In addition, they are representative of the significant digits that generally should be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user's objectives; and it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations. It is beyone the scope of this standard to consider significant digits used in analysis methods for engineering design.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids
D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
D2944 Practice of Sampling Processed Peat Materials
D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing
D6026 Practice for Using Significant Digits in Geotechnical Data
E145 Specification for Gravity-Convection and Forced-Ventilation Ovens

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of common technical terms in this standard, refer to Terminology D653.

4. Summary of Test Methods

4.1 *Test Method A*—Moisture is determined by drying a peat or organic soil sample at 110 ± 5°C. The moisture content is expressed as a percent of the oven dry mass.

[1] These test methods are under the jurisdiction of ASTM Committee D18 on Soil and Rock and are the direct responsibility of Subcommittee D18.22 on Soil as a Medium for Plant Growth.

Current edition approved Nov. 1, 2014. Published November 2014. Originally approved in 1971. Last previous edition approved in 2013 as D2974 – 13. DOI: 10.1520/D2974-14.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard**

4.2 *Test Method B*—This is an alternative moisture method which removes the total moisture in two steps: (*1*) evaporation of moisture in air at room temperature (air-drying), and (*2*) the subsequent oven drying of the air-dried sample at 110 ± 5°C. This method is used when the peat is to be used as fuel. The moisture content is expressed as both a percent of the oven dry mass and of the as received mass.

4.3 *Test Methods C and D*—Ash content of a peat or organic soil sample is determined by igniting the oven-dried sample from the moisture content determination in a furnace at 440 ± 40°C (Test Method C) or 750 ± 38°C (Test Method D). The substance remaining after ignition is the ash. The ash content is expressed as a percentage of the mass of the oven-dried sample.

4.4 Organic matter is determined by subtracting percent ash content from one hundred.

5. Significance and Use

5.1 This test method can be used to determine the moisture content, ash content, and percent organic matter in soil.

5.2 The percent organic matter is important in the following: (*1*) classifying peat or other organic soil, (*2*) geotechnical and general classification purposes, and (*3*) when peats are being evaluated as a fuel.

NOTE 1—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Oven*, meeting the requirements of E145 and capable of being regulated to a constant temperature of 110 ± 5°C.

6.2 The temperature of 110 ± 5°C is quite critical for organic soils. The oven should be checked for "hot spots" to avoid possible ignition of the specimen.

6.3 *Furnace*, capable of producing constant temperatures of 440 ± 40°C and 750 ± 38°C.

6.4 *Balance or Scale*, a balance or scale for determining the mass of the soil having a minimum capacity of 500 g and meeting the requirements of Guide D4753 for a balance or scale of 0.01 g readability.

6.5 *Rubber Sheet, Oil Cloth*, or other non-absorbent material.

6.6 *Evaporating Dishes*, of high silica or porcelain of not less than 100-mL capacity.

6.7 *Aluminum Foil*, heavy-duty.

6.8 *Porcelain Pan, Spoons*, and equipment of the like.

6.9 *Desiccator.*

7. Sampling and Test Specimens

7.1 Place a representative field sample on a rubber sheet, oil cloth, or equivalent material and mix thoroughly.

7.2 Reduce the sample to the quantity required for a test specimen by quartering.

7.3 Place the test specimen and the remaining sample in separate waterproof containers.

7.4 Work rapidly to prevent moisture loss or perform the operation in a room with a high humidity.

8. Procedure

8.1 *Moisture Content Determination:*

8.1.1 *Test Method A:*

8.1.1.1 Record to the nearest 0.01 g the mass of a high silica or porcelain evaporating dish fitted with a heavy-duty aluminum foil cover. The dish shall have a capacity of not less than 100 mL.

8.1.1.2 Following the instruction in Section 7 above, place a test specimen of at least 50 g in the container described in 8.1.1.1. Crush soft lumps with a spoon or spatula. The thickness of peat in the container should not exceed 3 cm.

8.1.1.3 Record the mass to the nearest 0.01 g.

8.1.1.4 Dry uncovered for at least 16 h at 110 ± 5°C or until there is less than 0.1 % change in mass of the sample per hour. Remove from the oven, cover tightly, cool in a desiccator, and record the mass to the nearest 0.01 g keeping exposure to the room atmosphere to a minimum.

8.1.2 *Calculations for Test Method A:*

8.1.2.1 Calculate the moisture content as follows:

$$\text{Moisture Content, \%} = [(A - B) \times 100]/B \quad (1)$$

where:

A = mass of the as-received test specimen, g, and
B = mass of the oven-dried specimen, g.

(*1*) This calculation is used for general purposes (except when the peat is to be used as a fuel) and the result should be referred to as the moisture content as a percentage of oven-dried mass.

8.1.3 *Test Method B:*

8.1.3.1 This test method should be used if the peat is to be used as a fuel.

8.1.3.2 Following the instructions in Section 7, select a 100 to 300 g representative test specimen. Determine the mass of this test specimen to the nearest 0.01 g and spread it evenly on a large flat pan. Crush soft lumps with a spoon or spatula and let the sample come to moisture equilibrium with room air. This will require at least 24 h. Stir occasionally during the normal workday to maintain maximum air exposure of the entire sample. Continue drying until there is less than 0.1% change in mass per hour, then calculate the moisture removed during air drying as a percentage of the as-received mass.

8.1.3.3 After thoroughly mixing the air-dried sample, obtain 50 g of material and record to the nearest 0.01 g.

8.1.3.4 Place the sample in a container as described in 8.1.1 and proceed as in Test Method A.

8.1.4 *Calculations for Test Method B:*

8.1.4.1 Calculate the moisture content as follows:

$$\text{Moisture Content for Air-Dried Sample, \%} = ((A_D - B) \times 100)/B \quad (2)$$

where:

A_D = mass of the air-dried sample, g, and
B = mass of the oven-dried sample, g.

(1) This calculation gives moisture content of the air dried sample as a percentage of oven-dried mass.

8.2 *Ash Content Determination:*

8.2.1 *Test Method C:*

8.2.1.1 Determine the mass of a covered high-silica or porcelain dish to the nearest 0.01 g.

8.2.1.2 Place a part or all of the oven-dried test specimen from a moisture determination in the dish and determine the mass of the dish and specimen to the nearest 0.01 g.

8.2.1.3 Remove the cover and place the dish in a furnace. Gradually bring the temperature in the furnace to 440 ± 40°C and hold until the specimen is completely ashed (no change of mass occurs after at least 1 hr period of heating).

8.2.1.4 Cool in a desiccator, and determine the mass to the nearest 0.01 g keeping the exposure to the room atmosphere to a minimum.

8.2.1.5 This test method should be used for general classification purposes, except the use of peat for fuel.

8.2.2 *Test Method D:*

8.2.2.1 Determine the mass of a covered high-silica or porcelain dish to the nearest 0.01 g.

8.2.2.2 Place a part of the oven-dried test specimen from a moisture determination in the dish and determine the mass of the dish and specimen to the nearest 0.01 g.

8.2.2.3 Remove the cover and place the dish in a furnace. Gradually bring the temperature in the furnace to 750 ± 38°C and hold until the specimen is completely ashed (no change in mass of the sample after further drying periods in excess of 1 h).

8.2.2.4 Cool in a desiccator, and determine the mass to the nearest 0.01 g keeping the exposure to the room atmosphere to a minimum.

8.2.2.5 This test method should be used when peats are being evaluated for use as a fuel.

8.2.3 *Calculation for Test Methods C and D:*

8.2.3.1 Calculate the ash content as follows:

$$\text{Ash Content, \%} = (C \times 100)/B \tag{3}$$

where:

C = mass of ash, g, and
B = oven-dried test specimen, g.

8.3 *Organic Matter Determination:*

8.3.1 *Calculation:*

8.3.1.1 Determine the amount of organic matter to the nearest 0.1 % by difference, as follows:

$$\text{Organic matter, \%} = 100.0 - D \tag{4}$$

where:

D = ash content, % (nearest 0.1 %).

9. Report: Test Data Sheet(s)/Form(s)

9.1 The methodology used to specify how data are recorded on the test data sheet(s)/form(s), as follows, is covered in 1.4.

9.2 Record as a minimum the following general information (data):

9.2.1 Sample/specimen identifying information, such as Project No., Boring No., Sample No., Depth, and alike.

9.2.2 Any special selection and preparation process, such as removal of gravel or other materials.

9.2.3 Technician name or initials, method used and date.

9.3 Record as a minimum the following test specimen data:

9.3.1 Results for organic matter and ash content, to the nearest 0.1 %.

9.3.2 Furnace temperature used for ash content determinations.

9.3.3 Express results for moisture content as a percentage of oven-dried mass as follows:

9.3.3.1 Below 100 % to the nearest 1 %.

9.3.3.2 Between 100 % and 500 % to the nearest 5 %.

9.3.3.3 Between 500 % and 1000 % to the nearest 10 %.

9.3.3.4 Above 1000 % to the nearest 20 %.

10. Precision and Bias

10.1 *Precision*—Test data on precision is not presented due to the nature of the soil materials tested by this test method. It is either not feasible or too costly at this time to have ten or more laboratories participate in a round-robin testing program.

10.1.1 The Subcommittee D18.22 is seeking any data from the users of this test method that might be used to make a limited statement on precision.

10.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

11. Keywords

11.1 ash content; moisture content; organic soil; peat; percent organic matter

SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (D2974 – 13) that may impact the use of this standard. (Approved November 1, 2014)

(1) Changes made throughout to clarify the uses of the different test methods contained in this standard.

(2) Reference to D2944 was added for sampling methodology.

S7514

Date Submitted	11/28/2018	**Section**	403.1	**Proponent**	Hill Kevin
Chapter	4	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Adding "highly organic" to expansive soil requirements and replacing "undisturbed soil" with compacted soil requirements for foundations.

Rationale

Highly organic soils should require the same special attention as expansive soils with regard to footings or other foundations. Also, "undisturbed" soil has no importance in Florida soils as undisturbed soil is generally loose to very loose. Of greater importance is ensuring at least 12 inches of embedment below final grade.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Should be none, but Building Official can more easily require a geotechnical report if highly organic soils are present.

Impact to building and property owners relative to cost of compliance with code

Typically no impact.

Impact to industry relative to the cost of compliance with code

Typically no impact.

Impact to small business relative to the cost of compliance with code

Typically no impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves public safety and general welfare by requiring testing if highly organic soils are present.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by better defining foundation embedment, removing undisturbed soil that isn't relevant in Florida, and helping to ensure highly organic soils be tested prior to building.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code

SECTION R403
FOOTINGS

R403.1General.

All exterior walls shall be supported on continuous solid or fully grouted masonry or concrete footings, crushed stone footings, wood foundations, or other *approved* structural systems which shall be of sufficient design to accommodate all loads according to Section R301 and to transmit the resulting loads to the soil within the limitations as determined from the character of the soil. Footings shall be supported on ~~undisturbed~~compacted natural soils or engineered fill. Footings shall not be installed above highly organic soils without an approved geotechnical report to provide foundation design. Concrete footing shall be designed and constructed in accordance with the provisions of Section R403 or in accordance with ACI 332.

R403.1.4Minimum depth.

Exterior footings shall be placed not less than 12 inches (305 mm) below ~~the undisturbed ground surface~~final grade. Where applicable, the depth of footings shall also conform to Sections R403.1.4.1 through R403.1.4.2.

R403.1.8Foundations on expansive or highly organic soils.

Foundation and floor slabs for buildings located on expansive or highly organic soils shall be designed in accordance with Section 1808.6 of the Florida Building Code, Building.

Exception: Slab-on-ground and other foundation systems which have performed adequately in expansive soil conditions similar to those encountered at the building site are permitted subject to the approval of the *building official*.

S7632

Date Submitted 12/2/2018
Chapter 4
Section 403.3
Affects HVHZ No
Proponent Ann Russo8
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**
Alternate Language **No**

Related Modifications

RB179-16

Summary of Modification

This proposal updates the IRC to be consistent with the latest published design values for insulation materials used on frost-protected shallow foundations (FPSF), per ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations.

Rationale

This proposal updates the IRC to be consistent with the latest published design values for insulation materials used on frost-protected shallow foundations (FPSF), per ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations;

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal updates the FBCR to be consistent with the latest published design values for insulation materials used on frost-protected shallow foundations (FPSF), per ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations only. No impact to code enforcement.

Impact to building and property owners relative to cost of compliance with code

This proposal updates the FBCR to be consistent with the latest published design values for insulation materials used on frost-protected shallow foundations (FPSF), per ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations only. No cost impact.

Impact to industry relative to the cost of compliance with code

This proposal updates the FBCR to be consistent with the latest published design values for insulation materials used on frost-protected shallow foundations (FPSF), per ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations only. No cost impact.

Impact to small business relative to the cost of compliance with code

This proposal updates the FBCR to be consistent with the latest published design values for insulation materials used on frost-protected shallow foundations (FPSF), per ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations only. No cost impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal updates the FBCR to be consistent with the latest published design values for insulation materials used on frost-protected shallow foundations (FPSF), per ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations only. No impact to code enforcement.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal updates the FBCR to be consistent with the latest published design values for insulation materials used on frost-protected shallow foundations (FPSF), per ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations only. No effect on the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Updates the FBCR with the latest published design values for insulation materials used on frost-protected shallow foundations (FPSF), per ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations only. Does not discriminate against materials, products, methods etc.

Does not degrade the effectiveness of the code

Updates the FBCR to be consistent with the latest published design values for insulation materials used on frost-protected shallow foundations (FPSF), per ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations only. Does not degrade the effectiveness of the code.

Revise as follows:

TABLE R403.3 (1)
MINIMUM FOOTING DEPTH AND INSULATION REQUIREMENTS FOR FROST-PROTECTED FOOTINGS IN HEATED BUILDINGS.[a]

AIR FREEZING INDEX (°F-days)[b]	MINIMUM FOOTING DEPTH, D (inches)	VERTICAL INSULATION R-VALUE[c, d]	HORIZONTAL INSULATION R-VALUE[c, e]		HORIZONTAL INSULATION DIMENSIONS PER FIGURE R403.3(1) (inches)		
			Along walls	At corners	A	B	C
1,500 or less	12	4.5	Not required	Not required	Not required	Not required	Not required
2,000	14	5.6	Not required	Not required	Not required	Not required	Not required
2,500	16	6.7	1.7	4.9	12	24	40
3,000	16	7.8	6.5	8.6	12	24	40
3,500	16	9.0	8.0	11.2	24	30	60
4,000	16	10.1	10.5	13.1	24	36	60

For SI: 1 inch = 25.4 mm, °C = [(°F) - 32]/1.8.

a. Insulation requirements are for protection against frost damage in heated buildings. Greater values may be required to meet energy conservationstandards.

b. See Figure R403.3(2) or Table R403.3(2) for Air Freezing Indexvalues.

c. Insulation materials shall provide the stated minimum R-values under long-term exposure to moist, below-ground conditions in freezing climates. The following R-values shall be used to determine insulation thicknesses required for this application: Type II expanded polystyrene~~-2.4R~~ (EPS)-3.2R per inch; ~~Type IV extruded polystyrene-4.5R~~ for vertical insulation and 2.6R per inch; ~~Type VI extruded polystyrene-4.5R per inch;~~ for horizontal insulation; Type IX expanded polystyrene~~-3.2R~~ (EPS)-3.4R per inch for vertical insulation and 2.8R per inch for horizontal insulation; Type IV, V, VI, VII, and X extruded polystyrene (XPS)-4.5R per inch for vertical insulation and 4.0R per inch for horizontalinsulation.

d. Vertical insulation shall be expanded polystyrene insulation or extruded polystyreneinsulation.

e. Horizontal insulation shall be expanded polystyrene insulation or extruded polystyreneinsulation.

S7653

Date Submitted 12/3/2018	**Section** 403.4	**Proponent** Ann Russo8
Chapter 4	**Affects HVHZ** No	**Attachments** No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

RB181-16

Summary of Modification

Revise drawings to add dimensions required.

Rationale

This proposal updates the figure to add the dimension T for the footing thickness.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Clarification only no additional impact.

Impact to building and property owners relative to cost of compliance with code

This proposal will not increase the cost of construction and is editorial only.

Impact to industry relative to the cost of compliance with code

This proposal will not increase the cost of construction and is editorial only.

Impact to small business relative to the cost of compliance with code

This proposal will not increase the cost of construction and is editorial only.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Simply adds T dimension for footer thickness with no additional effect on the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Simply adds T dimension for footer thickness with no additional effect on the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Simply adds T dimension for footer thickness with no additional effect on the code. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

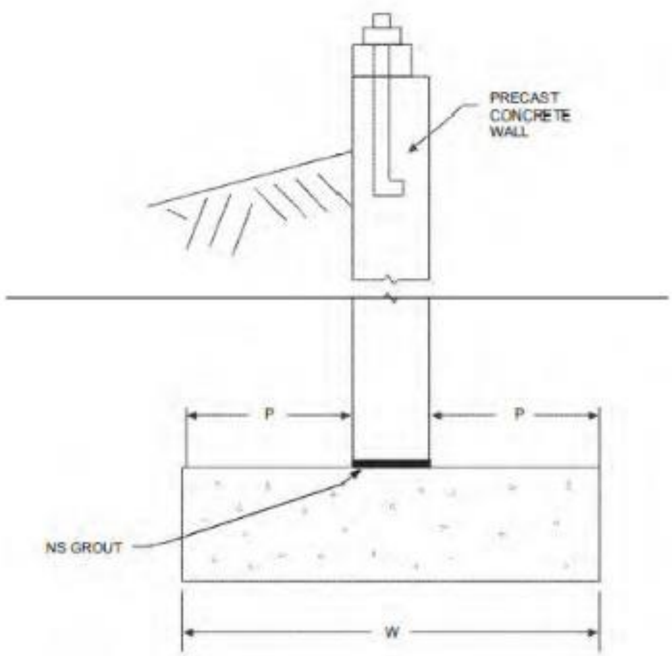
Simply adds T dimension for footer thickness with no additional effect on the code. Does not degrade the effectiveness of the code.

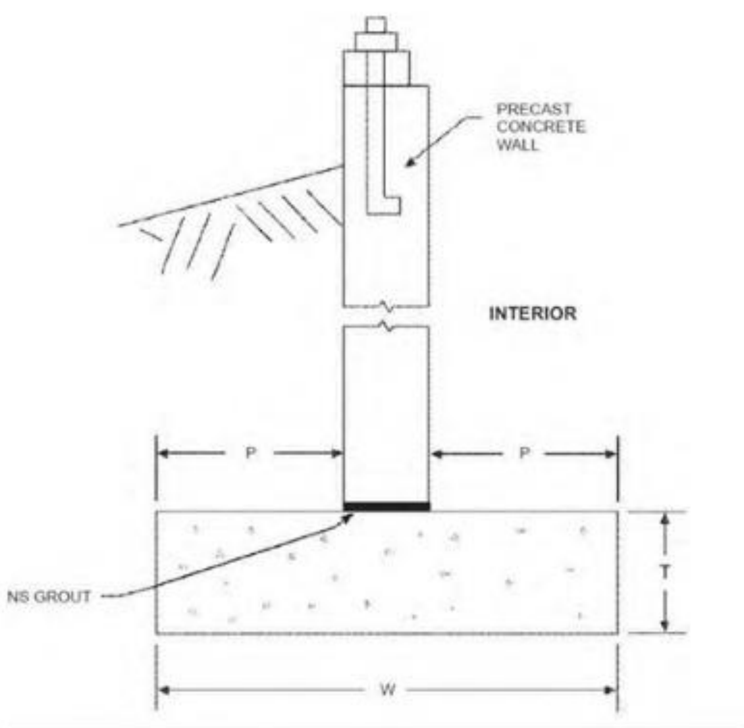
Mod 7653

Revise as follows:

FIGURE R403.4 (2)

BASEMENT OR CRAWL SPACE WITH PRECAST FOUNDATION WALL ON SPREAD FOOTING





S7654

Date Submitted	12/3/2018	**Section**	405.1	**Proponent**	Ann Russo8
Chapter	4	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

RB184-16

Summary of Modification

Editorial clarification for foundation drain locations.

Rationale

"area to be protected" is unclear and should be specified in the code. Placing drain tile too high is a primary cause of leaking basements.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will not increase the cost of construction, editorial clarification only.
There is no cost increase. Material & labor should be the same

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction
There is no cost increase. Material & labor should be the same

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction
There is no cost increase. Material & labor should be the same

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction
There is no cost increase. Material & labor should be the same

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Will not effect the code enforcement as this is an editorial clarification only.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

this is an editorial clarification only with no effect on the technical aspects of the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

this is an editorial clarification only. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

this is an editorial clarification only. Does not degrade the effectiveness of the code.

Revise as follows:

R405.1 Concrete or masonry foundations. Drains shall be provided around concrete or masonry foundations that retain earth and enclose habitable or usable spaces located below *grade*. Drainage tiles, gravel or crushed stone drains, perforated pipe or other *approved* systems or materials shall be installed at or below the ~~area to be protected~~ top of the footing or below the bottom of the slab and shall discharge by gravity or mechanical means into an *approved* drainage system. Gravel or crushed stone drains shall extend not less than 1 foot (305 mm) beyond the outside edge of the footing and 6 inches (152 mm) above the top of the footing and be covered with an *approved* filter membrane material. The top of open joints of drain tiles shall be protected with strips of building paper. Except where otherwise recommended by the drain manufacturer, perforated drains shall be surrounded with an *approved* filter membrane or the filter membrane shall cover the washed gravel or crushed rock covering the drain. Drainage tiles or perforated pipe shall be placed on a minimum of 2 inches (51 mm) of washed gravel or crushed rock not less than one sieve size larger than the tile joint opening or perforation and covered with not less than 6 inches (152 mm) of the same material.

> **Exception:** A drainage system is not required where the foundation is installed on well-drained ground or sand-gravel mixture soils according to the Unified Soil Classification System, Group I soils, as detailed in Table R405.1.

S7655

Date Submitted	12/3/2018	**Section**	408.3	**Proponent**	Ann Russo8
Chapter	4	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

RB187-16

Summary of Modification

This change adds an option for dehumidification for unvented crawl spaces.

Rationale

Typical conditioning measures involve supplying conditioned air from the occupied (conditioned) space of the building or exhausting air from the crawl space with make up air provided from the occupied (conditioned) space of the building. This code change allows another means of conditioning and controlling moisture, specifically dehumidification. Dehumidification is a proven technology.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Adding optional method only. No impact on code enforcement.

Impact to building and property owners relative to cost of compliance with code

This change will not increase the cost of construction as it is only adding an optional method for treatment of unvented crawl spaces.

Impact to industry relative to the cost of compliance with code

This change will not increase the cost of construction as it is only adding an optional method for treatment of unvented crawl spaces.

Impact to small business relative to the cost of compliance with code

This change will not increase the cost of construction as it is only adding an optional method for treatment of unvented crawl spaces.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This change is only adding an optional method for treatment of unvented crawl spaces so will not effect the code requirements or enforcement.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This change is only adding an optional method for treatment of unvented crawl spaces so will not effect the code requirements or enforcement.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This change is only adding an optional method for treatment of unvented crawl spaces so will not effect the code requirements or enforcement. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This change is only adding an optional method for treatment of unvented crawl spaces so will not effect the code requirements or enforcement. Does not degrade the effectiveness of the code.

Mod 7655

R408.3 Unvented crawl space. Ventilation openings in under-floor spaces specified in Sections R408.1 and R408.2 shall not be required where the following items are provided:

1. Exposed earth is covered with a continuous Class I vapor retarder. Joints of the vapor retarder shalloverlapby6inches(152mm)andshallbesealedortaped.Theedgesofthevaporretarder shall extend not less than 6 inches (152 mm) up the stem wall and shall be attached and sealed to the stem wall or insulation.

2. One of the following is provided for the under-floorspace:

   2.1.Continuously operated mechanical exhaust ventilation at a rate equal to 1 cubic foot per minute (0.47 L/s) for each 50 square feet (4.7 m2) of crawl space floor area, including an air pathwaytothecommonarea(suchasaductortransfergrille),andperimeterwallsinsulated in accordance with the Florida Building Code, Energy Conservation.

   2.2.*Conditioned air* supply sized to deliver at a rate equal to 1 cubic foot per minute (0.47L/s) for each 50 square feet (4.7 m2) of under-floor area, including a return air pathway to the common area (such as a duct or transfer grille), and perimeter walls insulated in accordance with the Florida Building Code, Energy Conservation.

   2.3.Plenum in existing structures complying with Section M1601.5, if under-floor space is used as a plenum.

   <u>2.4. Dehumidification sized to provide 70 pints (33 liters) of moisture removal per day for every 1,000 ft2 (93 m2) of crawl space floor area.</u>

Date Submitted	12/5/2018	**Section**	403.1.6	**Proponent**	Borrone Jeanette
Chapter	4	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Revise foundation anchorage R403.1.6

Summary of Modification

The change clarifies the anchorage of cold-formed steel framing with wood sill plates.

Rationale

This proposed revision is an editorial change intended to clarify the anchorage requirements for cold-formed steel wall assemblies. The referenced sections (R505.3.1 and R603.3.1) cover the anchorage requirements for cold-formed steel directly to the foundation or to the wood sill plate. The connection of the wood sill plate (that supports the CFS) to the foundation is intended to conform to this section.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will not impact local entity

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction This is simply a proposed editorial change that does not effect the intended prescribed construction requirements

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction This is simply a proposed editorial change that does not effect the intended prescribed construction requirements

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction This is simply a proposed editorial change that does not effect the intended prescribed construction requirements

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by clarifying the anchorage requirements for cold-formed steel wall assemblies

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by clarifying the anchorage requirements for cold-formed steel wall assemblies

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials, products, methods, or systems of construction clarifying the anchorage requirements for cold-formed steel wall assemblies

Does not degrade the effectiveness of the code

Increases the effectiveness of the code by clarifying the anchorage requirements for cold-formed steel wall assemblies

R403.1.6 Foundation anchorage.

Wood sill plates and wood walls supported directly on continuous foundations shall be anchored to the foundation in accordance with this section.

Cold-formed steel framing shall be anchored directly to the foundation or fastened to wood sill plates ~~anchored to the foundation~~in accordance with Section R505.3.1 or R603.3.1, as applicable. ~~Anchorage of cold-formed steel framing and~~ Wood sill plates supporting cold-formed steel framing shall be anchored to the foundation in accordance with this section ~~and Section R505.3.1 or R603.3.1~~.

Wood sole plates at all exterior walls on monolithic slabs, wood sole plates of braced wall panels at building interiors on monolithic slabs and all wood sill plates shall be anchored to the foundation with minimum 1/2-inch-diameter (12.7 mm) anchor bolts spaced a maximum of 6 feet (1829 mm) on center or approved anchors or anchor straps spaced as required to provide equivalent anchorage to 1/2-inch-iameter (12.7 mm) anchor bolts. Bolts shall extend a minimum of 7 inches (178 mm) into concrete or grouted cells of concrete masonry units. The bolts shall be located in the middle third of the width of the plate. A nut and washer shall be tightened on each anchor bolt. There shall be a minimum of two bolts per plate section with one bolt located not more than 12 inches (305 mm) or less than seven bolt diameters from each end of the plate section. Interior bearing wall sole plates on monolithic slab foundation that are not part of a braced wall panel shall be positively anchored with approved fasteners. Sill plates and sole plates shall be protected against decay and termites where required by Sections R317 and R318.

Exceptions:

1. Walls 24 inches (610 mm) total length or shorter connecting offset braced wall panels shall be anchored to the foundation with a minimum of one anchor bolt located in the center third of the plate section and shall be attached to adjacent braced wall panels at corners as shown in Item 9 of Table R602.3(1).
2. Connection of walls 12 inches (305 mm) total length or shorter connecting offset braced wall panels to the foundation without anchor bolts shall be permitted. The wall shall be attached to adjacent braced wall panels at corners as shown in Item 9 of Table R602.3(1).

S8385

Date Submitted 12/15/2018
Chapter 4
Section 408.3
Affects HVHZ No
Proponent Craig Conner
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

none

Summary of Modification

Additional option for unvented crawlspace dehumidification

Rationale

Unvented crawl spaces are required by Section R408.3 to provide to provide a method for moisture control. Typical conditioning measures involve supplying conditioned air from the occupied (conditioned) space of the building or exhausting air from the crawl space with make up air provided from the occupied (conditioned) space of the building. This code change allows another means of conditioning and controlling moisture, specifically dehumidification.

The existing language is based on a work done in the 1990's under the U.S. Department of Energy Building America Program. The work also examined dehumidification approaches.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

none

Impact to building and property owners relative to cost of compliance with code

potentially lower cost because it is an additional option

Impact to industry relative to the cost of compliance with code

potentially lower cost because it is an additional option

Impact to small business relative to the cost of compliance with code

Adds an option for crawlspace dehumidification.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

yes proven to mitigate moisture in crawlspace cavities

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Provides a potentially less expensive option and reduces moisture condensation and problems in crawlspace cavities.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Allows another option

Does not degrade the effectiveness of the code

Providing usable options improves the code.

R408.3 Unvented crawl space. Ventilation openings in under-floor spaces specified in Sections R408.1and R408.2 shall not be required where the following items are provided:
1. Exposed earth is covered with a continuous Class I vapor retarder. Joints of the vapor retarder shall overlap by 6 inches (152 mm) and shall be sealed or taped. The edges of the vapor retarder shall extend not less than 6 inches (152 mm) up the stem wall and shall be attached and sealed to the stem wall or insulation.
2. One of the following is provided for the under-floor space:
2.1.Continuously operated mechanical exhaust ventilation at a rate equal to 1 cubic foot per minute (0.47 L/s) for each 50 square feet (4.7 m_2) of crawl space floor area, including an air pathway to the common area (such as a duct or transfer grille), and perimeter walls insulated in accordance with Section N1102.2.11 of this code.
2.2. Conditioned air supply sized to deliver at a rate equal to 1 cubic foot per minute (0.47 L/s) for each 50 square feet (4.7 m_2) of under-floor area, including a return air pathway to the common area (such as a duct or transfer grille), and perimeter walls insulated in accordance with Section N1102.2.11 of this code.
2.3. Plenum in existing structures complying with Section M1601.5, if under-floor space is used as a plenum.
<u>2.4. Dehumidification sized to provide 70 pints (33 liters) of moisture removal per day for every 1,000 ft2 (93 m_2) of crawl space floor area.</u>

S7657

Date Submitted	12/3/2018	**Section**	502.6	**Proponent**	Ann Russo8
Chapter	5	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

RB192-16

Summary of Modification

This change provides better organization of this section for current construction techniques and improves the organization and the terminology.

Rationale

This change provides better organization of this section for current construction techniques and improves the organization and the terminology.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Editorial clarification and reorganization of the section only.

Impact to building and property owners relative to cost of compliance with code

Editorial clarification and reorganization of the section only. Will not increase construction cost.

Impact to industry relative to the cost of compliance with code

Editorial clarification and reorganization of the section only. Will not increase construction cost.

Impact to small business relative to the cost of compliance with code

Editorial clarification and reorganization of the section only. Will not increase construction cost.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Editorial clarification and reorganization of the section only. Will make code interpretation and enforcement easier without increase in cost of construction.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Editorial clarification and reorganization of the section only. Should make code interpretation and enforcement easier.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Editorial clarification and reorganization of the section only. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not degrade the effectiveness of the code

Editorial clarification and reorganization of the section only. Does not degrade the effectiveness of the code

Revise as follows:

R502.6 Bearing. The ends of each joist, beam or girder shall have not less than $1^1/_2$ inches (38 mm) of bearing on wood or metal and not less than 3 inches (76 mm) on masonry or concrete or be supported by approved joist hangers. Alternatively, the ends of joists shall be supported on a 1-inch by 4-inch (25 mm by 102 mm) ribbon strip and shall be nailed to the adjacent stud ~~or fastened by means of approved joist hangers. Alternatively, the ends of beams and girders shall be supported on approved connectors.~~ The bearing on masonry or concrete shall be direct, or a sill plate of 2-inch-minimum (51 mm) nominal thickness shall be provided under the joist, beam or girder. The sill plate shall provide a minimum nominal bearing area of 48 square inches (30 865 square mm).

S7661

Date Submitted	12/3/2018	**Section**	507.4	**Proponent**	Ann Russo8
Chapter	5	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No **Alternate Language** No

Related Modifications

RB209-16 and RB198-16

Summary of Modification

This code change modifies the decking text approved by the commission in October under change RB198 to permit custom decking materials and custom fasteners.

Rationale

This code change modifies the decking text approved by the commission in October under change RB198 to permit custom decking materials and custom fasteners.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Editorial change to allow additional options for decking only. No impact on code enforcement.

Impact to building and property owners relative to cost of compliance with code

Editorial change to allow additional options for decking only. No added cost to comply with the code.

Impact to industry relative to the cost of compliance with code

Editorial change to allow additional options for decking only. Does not increase the cost of construction.

Impact to small business relative to the cost of compliance with code

Editorial change to allow additional options for decking only. Does not increase the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Editorial change to allow additional options for decking only.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Editorial change to allow additional options for decking only. No effect on the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Editorial change to allow additional options for decking only. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

Editorial change to allow additional options for decking only. Does not degrade the effectiveness of the code.

Revise as follows:

SECTION R507
EXTERIOR DECKS

- **~~R507.4~~ R507.7 Decking. Maximum allowable spacing for joists supporting decking shall be in accordance with Table ~~R507.4~~R507.7. Wood decking shall be attached to each supporting member with not less than (2) 8d threaded nails or (2) No. 8 wood screws. Other types of decking or fastener systems shall be permitted in accordance with manufacturer's installation requirements.**

S7856

Date Submitted 12/12/2018
Chapter 5
Section 505
Affects HVHZ No
Proponent Bonnie Manley
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

7857, 7858, 7989, 7991

Summary of Modification

Deletes Section R505 and replaces it with a reference to AISI S230 in accordance with Section R301.2.1.1.

Rationale

In Florida, Section R301.2.1.1 of the residential code exempts the prescriptive provisions for cold-formed steel light frame construction in Section R505. Rather than continue to maintain the prescriptive provisions of Section R505, which aren't used anywhere in the state, we recommend deleting the provisions in favor of a direct reference to AISI S230, as is currently contained in Section R301.2.1.1. Similar modifications will be recommended for Section R603 and Section R804.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

Delete Section R505, Cold-Formed Steel Floor Framing, in its entirety and replace with the following:

SECTION R505 COLD-FORMED STEEL FLOOR FRAMING

R505.1 General. In accordance with Section R301.2.1.1, the design of cold-formed steel floor framing shall be in accordance with AISI S230, *Standard for Cold-Formed Steel Framing— Prescriptive Method For One- and Two-Family Dwellings.*

S7948

Date Submitted	12/12/2018	**Section**	502.1.3	**Proponent**	Borjen Yeh
Chapter	5	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** | **Alternate Language** **No**

Related Modifications

Summary of Modification

Add ANSI 117 to R502.1.3 for structural glued laminated timber.

Rationale

This proposal updates the references standard for ANSI A190.1 for structural glued laminated timber (glulam). ANSI/AITC A190.1 is now designed as ANSI A190.1. It also adds ANSI 117 to the code because the glulam layup combinations and laminating lumber grading requirements are included in ANSI 117.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal updated the referenced standards for glulam.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

R502.1.3 Structural glued laminated timbers.

Glued laminated timbers shall be manufactured and identified as required in ANSI/~~AITC~~ A190.1, ANSI 117 and ASTM D3737.

S8147

Date Submitted	12/14/2018	**Section**	502.2	**Proponent**	T Stafford
Chapter	5	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

This proposal is intended to clarify the limits for using the prescriptive (non-high) wind criteria that's been carried forward in the FBCR from the IRC.

Rationale

This proposal is intended to clarify the applicability of the prescriptive criteria in the FBCR for wood, masonry, concrete and steel buildings. Since the first edition, the FBCR has limited the use of the prescriptive criteria that has been carried forward from the IRC. With the adoption of ASCE 7-10 in the 2010 FBCR, the prescriptive provisions have not been permitted to be used in any area of Florida. Recent editions of the FBCR have simply deleted this criteria. During the last cycle, language was added to specifically address the limits but was not as comprehensive as in previous editions. This proposal simply provides additional clarification.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with the code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to cost of compliance with the code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to cost of compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal clarifies requirements for wind design of buildings within the scope of the FBCR.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code by clarifying the wind design requirements of buildings within the scope of the FBCR.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Revise as follows:

R502.2 Design and construction. Where the ultimate design wind speed, V_{ult}, equals or exceeds 115 mph, floors shall be designed in accordance with Section R301.2.1.1 or ANSI AWC NDS. Where ultimate design wind speed, V_{ult}, is less than 115 mphFfloors shall be designed and constructed in accordance with the provisions of this chapter, Figure R502.2 and Sections R317 and R318 or in accordance with ANSI AWC NDS.

Revise as follows:

R503.1 Design and construction. Where the ultimate design wind speed, V_{ult}, equals or exceeds 115 mph, floors sheathing shall be in accordance with Section R301.2.1.1 or ANSI AWC NDS. Where ultimate design wind speed, V_{ult}, is less than 115 mphfloors shall be in accordance with the provisions of this section.

R503.1.1 Lumber sheathing. Maximum allowable spans for lumber used as floor sheathing shall conform to Tables R503.1, R503.2.1.1(1) and R503.2.1.1(2)

R503.1.21 End joints. End joints in lumber used as subflooring shall occur over supports unless end-matched lumber is used, in which case each piece shall bear on not less than two joists. Subflooring shall be permitted to be omitted where joist spacing does not exceed 16 inches (406 mm) and a 1-inch (25 mm) nominal tongue-and-groove wood strip flooring is applied perpendicular to the joists.

Revise as follows:

R506.1 General. Concrete slab-on-ground floors shall be designed and constructed in accordance with the provisions of ACI 332 and this section. Floors shall be a minimum 3 ½ inches (89 mm) thick (for expansive soils, see Section R403.1.8). The specified compressive strength of concrete shall be as set forth in Section R402.2. Footings for concrete slab-on-grade floors shall be in accordance with Chapter 4.

Date Submitted	11/24/2018	**Section**	606.2.3	**Proponent**	Joseph Crum
Chapter	6	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

S243-16 PART II FBCR
S243-16 PART I FBCB

Summary of Modification

Update standards for definition.

Rationale

The definition is not needed and is incorrect. ASTM C1386 was withdrawn n by ASTM in 2013, and AAC is now manufactured to different ASTM standards (ASTM C1691 for AAC masonry and ASTM C1693 for AAC in general). In addition, IBC Section 202 already contains a definition for AAC Masonry, which is both more appropriate and correct. While this definition could apply AAC as used in conjunction with Chapter 19, that Chapter does not address AAC. Deleting the definition of Autoclaved Aerated Concrete thus removes the reference to an ASTM standard no longer used, and it cleans up the FBC as a whole.
Part II updates references to it in the FBCR.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Clean up and standard update only, no impact.

Impact to building and property owners relative to cost of compliance with code

Clean up and standard update only. Revision of this section does not impact the cost of construction.

Impact to industry relative to the cost of compliance with code

Clean up and standard update only. Revision of this section does not impact the cost of construction.

Impact to small business relative to the cost of compliance with code

Clean up and standard update only. Revision of this section does not impact the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Clean up and standard update only. No impact.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Clean up and standard update only. No impact.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Clean up and standard update only. No impact.

Does not degrade the effectiveness of the code

Clean up and standard update only. No impact.

Revise as follows:

R606.2.3 AAC masonry. AAC masonry units shall conform to ASTM C1691 and ASTM ~~C 1386~~ C1693 for the strength class specified.

Reference standards type: This contains both new and updated standards

Add new standard(s) as follows:

~~**ASTM C1386**~~

ASTM C1691- 11 Standard Specification for Unreinforced Autoclaved Aerated Concrete (AAC) Masonry Units

ASTM C1693-11 Standard Specification for Autoclaved Aerated Concrete (AAC)

S7482

Date Submitted	11/27/2018	**Section**	602	**Proponent**	Scott McAdam
Chapter	6	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No   **Alternate Language** No

Related Modifications

RB 230-16

Summary of Modification

move requirements for construction of braced wall panels in R602.10.10 and move it to the section on construction methods for braced wall panels in R602.10.4, and move an existing bracing amount correction from R602.10.10 (exception #3) into the Adjustment Factor Tables, R602.10.3(2) for wind

Rationale

WHAT: This code change proposal is intended to move requirements for construction of braced wall panels in R602.10.10 and move it to the section on construction methods for braced wall panels in R602.10.4, and move an existing bracing amount correction from R602.10.10 (exception #3) into the Adjustment Factor Tables, R602.10.3(2) for wind and R602.10.3(4) for seismic.

WHY: Several members of the past ICC Ad Hoc Wall Bracing committee discussed this issue and agreed that the existing language is confusing and that it made sense to move this this correction factor into the tables with all of the other adjustment factors.

Currently this adjustment factor for horizontal blocking is virtually lost because it is near the end of the wall bracing section. While discussing the issue, it became apparent to the members that there were some wrong materials listed in R602.10.10. Revisions of the panels that are permitted to omit horizontal blocking is based on the shear wall provisions of the AWC Special Design Provisions for Wind and Seismic (2015 SDPWS). That document is the code-referenced standard for design of shearwalls, and it permits unblocked WSP shearwalls only if the capacity is reduced by half. For SFB and PB shear walls, all panel edges are required to be blocked. Data was submitted to the ICC Ad Hoc Wall Bracing Committee regarding no reduction for horizontal gypsum board. Since SFB, vertical GB and HPS are not permitted to be unblocked, they were eliminated from the table.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will not increase the cost of construction. Under the 2015 IRC, it is possible that if the bracing amount is doubled, then blocking could be omitted for SFB, vertical GB, or HPS. But the cost of the blocking is far less than the cost of doubling the bracing amount

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction. Under the 2015 IRC, it is possible that if the bracing amount is doubled, then blocking could be omitted for SFB, vertical GB, or HPS. But the cost of the blocking is far less than the cost of doubling the bracing amount

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction. Under the 2015 IRC, it is possible that if the bracing amount is doubled, then blocking could be omitted for SFB, vertical GB, or HPS. But the cost of the blocking is far less than the cost of doubling the bracing amount

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction. Under the 2015 IRC, it is possible that if the bracing amount is doubled, then blocking could be omitted for SFB, vertical GB, or HPS. But the cost of the blocking is far less than the cost of doubling the bracing amount

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

moves sections and clarifies section, wall bracing

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

moves sections and clarifies section, wall bracing

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

moves sections and clarifies section, wall bracing

Does not degrade the effectiveness of the code

moves sections and clarifies section, wall bracing

Revise as follow:

TABLE R602.10.3 (2)

WIND ADJUSTMENT FACTORS TO THE REQUIRED LENGTH OF WALL BRACING

ITEM NUMBER	ADJUSTMENT BASED ON	STORY/SUPPORTING	CONDITION	ADJUSTMENT FACTOR[a, b] [multiply length from Table R602.10.3(1) by this factor]	APPLICABLE METHODS
1	Exposure category	One-story structure	B	1.00	All methods
			C	1.20	
			D	1.50	
		Two-story structure	B	1.00	
			C	1.30	
			D	1.60	
		Three-story structure	B	1.00	
			C	1.40	
			D	1.70	
2	Roof eave-to-ridge height	Roof only	= 5 feet	0.70	
			10 feet	1.00	
			15 feet	1.30	
			20 feet	1.60	
		Roof + 1 floor	= 5 feet	0.85	
			10 feet	1.00	
			15 feet	1.15	
			20 feet	1.30	
		Roof + 2 floors	= 5 feet	0.90	
			10 feet	1.00	
			15 feet	1.10	
			20 feet	Not permitted	
3	Wall height adjustment	Any story	8 feet	0.90	
			9 feet	0.95	
			10 feet	1.00	
			11 feet	1.05	
			12 feet	1.10	
4	Number of braced wall lines (per plan	Any story	2	1.00	
			3	1.30	
			4	1.45	

	direction)[c]		= 5	1.60	
5	Additional 800-pound hold-down device	Top story only	Fastened to the end studs of each braced wall panel and to the foundation or framing below	0.80	DWB, WSP, SFB, PBS, PCP, HPS
6	Interior gypsum board finish (or equivalent)	Any story	Omitted from inside face of braced wall panels	1.40	DWB, WSP, SFB, PBS, PCP, HPS, CS- WSP, CS-G, CS-SFB
7	Gypsum board fastening	Any story	4 inches o.c. at panel edges, including top and bottom plates, and all horizontal joints blocked	0.7	GB
8	Horizontal blocking	Any story	Horizontal blocking is omitted,	2.0	WSP, CS-WSP

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.48 N.

a. Linear interpolation shall be permitted.

b. The total adjustment factor is the product of all applicable adjustment factors.

c. The adjustment factor is permitted to be 1.0 when determining bracing amounts for intermediate braced wall lines provided the bracing amounts on adjacent braced wall lines are based on a spacing and number that neglects the intermediate braced wall line.

~~R602.10.10~~ R602.10.4.4 **Panel joints.** Vertical joints of panel sheathing shall occur over, and be fastened to, common studs. Horizontal joints of panel sheathing in *braced wall panels* shall occur over, and be fastened to, common blocking of a minimum 1 1/2 inch (38 mm) thickness.

Exceptions:

~~**1. Vertical joints of panel sheathing shall be permitted to occur over double studs, where adjoining panel edges are attached to separate studs with the required panel edge fastening schedule, and the adjacent studs are attached together with two rows of 10d box nails [3 inches by 0.128 inch (76.2 mm by 3.25 mm)] at 10 inches o.c. (254 mm). For methods WSP and CS-WSP, blocking of horizontal joints is permitted to be omitted when adjustment factor number 8 of Table R602.10.3(2) or number 9 of Table R602.3(4) isapplied.**~~

~~2. Blocking at horizontal joints shall not be required in wall segments that are not counted as *braced wall panels*.~~

~~3. Where the bracing length provided is not less than twice the minimum length required by Tables R602.10.3(1) and R602.10.3(3), blocking at horizontal joints shall not be required in *braced wall panels* constructed using Methods WSP, SFB, GB, PBS or HPS.~~
~~4. Where Method GB panels are installed horizontally, blocking of horizontal joints is not required.~~

1. For methods WSP and CS-WSP, blocking of horizontal joints is permitted to be omitted when adjustment factor number 8 of Table R602.10.3(2) or number 9 of Table R602.3(4) is applied.
2. Vertical joints of panel sheathing shall be permitted to occur over double studs, where adjoining panel edges are attached to separate studs with the required panel edge fastening schedule, and the adjacent studs are attached together with two rows of 10d box nails [3 inches by 0.128 inch (76.2 mm by 3.25 mm)] at 10 inches o.c. (254mm).
3. Blocking at horizontal joints shall not be required in wall segments that are not counted as *braced wall panels.*
4. Where Method GB panels are installed horizontally, blocking of horizontal joints is not required.

S7484

Date Submitted	11/27/2018	Section	602	Proponent	Scott McAdam
Chapter	6	Affects HVHZ	No	Attachments	No

TAC Recommendation	Pending Review
Commission Action	Pending Review

Comments

General Comments	No	Alternate Language	No

Related Modifications

RB 231-16

Summary of Modification

ICC staff requested an unofficial interpretation from the past ICC Ad Hoc Wall Bracing Committee regarding how the adjustment factor for Exposure Category applied. The new footnote has been vetted by several of the past members and is being submitted to clarify the intent.

Rationale

ICC staff requested an unofficial interpretation from the past ICC Ad Hoc Wall Bracing Committee regarding how the adjustment factor for Exposure Category applied. The new footnote has been vetted by several of the past members and is being submitted to clarify the intent.

Concurrently, icons have been added to further clarify the intention of both the exposure category and the eave-to-ridge height.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

no impact clarification footnote

Impact to building and property owners relative to cost of compliance with code

no impact clarification footnote

Impact to industry relative to the cost of compliance with code

no impact clarification footnote

Impact to small business relative to the cost of compliance with code

no impact clarification footnote

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

clarification footnote

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

clarification footnote

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

clarification footnote

Does not degrade the effectiveness of the code

clarification footnote

Revise as follows:

TABLE R602.10.3(2)

WIND ADJUSTMENT FACTORS TO THE REQUIRED LENGTH OF WALL BRACING

ITEM NUMBER	ADJUSTMENT BASED ON	STORY/SUPPORTING	CONDITION	ADJUSTMENT FACTOR[a, b] [multiply length from Table R602.10.3(1) by this factor]	APPLICABLE METHODS
1	Exposure category [d]	One-story structure	B	1.00	
			C	1.20	
			D	1.50	
		Two-story structure	B	1.00	
			C	1.30	
			D	1.60	
		Three-story structure	B	1.00	
			C	1.40	
			D	1.70	
2	Roof eave-to-ridge height	Roof only	= 5 feet	0.70	All methods
			10 feet	1.00	
			15 feet	1.30	
			20 feet	1.60	
		Roof + 1 floor	= 5 feet	0.85	
			10 feet	1.00	
			15 feet	1.15	
			20 feet	1.30	
		Roof + 2 floors	= 5 feet	0.90	
			10 feet	1.00	

			15 feet	1.10	
			20 feet	Not permitted	
			8 feet	0.90	
			9 feet	0.95	
			10 feet	1.00	
			11 feet	1.05	
3	Wall height adjustment	Any story	12 feet	1.10	
			2	1.00	
			3	1.30	
			4	1.45	
4	Number of braced wall lines (per plan direction)[c]	Any story	= 5	1.60	
5	Additional 800-pound hold-down device	Top story only	Fastened to the end studs of each braced wall panel and to the foundation or framing below	0.80	DWB, WSP, SFB, PBS, PCP, HPS
6	Interior gypsum board finish (or equivalent)	Any story	Omitted from inside face of braced wall panels	1.40	DWB, WSP, SFB, PBS, PCP, HPS, CS- WSP, CS-G, CS-SFB
7	Gypsum board fastening	Any story	4 inches o.c. at panel edges, including top and bottom plates, and all horizontal joints blocked	0.7	GB

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.48 N.

a. Linear interpolation shall bepermitted.

The total adjustment factor is the product of all applicable adjustment factors.

The adjustment factor is permitted to be 1.0 when determining bracing amounts for intermediate braced wall lines provided the bracing amounts on adjacent braced wall lines are based on a spacing and number thatneglects the intermediate braced wall line.

The same adjustment factor shall be applied to all braced wall lines on all floors of the structure, based on worst case exposurecategory.

S7727

Date Submitted 12/6/2018
Chapter 6
Section 609
Affects HVHZ No
Proponent Borrone Jeanette
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

Add new definition: Impact Protective System

Summary of Modification

Add new definition: Impact Protective System and Revise Wind-borne debris protection and Fenestration testing and labeling

Rationale

This proposal is one of several that are addressing labeling of critical components of the building envelope. The primary purpose of this code change is to require that impact protective systems (hurricane shutters) have a permanent label that provides a way for building owners, homeowners, and others to be able to determine their performance characteristics after the building has been occupied. The 2015 IRC does not require any type of label for impact protective systems. For products that don't have permanent labels, it becomes nearly impossible for the owner to determine the structural wind load resistance and impact resistance of the products after they've occupied the building. This proposal would simply require some type of permanent marking on the impact protective system indicating the manufacturer and model/series number, and performance characteristics so that the specific performance characteristics could be retrieved at a later date. The permanent label would only need to provide traceability to the product. However, it could provide all the required information. If the relevant information is not provided on a permanent label, a temporary removable label is required to be applied so that local code officials can verify that the appropriate impact protective system was provided.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will not impact local entity

Impact to building and property owners relative to cost of compliance with code

Will result in an increase in cost. a. Water Resistant Self-adhering Permanent Labels approximately $0.15 per label. b. Embossed or ink jet labels used on metal and plastic panels would cost approximately $0.05 per label

Impact to industry relative to the cost of compliance with code

Will result in an increase in cost. a. Water Resistant Self-adhering Permanent Labels approximately $0.15 per label. b. Embossed or ink jet labels used on metal and plastic panels would cost approximately $0.05 per label

Impact to small business relative to the cost of compliance with code

Will result in an increase in cost. a. Water Resistant Self-adhering Permanent Labels approximately $0.15 per label. b. Embossed or ink jet labels used on metal and plastic panels would cost approximately $0.05 per label

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by requiring that impact protective systems have a permanent label that provides a way for building owners, homeowners, and others to be able to determine their performance characteristics after the building has been occupied.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by requiring that impact protective systems have a permanent label that provides a way for building owners, homeowners, and others to be able to determine their performance characteristics after the building has been occupied.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials, products, methods, or systems of construction it helps future building owners, inspectors, and contractors.

Does not degrade the effectiveness of the code

Does not discriminate against materials, products, methods, or systems of construction

Add new definition to Section 202 as follows:

Impact Protective System Construction:

Impact Protective System Construction that has been shown by testing to withstand the impact of test missiles and that is applied, attached, or locked over exterior glazing.

Revise as follows:

R609.6 Wind-borne debris protection. Protection of exterior ~~glazed openings~~ windows and, glass doors, and doors with glass in buildings located in wind-borne debris regions shall be in accordance with Section R301.2.1.2.

R609.6.1 Fenestration testing and labeling. Fenestration shall be tested by an approved independent laboratory, listed by an approved entity, and bear a label identifying manufacturer, performance characteristics, and approved inspection agency to indicate compliance with the requirements of the following specification(s):

ASTM E 1886 and ASTM E 1996; or

1. AAMA 506.

Add new text as follows:

R609.6.2 Impact protective systems testing and labeling Impact protective systems shall be tested for impact resistance by an approved independent laboratory for compliance with ASTM E 1886 and ASTM E 1996. Impact protective systems shall also be tested for design wind pressure by an approved independent laboratory for compliance with ASTM E 330. Required design wind pressures shall be determined in accordance with Table R301.2(2) adjusted for height and exposure in accordance with Table R301.2(3) or determined in accordance with ASCE 7. For the purposes of this section, design wind pressures determined in accordance with ASCE 7 are permitted to be multiplied by 0.6.

Impact protective systems bear a label identifying the manufacturer, performance characteristics, and approved inspection agency. Impact protective systems shall have a permanent label providing traceability to the manufacturer, product designation, and performance characteristics. The permanent label shall be acid etched, sand blasted, ceramic fired, laser etched, embossed or of a type that, once applied, cannot be removed without being destroyed.

S7731

Date Submitted	12/6/2018	**Section** 609		**Proponent**	Borrone Jeanette
Chapter	6	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

R609.2 Performance. R609.3 and R609.5

Summary of Modification

Exterior windows and doors shall be capable of resisting the design wind loads specified in Table R301.2(2) adjusted for height and exposure in accordance with Table R301.2(3) or determined in accordance with ASCE 7

Rationale

This proposal is intended to clarify that the use of the 0.6 conversion multiplier is allowed with respect to the determination of design wind pressures in accordance with ASCE 7 and testing of the respective assemblies in accordance with Section R609.3 or R609.5 accordingly. While that is what the existing provision allows, as currently written, that is not entirely clear and has led to confusion regarding wind load requirements. This proposed amendment expressly states that the use of 0.6 multiplier is allowed and will alleviate the confusion that currently exists benefiting all – code officials, manufacturers and builders.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will not impact local entity

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction This is a clarification. No substantive change.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction This is a clarification. No substantive change.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction This is a clarification. No substantive change.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by clarifying that the use of the 0.6 conversion multiplier is allowed

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by clarifying that the use of the 0.6 conversion multiplier is allowed

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials, products, methods, or systems of construction clarifying that the use of the 0.6 conversion multiplier is allowed

Does not degrade the effectiveness of the code

Increases the effectiveness of the code by clarifying that the use of the 0.6 conversion multiplier is allowed

R609.2 Performance. Exterior windows and doors shall be ~~designed to resist~~<u>capable of resisting</u> the design wind loads specified in Table R301.2(2) adjusted for height and exposure in accordance with Table R301.2(3) or determined in accordance with ASCE 7 ~~using the allowable stress~~. <u>For exterior windows and doors tested in accordance with Sections R609.3 and R609.5, required</u> design ~~loadcombinationsof~~ wind pressures determined from ASCE 7 <u>are permitted to be multiplied by 0.6.</u> Design wind loads for exterior glazing not part of a labeled assembly shall be permitted to be determined in accordance with Chapter 24 of the *Florida Building Code, Building*.

S7780

Date Submitted	12/8/2018	**Section**	602.1	**Proponent**	Borjen Yeh
Chapter	6	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No **Alternate Language** No

Related Modifications

Summary of Modification

Add the reference to ANSI/APA PRS 610.1 for structural insulated panels.

Rationale

This proposal sets the basis of structural insulated panels (SIPs) that are prescribed in Section R610. ANSI/APA PRS 610.1 is available for free download at https://www.apawood.org/publication-search?q=PRS+610.1&tid=1. A copy of the standard has been provided to Structural TAC and staff by email.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal provides a national consensus standard for the health, safety, and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

R602.1.11 Structural insulated panels. Structural insulated panels shall be manufactured and identified in accordance with ANSI/APA PRS 610.1.

Date Submitted	12/9/2018	**Section** 610		**Proponent**	Borjen Yeh
Chapter	6	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Re-organize and clarify the structural insulated panel section (R610) of the code.

Rationale

The proposal is a minor reorganization and clarification of the Structural Insulated Panels (SIPs) section. The intention is to add clarity to the proposal as it is currently written. Since the inclusion of SIPs in the FBC, there have been several changes that have revised the SIP requirements. Proposed changes are intended to bring the SIP provisions more in line with the other sections of the code. In addition, ANSI/APA PRS 610.1, Standard for Performance-Rated Structural Insulated Panels in Wall Applications, a consensus-based document is proposed for addition to the FBC-Residential. As a result, much of the detailed information currently in the FBC-R with respect to SIP core, facers and adhesive requirements may now be taken out of the code. Specifically,

1) R610.3.1 to R610.3.3 – Removes SIP core, facer, and adhesive requirements and references ANSI/APA PRS 610.1.
2) R610.3.4 - Adds thermal barrier requirements consistent with R316.4.
3) R610.4.1 – Delete as it has been specified in ANSI/APA PRS 610.1.
4) R610.5.3 and R610.5.4 - Re-organization. No technical changes made.
5) R610.5.5 – Added a reference to the bracing method.
6) R610.8 – Renumber. No technical changes.
7) Table R610.8 – Add additional footnotes to simplify the table. Corrected deflection criteria.
8) Fig R610.5(1) and (2) – Added a reference
9) Fig R610.5(3) and (4) – Clarification.
10) Fig R610.5(5) – Title of the figure changed to more accurately reflect the figure.
11) Fig R610.5.1 – Footnote 4 was removed as it is a duplicate of the requirements in the text.
12) Figs R610.5.2, R610.5.8 and R610.5.9 – Clarification.

All figures have been redrawn and reformatted. All changes included in this proposal have been published in the 2018 IRC.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal simplifies and clarifies the code and has a reasonable and substantial connection with the health, safety, and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Mod 7781

SECTIONR610
STRUCTURAL INSULATED PANEL WALL
CONSTRUCTION

R610.1 General.
No change

R610.2 Applicability limits.
The provisions of this section shall control the construction of exterior structural insulated panel walls and interior load-bearing structural insulated panel walls for buildings not greater than 60 feet (18 288 mm) in length perpendicular to the joist or truss span, not greater than 40 feet (12 192 mm) in width parallel to the joist or truss span and not greater than two stories in height with each wall not greater than 10 feet (3048 mm) high. Exterior walls installed in accordance with the provisions of this section shall be considered as load-bearing walls. Structural insulated panel walls constructed in accordance with the provisions of this section shall be limited to sites where the ultimate design wind speed (*Vult*) is not greater than 155 miles per hour (69 m/s), Exposure B or 140 miles per hour (63 m/s) Exposure C, the ground snow load is not greater than 70 pounds per <u>sqaure </u>foot (3.35 kPa), and the seismic design category is A, B or C.

R610.3 Materials.
SIPs shall comply with the ~~following criteria~~ <u>requirements of ANSI/APA PRS 610.1</u>:

~~**R610.3.1 Core.**~~
~~The core material shall be composed of foam plastic insulation meeting one of the following requirements:~~

1. ~~1.ASTM C578 and have a minimum density of 0.90 pounds per cubic feet (14.4 kg/m3).~~
2. ~~2.Polyurethane meeting the physical properties shown in Table R610.3.1.~~
3. ~~3.An *approved* alternative.~~

~~All cores shall meet the requirements of Section R316.~~

~~**TABLE R610.3.1**~~

~~**MINIMUM PROPERTIES FOR POLYURETHANE INSULATION USED AS SIPS CORE**~~

~~**PHYSICAL PROPERTY**~~	~~**POLYURETHANE**~~
~~Density, core nominal (ASTM D1622)~~	~~2.2 lb/ft3~~
~~Compressive resistance at yield or 10% deformation, whichever occurs first (ASTM D1621)~~	~~19 psi (perpendicular to rise)~~
~~Flexural strength, min. (ASTM C203)~~	~~30 psi~~
~~Tensile strength, min. (ASTM D1623)~~	~~35 psi~~
~~Shear strength, min. (ASTM C273)~~	~~25 psi~~

~~Substrate adhesion, min. (ASTM D1623)~~	~~22 psi~~
~~Water vapor permeance of 1.00-in. thickness, max. (ASTM E96)~~	~~2.3 perm~~
~~Water absorption by total immersion, max. (ASTM C272)~~	~~4.3% (volume)~~
~~Dimensional stability (change in dimensions), max. [ASTM D2126 (7 days at 158°F/100% humidity and 7 days at -20°F)]~~	~~2%~~

~~For SI: 1 pound per cubic foot = 16.02 kg/m3, 1 pound per square inch = 6.895 kPa, °C = [(°F) - 32]1.8.~~

~~R610.3.2 Facing.~~

~~Facing materials for SIPs shall be wood structural panels conforming to DOC PS 1 or DOC PS 2, each having a minimum nominal thickness of 7/16 inch (11 mm) and shall meet the additional minimum properties specified in Table R610.3.2. Facing shall be identified by a grade mark or certificate of inspection issued by an *approved* agency.~~

~~TABLE R610.3.2~~
~~MINIMUM PROPERTIESa FOR ORIENTED STRAND BOARD FACER MATERIAL IN SIP WALLS~~

~~THICKNESS(in.)~~	~~PRODUCT~~	~~FLATWISE STIFFNESSb(lbf-in2/ft)~~		~~FLATWISE STRENGTHc(lbf-in/ft)~~		~~TENSIONc(lbf/ft)~~		~~DENSITYd(pcf)~~
		~~Along~~	~~Across~~	~~Along~~	~~Across~~	~~Along~~	~~Across~~	
~~7/16~~	~~Sheathing~~	~~55,600~~	~~16,500~~	~~1,040~~	~~460~~	~~7,450~~	~~5,800~~	~~34~~

~~For SI: 1 inch = 25.4 mm, 1 lbf-in2/ft = 9.415 × 10-6 kPa/m, 1 lbf-in/ft = 3.707 × 10-4 kN/m, 1 lbf/ft = 0.0146 N/mm, 1 pound per cubic foot = 16.018 kg/m3.~~

1. ~~a.Values listed in Table R610.3.2 are qualification test values and are not to be used for design purposes.~~
2. ~~b.Mean test value shall be in accordance with Section 7.6 of DOC PS 2.~~
3. ~~c.Characteristic test value (5th percent with 75% confidence).~~
4. ~~d.Density shall be based on oven-dry weight and oven-dry volume.~~

~~R610.3.3 Adhesive.~~

~~Adhesives used to structurally laminate the foam plastic insulation core material to the structural wood facers shall conform to ASTM D2559 or *approved* alternative specifically intended for use as an adhesive used in the lamination of structural insulated panels. Each container of adhesive shall bear a *label* with the adhesive manufacturer's name, adhesive name and type and the name of the quality assurance agency.~~

R610.3.~~4~~1 Lumber.

The minimum lumber framing material used for SIPs prescribed in this document is NLGA graded No. 2 Spruce-pine-fir. Substitution of other wood species/grades that meet or exceed the mechanical properties and specific gravity of No. 2 Spruce-pine-fir shall be permitted.

R610.3.~~5~~2 SIP screws.

Screws used for the erection of SIPs as specified in Section R610.5 shall be fabricated from steel, shall be provided by the SIP manufacturer and shall be sized to penetrate the wood member to which the assembly is being attached by not less than 1 inch (25 mm). The screws shall be corrosion resistant and have a minimum shank diameter of 0.188 inch (4.7 mm) and a minimum head diameter of 0.620 inch (15.5 mm).

R610.3.~~6~~3 Nails.

Nails specified in Section R610 shall be common or galvanized box unless otherwise stated.

R610.4 SIP wall panels.
SIPs shall comply with Figure R610.4 and shall have minimum panel thickness in accordance with Tables R610.5(1) and R610.5(2) for above-grade walls. SIPs shall be identified by grade mark or certificate of inspection issued by an *approved* agency <u>in accordance with ANSI/APA PRS 610.1</u>.

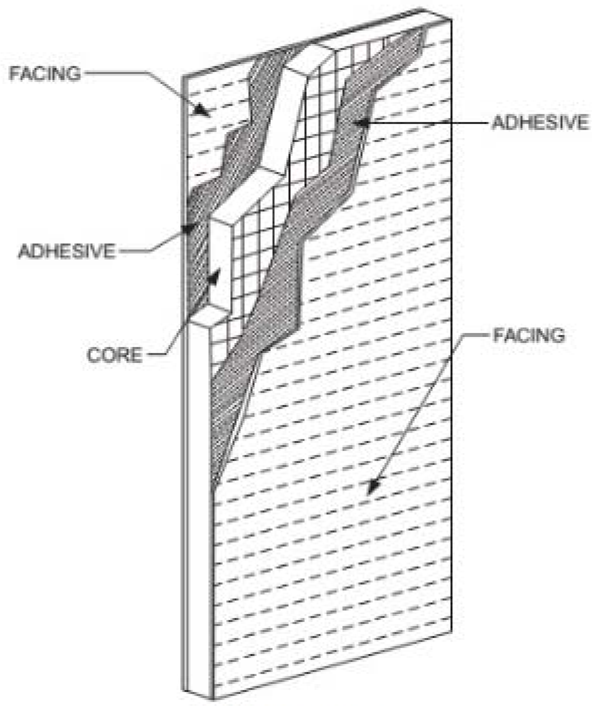


FIGURE R610.4

SIP WALL PANEL

~~**R610.4.1 Labeling.**~~
~~Panels shall be identified by grade mark or certificate of inspection issued by an *approved* agency. Each (SIP) shall bear a stamp or *label* with the following minimum information:~~

1. ~~1.Manufacturer name/logo.~~
2. ~~2.Identification of the assembly.~~
3. ~~3.Quality assurance agency.~~

R610.5 Wall construction.
Exterior walls of SIP construction shall be designed and constructed in accordance with the provisions of this section and Tables R610.5(1) and R610.5(2) and Figures R610.5(1) through R610.5(5). SIP walls shall be fastened to other wood building components in accordance with Tables R602.3(1) through R602.3(4). Framing shall be attached in accordance with Table R602.3(1) unless otherwise provided for in Section R610.

TABLE R610.5(1)

MINIMUM THICKNESS FOR SIP WALL SUPPORTING SIP OR LIGHT-FRAME ROOF ONLY (inches)[a]

ULTIMATE DESIGN WIND SPEED V_{ult} (mph)		SNOW LOAD (psf)	BUILDING WIDTH (ft)														
			24			28			32			36			40		
			Wall Height (feet)			Wall Height (feet)			Wall Height (feet)			Wall Height (feet)			Wall Height (feet)		
Exp. B	Exp. C		8	9	10	8	9	10	8	9	10	8	9	10	8	9	10
110	—	20	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		50	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		70	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	6.5
115	—	20	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		50	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5
		70	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR
130	110	20	4.5	4.5	6.5	4.5	4.5	6.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR
		30	4.5	4.5	6.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR	4.5	4.5	DR
		50	4.5	4.5	DR	4.5	4.5	DR	4.5	4.5	DR	4.5	6.5	DR	4.5	DR	DR
		70	4.5	4.5	DR	4.5	DR	DR	4.5	DR	DR	4.5	DR	DR	DR	DR	DR
140	120	20	4.5	6.5	DR	4.5	6.5	DR	4.5	DR	DR	4.5	DR	DR	4.5	DR	DR
		30	4.5	6.5	DR	4.5	DR	DR	4.5	DR	DR	4.5	DR	DR	4.5	DR	DR
		50	4.5	DR	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
		70	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 mile per hour = 0.447 m/s.

DR = design required.

a.Design assumptions:

Maximum deflection criteria: *L*/240.

Maximum roof dead load: 10 psf.

Maximum roof live load: 70 psf.

Maximum ceiling dead load: 5 psf.

Maximum ceiling live load: 20 psf.

Wind loads based on Table R301.2 (2).

Strength axis of facing material applied vertically.

TABLE R610.5(2)

MINIMUM THICKNESS FOR SIP WALL SUPPORTING SIP OR LIGHT-FRAME ONE STORY AND ROOF ONLY (inches)[a]

ULTIMATE DESIGN WIND SPEED V_{ult} (mph)		SNOW LOAD (psf)	BUILDING WIDTH (ft)														
			24			28			32			36			40		
			Wall Height (feet)			Wall Height (feet)			Wall Height (feet)			Wall Height (feet)			Wall Height (feet)		
Exp. B	Exp. C		8	9	10	8	9	10	8	9	10	8	9	10	8	9	10
110	—	20	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR
		30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	6.5	DR
		50	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	DR	DR	DR	DR	DR
		70	4.5	4.5	6.5	4.5	4.5	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR
115	—	20	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR	4.5	DR	DR
		30	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	6.5	DR	4.5	DR	DR
		50	4.5	4.5	6.5	4.5	4.5	DR	4.5	DR	DR	4.5	DR	DR	DR	DR	DR
		70	4.5	4.5	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
120	—	20	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR	4.5	DR	DR	4.5	DR	DR
		30	4.5	4.5	DR	4.5	4.5	DR	4.5	6.5	DR	4.5	DR	DR	DR	DR	DR
		50	4.5	4.5	DR	4.5	DR	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR
		70	4.5	DR	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
130	110	20	4.5	6.5	DR	4.5	DR	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR
		30	4.5	DR	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
		50	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
		70	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR

For SI: 1 Inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 mile per hour = 0.447 m/s.

DR = Design required.

a. Design assumptions:

Maximum deflection criteria: *L*/240.

Maximum roof dead load: 10 psf.

Maximum roof live load: 70 psf.

Maximum ceiling dead load: 5 psf.

Maximum ceiling live load: 20 psf.

Maximum second-floor dead load: 10 psf.

Maximum second-floor live load: 30 psf.

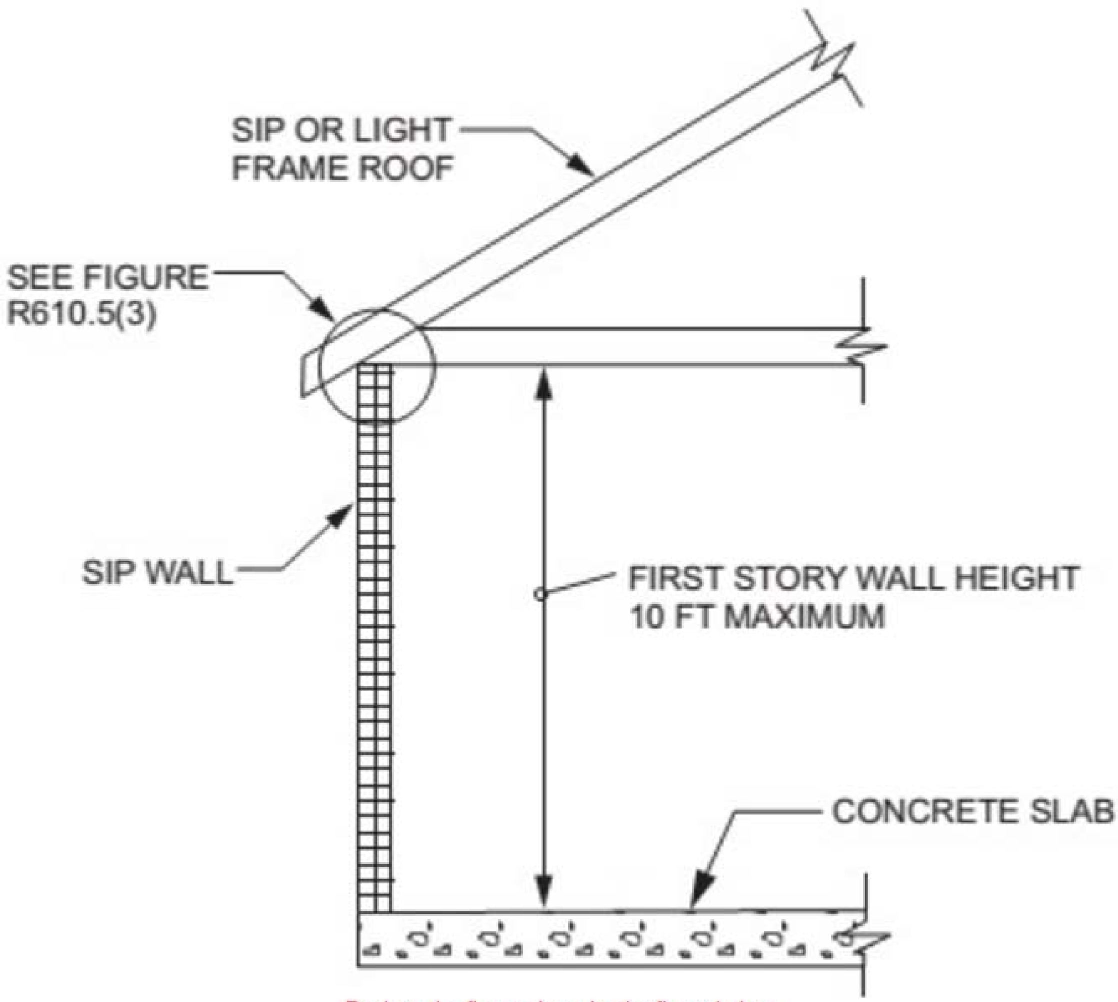
Maximum second-floor dead load from walls: 10 psf.

Maximum first-floor dead load: 10 psf.

Maximum first-floor live load: 40 psf.

Wind loads based on Table R301.2 (2).

Strength axis of facing material applied vertically.



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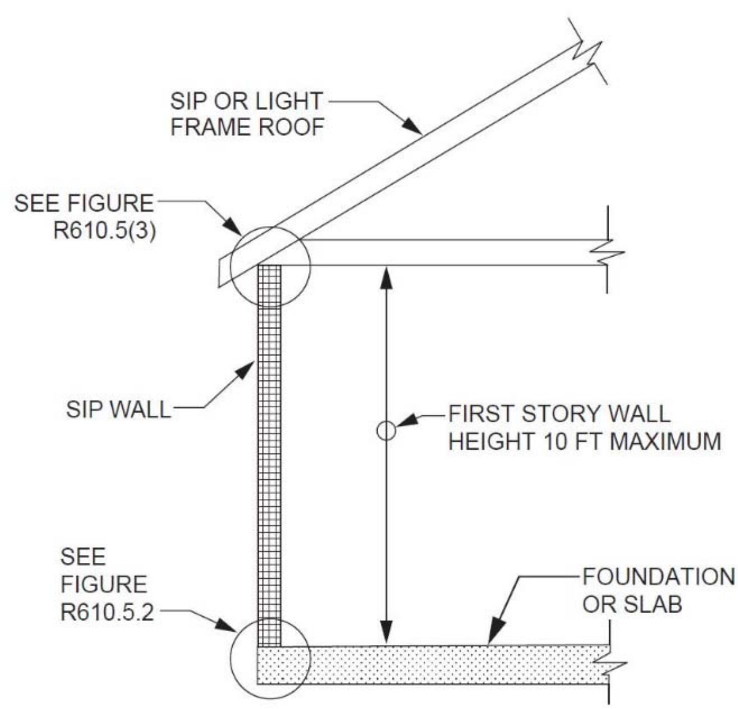
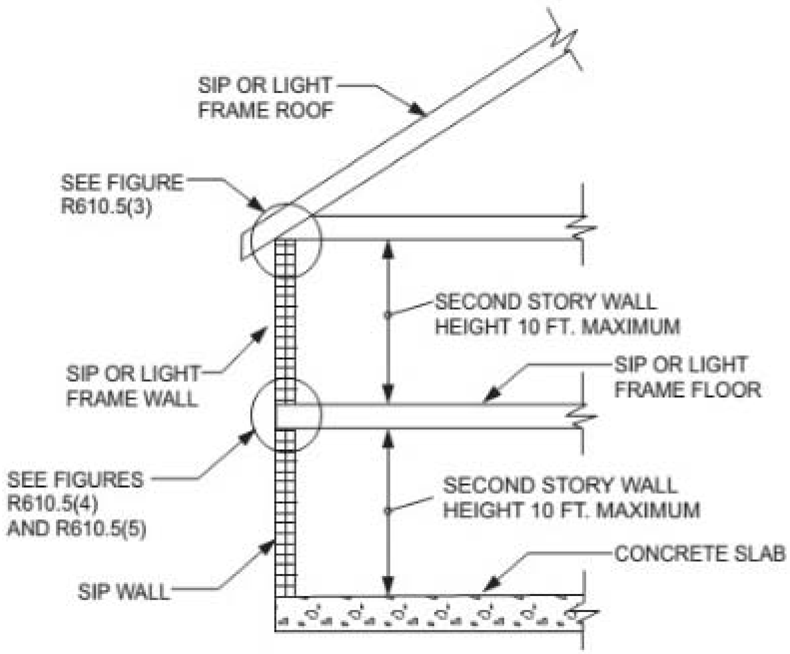


For SI: 1 foot = 304.8 mm.

Note: Figures illustrate SIP-specific attachment requirements. Other connections shall be made in accordance with Tables R602.3(1) and (2), as appropriate.

FIGURE R610.5(1)

MAXIMUM ALLOWABLE HEIGHT OF SIP WALLS



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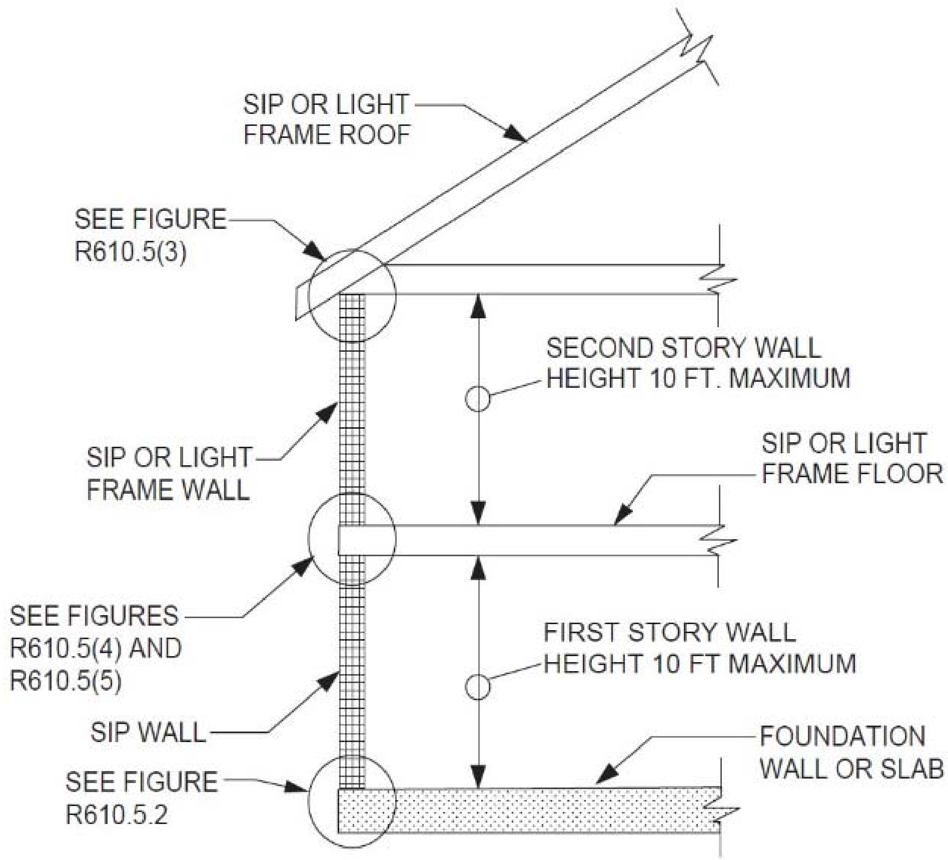
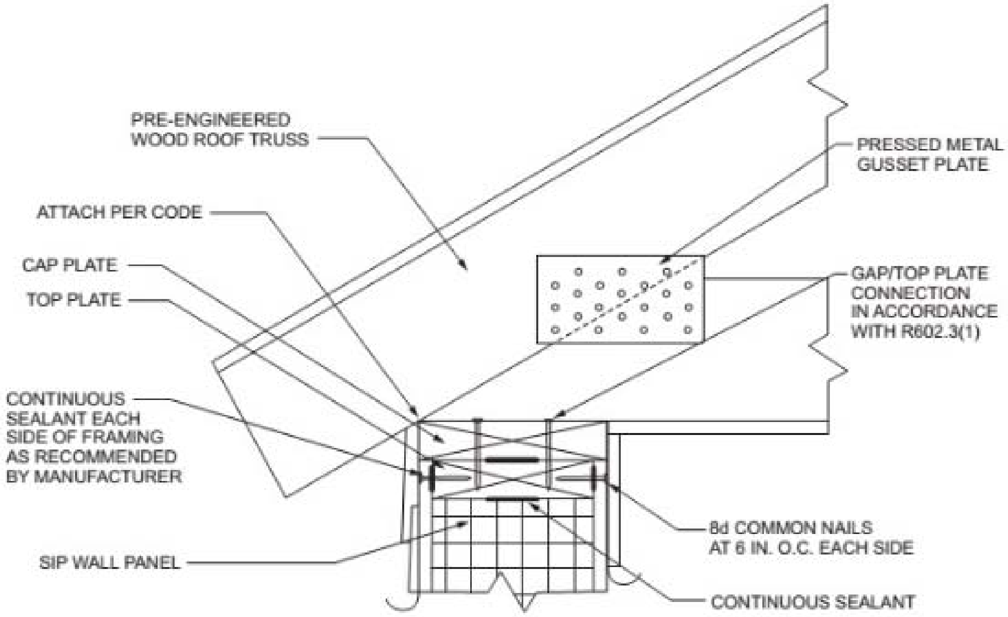


For SI: 1 inch = 25.4 mm.

Note: Figures illustrate SIP-specific attachment requirements. Other connections shall be made in accordance with Tables R602.3(1) and (2), as appropriate.

FIGURE R610.5(2)

MAXIMUM ALLOWABLE HEIGHT OF SIP WALLS



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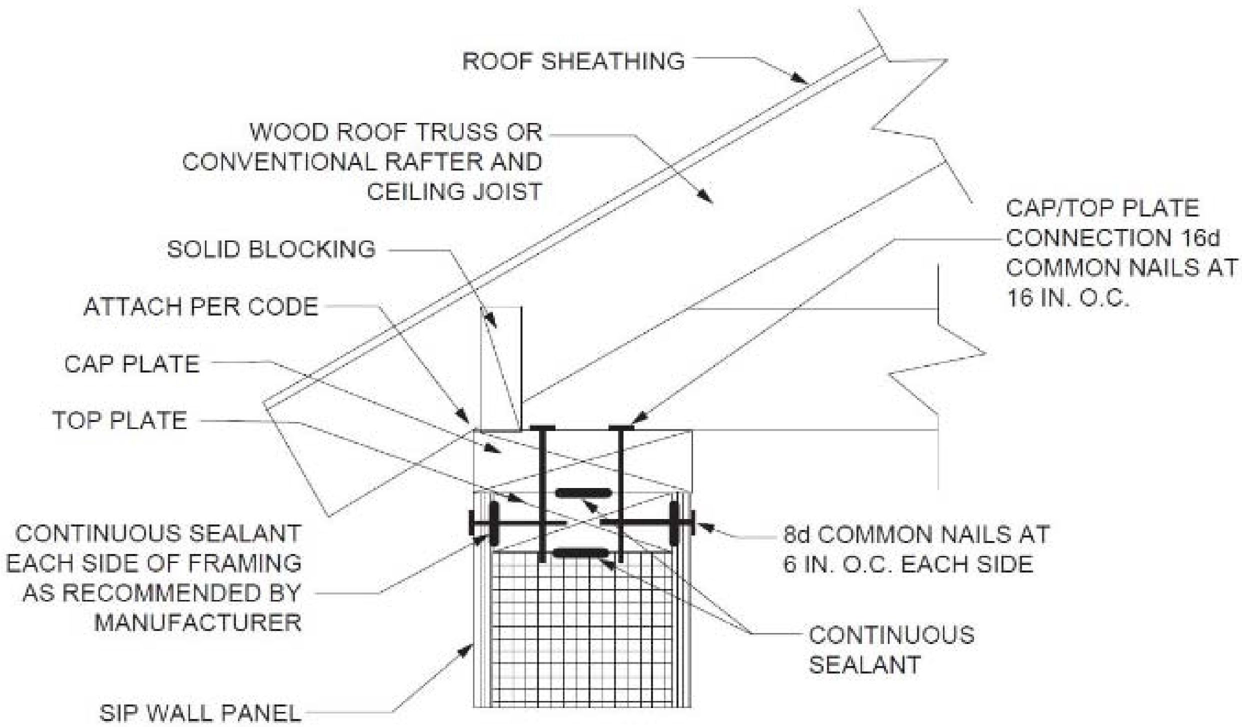
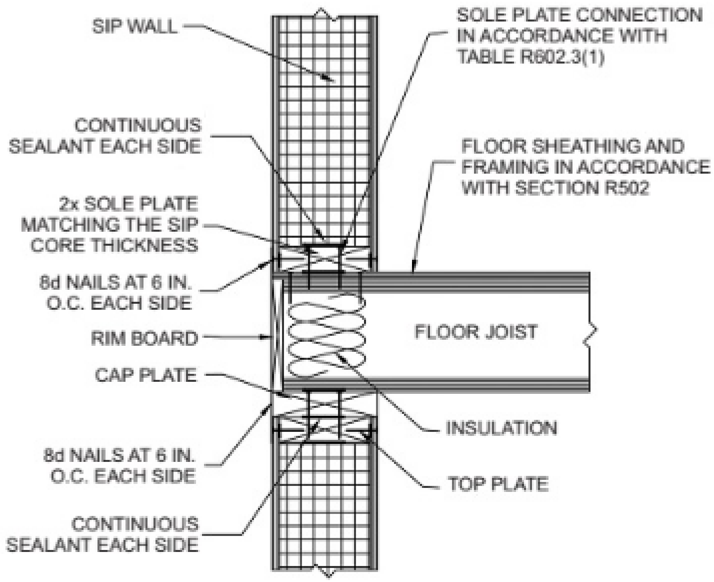


For SI: 1 inch = 25.4 mm.

Note: Figures illustrate SIP-specific attachment requirements. Other connections shall be made in accordance with Tables R602.3(1) and (2) as appropriate.

FIGURE R610.5(3)
TRUSSED ROOF TO TOP PLATE CONNECTION



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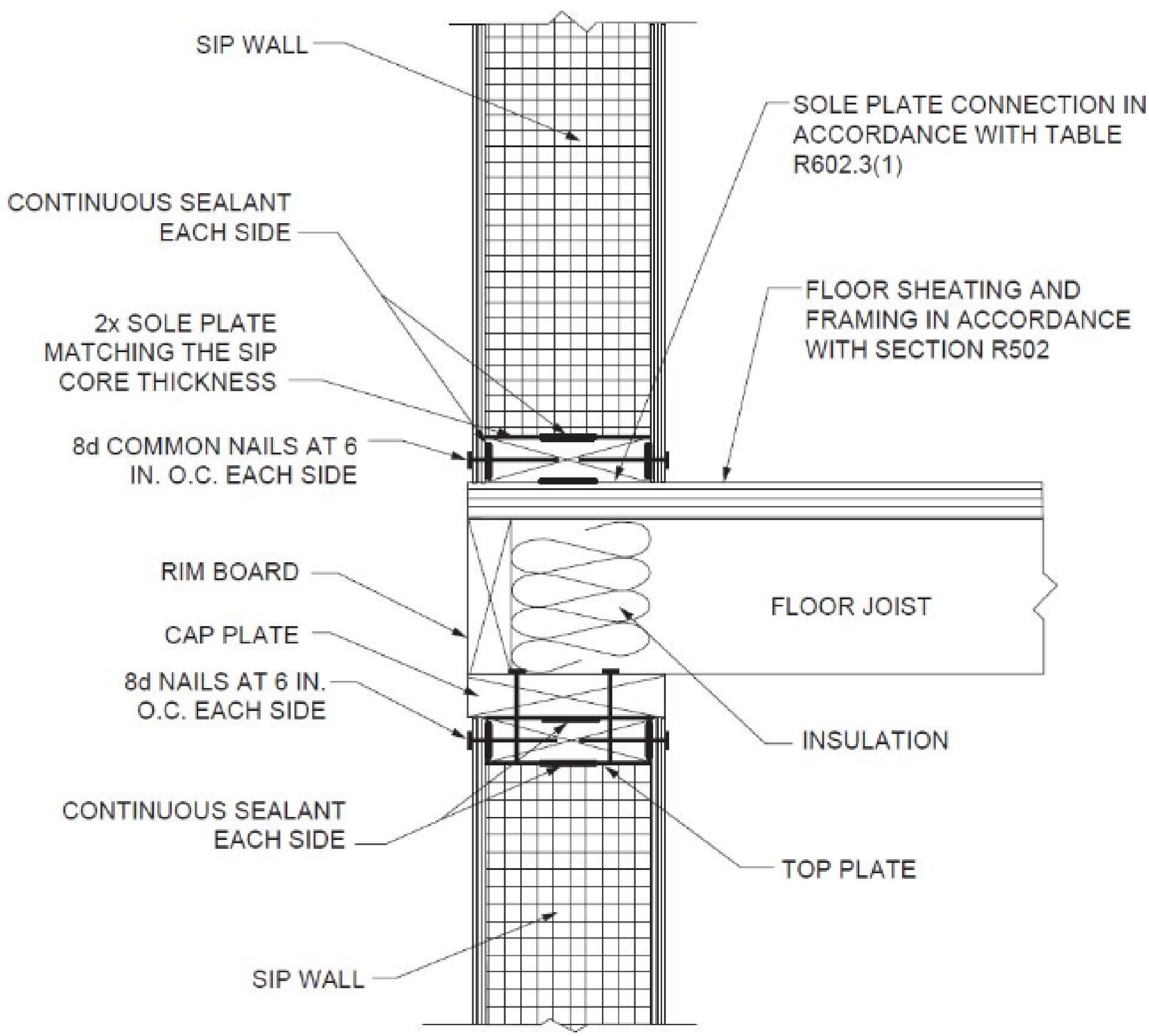
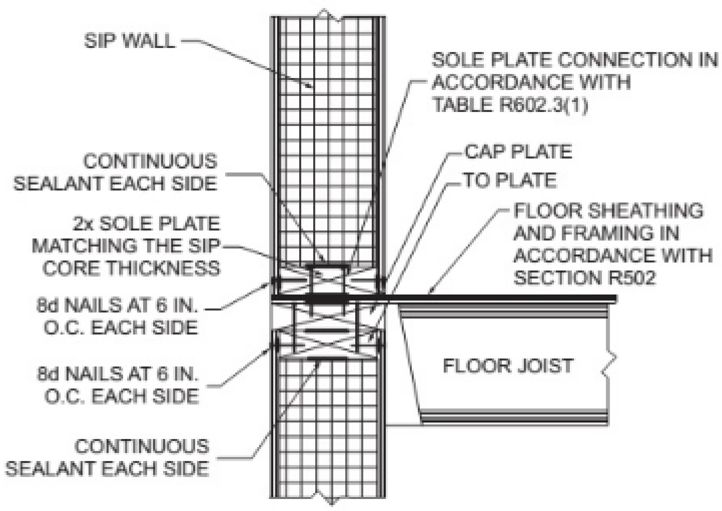


For SI: 1 inch = 25.4 mm.

Note: Figures illustrate SIP-specific attachment requirements. Other connections shall be made in accordance with Tables R602.3(1) and (2), as appropriate.

FIGURE R610.5(4)

SIP WALL-TO-WALL PLATFORM FRAME CONNECTION



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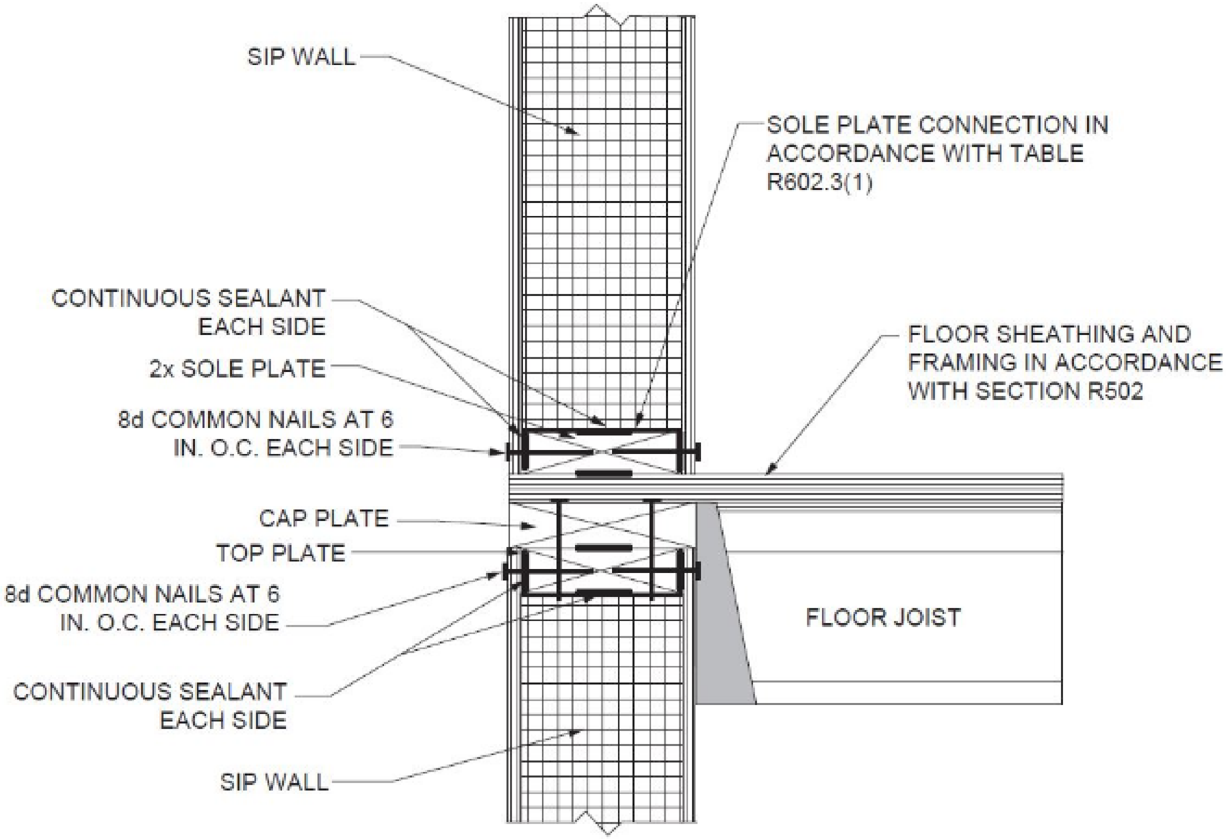
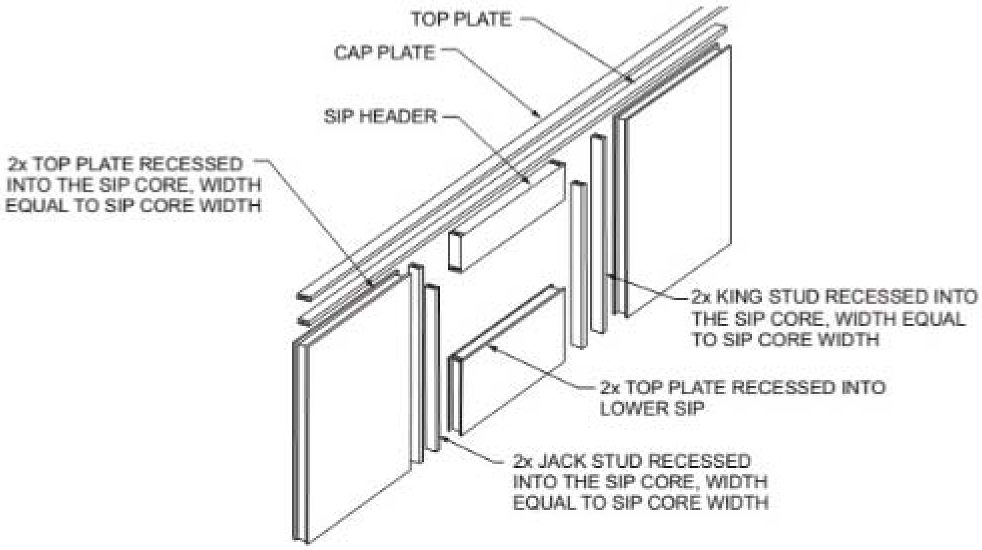


For SI: 1 inch = 25.4 mm.
Note: Figures illustrate SIP-specific attachment requirements. Other connections shall be made in accordance with Tables R602.3(1) and (2), as appropriate.

FIGURE R610.5(5)
SIP WALL-TO-WALL ~~BALLOON FRAME~~ HANGING FLOOR CONNECTION
(I-Joist floor shown for Illustration only)

R610.5.1 Top plate connection.
SIP walls shall be capped with a double top plate installed to provide overlapping at corner, intersections and splines in accordance with Figure R610.5.1. The double top plates shall be made up of a single 2 by top plate having a width equal to the width of the panel core, and shall be recessed into the SIP below. Over this top plate a cap plate shall be placed. The cap plate width shall match the SIP thickness and overlap the facers on both sides of the panel. End joints in top plates shall be offset not less than 24 inches (610 mm).



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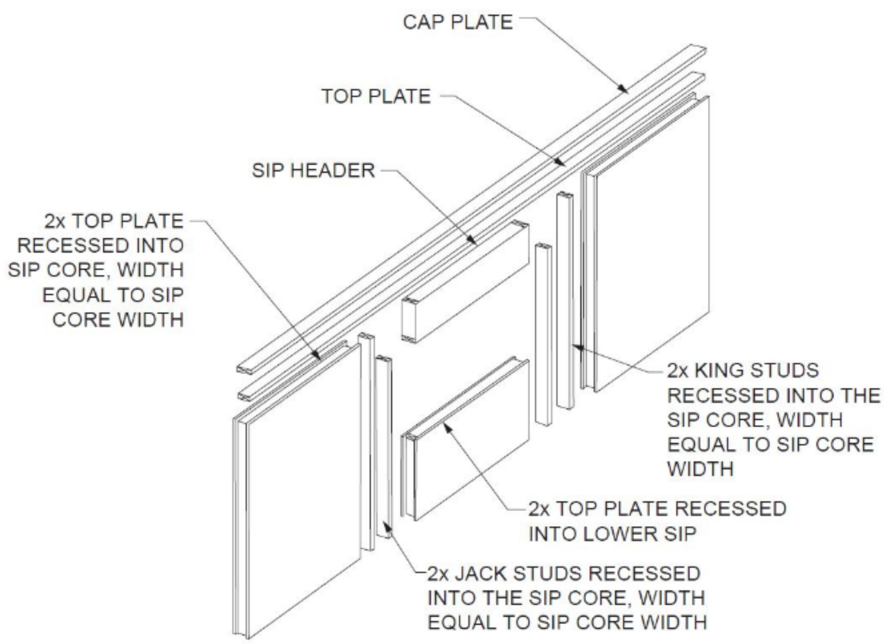


FIGURE R610.5.1

SIP WALL FRAMING CONFIGURATION

For SI: 1 inch = 25.4 mm.

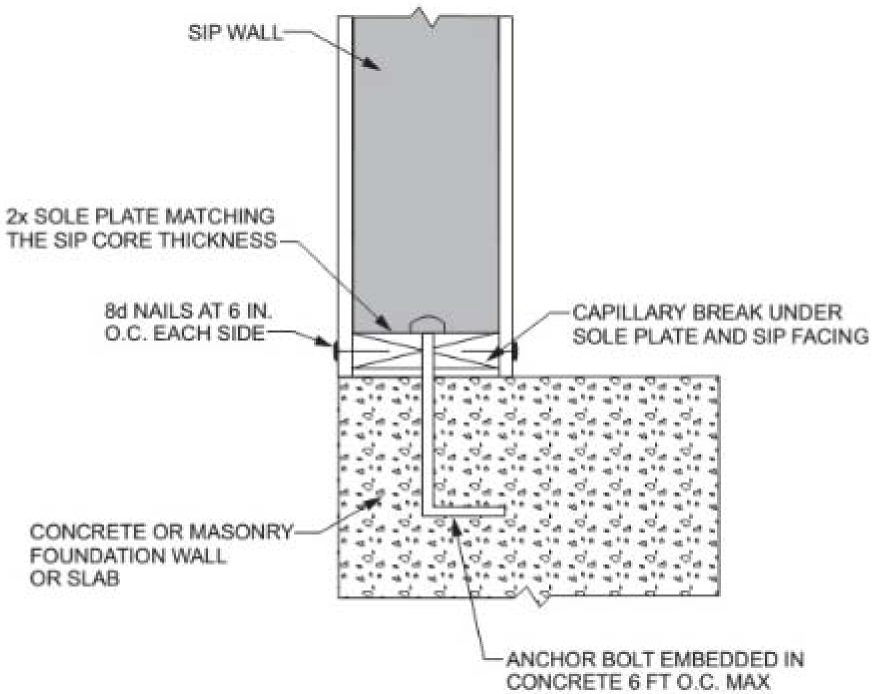
Notes:

1.Top plates shall be continuous over header.

2.Lower 2x top plate shall have a width equal to the SIP core width and shall be recessed into the top edge of the panel. Cap plate shall be placed over the recessed top plate and shall have a width equal to the SIPs width.

3.SIP facing surfaces shall be nailed to framing and cripples with 8d common or galvanized box nails spaced 6 inches on center.

~~4.Galvanized nails shall be hot-dipped or tumbled. Framing shall be attached in accordance to Section R602.3(1)unless otherwise provide for in Section R610.~~



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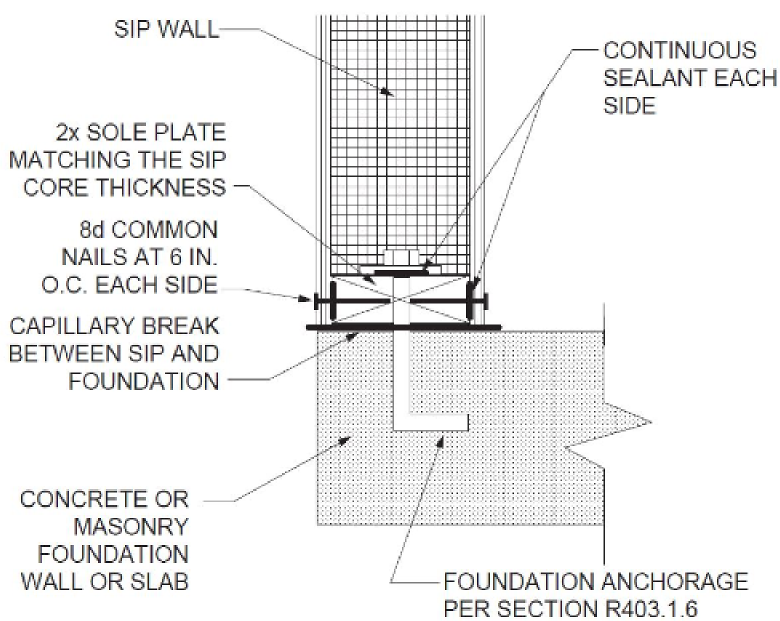


For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

FIGURE R610.5.2

SIP WALL TO CONCRETE SLAB FOR FOUNDATION WALL ATTACHMENT

R610.5.3 Panel-to-panel connection.
SIPs shall be connected at vertical in-plane joints in accordance with Figure R610.8 or by other approved methods.

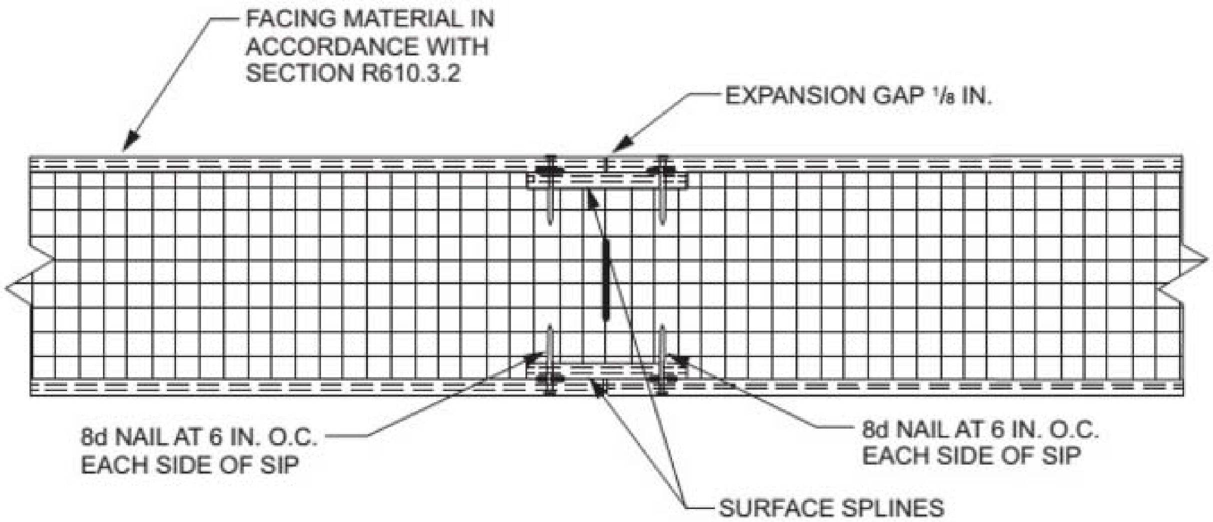
R610.5.4 Corner framing.
Corner framing of SIP walls shall be constructed in accordance with Figure R610.5.4.

R610.5.3 Wall bracing.
SIP walls shall be braced in accordance with Section R602.10. SIP walls shall be considered continuous wood structural panel sheathing (Bracing Method CS-WSP) for purposes of computing required bracing. SIP walls shall meet the requirements of Section R602.10.4.2 except that SIP corners shall be fabricated as shown in Figure R610.9. Where SIP walls are used for wall bracing, the SIP bottom plate shall be attached to wood framing below in accordance with Table R602.3(1).

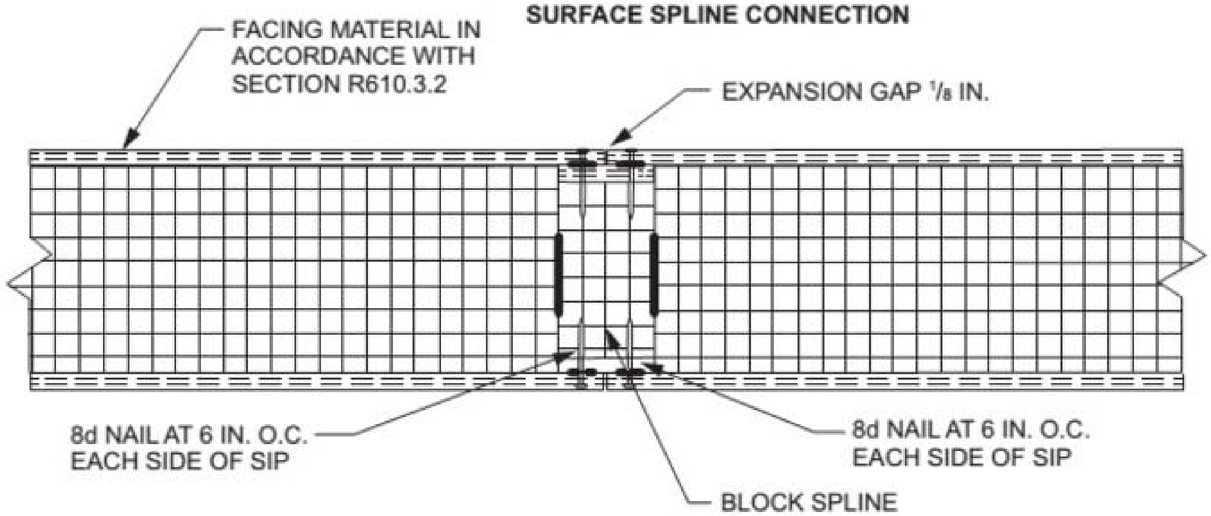
R610.6 Interior load-bearing walls.
Interior load-bearing walls shall be constructed as specified for exterior walls.

R610.7 Drilling and notching.
The maximum vertical chase penetration in SIPs shall have a maximum side dimension of 2 inches (51 mm) centered in the panel. Vertical chases shall have a minimum spacing of 24 inches (610 mm) on center. A maximum of two horizontal chases shall be permitted in each wall panel—one at 14 inches (360 mm) plus or minus 2 inches (51 mm) from the bottom of the panel and one at 48 inches (1220 mm) plus or minus 2 inches (51 mm) from the bottom edge of the SIPs panel. Additional penetrations are permitted where justified by analysis.

~~**R610.8 Connection.**~~
~~SIPs shall be connected at vertical in-plane joints in accordance with Figure R610.8 or by other *approved* methods.~~

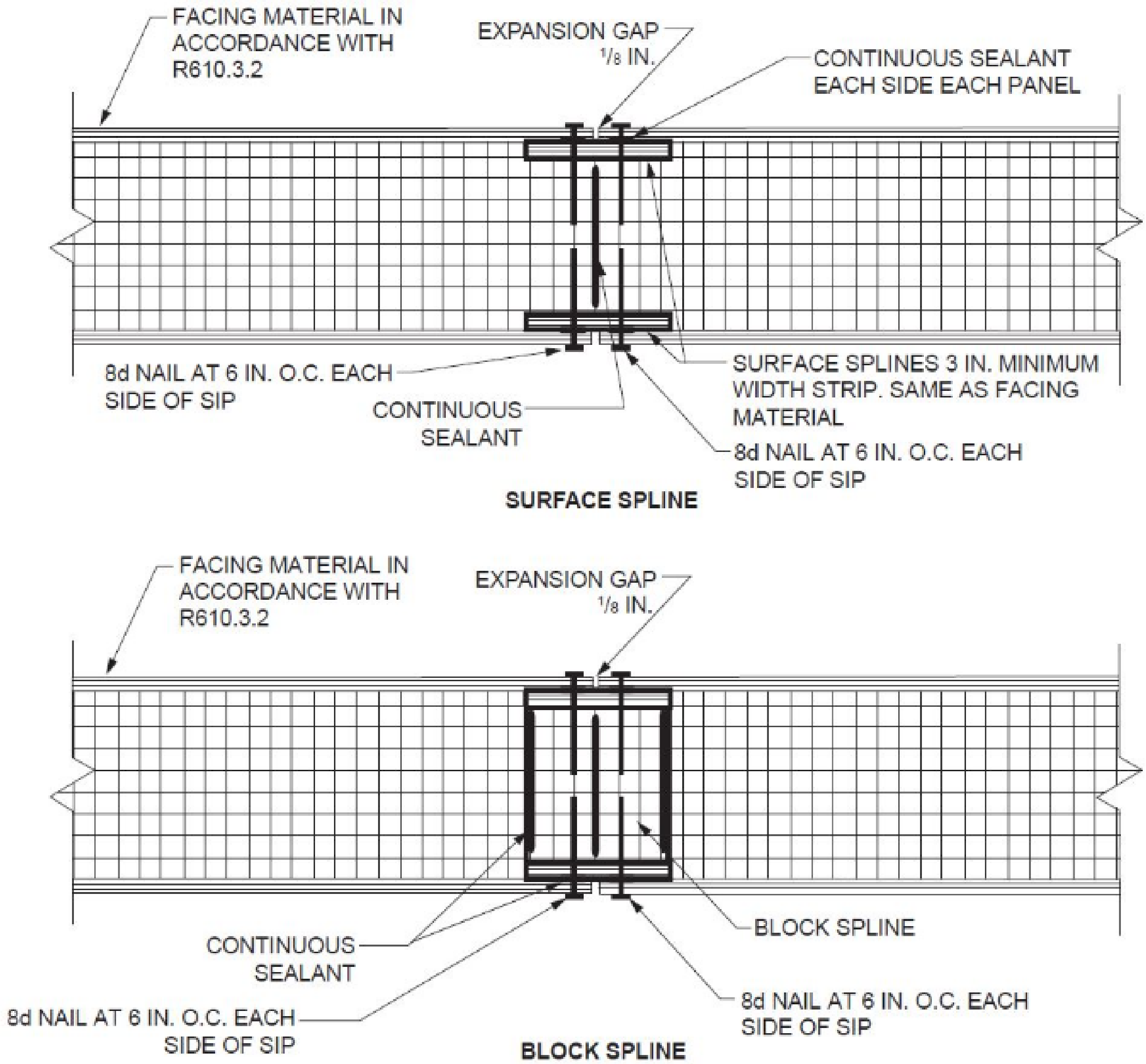


SURFACE SPLINE CONNECTION



BLOCK SPLINE CONNECTION

Replace the figure above by the figure below



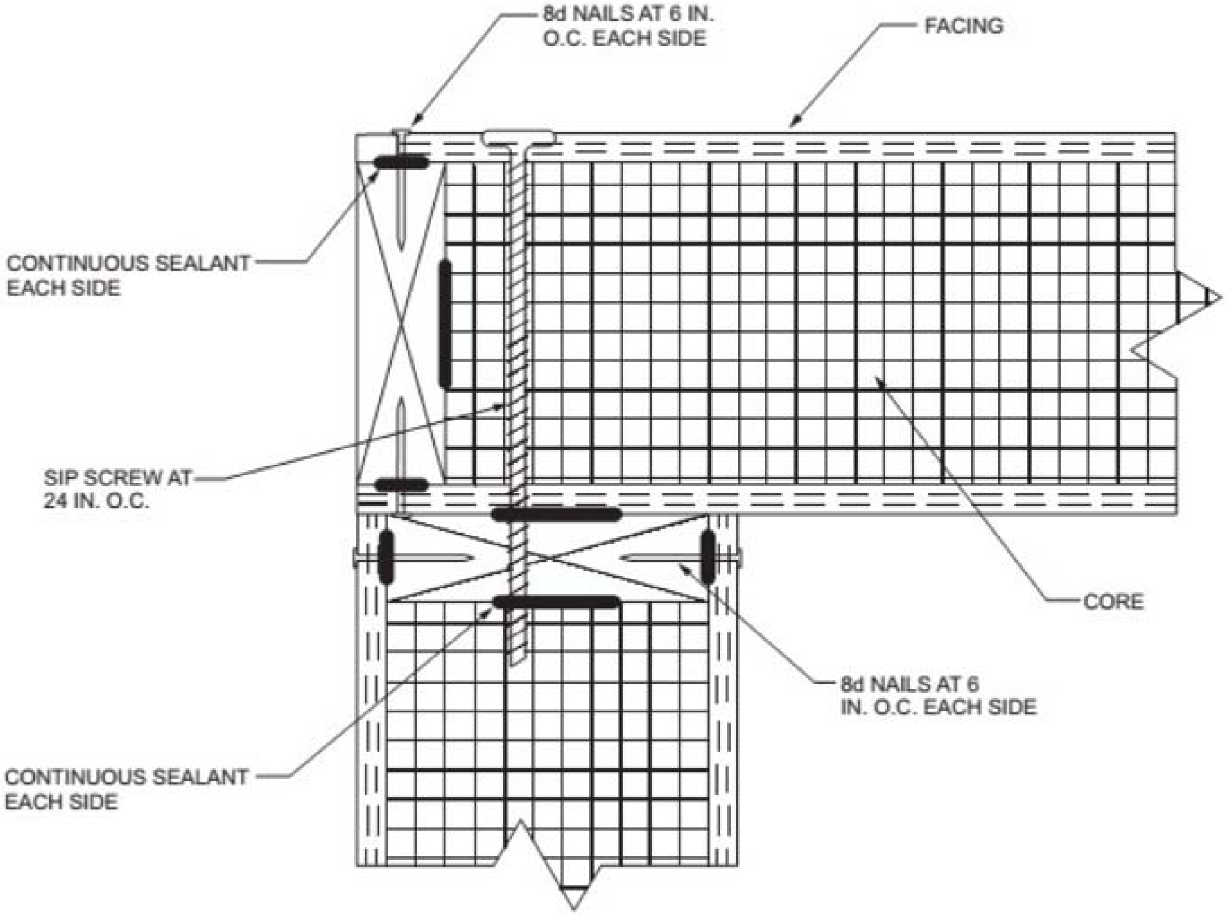
For SI: 1 inch = 25.4 mm.

FIGURE R610.8

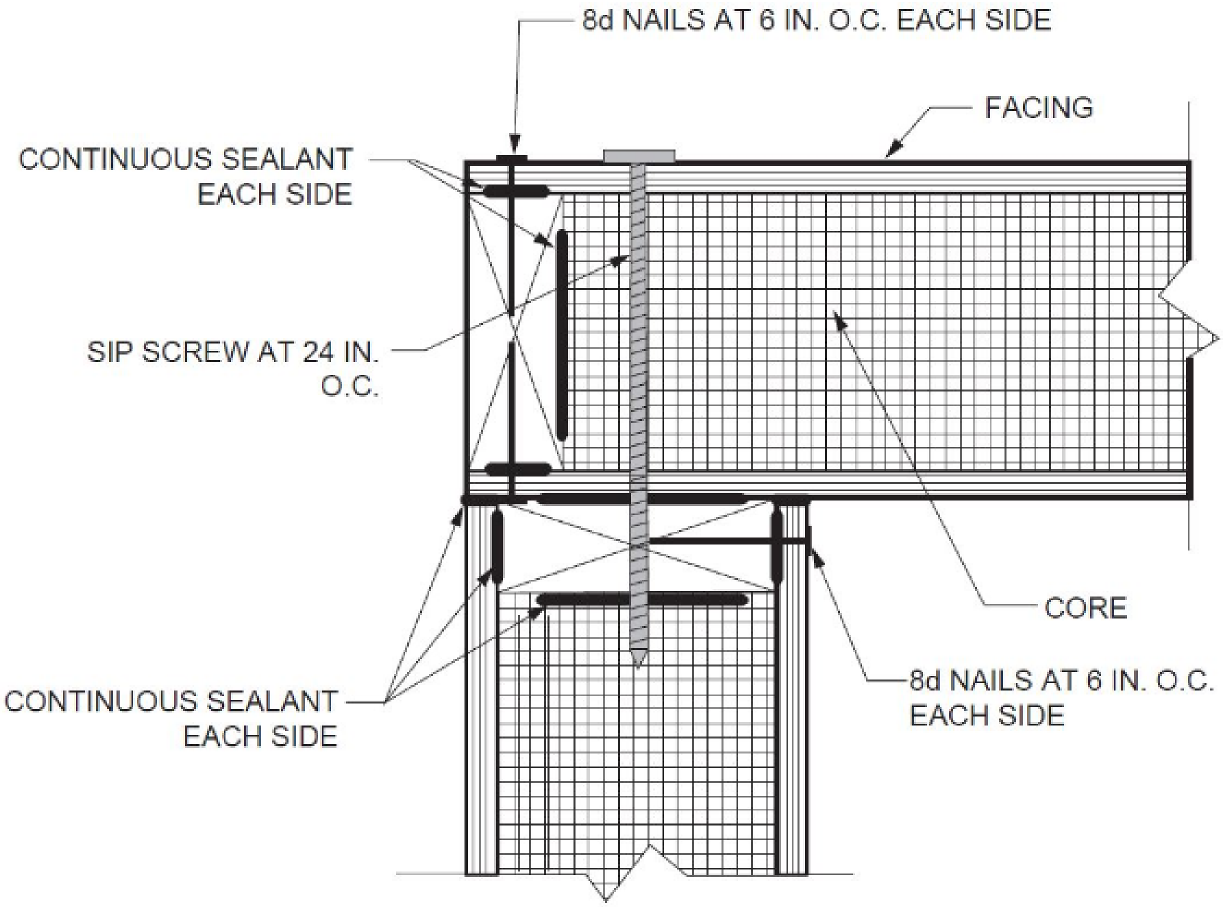
TYPICAL SIP WALL PANEL-TO-PANEL CONNECTION DETAILS ~~FOR VERTICAL IN-PLANE JOINTS~~

~~**R610.9 Corner framing.**~~

~~Corner framing of SIP walls shall be constructed in accordance with Figure R610.9.~~



Replace the figure above by the figure below



For SI: 1 inch = 25.4 mm.

FIGURE R610.~~9~~5.4

SIP CORNER FRAMING DETAIL

R610.~~10~~8 Headers.

SIP headers shall be designed and constructed in accordance with Table R610.~~10~~8 and Figure R610.5.1. SIP headers shall be continuous sections without splines. Headers shall be not less than 117/8 inches (302 mm) deep. Headers longer than 4 feet (1219 mm) shall be constructed in accordance with Section R602.7. The strength axis of the factors on the header shall be oriented horizontally.

TABLE R610.~~10~~8

MAXIMUM SPANS FOR 117/8-INCH ~~DEEP~~ OR DEEPER SIP HEADERS (feet)[a]

LOAD CONDITION	SNOW LOAD (psf)	• BUILDING width (feet)				
		24	28	32	36	40
Supporting roof only	20	4	4	4	4	2
	30	4	4	4	2	2
	50	2	2	2	2	2
	70	2	2	2	~~N/A~~DR	~~N/A~~DR
Supporting roof and one-story	20	2	2	~~N/A~~DR	~~N/A~~DR	~~N/A~~DR
	30	2	2	~~N/A~~DR	~~N/A~~DR	~~N/A~~DR
	50	2	~~N/A~~DR	~~N/A~~DR	~~N/A~~DR	~~N/A~~DR
	70	~~N/A~~DR	~~N/A~~DR	~~N/A~~DR	~~N/A~~DR	~~N/A~~DR

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

~~N/A = Not Applicable.~~

a. Design assumptions:

Maximum deflection criterion: *L*/~~360~~240.

Maximum roof dead load: 10 psf.

Maximum ceiling load: 5 psf.

Maximum ceiling live load: 20 psf.

Maximum second-floor live load: 30 psf.

Maximum second-floor dead load: 10 psf.

Maximum second-floor dead load from walls: 10 psf.

Maximum first-floor dead load: 10 psf.

Wind load based on Table R301.2(2).

Strength axis of facing material applied horizontally.

DR = Design Required

b. Building width is in the direction of horizontal framing members supported by the header.

c. The table provides for roof slopes between 3:12 and 12:12.

d. The maximum roof overhang is 24 inches (610 mm).

R610.~~10~~8.1 Wood structural panel box headers.

Wood structural panel box headers shall be allowed where SIP headers are not applicable. Wood structural panel box headers shall be constructed in accordance with Figure R602.7.3 and Table R602.7.3.

S7784

Date Submitted	12/9/2018	**Section**	602.10.3	**Proponent**	Borjen Yeh
Chapter	6	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review

Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

Summary of Modification

Revise Footnote (c) to Table R602.10.3(1)

Rationale

As Footnote (c) is currently written, it is unclear that the "differing dimensions" discussed are the distance between braced wall lines and not braced wall line lengths. In addition, for differing distances between braced wall lines to be possible, there must be at least 3 parallel braced wall lines. As such it is not possible for this to be true if the parallel braced wall line exists only on "one side". The proposed language corrects this possible confusion while it more clearly states the intent of the provision. This proposed change has been published in the 2018 IRC.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal has a reasonable connection with the health, safety, and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code, and provides equivalent or better products, methods, or systems of construction.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

TABLE R602.10.3(1) BRACING REQUIREMENTS BASED ON WIND SPEED

No change to Table R602.10.3(1) itself except for Footnote (c) as follows:

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s.

1. a.Linear interpolation shall be permitted.
2. b.Method LIB shall have gypsum board fastened to not less than one side with nails or screws in accordance with Table R602.3(1) for exterior sheathing or Table R702.3.5 for interior gypsum board. Spacing of fasteners at panel edges shall not exceed 8 inches.
3. c.Where ~~a braced wall line has~~ three or more parallel braced wall lines ~~on one or both sides of differing dimensions~~ are present and the distances between adjacent braced wall lines are different, the average dimension shall be permitted to be used for braced wall line spacing.

S7786

Date Submitted	12/9/2018	**Section**	602.10.3	**Proponent**	Borjen Yeh
Chapter	6	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Revise the term "wall height adjustment" in Table R602.10.3(2), Item 3 and add a new footnote (d) to the same table to clarify the applicability of the exposure category adjustment

Rationale

This change to Item 3 provides consistency with the seismic bracing table and Section R301.3 as regards the story height. The added footnote (d) clarifies the applicability of the adjustment factor for based on the exposure category. Both changes have been published in the 2018 IRC.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal clarifies the intent of the code provision and has a reasonable and substantial connection with the health, safety, and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Mod 7786

TABLE R602.10.3(2)

WIND ADJUSTMENT FACTORS TO THE REQUIRED LENGTH OF WALL BRACING

ITEM NUMBER	ADJUSTMENT BASED ON	STORY/SUPPORTING	CONDITION	ADJUSTMENT FACTOR[a, b] [multiply length fromTable R602.10.3(1) by this factor]	APPLICABLE METHODS
1	Exposure category[d]	One-storystructure	B	1.00	All methods
			C	1.20	
			D	1.50	
		Two-storystructure	B	1.00	
			C	1.30	
			D	1.60	
		Three-storystructure	B	1.00	
			C	1.40	
			D	1.70	
2	Roof eave-to-ridge height	Roof only	= 5 feet	0.70	
			10 feet	1.00	
			15 feet	1.30	
			20 feet	1.60	
		Roof + 1 floor	= 5 feet	0.85	
			10 feet	1.00	

			15 feet	1.15	
			20 feet	1.30	
		Roof + 2 floors	= 5 feet	0.90	
			10 feet	1.00	
			15 feet	1.10	
			20 feet	Not permitted	
3	~~Wall~~ Story height adjustment (Section R301.3)	Any story	8 feet	0.90	
			9 feet	0.95	
			10 feet	1.00	
			11 feet	1.05	
			12 feet	1.10	
4	Number of braced wall lines (per plan direction)c	Any story	2	1.00	
			3	1.30	
			4	1.45	
			= 5	1.60	
5	Additional 800-poundhold-down device	Top story only	Fastened to the end studs of each braced wall panel and to the foundation or framing below	0.80	DWB, WSP, SFB,PBS, PCP, HPS
6	Interior gypsum board finish (or equivalent)	Any story	Omitted from inside face of braced wall panels	1.40	DWB, WSP, SFB,PBS, PCP, HPS, CS-WSP, CS-G, CS-SFB

7	Gypsum board fastening	Any story	4 inches o.c. at panel edges, including top and bottom plates, and all horizontal joints blocked	0.7	GB

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.48 N.

a.Linear interpolation shall be permitted.

b.The total adjustment factor is the product of all applicable adjustment factors.

c.The adjustment factor is permitted to be 1.0 when determining bracing amounts for intermediate braced wall lines provided the bracing amounts on adjacent braced wall lines are based on a spacing and number that neglects the intermediate braced wall line.

d. The same adjustment factor shall be applied to all braced wall lines on all floors of the structure, based on the worst-case exposure category.

Date Submitted 12/9/2018
Chapter 6
Section 602.10.4.1
Affects HVHZ No
Proponent Borjen Yeh
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

Summary of Modification

Revise Section R602.10.4.1 Item 4, and Table R602.10.3(3)

Rationale

Methods ABW, PFH, and PFG are added to the WSP column of Table R602.10.3(4) since these are considered intermittent bracing methods and their length of bracing would be the same as a WSP (that was the basis for the testing that originally evaluated these methods). Footnote (e) is revised to include Method PFG because PFG is only permitted in Seismic Design Categories A, B, and C per Section R602.10.6.3. Footnote (f) is added to point out that the methods can be combined as long as the requirements of Section R602.10.4.1 are met. Pointing to the general requirements on combining all methods is better than only showing what is permitted for three methods.

These changes have been published in the 2018 IRC except for the addition of Methods ABW, PFH, and PFG to the WSP column of Table R602.10.3(4). However, since the revised Footnote (e) and Item 4 of Section R602.10.4 are specifically published in the 2018 IRC by referencing ABW, PFH, and PFG, it is an omission in Table R602.10.3.(4) that currently does not list those 3 intermittent methods in the table.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal clarifies the intent of the code and has a reasonable and substantial connection with the health, safety, and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code

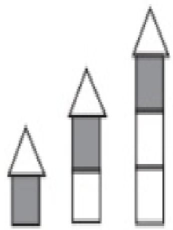
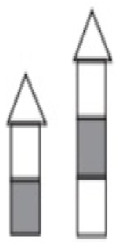
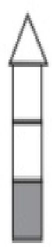
Mod 7787

TABLE R602.10.3(3)

BRACING REQUIREMENTS BASED ON SEISMIC DESIGN CATEGORY

• SOIL CLASS D[b] • WALL HEIGHT = 10 FEET • 10 PSF FLOOR DEAD LOAD • 15 PSF ROOF/CEILING DEAD LOAD • BRACED WALL LINE SPACING = 25 FEET			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[a,f]				
Seismic Design Category	Story Location	Braced Wall Line Length (feet)[c]	Method LIB[d]	Method GB	Methods DWB, SFB, PBS, PCP, HPS, CS-SFB[e]	Methods WSP, ABW, PFH, PFG[e]	Methods CS-WSP, CS-G, CS-PF
C (townhouses only)		10	2.5	2.5	2.5	1.6	1.4
		20	5.0	5.0	5.0	3.2	2.7
		30	7.5	7.5	7.5	4.8	4.1
		40	10.0	10.0	10.0	6.4	5.4
		50	12.5	12.5	12.5	8.0	6.8
		10	NP	4.5	4.5	3.0	2.6
		20	NP	9.0	9.0	6.0	5.1
		30	NP	13.5	13.5	9.0	7.7
		40	NP	18.0	18.0	12.0	10.2
		50	NP	22.5	22.5	15.0	12.8
		10	NP	6.0	6.0	4.5	3.8
		20	NP	12.0	12.0	9.0	7.7
		30	NP	18.0	18.0	13.5	11.5
		40	NP	24.0	24.0	18.0	15.3
		50	NP	30.0	30.0	22.5	19.1

D_0		10	NP	2.8	2.8	1.8	1.6
		20	NP	5.5	5.5	3.6	3.1
		30	NP	8.3	8.3	5.4	4.6
		40	NP	11.0	11.0	7.2	6.1
		50	NP	13.8	13.8	9.0	7.7
		10	NP	5.3	5.3	3.8	3.2
		20	NP	10.5	10.5	7.5	6.4
		30	NP	15.8	15.8	11.3	9.6
		40	NP	21.0	21.0	15.0	12.8
		50	NP	26.3	26.3	18.8	16.0
		10	NP	7.3	7.3	5.3	4.5
		20	NP	14.5	14.5	10.5	9.0
		30	NP	21.8	21.8	15.8	13.4
		40	NP	29.0	29.0	21.0	17.9
		50	NP	36.3	36.3	26.3	22.3
D_1		10	NP	3.0	3.0	2.0	1.7
		20	NP	6.0	6.0	4.0	3.4
		30	NP	9.0	9.0	6.0	5.1
		40	NP	12.0	12.0	8.0	6.8
		50	NP	15.0	15.0	10.0	8.5
		10	NP	6.0	6.0	4.5	3.8
		20	NP	12.0	12.0	9.0	7.7
		30	NP	18.0	18.0	13.5	11.5
		40	NP	24.0	24.0	18.0	15.3
		50	NP	30.0	30.0	22.5	19.1
		10	NP	8.5	8.5	6.0	5.1
		20	NP	17.0	17.0	12.0	10.2
		30	NP	25.5	25.5	18.0	15.3
		40	NP	34.0	34.0	24.0	20.4
		50	NP	42.5	42.5	30.0	25.5

D_2		10	NP	4.0	4.0	2.5	2.1
		20	NP	8.0	8.0	5.0	4.3
		30	NP	12.0	12.0	7.5	6.4
		40	NP	16.0	16.0	10.0	8.5
		50	NP	20.0	20.0	12.5	10.6
		10	NP	7.5	7.5	5.5	4.7
		20	NP	15.0	15.0	11.0	9.4
		30	NP	22.5	22.5	16.5	14.0
		40	NP	30.0	30.0	22.0	18.7
		50	NP	37.5	37.5	27.5	23.4
		10	NP	NP	NP	NP	NP
		20	NP	NP	NP	NP	NP
		30	NP	NP	NP	NP	NP
		40	NP	NP	NP	NP	NP
		50	NP	NP	NP	NP	NP
	Cripple wall below one- or two-story dwelling	10	NP	NP	NP	7.5	6.4
		20	NP	NP	NP	15.0	12.8
		30	NP	NP	NP	22.5	19.1
		40	NP	NP	NP	30.0	25.5
		50	NP	NP	NP	37.5	31.9

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.
NP = Not Permitted

a.Linear interpolation shall be permitted.

b.Wall bracing lengths are based on a soil site class “D.” Interpolation of bracing length between the *Sds* values associated with the seismic design categories shall be permitted when a site-specific *Sds* value is determined in accordance with Section 1613.3 of the Florida Building Code, Building.

c.Where the braced wall line length is greater than 50 feet, braced wall lines shall be permitted to be divided into shorter segments having lengths of 50 feet or less, and the amount of bracing within each segment shall be in accordance with this table.

d.Method LIB shall have gypsum board fastened to not less than one side with nails or screws in accordance with Table R602.3(1) for exterior sheathing or Table R702.3.5 for interior gypsum board. Spacing of fasteners at panel edges shall not exceed 8 inches.

e.Methods PFG and CS-SFB does not apply in Seismic Design Categories D0, D1 and D2.

f. Where more than one bracing method is used, mixing methods shall be in accordance with Section R602.10.4.1.

R602.10.4.1 Mixing methods.
Mixing of bracing methods shall be permitted as follows:

1.Mixing intermittent bracing and continuous sheathing methods from story to story shall be permitted.

2.Mixing intermittent bracing methods from *braced wall line* to *braced wall line* within a story shall be permitted. In regions within Seismic Design Categories A, B and C where the ultimate design wind speed is less than or equal to 130 mph (58m/s), mixing of intermittent bracing and continuous sheathing methods from braced wall line to braced wall line within a story shall be permitted.

3.Mixing intermittent bracing methods along a *braced wall line* shall be permitted in Seismic Design Categories A and B, and detached dwellings in Seismic Design Category C, provided the length of required bracing in accordance with Table R602.10.3(1) or R602.10.3(3) is the highest value of all intermittent bracing methods used.

4.Mixing of continuous sheathing methods CS-WSP, CS-G and CS-PF along a *braced wall line* shall be permitted. Intermittent methods ABW, PFH and PFG shall be permitted to be used along a *braced wall line* with continuous sheathed methods, provided that the length of required bracing for that braced wall line is determined in accordance with Table R602.10.3(1) or R602.10.3(3) using the highest value of the bracing methods used.

5.In Seismic Design Categories A and B, and for detached one- and two-family dwellings in Seismic Design Category C, mixing of intermittent bracing methods along the interior portion of a *braced wall line* with continuous sheathing methods CS-WSP, CS-G and CS-PF along the exterior portion of the same braced wall line shall be permitted. The length of required bracing shall be the highest value of all intermittent bracing methods used in accordance with Table R602.10.3(1) or R602.10.3(3) as adjusted by Tables R602.10.3(2)and R602.10.3(4), respectively. The requirements of Section R602.10.7 shall apply to each end of the continuously sheathed portion of the braced wall line.

S7789

Date Submitted	12/9/2018	**Section**	602.10.6.2	**Proponent**	Borjen Yeh
Chapter	6	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

Summary of Modification

Revise and clarify Figure R602.10.6.2

Rationale

This revision includes 2 clarification of the existing Figure R602.10.6.2:
1) The current figure displays the sheathing on the right-hand side of the portal frame that overlaps the double top plate and has a single row of fasteners, while it erroneously shows double rows of fasteners on the left-hand side. The change corrects the error and confusion. All tests was conducted with a single row of fasteners.
2) It added a note to indicate that the nailing of sheathing behind the 3500 lb strap shall not be required. The required nailing on the 3500 lb strap provides sufficient anchorage for the wood structural panel to framing connection while preventing the potential for the splitting of the framing while anchoring the strap. It also prevents the sheathing-to-framing nailing from interfering with the required strap nailing. In addition, it saves time and money for the builder without compromising the effectiveness of the portal.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

Slightly reduce to building and property owners relative to cost of compliance with code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal provides clarification that has a reasonable and substantial connection with the health, safety, and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

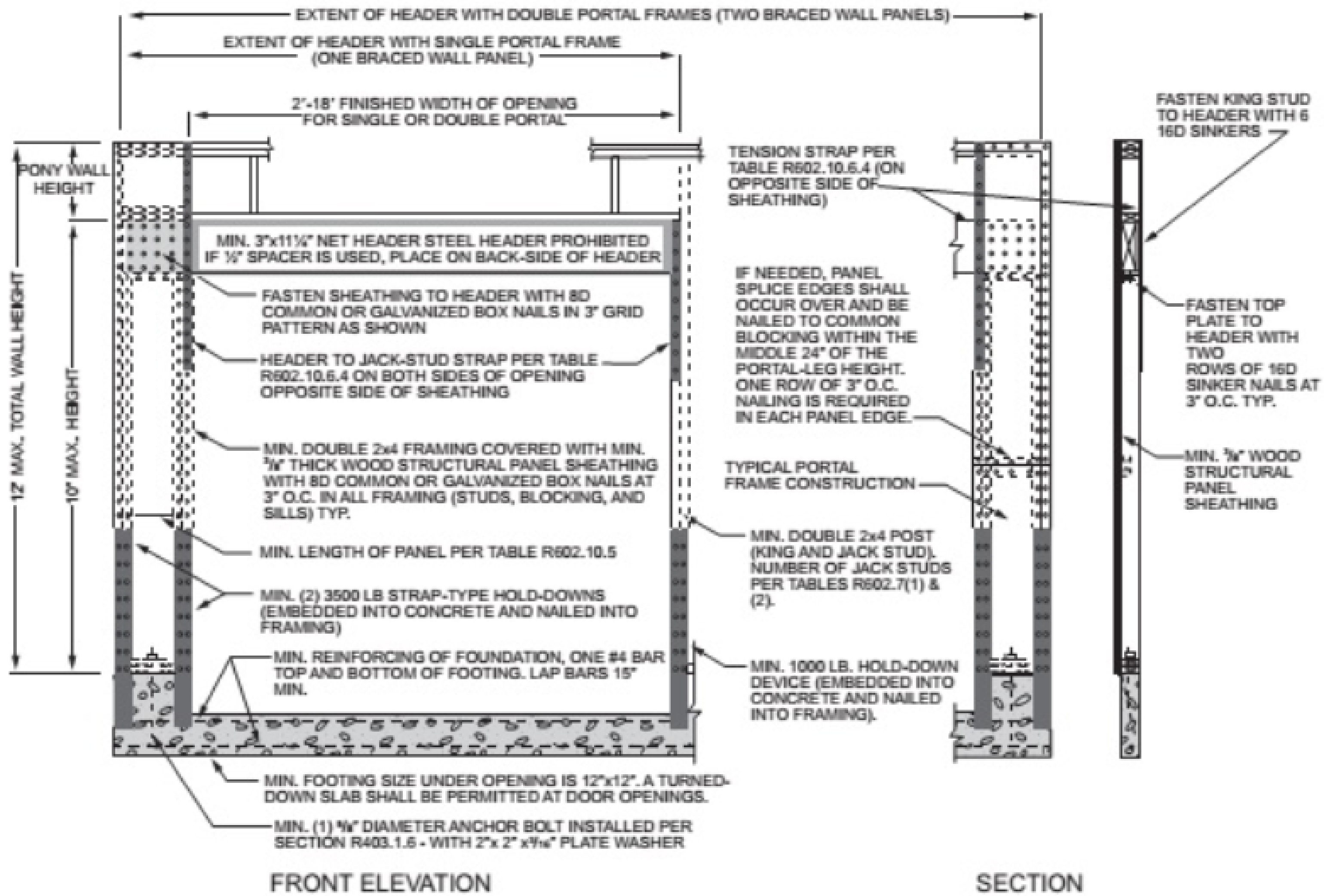
Does not degrade the effectiveness of the code

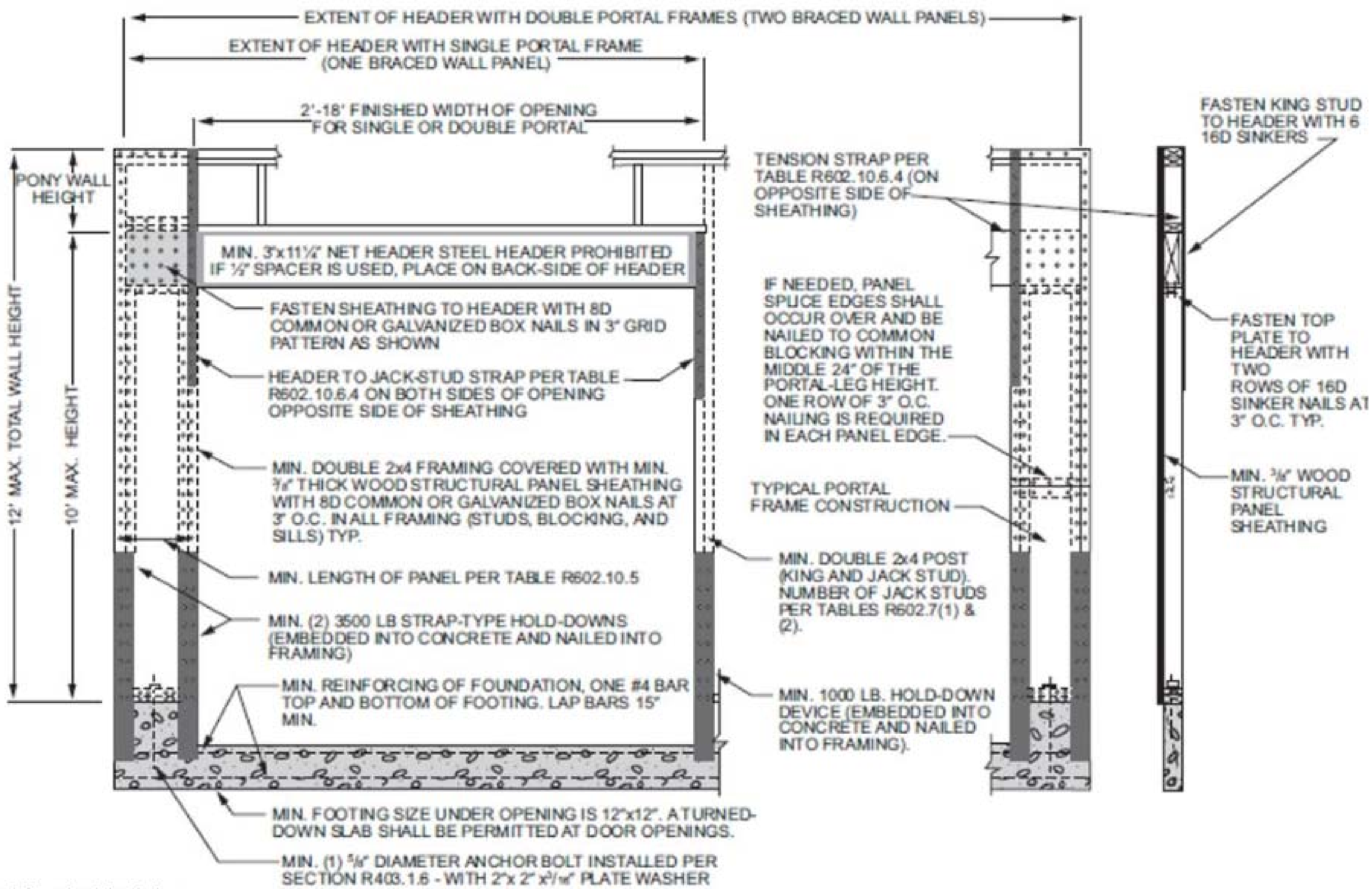
This proposal does not degrade the effectiveness of the code.

R602.10.6.2Method PFH: Portal frame with holddowns.

Method PFH *braced wall panels* shall be constructed in accordance with Figure R602.10.6.2.

Method PFH *braced wall panels* shall be constructed in accordance with Figure R602.10.6.2.





FRONT ELEVATION

SECTION

Note: Nailing of sheathing behind the 3500 lb strap shall not be required.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

FIGURE R602.10.6.2

METHOD PFH—PORTAL FRAME WITH HOLD-DOWNS

S7797

Date Submitted 12/9/2018
Chapter 6
Section 602.10.6.4
Affects HVHZ No
Proponent Borjen Yeh
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**
Alternate Language **No**

Related Modifications

Summary of Modification

Revise Figure R602.10.6.4

Rationale

This proposal clarifies that the Method CS-PF should have 2 rows of nails on the right-hand side of Figure R602.10.6.4, which is consistent with the rest of the figure.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal clarifies the intent of the code and has a reasonable and substantial connection with the health, safety, and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

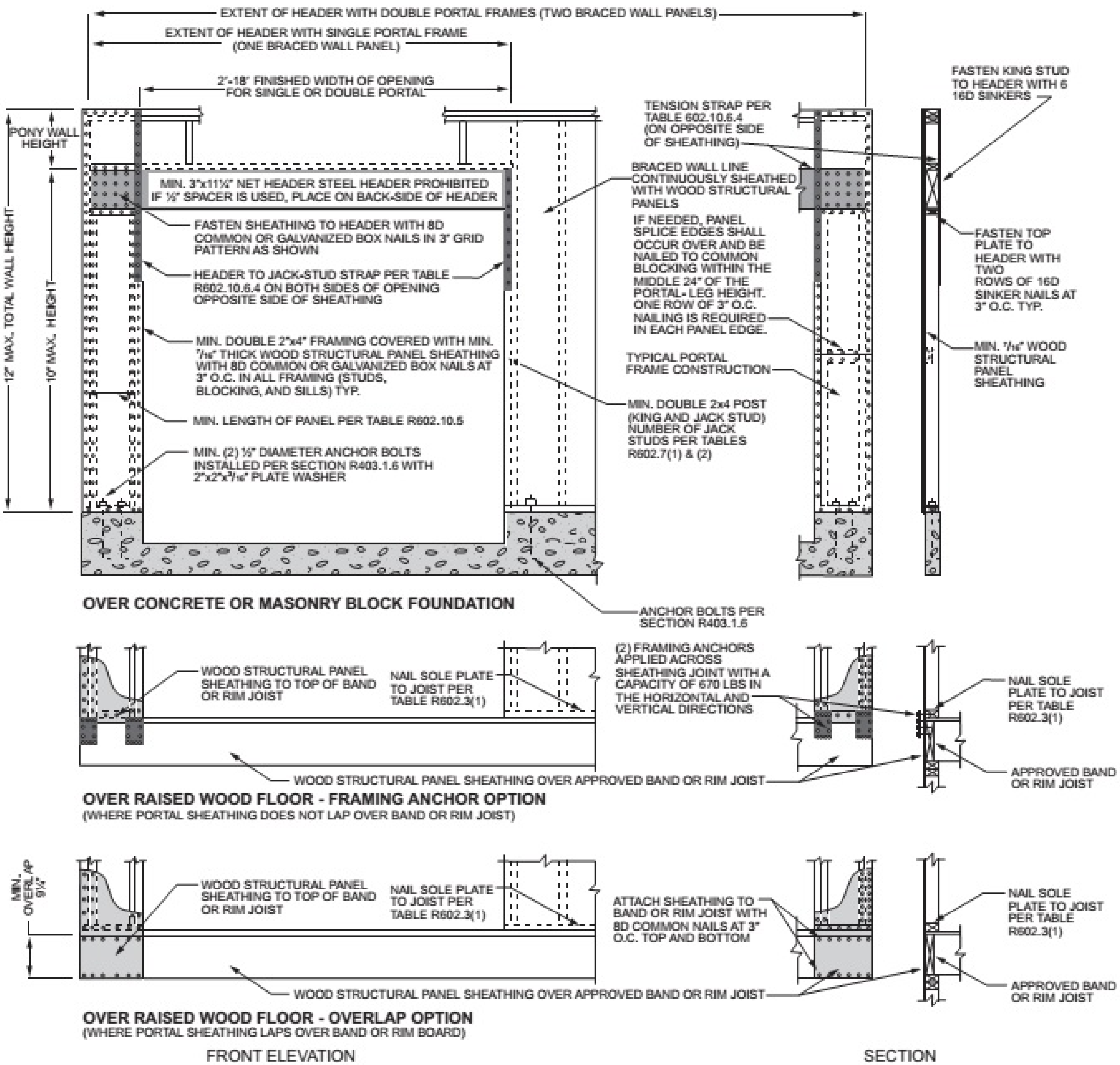
Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

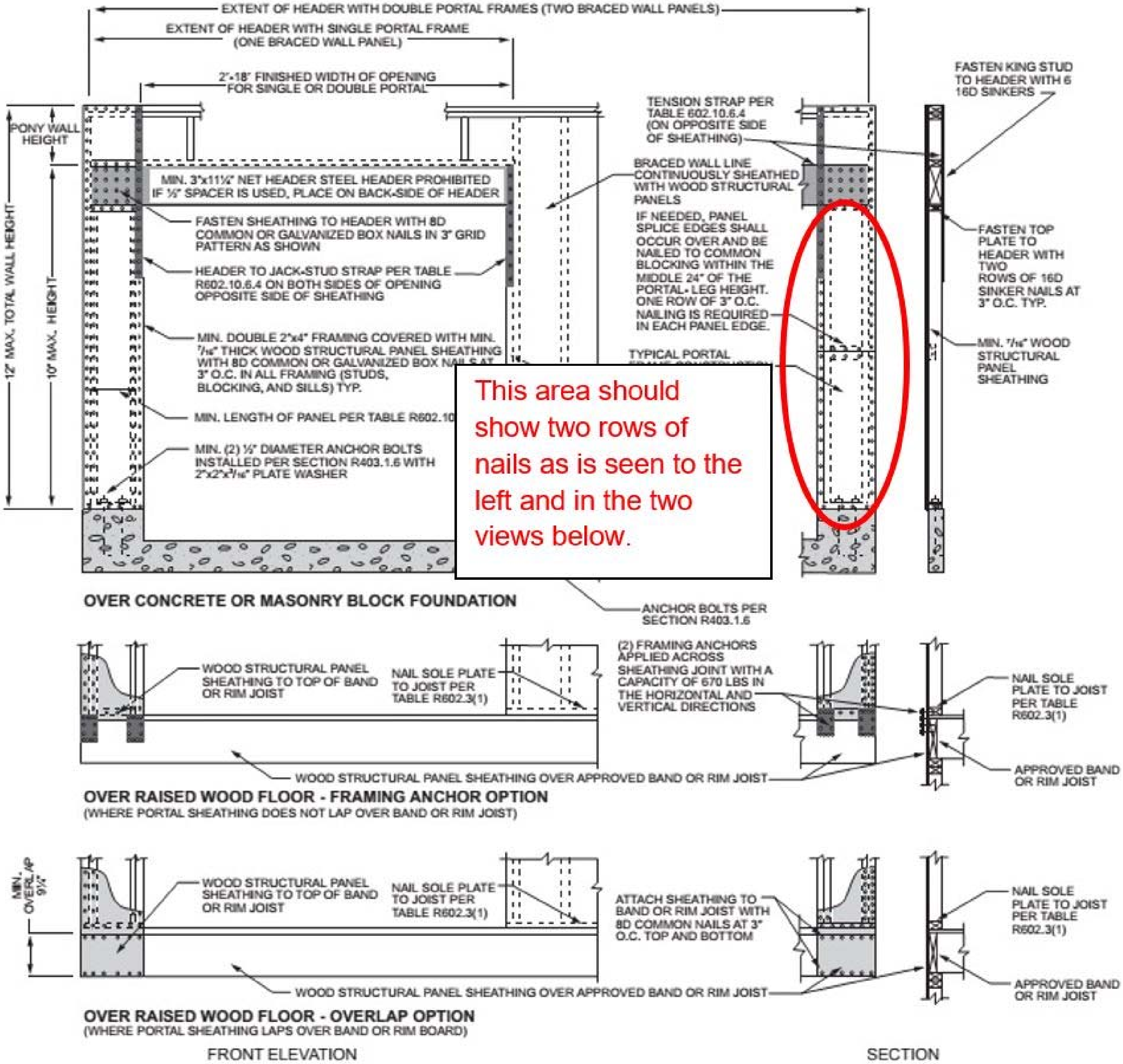
Mod 7797

R602.10.6.4Method CS-PF: Continuously sheathed portal frame.

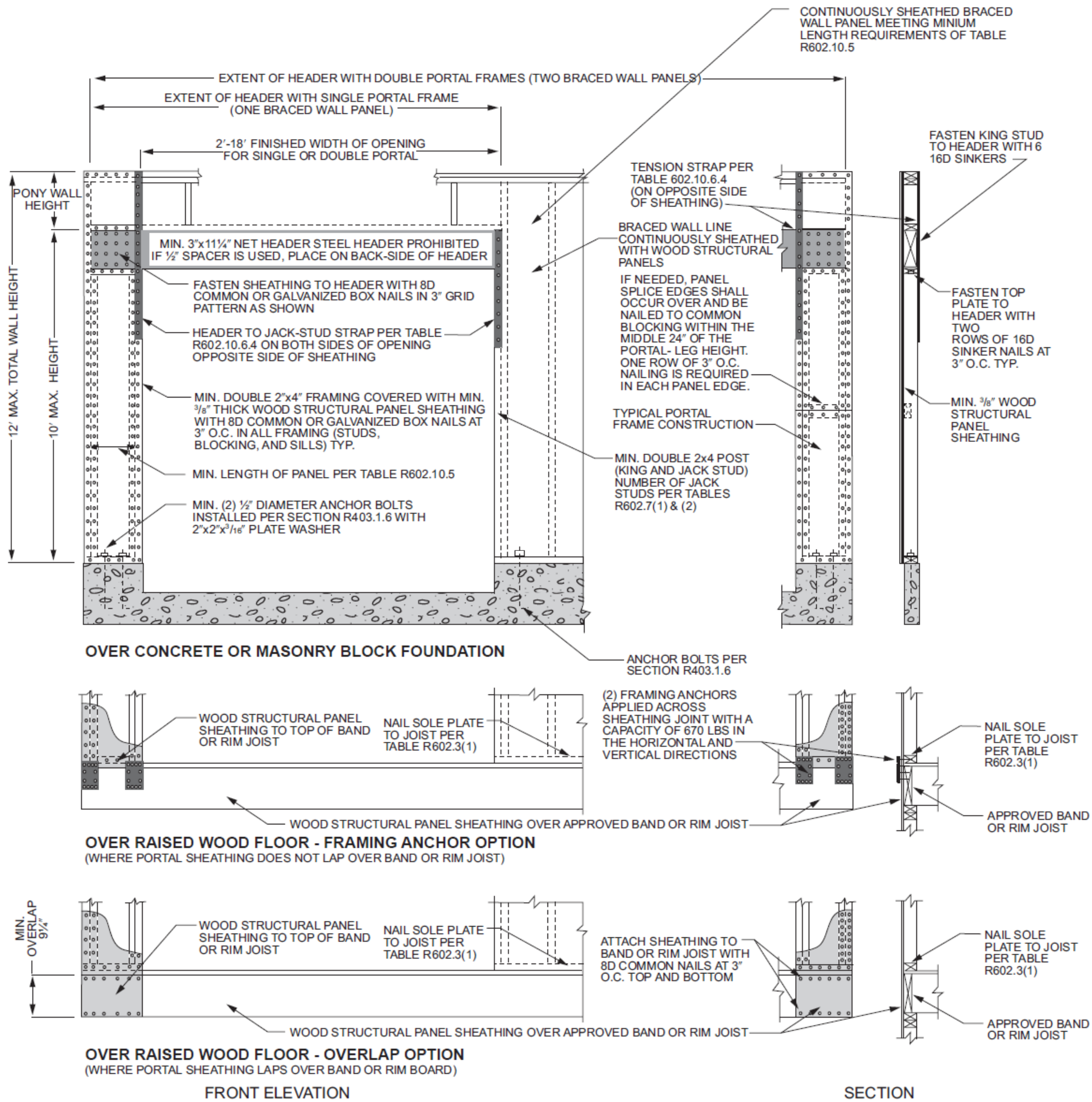
Continuously sheathed portal frame *braced wall panels* shall be constructed in accordance with Figure R602.10.6.4and Table R602.10.6.4. The number of continuously sheathed portal frame panels in a single *braced wall line* shall



Replace the figure above with the modification in the figure below.



A clean copy of the revised figure is shown below from the 2018 IRC (except that the WSP sheathing should remain unchanged at 7/16").



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

FIGURE R602.10.6.4
METHOD CS-PF—CONTINUOUSLY SHEATHED PORTAL FRAME PANEL CONSTRUCTION

S7799

Date Submitted	12/9/2018	**Section**	602.10.6.4	**Proponent**	Borjen Yeh
Chapter	6	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

Summary of Modification

Revise Figure R602.10.6.4

Rationale

The proposed code change more clearly states the intent of the original language. It is important that the wall element away from the single portal be well anchored to obviate the need for the anchor strap at the base of the post-end of the single-portal. This anchorage is provided by the presence of a continuously sheathed braced wall panel meeting the minimum length requirements of Table R602.10.5. The way the current figure treats the post-end sheathing requirement, any element of a continuously sheathed braced wall line, regardless of length, could be used. Even an element less than the minimum length requirements listed in Table R602.10.5 would be permitted even though such an element would not provide the necessary anchorage. This proposal modifies the language to more clearly represent the intent of the provision. This proposal has been published in the 2018 IRC.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal clarifies the code and has a reasonable and substantial connection with the health, safety, and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

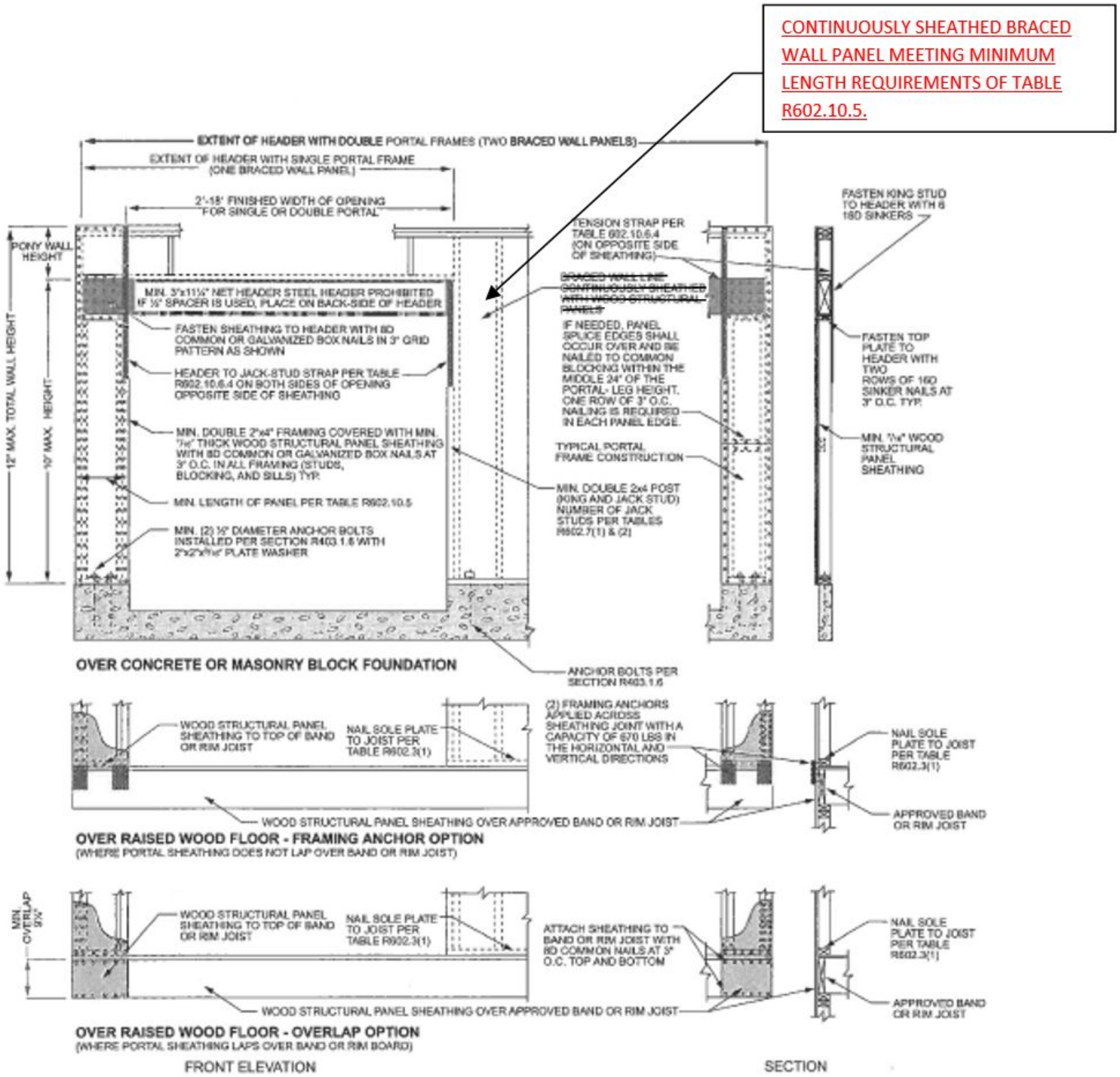
This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Mod 7799

R602.10.6.4 Method CS-PF: Continuously sheathed portal frame.
Continuously sheathed portal frame *braced wall panels* shall be constructed in accordance with Figure R602.10.6.4 and Table R602.10.6.4. The number of continuously sheathed portal frame panels in a single *braced wall line* shall not exceed four.



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

FIGURE R602.10.6.4

METHOD CS-PF—CONTINUOUSLY SHEATHED PORTAL FRAME PANEL CONSTRUCTION

S7809

Date Submitted	12/9/2018	Section	602.10.3	Proponent	Borjen Yeh
Chapter	6	Affects HVHZ	No	Attachments	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Revise Table R602.10.3(4)

Rationale

The existing language is proposed to be changed to better correlate with the column heading, "STORY". In doing so, an important condition was inadvertently left out at the last code cycle. This combination was the adjustment for the top story of a multiple story building for the condition "^15 psf and ~/= 25 psf". For this case, the appropriate adjustment factor is the same as it is for a single story building. This proposal will correct the error resulting from the wording change at last cycle and bring the provisions back in line with the earlier codes. This change has been published in the 2018 IRC.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal provides clarification of the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

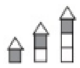
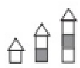
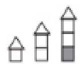
Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Mod 7809

TABLE R602.10.3(4)

SEISMIC ADJUSTMENT FACTORS TO THE REQUIRED LENGTH OF WALL BRACING

ITEM NUMBER	ADJUSTMENT BASED ON:	STORY	CONDITION	ADJUSTMENT FACTOR[a, b] [Multiply length from Table R602.10.3(3) by this factor]	APPLICABLE METHODS
1	Story height (Section 301.3)	Any story	= 10 feet	1.0	All methods
			> 10 feet and = 12 feet	1.2	
2	Braced wall line spacing, townhouses in SDC C	Any story	= 35 feet	1.0	
			> 35 feet and = 50 feet	1.43	
3	Braced wall line spacing, in SDC D_0, D_1, D_2[c]	Any story	> 25 feet and = 30 feet	1.2	
			> 30 feet and = 35 feet	1.4	
4	Wall dead load	Any story	> 8 psf and < 15 psf	1.0	
			< 8 psf	0.85	
5	Roof/ceiling dead load for wall supporting	1-, 2- or 3-story building	= 15 psf	1.0	
		2- or 3-story building	> 15 psf and = 25 psf	1.1	
		1-story building or top story	> 15 psf and = 25 psf	1.2	
6	Walls with stone or masonry veneer, townhouses in SDC C[d, e]		1.0		All methods
			1.5		
			1.5		
7	Walls with stone or masonry veneer, detached one- and two-family dwellings in SDC D_0 – D_2[d, f]	Any story	See Table R602.10.6.5		BV-WSP
8	Interior gypsum board finish (or equivalent)	Any story	Omitted from inside face of braced wall panels	1.5	DWB, WSP, SFB, PBS, PCP, HPS, CS-WSP, CS-G, CS-SFB

For SI: 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. Linear interpolation shall be permitted.

b. The total length of bracing required for a given wall line is the product of all applicable adjustment factors.

c. The length-to-width ratio for the floor/roof *diaphragm* shall not exceed 3:1. The top plate lap splice nailing shall be in accordance with Table R602.3(1), Item 13.

d. Applies to stone or masonry veneer exceeding the first story height.

e. The adjustment factor for stone or masonry veneer shall be applied to all exterior *braced wall lines* and all *braced wall lines* on the interior of the building, backing or perpendicular to and laterally supported veneered walls.

f. See Section R602.10.6.5 for requirements where stone or masonry veneer does not exceed the first-story height.

Date Submitted 12/12/2018
Chapter 6
Section 603
Affects HVHZ No
Proponent Bonnie Manley
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**
Alternate Language **No**

Related Modifications

7856, 7858, 7989, 7991

Summary of Modification

Deletes Section R603 and replaces it with a reference to AISI S230 in accordance with Section R301.2.1.1.

Rationale

In Florida, Section R301.2.1.1 of the residential code exempts the prescriptive provisions for cold-formed steel light frame construction in Section R603. Rather than continue to maintain the prescriptive provisions of Section R603, which aren't used anywhere in the state, we recommend deleting the provisions in favor of a direct reference to AISI S230, as is currently contained in Section R301.2.1.1. Similar modifications will be recommended for Section R505 and Section R804.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

Delete Section R603, Cold-Formed Steel Wall Framing, in its entirety and replace with the following:

Section R603 COLD-FORMED STEEL WALL FRAMING

R603.1 General. In accordance with Section R301.2.1.1, the design of cold-formed steel wall framing shall be in accordance with AISI S230, *Standard for Cold-Formed Steel Framing— Prescriptive Method For One- and Two-Family Dwellings*.

Date Submitted	12/11/2018	**Section**	602.10.5	**Proponent**	Borjen Yeh
Chapter	6	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No | **Alternate Language** No

Related Modifications

Summary of Modification

Revise Table R602.10.5

Rationale

The proposed table was reorganized to place the portal frame bracing methods at the bottom of the table for clarity. It also updates the measured of wall height for portal frame based on full-scale tests contained in APA Report T2014L-39 (Copies available for free download at www.apawood.org). Another change is proposed for Footnotes (d) and (e). Currently, both footnotes specify a maximum opening height of 10 feet, when the figures referenced in the footnotes clearly provide for a maximum 10-foot-header height. This change corrects contradictions existent in the present edition of the code. All changes proposed above have been published in the 2018 IRC.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal clarifies the intent of the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

R602.10.5 Minimum length of a braced wall panel.

The minimum length of a *braced wall panel* shall comply with Table R602.10.5. For Methods CS-WSP and CS-SFB, the minimum panel length shall be based on the adjacent clear opening height in accordance with Table R602.10.5 and Figure R602.10.5. Where a panel has an opening on either side of differing heights, the taller opening height shall be used to determine the panel length.

TABLE R602.10.5

MINIMUM LENGTH OF BRACED WALL PANELS

METHOD(See Table R602.10.4)		MINIMUM LENGTH[a](inches)					CONTRIBUTING LENGTH(inches)
		Wall Height					
		8 feet	9 feet	10 feet	11 feet	12 feet	
DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP		48	48	48	53	58	Actual[b]
GB		48	48	48	53	58	Double sided = ActualSingle sided = 0.5 × Actual
LIB		55	62	69	NP	NP	Actual[b]
ABW	SDC A, B and C, ultimatedesign wind speed < 140 mph	28	32	34	38	42	48
	SDC D_0, D_1 and D_2, ultimatedesign wind speed < 140 mph	32	32	34	NP	NP	
~~PFH~~	~~Supporting roof only~~	~~16~~	~~16~~	~~16~~	~~18[c]~~	~~20[c]~~	48
	~~Supporting one story and roof~~	~~24~~	~~24~~	~~24~~	~~27[c]~~	~~29[c]~~	48
~~PFG~~		~~24~~	~~27~~	~~30~~	~~33[d]~~	~~36[d]~~	~~1.5 × Actual[b]~~
CS-G		24	27	30	33	36	Actual[b]
~~CS-PF~~	~~SDC A, B and C~~	~~16~~	~~18~~	~~20~~	~~22[e]~~	~~24[e]~~	~~1.5 × Actual[b]~~
	~~SDC D_0, D_1 and D_2~~	~~16~~	~~18~~	~~20~~	~~22[e]~~	~~24[e]~~	~~Actual[b]~~
CS-WSP,	Adjacent clear opening height(inches)						

CS-SFB	= 64	24	27	30	33	36	
	68	26	27	30	33	36	
	72	27	27	30	33	36	
	76	30	29	30	33	36	
	80	32	30	30	33	36	
	84	35	32	32	33	36	
	88	38	35	33	33	36	
	92	43	37	35	35	36	
	96	48	41	38	36	36	Actual[b]
	100	—	44	40	38	38	
	104	—	49	43	40	39	
	108	—	54	46	43	41	
	112	—	—	50	45	43	
	116	—	—	55	48	45	
	120	—	—	60	52	48	
	124	—	—	—	56	51	

	128	—	—	—	61	54
	132	—	—	—	66	58
	136	—	—	—	—	62
	140	—	—	—	—	66
	144	—	—	—	—	72

METHOD(See Table R602.10.4)		Portal Header Height					CONTRIBUTING LENGTH(inches)
		8 feet	9 feet	10 feet	11 feet	12 feet	
(delete this empty row)							
PFH	Supporting roof only	16	16	16	18c	20c	48
	Supporting one story and roof	24	24	24	27c	29c	48
PFG		24	27	30	33d	36d	1.5 × Actualb
(delete this empty row)							
CS-PF	SDC A, B and C	16	18	20	22e	24e	1.5 × Actualb
	SDC D_0, D_1 and D_2	16	18	20	22e	24e	Actualb

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s.

NP = Not Permitted.

1. a.Linear interpolation shall be permitted.
2. b.Use the actual length where it is greater than or equal to the minimum length.
3. c.Maximum header height for PFH is 10 feet in accordance with Figure R602.10.6.2, but wall height shall be permitted to be increased to 12 feet with pony wall.
4. d.Maximum ~~opening~~ header height for PFG is 10 feet in accordance with Figure R602.10.6.3, but wall height shall be permitted to be increased to 12 feet with pony wall.
5. e.Maximum ~~opening~~ header height for CS-PF is 10 feet in accordance with Figure R602.10.6.4, but wall height shall be permitted to be increased to 12 feet with pony wall.

S7949

Date Submitted	12/12/2018	**Section**	602.1.3	**Proponent**	Borjen Yeh
Chapter	6	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Update the referenced standards for structural glued laminated timber.

Rationale

This proposal updates the references standard for ANSI A190.1 for structural glued laminated timber (glulam). ANSI/AITC A190.1 is now designed as ANSI A190.1. It also adds ANSI 117 to the code because the glulam layup combinations and laminating lumber grading requirements are included in ANSI 117.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal updates the referenced standards in the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

R602.1.3 Structural glued-laminated timbers.

Glued-laminated timbers shall be manufactured and identified as required in ANSI/~~AITC~~ A190.1, ANSI 117 and ASTM D3737.

S8010

Date Submitted	12/12/2018	**Section**	602.3	**Proponent**	Paul Coats
Chapter	6	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No | **Alternate Language** No

Related Modifications

Summary of Modification

Minor editorial corrections, updates, correlations, and added options to Table 602.3(1) Fastener Schedule.

Rationale

The modification affects only items 7, 13, 23, 29, 33, and 34 of Table 602.3(1), and footnote "c" of Table R602.10.3(4). This modification was approved by the ICC committees and membership and appears in the 2018 edition of the IRC. See the reason statement in the attached uploaded support file for information about each item. The explanation exceeded the allowable space for this input field.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Improves enforceability

Impact to building and property owners relative to cost of compliance with code

No cost-related impact.

Impact to industry relative to the cost of compliance with code

No cost-related impact.

Impact to small business relative to the cost of compliance with code

No cost-related impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improvements to the fastener table, yes.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness.

Mod 8010

TABLE R602.3(1)

FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPEOF FASTENER[a, b, c]	SPACING AND LOCATION
Roof			
1	Blocking between ceiling joists or rafters to top plate	4-8d box (2 1/2" × 0.113") or3-8d common (2 1/2" × 0.131"); or3-10d box (3" × 0.128"); or3-3" × 0.131" nails	Toe nail
2	Ceiling joists to top plate	4-8d box (2 1/2" × 0.113"); or3-8d common (2 1/2" × 0.131"); or3-10d box (3" × 0.128"); or3-3" × 0.131" nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Sections R802.3.1, R802.3.2 and Table R802.5.1(9)]	4-10d box (3" × 0.128"); or3-16d common (3 1/2" × 0.162"); or4-3" × 0.131" nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Sections R802.3.1 and R802.3.2 and Table R802.5.1(9)]	Table R802.5.1(9)	Face nail
5	Collar tie to rafter, face nail or 1 1/4" × 20 ga. ridge strap to rafter	4-10d box (3" × 0.128"); or3-10d common (3" × 0.148"); or4-3" × 0.131" nails	Face nail each rafter
6	Rafter or roof truss to plate	3-16d box nails (3 1/2" × 0.135"); or3-10d common nails (3" × 0.148"); or4-10d box (3" × 0.128"); or4-3" × 0.131" nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss[i]
7	Roof rafters to ridge, valley or hip rafters or roof rafterto minimum 2" ridge beam	4-16d (3 1/2" × 0.135"); or3-10d common (3 1/2" × 0.148"); or4-10d box (3" × 0.128"); or4-3" × 0.131" nails	Toe nail
		3-16d box 3 1/2" × 0.135"); or2-16d common (3 1/2" × 0.162"); or3-10d box (3" × 0.128"); or3-3" × 0.131" nails	End nail
Wall			
8	Stud to stud (not at braced wall panels)	16d common (3 1/2" × 0.162")	24" o.c. face nail
		10d box (3" × 0.128"); or3" × 0.131" nails	16" o.c. face nail
9	Stud to stud and abutting studs at intersecting wall corners(at braced wall panels)	16d box (3 1/2" × 0.135"); or3" × 0.131" nails	12" o.c. face nail
		16d common (3 1/2" × 0.162")	16" o.c. face nail
10	Built-up header (2" to 2" header with 1/2" spacer)	16d common (3 1/2" × 0.162")	16" o.c. each edge face nail

		16d box ($3^1/_2$" × 0.135")	12" o.c. each edge face nail
11	Continuous header to stud	5-8d box ($2^1/_2$" × 0.113"); or4-8d common ($2^1/_2$" × 0.131"); or4-10d box (3" × 0.128")	Toe nail
12	Top plate to top plate	16d common ($3^1/_2$" × 0.162")	16" o.c. face nail
		10d box (3" × 0.128"); or3" × 0.131" nails	12" o.c. face nail
13	Double top plate spli~~ce for SDCs A-D_2 with seismic bracedwall line spacing < 25'~~	8-16d common ($3^1/_2$" × 0.162"); or12-16d box ($3^1/_2$" × 0.135"); or12-10d box (3" × 0.128"); or12-3" × 0.131" nails	Face nail on each side of end joint(minimum 24" lap splice length eachside of end joint)
	~~Double top plate splice SDCs D_0, D_1, or D_2; and bracedwallline spacing = 25'~~	~~12-16d ($3^1/_2$" × 0.135")~~	
14	Bottom plate to joist, rim joist, band joist orblocking (not at braced wall panels)	16d common ($3^1/_2$" × 0.162")	16" o.c. face nail
		16d box ($3^1/_2$" × 0.135"); or3" × 0.131" nails	12" o.c. face nail
15	Bottom plate to joist, rim joist, band joist orblocking (at braced wall panel)	3-16d box ($3^1/_2$" × 0.135"); or2-16d common ($3^1/_2$" × 0.162"); or4-3" × 0.131" nails	3 each 16" o.c. face nail2 each 16" o.c. face nail4 each 16" o.c. face nail
16	Top or bottom plate to stud	4-8d box ($2^1/_2$" × 0.113"); or3-16d box ($3^1/_2$" × 0.135"); or4-8d common ($2^1/_2$" × 0.131"); or4-10d box (3" × 0.128"); or4-3" × 0.131" nails	Toe nail
		3-16d box ($3^1/_2$" × 0.135"); or2-16d common ($3^1/_2$" × 0.162"); or3-10d box (3" × 0.128"); or3-3" × 0.131" nails	End nail
17	Top plates, laps at corners and intersections	3-10d box (3" × 0.128"); or2-16d common ($3^1/_2$" × 0.162"); or3-3" × 0.131" nails	Face nail
18	1" brace to each stud and plate	3-8d box ($2^1/_2$" × 0.113"); or2-8d common ($2^1/_2$" × 0.131"); or2-10d box (3" × 0.128"); or2 staples $1^3/_4$"	Face nail
19	1" × 6" sheathing to each bearing	3-8d box ($2^1/_2$" × 0.113"); or2-8d common ($2^1/_2$" × 0.131"); or2-10d box (3" × 0.128"); or2 staples, 1" crown, 16 ga., $1^3/_4$" long	Face nail
20	1" × 8" and wider sheathing to each bearing	3-8d box ($2^1/_2$" × 0.113"); or3-8d common ($2^1/_2$" × 0.131"); or3-10d box (3" × 0.128"); or3 staples, 1" crown, 16 ga., $1^3/_4$" long	Face nail
		Wider than 1" × 8"4-8d box ($2^1/_2$" × 0.113"); or3-8d common ($2^1/_2$" × 0.131");	

		or3-10d box (3" × 0.128"); or4 staples, 1" crown, 16 ga., 1$^{3}/_{4}$" long	
		Floor	
21	Joist to sill, top plate or girder	4-8d box (2$^{1}/_{2}$" × 0.113"); or3-8d common (2$^{1}/_{2}$" × 0.131"); or3-10d box (3" × 0.128"); or3-3" × 0.131" nails	Toe nail
22	Rim joist, band joist or blocking to sill or topplate (roof applications also)	8d box (2$^{1}/_{2}$" × 0.113")	4" o.c. toe nail
		8d common (2$^{1}/_{2}$" × 0.131"); or10d box (3" × 0.128"); or3" × 0.131" nails	6" o.c. toe nail
23	1" × 6" subfloor or less to each joist	• 3-8d box (2$^{1}/_{2}$" × 0.113"); or2-8d common (2$^{1}/_{2}$" × 0.131"); or~~3~~2-10d box (3" × 0.128"); or2 staples, 1" crown, 16 ga., 1$^{3}/_{4}$" long	Face nail
24	2" subfloor to joist or girder	3-16d box (3$^{1}/_{2}$" × 0.135"); or2-16d common (3$^{1}/_{2}$" × 0.162")	Blind and face nail
25	2" planks (plank & beam—floor & roof)	3-16d box (3$^{1}/_{2}$" × 0.135"); or2-16d common (3$^{1}/_{2}$" × 0.162")	At each bearing, face nail
26	Band or rim joist to joist	3-16d common (3$^{1}/_{2}$" × 0.162")4-10 box (3" × 0.128"), or4-3" × 0.131" nails; or4-3" × 14 ga. staples, $^{7}/_{16}$" crown	End nail
27	Built-up girders and beams, 2-inch lumberlayers	20d common (4" × 0.192"); or	Nail each layer as follows: 32" o.c.at top and bottom and staggered.
		10d box (3" × 0.128"); or3" × 0.131" nails	24" o.c. face nail at top and bottomstaggered on opposite sides
		And:2-20d common (4" × 0.192"); or3-10d box (3" × 0.128"); or3-3" × 0.131" nails	Face nail at ends and at each splice
28	Ledger strip supporting joists or rafters	4-16d box (3$^{1}/_{2}$" × 0.135"); or3-16d common (3$^{1}/_{2}$" × 0.162"); or4-10d box (3" × 0.128"); or4-3" × 0.131" nails	At each joist or rafter, face nail
29	Bridging or blocking to joist	2-10d box (3" × 0.128"), or 2-8d common (2-1/2" x 0.131"; or 2-3" x 0.131") nails	Each end, toe nail

ITEM	DESCRIPTIONOF BUILDING ELEMENTS	NUMBER ANDTYPE OF FASTENER[a, b, c]	SPACING OF FASTENERS	
			Edges(inches)[h]	Intermediatesupports[c, e](inches)
Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing[see Table R602.3(3) for wood structural panel *exterior wall sheathing to wall framing]*				

30	3/8" – 1/2"	6d common (2" × 0.113") nail (subfloor, wall)[i]8d common (2 1/2" × 0.131") nail (roof)	6	12[f]
31	19/32" – 1"	8d common nail (2 1/2" × 0.131")	6	12[f]
32	1 1/8" – 1 1/4"	10d common (3" × 0.148") nail; or8d (2 1/2" × 0.131") deformed nail	6	12
Other wall sheathing[g]				
33	1/2" structural cellulosic fiberboardsheathing	1 1/2" galvanized roofing nail, 7/16" head diameter, or ~~1" crown staple 16 ga.,~~ 1 1/4" long 16 ga. Staple with 7/16" or 1" crown	3	6
34	25/32" structural cellulosicfiberboard sheathing	1 3/4" galvanized roofing nail, 7/16" head diameter, or ~~1" crown staple 16 ga., 1 1/4" long~~1 ½" long 16 ga. staple with 7/16" or 1" crown	3	6
35	1/2" gypsum sheathing[d]	1 1/2" galvanized roofing nail; staple galvanized,1 1/2" long; 1 1/4" screws, Type W or S	7	7
36	5/8" gypsum sheathing[d]	1 3/4" galvanized roofing nail; staple galvanized,1 5/8" long; 1 5/8" screws, Type W or S	7	7
Wood structural panels, combination subfloor underlayment to framing				
37	3/4" and less	6d deformed (2" × 0.120") nail; or8d common (2 1/2" × 0.131") nail	6	12
38	7/8" – 1"	8d common (2 1/2" × 0.131") nail; or8d deformed (2 1/2" × 0.120") nail	6	12
39	1 1/8" – 1 1/4"	10d common (3" × 0.148") nail; or8d deformed (2 1/2" × 0.120") nail	6	12

Revise footnote "c" to Table R602.10.3(4) Seismic Adjustment Factors to the Required Length of Wall Bracing as follows:

c.The length-to-width ratio for the floor/roof *diaphragm* shall not exceed 3:1~~. The top plate lap splice nailing shall be in accordance with Table R602.3(1), Item 13.~~

RB219-16

IRC: R602.10.3, R602.3.

Proponent : Paul Coats, PE CBO, American Wood Council, representing American Wood Council (pcoats@awc.org)

2015 International Residential Code

Revise as follows:

TABLE R602.3(1)
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
		Roof	
1	Blocking between ceiling joists or rafters to top plate	4-8d box (2 1/2″ × 0.113″) or 3-8d common (2 1/2″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
2	Ceiling joists to top plate	4-8d box (2 1/2″ × 0.113″); or 3-8d common (2 1/2″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Sections R802.3.1, R802.3.2 and Table R802.5.1(9)]	4-10d box (3″ × 0.128″); or 3-16d common (3 1/2″ × 0.162″); or 4-3″ × 0.131″ nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Sections R802.3.1 and R802.3.2 and Table R802.5.1(9)]	Table R802.5.1(9)	Face nail
5	Collar tie to rafter, face nail or 1 1/4″ × 20 ga. ridge strap to rafter	4-10d box (3″ × 0.128″); or 3-10d common (3″ × 0.148″); or 4-3″ × 0.131″ nails	Face nail each rafter
6	Rafter or roof truss to plate	3-16d box nails (3 1/2″ × 0.135″); or 3-10d common nails (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss[i]
7	Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2″ ridge beam	4-16d (3 1/2″ × 0.135″); or 3-10d common (3~~1/2~~″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box 3 1/2″ × 0.135″); or 2-16d common (3 1/2″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
		Wall	
8	Stud to stud (not at braced wall panels)	16d common (3 1/2″ × 0.162″)	24″ o.c. face nail
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	16″ o.c. face nail
9	Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d box (3 1/2″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
		16d common (3 1/2″ × 0.162″)	16″ o.c. face nail
10	Built-up header (2″ to 2″ header with 1/2″ spacer)	16d common (3 1/2″ × 0.162″)	16″ o.c. each edge face nail
		16d box (3 1/2″ × 0.135″)	12″ o.c. each edge face nail

11	Continuous header to stud	5-8d box (2 1/2 ″ × 0.113″); or 4-8d common (2 1/2 ″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toe nail
12	Top plate to top plate	16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	12″ o.c. face nail
13	Double top plate splice ~~for SDCs A-D2 with seismic braced wall line spacing~~	8-16d common (3 1/2 ″ × 0.162″); or 12-16d box (3 1/2 ″ × 0.135″); or 12-10d box (3″ × 0.128″); or 12-3″ × 0.131″ nails	Face nail on each side of end joint (minimum 24″ lap splice length each side of end joint)
	~~Double top plate splice SDCs D_0, D_1, or D_2; and braced wall line spacing ≥ 25′~~	~~12-16d (3 1/2 ″ × 0.135″)~~	

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
14	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail
		16d box (3 1/2 ″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
15	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box (3 1/2 ″ × 0.135″); or 2-16d common (3 1/2 ″ × 0.162″); or 4-3″ × 0.131″ nails	3 each 16″ o.c. face nail 2 each 16″ o.c. face nail 4 each 16″ o.c. face nail
16	Top or bottom plate to stud	4-8d box (2 1/2 ″ × 0.113″); or 3-16d box (3 1/2 ″ × 0.135″); or 4-8d common (2 1/2 ″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box (3 1/2 ″ × 0.135″); or 2-16d common (3 1/2 ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
17	Top plates, laps at corners and intersections	3-10d box (3″ × 0.128″); or 2-16d common (3 1/2 ″ × 0.162″); or 3-3″ × 0.131″ nails	Face nail
18	1″ brace to each stud and plate	3-8d box (2 1/2 ″ × 0.113″); or 2-8d common (2 1/2 ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples 1 3/4 ″	Face nail
19	1″ × 6″ sheathing to each bearing	3-8d box (2 1/2 ″ × 0.113″); or 2-8d common (2 1/2 ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., 1 3/4 ″ long	Face nail
20	1″ × 8″ and wider sheathing to each bearing	3-8d box (2 1/2 ″ × 0.113″); or 3-8d common (2 1/2 ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3 staples, 1″ crown, 16 ga., 1 3/4 ″ long	Face nail
		Wider than 1″ × 8″ 4-8d box (2 1/2 ″ × 0.113″); or 3-8d common (2 1/2 ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 4 staples, 1″ crown, 16 ga., 1 3/4 ″ long	
Floor			

21	Joist to sill, top plate or girder	4-8d box (2 1/2 ″ × 0.113″); or 3-8d common (2 1/2 ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
22	Rim joist, band joist or blocking to sill or top plate (roof applications also)	8d box (2 1/2 ″ × 0.113″)	4″ o.c. toe nail
		8d common (2 1/2 ″ × 0.131″); or 10d box (3″ × 0.128″); or 3″ × 0.131″ nails	6″ o.c. toe nail
23	1″ × 6″ subfloor or less to each joist	3-8d box (2 1/2 ″ × 0.113″); or 2-8d common (2 1/2 ″ × 0.131″); or ~~3~~2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., 1 3/4 ″ long	Face nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Floor			
24	2″subfloor to joist or girder	3-16d box (3 1/2 ″× 0.135″); or 2-16d common (3 1/2 ″× 0.162″)	Blind and face nail
25	2″planks (plank & beam—floor & roof)	3-16d box (3 1/2 ″× 0.135″); or 2-16d common (3 1/2 ″× 0.162″)	At each bearing, face nail
26	Band or rim joist to joist	3-16d common (3 1/2 ″× 0.162″) 4-10 box (3″× 0.128″), or 4-3″× 0.131″nails; or 4-3″× 14 ga. staples, 7/16 ″crown	End nail
27	Built-up girders and beams, 2-inch lumber layers	20d common (4″× 0.192″); or	Nail each layer as follows: 32″o.c. at top and bottom and staggered.
		10d box (3″× 0.128″); or 3″× 0.131″nails	24″o.c. face nail at top and bottom staggered on opposite sides
		And: 2-20d common (4″× 0.192″); or 3-10d box (3″× 0.128″); or 3-3″× 0.131″nails	Face nail at ends and at each splice
28	Ledger strip supporting joists or rafters	4-16d box (3 1/2 ″× 0.135″); or 3-16d common (3 1/2 ″× 0.162″); or 4-10d box (3″× 0.128″); or 4-3″× 0.131″nails	At each joist or rafter, face nail
29	Bridging or blocking to joist	2-10d box (3″× 0.128″), or 2-8d common (2-1/2″ x 0.131″; or 2-3″ x 0.131″ nails	Each end, toe nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING OF FASTENERS	
			Edges (inches)[h]	Intermediate supports[c, e] (inches)
Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing [see Table R602.3(3) for wood structural panel *exterior* wall sheathing to wall framing]				
		6d common (2″× 0.113″) nail		
		8d common nail		

30	3/8"– 1/2"	(subfloor, wall)[i] 8d common (2 1/2"× 0.131") nail (roof)	6	12[f]
31	19/32"– 1"	(2 1/2"× 0.131")	6	12[f]
32	1 1/8"–1 1/4"	10d common (3"× 0.148") nail; or 8d (2 1/2"× 0.131") deformed nail	6	12
Other wall sheathing[g]				
33	1/2" structural cellulosic fiberboard sheathing	1 1/2" galvanized roofing nail, 7/16" head diameter, or ~~1" crown staple 16 ga.,~~ 1 1/4" long 16 ga. staple with 7/16" or 1" crown	3	6
34	25/32" structural cellulosic fiberboard sheathing	1 3/4" galvanized roofing nail, 7/16" head diameter, or ~~1" crown staple 16 ga., 1 1/4" long~~ 1-1/2" long 16 ga. staple with 7/16" or 1" crown	3	6
35	1/2" gypsum sheathing[d]	1 1/2" galvanized roofing nail; staple galvanized, 1 1/2" long; 1 1/4" screws, Type W or S	7	7
36	5/8" gypsum sheathing[d]	1 3/4" galvanized roofing nail; staple galvanized, 1 5/8" long; 1 5/8" screws, Type W or S	7	7
Wood structural panels, combination subfloor underlayment to framing				
37	3/4" and less	6d deformed (2"× 0.120") nail; or 8d common (2 1/2"× 0.131") nail	6	12
38	7/8"– 1"	8d common (2 1/2"× 0.131") nail; or 8d deformed (2 1/2"× 0.120") nail	6	12
39	1 1/8"– 1 1/4"	10d common (3"× 0.148") nail; or 8d deformed (2 1/2"× 0.120") nail	6	12

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.

a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.

b. Staples are 16 gage wire and have a minimum 7/16-inch on diameter crown width.

c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.

d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.

e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).

f. Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.

g. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.

h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.

i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

TABLE R602.10.3 (4)
SEISMIC ADJUSTMENT FACTORS TO THE REQUIRED LENGTH OF WALL BRACING

ITEM NUMBER	ADJUSTMENT BASED ON:	STORY	CONDITION	ADJUSTMENT FACTOR[a, b] [Multiply length from Table R602.10.3(3) by this factor]	APPLICABLE METHODS
1	Story height (Section 301.3)	Any story	≤ 10 feet	1.0	All methods
			> 10 feet and ≤ 12 feet	1.2	
2	Braced wall line spacing, townhouses in SDC C	Any story	≤ 35 feet	1.0	
			> 35 feet and ≤ 50 feet	1.43	
3	Braced wall line spacing, in SDC D_0, D_1, D_2[c]	Any story	> 25 feet and ≤ 30 feet	1.2	
			> 30 feet and ≤ 35 feet	1.4	
			> 8 psf and < 15		

4	Wall dead load	Any story	psf	1.0	
			< 8 psf	0.85	
5	Roof/ceiling dead load for wall supporting	1-, 2- or 3-story building	≤15 psf	1.0	
		2- or 3-story building	> 15 psf and ≤ 25 psf	1.1	
		1-story building	> 15 psf and ≤ 25 psf	1.2	
6	Walls with stone or masonry veneer, townhouses in SDC C[d, e]		1.0		All methods
			1.5		
			1.5		
7	Walls with stone or masonry veneer, detached one- and two-family dwellings in SDC $D_0 – D_2$[d, f]	Any story	See Table R602.10.6.5		BV-WSP
8	Interior gypsum board finish (or equivalent)	Any story	Omitted from inside face of braced wall panels	1.5	DWB, WSP, SFB, PBS, PCP, HPS, CS-WSP, CS-G, CS-SFB

For SI: 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. Linear interpolation shall be permitted.

b. The total length of bracing required for a given wall line is the product of all applicable adjustment factors.

c. The length-to-width ratio for the floor/roof *diaphragm* shall not exceed 3:1. ~~The top plate lap splice nailing shall be in accordance with Table R602.3(1), Item 13.~~

d. Applies to stone or masonry veneer exceeding the first story height.

e. The adjustment factor for stone or masonry veneer shall be applied to all exterior *braced wall lines* and all *braced wall lines* on the interior of the building, backing or perpendicular to and laterally supported veneered walls.

f. See Section R602.10.6.5 for requirements where stone or masonry veneer does not exceed the first-story height.

Reason: ITEM 7: The correct length of the 10d common nail is 3", not 3-1/2". 10d common is correctly shown as 3" long elsewhere in the table. This is considered to be an editorial change as a 10d common nail is 3" long per ASTM F1667 and correctly shown as 3" long elsewhere in the table.
ITEM 13: Multiple changes to the top plate splice nailing were approved in the previous code change cycle. One change, RB272-13, increased the nailing of the top plate splice to bring it in line with the 2015 IBC as well as to include nailing schedules that are of roughly equivalent lateral resistance. A second change, RB274-13, specified increased top plate splice nailing only for higher SDCs and where braced wall line spacing is greater than 25'. The combination of both proposals produced line 13 of the 2015 IRC in which the same double top plate splice nailing is shown for wall line spacing <25' and ≥25' (i.e. 12-16d (3-1/2" x 0.135" box nails). To simplify presentation of the top plate nailing schedule to the singular nailing pattern intended by RB272-13, it is proposed to delete language associated with triggering different nailing based on SDC or wall line spacing. The special reference from footnote c of Table R602.10.3(4) that addresses applicable top plate nailing is also no longer necessary with the proposed revision to a single nail schedule and is proposed to be deleted. Related: prior cycle RB272-13, RB274-13, Rb278-13.

ITEM 23: The equivalent nailing to the 8d common case is (2) 10d box versus (3) 10d box. 2 nails is consistent with item 24 in IBC Table 2304.10.1.

ITEM 29: The "bridging to joist" case was added during the previous code change cycle but included only the 10d (3" x 0.128") nail option. The 10d is clarified as a box nail size in this change. Other equivalent nail options are added and "or blocking" is added to the description to pick up the commonly used term for the application being described.

ITEMS 33 and 34: 7/16" crown was inadvertently excluded from change proposal RB278-13 which reorganized the fastening table to create a more consistent format between the IBC and IRC prescriptive fastening tables. This change restores the 7/16" crown. It also increases the staple length for 25/32" sheathing thickness which was previously proposed and approved (S75-06/07 Part II) but not picked up in publication.

REVISION TO FOOTNOTE c IN TABLE R602.10.3(4): See the explanation in Item 13 above, and the last sentence.

Cost Impact: Will not increase the cost of construction
Because these are mostly editorial corrections and correlations, it is not anticipated that the cost of construction will increase. For rows where the nailing changes slightly, current alternatives are also retained.

RB219-16 : TABLE R602.3-COATS11584

Final Action: AS (Approves as Submitted)

RB219-16

Errata: In Table R602,10.3(4), at Item 6 under story, the icons are not deleted.

Committee Action: **Approved as Submitted**

Committee Reason: The committee approved this proposal based on the proponents published reason statement.

Assembly Action: **None**

S8073

Date Submitted 12/13/2018	**Section** 602.3	**Proponent** Paul Coats
Chapter 6	**Affects HVHZ** No	**Attachments** Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Adds a standardized ring shank nail to the roof sheathing row of the fastener schedule Table R602.3(1)

Rationale

This modification was approved by the ICC committee and membership and appears in the 2018 edition of the International Residential Code. Connections and fastening for wind design need to be designed per R301.2.1.1 of the code, so this table has limited applicability. However, since it appears in the Florida code the table should be kept up to date. This change adds a new standardized roof sheathing ring shank (RSRS) nail for roof sheathing applications. The RSRS nail has been standardized in ASTM F1667 and added in this proposal as equivalent to the 8d common nail to resist uplift of roof sheathing. This standard ring shank nail provides improved withdrawal resistance relative to the 8d common smooth shank nail. A head size of 0.281" diameter is specified for the RSRS- 01 in ASTM F1667 which is equivalent to the head diameter of the 8d common nail. The slightly larger net area under the head (i.e. area of head minus area of shank) is considered to provide slightly improved head pull through performance.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Adds an additional nailing option; no impact.

Impact to building and property owners relative to cost of compliance with code

No cost-related impact.

Impact to industry relative to the cost of compliance with code

No cost-related impact.

Impact to small business relative to the cost of compliance with code

No cost-related impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves nailing alternatives.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code with an additional nailing alternative.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

Add the following to the "NUMBER AND TYPE OF FASTENER" column of rows 30 and 31 of Table R602.3(1) FASTENING SCHEDULE, and a new footnote "j" as follows:

30	3/8" – 1/2"	6d common (2" × 0.113") nail (subfloor, wall)i8d common (21/2" × 0.131") nail (roof); or RSRS-01 (2-3/8"
31	19/32" – 1"	8d common nail (21/2" × 0.131"); or RSRS-01 (2 3/8" x 0.113") nail (roof)[j]

j. RSRS-01 is a Roof Sheathing Ring Shank nail meeting the specifications in ASTM F1667.

TABLE R602.3 (1)
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Roof			
1	Blocking between ceiling joists or rafters to top plate	4-8d box ($2^1/_2$ ″ × 0.113″) or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
2	Ceiling joists to top plate	4-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Sections R802.3.1, R802.3.2 and Table R802.5.1(9)]	4-10d box (3″ × 0.128″); or 3-16d common ($3^1/_2$ ″ × 0.162″); or 4-3″ × 0.131″ nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Sections R802.3.1 and R802.3.2 and Table R802.5.1(9)]	Table R802.5.1(9)	Face nail
5	Collar tie to rafter, face nail or $1^1/_4$ ″ × 20 ga. ridge strap to rafter	4-10d box (3″ × 0.128″); or 3-10d common (3″ × 0.148″); or 4-3″ × 0.131″ nails	Face nail each rafter

6	Rafter or roof truss to plate	3-16d box nails (3 1/2 ″ × 0.135″); or 3-10d common nails (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss[i]
7	Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2″ ridge beam	4-16d (3 1/2 ″ × 0.135″); or 3-10d common (3 1/2 ″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box 3 1/2 ″ × 0.135″); or 2-16d common (3 1/2 ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
Wall			
8	Stud to stud (not at braced wall panels)	16d common (3 1/2 ″ × 0.162″)	24″ o.c. face nail
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	16″ o.c. face nail
9	Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d box (3 1/2 ″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
		16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail
10	Built-up header (2″ to 2″ header with 1/2 ″ spacer)	16d common (3 1/2 ″ × 0.162″)	16″ o.c. each edge face nail
		16d box (3 1/2 ″ × 0.135″)	12″ o.c. each edge face nail
11	Continuous header to stud	5-8d box (2 1/2 ″ × 0.113″); or 4-8d common (2 1/2 ″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toe nail
		16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail

12	Top plate to top plate	10d box (3″ × 0.128″); or 3″ × 0.131″ nails	12″ o.c. face nail
13	Double top plate splice for SDCs A-D2 with seismic braced wall line spacing	8-16d common ($3^{1}/_{2}$″ × 0.162″); or 12-16d box ($3^{1}/_{2}$″ × 0.135″); or 12-10d box (3″ × 0.128″); or 12-3″ × 0.131″ nails	Face nail on each side of end joint (minimum 24″ lap splice length each side of end joint)
	Double top plate splice SDCs D_0, D_1, or D_2; and braced wall line spacing ≥ 25′	12-16d ($3^{1}/_{2}$″ × 0.135″)	

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
14	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common ($3^{1}/_{2}$″ × 0.162″)	16″ o.c. face nail
		16d box ($3^{1}/_{2}$″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
15	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box ($3^{1}/_{2}$″ × 0.135″); or 2-16d common ($3^{1}/_{2}$″ × 0.162″); or 4-3″ × 0.131″ nails	3 each 16″ o.c. face nail 2 each 16″ o.c. face nail 4 each 16″ o.c. face nail
16	Top or bottom plate to stud	4-8d box ($2^{1}/_{2}$″ × 0.113″); or 3-16d box ($3^{1}/_{2}$″ × 0.135″); or 4-8d common ($2^{1}/_{2}$″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box ($3^{1}/_{2}$″ × 0.135″); or 2-16d common ($3^{1}/_{2}$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail

17	Top plates, laps at corners and intersections	3-10d box (3″ × 0.128″); or 2-16d common ($3^{1}/_{2}$ ″ × 0.162″); or 3-3″ × 0.131″ nails	Face nail
18	1″ brace to each stud and plate	3-8d box ($2^{1}/_{2}$ ″ × 0.113″); or 2-8d common ($2^{1}/_{2}$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples $1^{3}/_{4}$ ″	Face nail
19	1″ × 6″ sheathing to each bearing	3-8d box ($2^{1}/_{2}$ ″ × 0.113″); or 2-8d common ($2^{1}/_{2}$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1^{3}/_{4}$ ″ long	Face nail
20	1″ × 8″ and wider sheathing to each bearing	3-8d box ($2^{1}/_{2}$ ″ × 0.113″); or 3-8d common ($2^{1}/_{2}$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3 staples, 1″ crown, 16 ga., $1^{3}/_{4}$ ″ long	Face nail
		Wider than 1″ × 8″ 4-8d box ($2^{1}/_{2}$ ″ × 0.113″); or 3-8d common ($2^{1}/_{2}$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 4 staples, 1″ crown, 16 ga., $1^{3}/_{4}$ ″ long	
Floor			
21	Joist to sill, top plate or girder	4-8d box ($2^{1}/_{2}$ ″ × 0.113″); or 3-8d common ($2^{1}/_{2}$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
		8d box ($2^{1}/_{2}$ ″ × 0.113″)	4″ o.c. toe nail

22	Rim joist, band joist or blocking to sill or top plate (roof applications also)	8d common ($2^1/_2$ " × 0.131"); or 10d box (3" × 0.128"); or 3" × 0.131" nails	6" o.c. toe nail
23	1" × 6" subfloor or less to each joist	3-8d box ($2^1/_2$ " × 0.113"); or 2-8d common ($2^1/_2$ " × 0.131"); or 3-10d box (3" × 0.128"); or 2 staples, 1" crown, 16 ga., $1^3/_4$ " long	Face nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Floor			
24	2"subfloor to joist or girder	3-16d box ($3^1/_2$ "× 0.135"); or 2-16d common ($3^1/_2$ "× 0.162")	Blind and face nail
25	2"planks (plank & beam—floor & roof)	3-16d box ($3^1/_2$ "× 0.135"); or 2-16d common ($3^1/_2$ "× 0.162")	At each bearing, face nail
26	Band or rim joist to joist	3-16d common ($3^1/_2$ "× 0.162") 4-10 box (3"× 0.128"), or 4-3"× 0.131"nails; or 4-3"× 14 ga. staples, $^7/_{16}$ "crown	End nail
27	Built-up girders and beams, 2-inch lumber layers	20d common (4"× 0.192"); or	Nail each layer as follows: 32"o.c. at top and bottom and staggered.
		10d box (3"× 0.128"); or 3"× 0.131"nails	24"o.c. face nail at top and bottom staggered on opposite sides
		And: 2-20d common (4"×	

		0.192"); or 3-10d box (3"× 0.128"); or 3-3"× 0.131"nails	Face nail at ends and at each splice	
28	Ledger strip supporting joists or rafters	4-16d box (3 1/2"× 0.135"); or 3-16d common (3 1/2"× 0.162"); or 4-10d box (3"× 0.128"); or 4-3"× 0.131"nails	At each joist or rafter, face nail	
29	Bridging to joist	2-10d (3"× 0.128")	Each end, toe nail	
ITEM	**DESCRIPTION OF BUILDING ELEMENTS**	**NUMBER AND TYPE OF FASTENER**[a, b, c]	**SPACING OF FASTENERS**	
			Edges (inches)[h]	**Intermediate supports**[c, e] **(inches)**
Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing [see Table R602.3(3) for wood structural panel *exterior* wall sheathing to wall framing]				
30	3/8"– 1/2"	6d common (2"× 0.113") nail (subfloor, wall)[i] 8d common (2 1/2"× 0.131") nail (roof); or RSRS-01 (2-3/8" x 0.113") nail (roof)[j]	6	12[f]
31	19/32"– 1"	8d common nail (2 1/2"× 0.131"); or RSRS-01 (2 3/8" x 0.113") nail (roof)[j]	6	12[f]
32	11/8"–11/4"	10d common (3"× 0.148") nail; or 8d (21/2"× 0.131") deformed nail	6	12
Other wall sheathing[g]				
	1/2"structural cellulosic	1 1/2"galvanized roofing nail, 7		

33	fiberboard sheathing	/16 " head diameter, or 1"crown staple 16 ga., 1 1/4 " long	3	6
34	25 /32 "structural cellulosic fiberboard sheathing	1 3/4 "galvanized roofing nail, 7/16 "head diameter, or 1"crown staple 16 ga., 1 1/4 " long	3	6
35	1/2 "gypsum sheathing[d]	1 1/2 "galvanized roofing nail; staple galvanized, 1 1/2 "long; 1 1/4 " screws, Type W or S	7	7
36	5/8 "gypsum sheathing[d]	1 3/4 "galvanized roofing nail; staple galvanized, 1 5/8 " long; 1 5/8 " screws, Type W or S	7	7
Wood structural panels, combination subfloor underlayment to framing				
37	3/4 " and less	6d deformed (2"× 0.120") nail; or 8d common (2 1/2 "× 0.131") nail	6	12
38	7/8 "– 1"	8d common (2 1/2 "× 0.131") nail; or 8d deformed (2 1/2 "× 0.120") nail	6	12
39	1 1/8 "– 1 1/4 "	10d common (3"× 0.148") nail; or 8d deformed (2 1/2 "× 0.120") nail	6	12

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.

a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.

b. Staples are 16 gage wire and have a minimum 7/16-inch on diameter crown width.

c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.

d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.

e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).

f. Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.

g. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.

h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.

i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

j. RSRS-01 is a Roof Sheathing Ring Shank nail meeting the specifications in ASTM F1667.

Final Action: AS (Approved as Submitted)

RB220-16

IRC: R602.3.

Proponent : Paul Coats, PE CBO, American Wood Council, representing American Wood Council (pcoats@awc.org)

2015 International Residential Code

**TABLE R602.3 (1)
FASTENING SCHEDULE**

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Roof			
1	Blocking between ceiling joists or rafters to top plate	4-8d box ($2\frac{1}{2}$″ × 0.113″) or 3-8d common ($2\frac{1}{2}$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
2	Ceiling joists to top plate	4-8d box ($2\frac{1}{2}$″ × 0.113″); or 3-8d common ($2\frac{1}{2}$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Sections R802.3.1, R802.3.2 and Table R802.5.1(9)]	4-10d box (3″ × 0.128″); or 3-16d common ($3\frac{1}{2}$″ × 0.162″); or 4-3″ × 0.131″ nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Sections R802.3.1 and R802.3.2 and Table R802.5.1(9)]	Table R802.5.1(9)	Face nail
5	Collar tie to rafter, face nail or $1\frac{1}{4}$″ × 20 ga. ridge strap to rafter	4-10d box (3″ × 0.128″); or 3-10d common (3″ × 0.148″); or 4-3″ × 0.131″ nails	Face nail each rafter

6	Rafter or roof truss to plate	3-16d box nails (3 1/2 ″ × 0.135″); or 3-10d common nails (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss[i]
7	Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2″ ridge beam	4-16d (3 1/2 ″ × 0.135″); or 3-10d common (3 1/2 ″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box 3 1/2 ″ × 0.135″); or 2-16d common (3 1/2 ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
Wall			
8	Stud to stud (not at braced wall panels)	16d common (3 1/2 ″ × 0.162″)	24″ o.c. face nail
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	16″ o.c. face nail
9	Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d box (3 1/2 ″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
		16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail
10	Built-up header (2″ to 2″ header with 1/2 ″ spacer)	16d common (3 1/2 ″ × 0.162″)	16″ o.c. each edge face nail
		16d box (3 1/2 ″ × 0.135″)	12″ o.c. each edge face nail
11	Continuous header to stud	5-8d box (2 1/2 ″ × 0.113″); or 4-8d common (2 1/2 ″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toe nail
		16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail

12	Top plate to top plate	10d box (3″ × 0.128″); or 3″ × 0.131″ nails	12″ o.c. face nail
13	Double top plate splice for SDCs A-D2 with seismic braced wall line spacing	8-16d common ($3^1/_2$ ″ × 0.162″); or 12-16d box ($3^1/_2$ ″ × 0.135″); or 12-10d box (3″ × 0.128″); or 12-3″ × 0.131″ nails	Face nail on each side of end joint (minimum 24″ lap splice length each side of end joint)
	Double top plate splice SDCs D_0 , D_1 , or D_2 ; and braced wall line spacing ≥ 25′	12-16d ($3^1/_2$ ″ × 0.135″)	

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
14	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common ($3^1/_2$ ″ × 0.162″)	16″ o.c. face nail
		16d box ($3^1/_2$ ″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
15	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box ($3^1/_2$ ″ × 0.135″); or 2-16d common ($3^1/_2$ ″ × 0.162″); or 4-3″ × 0.131″ nails	3 each 16″ o.c. face nail 2 each 16″ o.c. face nail 4 each 16″ o.c. face nail
16	Top or bottom plate to stud	4-8d box ($2^1/_2$ ″ × 0.113″); or 3-16d box ($3^1/_2$ ″ × 0.135″); or 4-8d common ($2^1/_2$ ″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box ($3^1/_2$ ″ × 0.135″); or 2-16d common ($3^1/_2$ ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail

17	Top plates, laps at corners and intersections	3-10d box (3″ × 0.128″); or 2-16d common ($3\frac{1}{2}$″ × 0.162″); or 3-3″ × 0.131″ nails	Face nail
18	1″ brace to each stud and plate	3-8d box ($2\frac{1}{2}$″ × 0.113″); or 2-8d common ($2\frac{1}{2}$″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples $1\frac{3}{4}$″	Face nail
19	1″ × 6″ sheathing to each bearing	3-8d box ($2\frac{1}{2}$″ × 0.113″); or 2-8d common ($2\frac{1}{2}$″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1\frac{3}{4}$″ long	Face nail
20	1″ × 8″ and wider sheathing to each bearing	3-8d box ($2\frac{1}{2}$″ × 0.113″); or 3-8d common ($2\frac{1}{2}$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3 staples, 1″ crown, 16 ga., $1\frac{3}{4}$″ long Wider than 1″ × 8″ 4-8d box ($2\frac{1}{2}$″ × 0.113″); or 3-8d common ($2\frac{1}{2}$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 4 staples, 1″ crown, 16 ga., $1\frac{3}{4}$″ long	Face nail
Floor			
21	Joist to sill, top plate or girder	4-8d box ($2\frac{1}{2}$″ × 0.113″); or 3-8d common ($2\frac{1}{2}$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
		8d box ($2\frac{1}{2}$″ × 0.113″)	4″ o.c. toe nail

22	Rim joist, band joist or blocking to sill or top plate (roof applications also)	8d common ($2^1/_2$" × 0.131"); or 10d box (3" × 0.128"); or 3" × 0.131" nails	6" o.c. toe nail
23	1" × 6" subfloor or less to each joist	3-8d box ($2^1/_2$" × 0.113"); or 2-8d common ($2^1/_2$" × 0.131"); or 3-10d box (3" × 0.128"); or 2 staples, 1" crown, 16 ga., $1^3/_4$" long	Face nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Floor			
24	2"subfloor to joist or girder	3-16d box ($3^1/_2$"× 0.135"); or 2-16d common ($3^1/_2$"× 0.162")	Blind and face nail
25	2"planks (plank & beam—floor & roof)	3-16d box ($3^1/_2$"× 0.135"); or 2-16d common ($3^1/_2$"× 0.162")	At each bearing, face nail
26	Band or rim joist to joist	3-16d common ($3^1/_2$"× 0.162") 4-10 box (3"× 0.128"), or 4-3"× 0.131"nails; or 4-3"× 14 ga. staples, $^7/_{16}$"crown	End nail
27	Built-up girders and beams, 2-inch lumber layers	20d common (4"× 0.192"); or	Nail each layer as follows: 32"o.c. at top and bottom and staggered.
		10d box (3"× 0.128"); or 3"× 0.131"nails	24"o.c. face nail at top and bottom staggered on opposite sides
		And: 2-20d common (4"×	

		0.192"); or 3-10d box (3"× 0.128"); or 3-3"× 0.131"nails	Face nail at ends and at each splice	
28	Ledger strip supporting joists or rafters	4-16d box (3 1/2 "× 0.135"); or 3-16d common (3 1/2 "× 0.162"); or 4-10d box (3"× 0.128"); or 4-3"× 0.131"nails	At each joist or rafter, face nail	
29	Bridging to joist	2-10d (3"× 0.128")	Each end, toe nail	
ITEM	**DESCRIPTION OF BUILDING ELEMENTS**	**NUMBER AND TYPE OF FASTENER[a, b, c]**	**SPACING OF FASTENERS**	
			Edges (inches)[h]	**Intermediate supports[c, e] (inches)**
Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing [see Table R602.3(3) for wood structural panel *exterior* wall sheathing to wall framing]				
30	3/8 "– 1/2 "	6d common (2"× 0.113") nail (subfloor, wall)[i] 8d common (2 1/2 "× 0.131") nail (roof); or RSRS-01 (2-3/8" x 0.113") nail (roof)[j]	6	12[f]
31	19/32 "– 1"	8d common nail (2 1/2 "× 0.131"); or RSRS-01 (2 3/8" x 0.113") nail (roof)[j]	6	12[f]
32	11 /8 "–11 /4 "	10d common (3"× 0.148") nail; or 8d (21 /2 "× 0.131") deformed nail	6	12
Other wall sheathing[g]				
	1/2 "structural cellulosic	1 1/2 "galvanized roofing nail, 7		

33	fiberboard sheathing	$^{}/_{16}$" head diameter, or 1"crown staple 16 ga., $1^1/_4$" long	3	6
34	$25/_{32}$"structural cellulosic fiberboard sheathing	$1^3/_4$"galvanized roofing nail, $^7/_{16}$"head diameter, or 1"crown staple 16 ga., $1^1/_4$" long	3	6
35	$^1/_2$"gypsum sheathing[d]	$1^1/_2$"galvanized roofing nail; staple galvanized, $1^1/_2$"long; $1^1/_4$" screws, Type W or S	7	7
36	$^5/_8$"gypsum sheathing[d]	$1^3/_4$"galvanized roofing nail; staple galvanized, $1^5/_8$" long; $1^5/_8$" screws, Type W or S	7	7
Wood structural panels, combination subfloor underlayment to framing				
37	$^3/_4$" and less	6d deformed (2"× 0.120") nail; or 8d common ($2^1/_2$"× 0.131") nail	6	12
38	$^7/_8$"– 1"	8d common ($2^1/_2$"× 0.131") nail; or 8d deformed ($2^1/_2$"× 0.120") nail	6	12
39	$1^1/_8$"– $1^1/_4$"	10d common (3"× 0.148") nail; or 8d deformed ($2^1/_2$"× 0.120") nail	6	12

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.

a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.

b. Staples are 16 gage wire and have a minimum $^7/_{16}$-inch on diameter crown width.

c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.

d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.

e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).

f. Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.

g. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.

h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.

i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

j. RSRS-01 is a Roof Sheathing Ring Shank nail meeting the specifications in ASTM F1667.

Reason: This change adds a new standardized roof sheathing ring shank (RSRS) nail for roof sheathing applications. The RSRS nail has been standardized in ASTM F1667 and added in this proposal as equivalent to the 8d common nail to resist uplift of roof sheathing. This standard ring shank nail provides improved withdrawal resistance relative to the 8d common smooth shank nail. A head size of 0.281" diameter is specified for the RSRS-01 in ASTM F1667 which is equivalent to the head diameter of the 8d common nail. The slightly larger net area under the head (i.e. area of head minus area of shank) is considered to provide slightly improved head pull through performance.

Cost Impact: Will not increase the cost of construction
An alternative nail is being added only, so there is no increase in cost since the current nailing alternatives may still be used.

RB220-16 : TABLE 602.3 (1)-COATS11445

Final Action: AS (Approved as Submitted)

S8081

Date Submitted	12/13/2018	**Section**	602.3	**Proponent**	Paul Coats
Chapter	6	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments	**No**	**Alternate Language**	**No**

Related Modifications

8084, 8092, 8096

Summary of Modification

Adjustment to roof sheathing nail spacing in accordance with the criteria of ASCE 7-10

Rationale

This modification was approved by the ICC committee and membership and appears in the 2018 edition of the International Residential Code. Nailing requirements provided in the IRC Table 602.3(1) were reviewed using loads from ASCE 7-10 Minimum Design Loads for Buildings and Other Structures. Nailing requirements for common species of roof framing with specific gravities of 0.42 or greater (e.g. SPF, Hem-Fir) were analyzed and it was found that the nail spacing requirements in footnote "f" needed to be slightly modified to clarify that nail spacing for all sheathing to framing attached to intermediate supports within 48" of roof end zones, eaves, and ridges must be reduced, not just at the gable end roof framing. For ultimate wind speeds of 130 mph and greater, the threshold for reducing the nail spacing from 6" to 4" in the 48" end zone areas w as slightly modified while clarifying that ultimate wind speeds of 140 mph or greater are is outside the scope of the IRC structural provisions. The language in footnote "f" w as revised to clarify the intent of this footnote. A sentence was also added to R803.2.3 to clarify the appropriate limit on the distance unsupported sheathing can cantilever past the gable end roof framing. Tabulated calculation results based on ASCE 7-10 are provided in the uploaded support file reason statement. Please note that although the 2018 IRC references the 2016 edition of ASCE 7, component and cladding wind pressures and criteria in Chapter 3 remained as in the previous edition of the IRC (in accordance with ASCE 7-10) and this change was also adopted in the 2018 IRC. For complete consistency with ASCE 7-16, see proposed modifications 8084, 8092, and 8096 as an alternative to this one.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Enforcement will remain the same with slightly modified nail spacings.

Impact to building and property owners relative to cost of compliance with code

May have a slight cost increase.

Impact to industry relative to the cost of compliance with code

May have a very slight cost increase.

Impact to small business relative to the cost of compliance with code

No cost-related impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Nail spacings slightly modified in accordance with design standards.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

Revise footnote "f" of Table R602.3(1) as follows:

~~f.Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.~~

<u>For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48" of roof end zones, eaves, and ridges, nails shall be spaced at 6 inches on center where the ultimate design wind speed is less than 130 mph and shall be spaced 4 inches on center where the ultimate design wind speed is 130 mph or greater but less than 140 mph.</u>

RB221-16

IRC: R602.3, R803.2.3.

Proponent : James Smith (jsmith@awc.org)

2015 International Residential Code

TABLE R602.3 (1)
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Roof			
1	Blocking between ceiling joists or rafters to top plate	4-8d box ($2^1/_2$ ″ × 0.113″) or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
2	Ceiling joists to top plate	4-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Sections R802.3.1, R802.3.2 and Table R802.5.1(9)]	4-10d box (3″ × 0.128″); or 3-16d common ($3^1/_2$ ″ × 0.162″); or 4-3″ × 0.131″ nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Sections R802.3.1 and R802.3.2 and Table R802.5.1(9)]	Table R802.5.1(9)	Face nail
5	Collar tie to rafter, face nail or $1^1/_4$ ″ × 20 ga. ridge strap to rafter	4-10d box (3″ × 0.128″); or 3-10d common (3″ × 0.148″); or 4-3″ × 0.131″ nails	Face nail each rafter

6	Rafter or roof truss to plate	3-16d box nails (3 1/2 ″ × 0.135″); or 3-10d common nails (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss[i]
7	Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2″ ridge beam	4-16d (3 1/2 ″ × 0.135″); or 3-10d common (3 1/2 ″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box 3 1/2 ″ × 0.135″); or 2-16d common (3 1/2 ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
Wall			
8	Stud to stud (not at braced wall panels)	16d common (3 1/2 ″ × 0.162″)	24″ o.c. face nail
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	16″ o.c. face nail
9	Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d box (3 1/2 ″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
		16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail
10	Built-up header (2″ to 2″ header with 1/2 ″ spacer)	16d common (3 1/2 ″ × 0.162″)	16″ o.c. each edge face nail
		16d box (3 1/2 ″ × 0.135″)	12″ o.c. each edge face nail
11	Continuous header to stud	5-8d box (2 1/2 ″ × 0.113″); or 4-8d common (2 1/2 ″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toe nail
		16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail

12	Top plate to top plate	10d box (3″ × 0.128″); or 3″ × 0.131″ nails	12″ o.c. face nail
13	Double top plate splice for SDCs A-D2 with seismic braced wall line spacing	8-16d common (3$^1/_2$ ″ × 0.162″); or 12-16d box (3$^1/_2$ ″ × 0.135″); or 12-10d box (3″ × 0.128″); or 12-3″ × 0.131″ nails	Face nail on each side of end joint (minimum 24″ lap splice length each side of end joint)
	Double top plate splice SDCs D_0 , D_1 , or D_2 ; and braced wall line spacing ≥ 25′	12-16d (3$^1/_2$ ″ × 0.135″)	

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER$^{a, b, c}$	SPACING AND LOCATION
14	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common (3$^1/_2$ ″ × 0.162″)	16″ o.c. face nail
		16d box (3$^1/_2$ ″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
15	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box (3$^1/_2$ ″ × 0.135″); or 2-16d common (3$^1/_2$ ″ × 0.162″); or 4-3″ × 0.131″ nails	3 each 16″ o.c. face nail 2 each 16″ o.c. face nail 4 each 16″ o.c. face nail
16	Top or bottom plate to stud	4-8d box (2$^1/_2$ ″ × 0.113″); or 3-16d box (3$^1/_2$ ″ × 0.135″); or 4-8d common (2$^1/_2$ ″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box (3$^1/_2$ ″ × 0.135″); or 2-16d common (3$^1/_2$ ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail

17	Top plates, laps at corners and intersections	3-10d box (3″ × 0.128″); or 2-16d common (3 1/2 ″ × 0.162″); or 3-3″ × 0.131″ nails	Face nail
18	1″ brace to each stud and plate	3-8d box (2 1/2 ″ × 0.113″); or 2-8d common (2 1/2 ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples 1 3/4 ″	Face nail
19	1″ × 6″ sheathing to each bearing	3-8d box (2 1/2 ″ × 0.113″); or 2-8d common (2 1/2 ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., 1 3/4 ″ long	Face nail
20	1″ × 8″ and wider sheathing to each bearing	3-8d box (2 1/2 ″ × 0.113″); or 3-8d common (2 1/2 ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3 staples, 1″ crown, 16 ga., 1 3/4 ″ long	Face nail
		Wider than 1″ × 8″ 4-8d box (2 1/2 ″ × 0.113″); or 3-8d common (2 1/2 ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 4 staples, 1″ crown, 16 ga., 1 3/4 ″ long	
Floor			
21	Joist to sill, top plate or girder	4-8d box (2 1/2 ″ × 0.113″); or 3-8d common (2 1/2 ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
		8d box (2 1/2 ″ × 0.113″)	4″ o.c. toe nail

22	Rim joist, band joist or blocking to sill or top plate (roof applications also)	8d common ($2^1/_2$ " × 0.131″); or 10d box (3″ × 0.128″); or 3″ × 0.131″ nails	6″ o.c. toe nail
23	1″ × 6″ subfloor or less to each joist	3-8d box ($2^1/_2$ " × 0.113″); or 2-8d common ($2^1/_2$ " × 0.131″); or 3-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1^3/_4$ " long	Face nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
		Floor	
24	2″subfloor to joist or girder	3-16d box ($3^1/_2$ "× 0.135″); or 2-16d common ($3^1/_2$ "× 0.162″)	Blind and face nail
25	2″planks (plank & beam—floor & roof)	3-16d box ($3^1/_2$ "× 0.135″); or 2-16d common ($3^1/_2$ "× 0.162″)	At each bearing, face nail
26	Band or rim joist to joist	3-16d common ($3^1/_2$ "× 0.162″) 4-10 box (3″× 0.128″), or 4-3″× 0.131″nails; or	End nail

		4-3″× 14 ga. staples, $^{7}/_{16}$ ″crown					
27	Built-up girders and beams, 2-inch lumber layers	20d common (4″× 0.192″); or	Nail each layer as follows: 32″o.c. at top and bottom and staggered.				
		10d box (3″× 0.128″); or 3″× 0.131″nails	24″o.c. face nail at top and bottom staggered on opposite sides				
		And: 2-20d common (4″× 0.192″); or 3-10d box (3″× 0.128″); or 3-3″× 0.131″nails	Face nail at ends and at each splice				
28	Ledger strip supporting joists or rafters	4-16d box ($3^{1}/_{2}$ ″× 0.135″); or 3-16d common ($3^{1}/_{2}$ ″× 0.162″); or 4-10d box (3″× 0.128″); or 4-3″× 0.131″nails	At each joist or rafter, face nail	29	Bridging to joist	2-10d (3″× 0.128″)	Each end, toe nail
ITEM	**DESCRIPTION OF BUILDING ELEMENTS**	**NUMBER AND TYPE OF FASTENER**[a, b, c]	**SPACING OF FASTENERS**				
			Panel Edges (inches)[h]	**Intermediate supports**[c, e] **(inches)**			
Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing [see Table R602.3(3) for wood structural panel *exterior* wall sheathing to wall framing]							

30	3/8"–1/2"	6d common (2"× 0.113") nail (subfloor, wall)[i] 8d common (2 1/2"× 0.131") nail (roof)	6	12[f]	31	19/32"–1"	8d common nail (2 1/2"× 0.131")	6	12[f]
32	11/8"–11/4"	10d common (3"× 0.148") nail; or 8d (21/2"× 0.131") deformed nail	6	12					
Other wall sheathing[g]									
33	1/2" structural cellulosic fiberboard sheathing	1 1/2" galvanized roofing nail, 7/16" head diameter, or 1" crown staple 16 ga., 1 1/4" long	3	6					
34	25/32" structural cellulosic fiberboard sheathing	1 3/4" galvanized roofing nail, 7/16" head diameter, or 1" crown staple 16 ga., 1 1/4" long	3	6					
		1 1/2							

35	1/2 "gypsum sheathing[d]	"galvanized roofing nail; staple galvanized, 1 1/2 "long; 1 1/4 " screws, Type W or S	7	7
36	5/8 "gypsum sheathing[d]	1 3/4 "galvanized roofing nail; staple galvanized, 1 5/8 " long; 1 5/8 " screws, Type W or S	7	7
Wood structural panels, combination subfloor underlayment to framing				
37	3/4 " and less	6d deformed (2"× 0.120") nail; or 8d common (2 1/2 "× 0.131") nail	6	12
38	7/8 "– 1"	8d common (2 1/2 "× 0.131") nail; or 8d deformed (2 1/2 "× 0.120") nail	6	12
39	1 1/8 "– 1 1/4 "	10d common (3"× 0.148") nail; or 8d deformed (2 1	6	12

		/2 "× 0.120") nail		

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.

a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.

b. Staples are 16 gage wire and have a minimum $^{7}/_{16}$ -inch on diameter crown width.

c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.

d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.

e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).

~~f. Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.~~

f. For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48" of roof end zones, eaves, and ridges, nails shall be spaced at 6 inches on center where the ultimate design wind speed is less than 130 mph and shall be spaced 4 inches on center where the ultimate design wind speed is 130 mph or greater but less than 140 mph.

g. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.

h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.

i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

R803.2.3 Installation. Wood structural panel used as roof sheathing shall be installed with joints staggered or not staggered in accordance with Table R602.3(1), APA E30 for wood roof framing or with Table R804.3 for cold-formed steel roof framing. Wood structural panel roof sheathing shall not cantlever more than 9 inches beyond the gable end wall unless supported by gable overhang framing.

Reason: Nailing requirements provided in the IRC Table 602.3(1) were reviewed using loads from ASCE 7-10 *Minimum Design Loads for Buildings and Other Structures.* Nailing requirements for common species of roof framing with specific gravities of 0.42 or greater (e.g. SPF, Hem-Fir) were analyzed and it was found that the nail spacing requirements in footnote "f" needed to be slightly modified to clarify that nail spacing for all sheathing to framing attached to intermediate supports within 48" of roof end zones, eaves, and ridges must be reduced, not just at the gable end roof framing. For ultimate wind speeds of 130 mph and greater, the threshold for reducing the nail spacing from 6" to 4" in the 48" end zone areas was slightly modified while clarifying that ultimate wind speeds of 140 mph or greater are is outside the scope of the IRC structural provisions. The language in footnote "f" was revised to clarify the intent of this footnote. A sentence was also added to R803.2.3 to clarify the appropriate limit on the distance unsupported sheathing can cantilever past the gable end roof framing. Tabulated calculation results based on ASCE 7-10 are provided below: (insert attachment here)

WFCM Table 3.10 (Exposure C) - Based on ASCE 7-10
Roof Sheathing Attachment Requirements for Wind Loads

700-yr. Wind Speed 3-second gust (mph)			110		115		120		130		140	
			Wood Structural Panel Sheathing									
			E	F	E	F	E	F	E	F	E	F
Sheathing Location[1]	Rafter/Truss Framing Specific Gravity, G	Rafter/Truss Spacing (in.)	Maximum Nail Spacing for 8d Common Nails or 10d Box Nails (inches, o.c.)[2]									
Interior Zone	0.42	12	6	12	6	12	6	12	6	12	6	12
		16	6	12	6	12	6	12	6	12	6	12
		19.2	6	12	6	12	6	12	6	12	6	12
		24	6	12	6	12	6	12	6	12	6	12
Perimeter Edge Zone	0.42	12	6	12	6	12	6	12	6	12	6	6
		16	6	12	6	6	6	6	6	6	6	6
		19.2	6	6	6	6	6	6	6	6	6	6
		24	6	6	6	6	6	6	6	4	6	4
Gable Endwall Rake or Rake Truss with up to 9" Rake Overhang	0.42	-	6		6		6		4		4	

E - Nail spacing at panel edges (in.)
F - Nail spacing at intermediate supports in the panel field (in.)

1 For roof sheathing within 4 feet of the perimeter edge of the roof, including 4 feet on each side of the roof peak, the 4 foot perimeter edge zone attachment requirements shall be used.
2 For wind speeds greater than 130 mph, blocking is required which transfers shear load to two additional joi

Cost Impact: Will not increase the cost of construction
The change to footnote "f" is a clarification of the current footnote "f" intent. The 9" limit on gable overhang is not really an increase in requirement, but a limitation to allow more efficient nailing patterns.

RB221-16 : TABLE R602.3-SMITH11542

Final Action: AM (Approved as Modified by the Committee)

RB221-16

Committee Action: **Approved as Modified**

Modification:

TABLE R602.3 (1)
FASTENING SCHEDULE

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.
a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.
b. Staples are 16 gage wire and have a minimum $^{7}/_{16}$-inch on diameter crown width.
c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.
d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.
e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).
f. For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48" of roof ~~end zones, eaves,~~ edges and ridges, nails shall be spaced at 6 inches on center where the ultimate design wind speed is less than 130 mph and shall be spaced 4 inches on center where the ultimate design wind speed is 130 mph or greater but less than 140 mph.
g. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.

h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.
i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

R803.2.3 Installation. Wood structural panel used as roof sheathing shall be installed with joints staggered or not staggered in accordance with Table R602.3(1), APA E30 for wood roof framing or with Table R804.3 for cold-formed steel roof framing. Wood structural panel roof sheathing in accordance with Table R503.2.1.1(1) shall not cantilever more than 9 inches beyond the gable end wall unless supported by gable overhang framing.

Committee Reason:

The committee approved this change based on the proponents published reason statement. The proposal aligns the roof sheathing nail spacing with the ASCE 7-10 loading and provides an allowable cantilever for the sheathing past the gable end. The modifications deleted the terms end zones and eaves to avoid confusion with edges and added a reference to the sheathing installation table.

Assembly Action: **None**

Date Submitted	12/13/2018	**Section**	602.3	**Proponent**	Paul Coats
Chapter	6	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No **Alternate Language** No

Related Modifications

8073

Summary of Modification

Adjustment to roof sheathing nail spacing in accordance with the criteria of ASCE 7-16

Rationale

The nailing requirements provided in IRC Table R602.3(1) were reviewed using loads from the New ASCE 7-16 Minimum Design Loads for Buildings and Other Structures. As show n in the table below , calculated wind loads on elements and fasteners with small tributary areas like roof sheathing nails have increased dramatically, almost doubling in the interior portions of the roof (Roof Zone 1). To determine the impact of the new ASCE 7-16 loading provisions, nailing requirements for common species of roof framing with specific gravities of 0.42 or greater (e.g. SPF, Hem-Fir) w ere analyzed using ASCE 7-16 and it was found that the nail spacing requirements in Table R602.3(1) needed to be significantly modified, especially in the interior portion of the roof. As shown in the tabulated results below , nailing at intermediate supports in the interior portions of the roof (Roof Zone 1) need to be reduced from 12" o.c. to 6" o.c. How ever, changes to loads in the end zone portions of the roof were less significant and required far less adjustment. In fact, the 6" o.c. spacing is appropriate for all connection in the end zone portions, except w here ultimate wind speeds equal or exceed 120 mph. The language in footnote "f" needed to be slightly modified to clarify that nail spacing for all sheathing to framing attached to gable end roof framing and intermediate supports within 48" of roof end zones, eaves and ridges must be reduced from 6" to 4" w here ultimate w ind speeds exceed 120 mph. Language w as also added to clarify that ultimate wind speeds of 140 mph or greater is outside the scope of the IRC structural provisions. A sentence was also added to R803.2.3 to clarify the appropriate limit on the distance unsupported sheathing can cantilever past the gable end roof framing. See the additional tables in the Reason statement of the attached support file.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Enforcement will remain the same with slightly modified nail spacings.

Impact to building and property owners relative to cost of compliance with code

May have a slight cost increase.

Impact to industry relative to the cost of compliance with code

May have a very slight cost increase.

Impact to small business relative to the cost of compliance with code

No cost-related impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Nail spacings slightly modified in accordance with design standards.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

Revise rows 30 and 31, and footnote "f" of Table R602.3(1) as follows:

30	3/8" – 1/2"	6d common (2" × 0.113") nail (subfloor, wall)i8d common (21/2" × 0.131") nail (roof)
31	19/32" – 1"	8d common nail (21/2" × 0.131")

~~f.Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.~~

For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48" of roof end zones, eaves, and ridges, nails shall be spaced at 4" on center where the ultimate design wind speed is 120 mph or greater but less than 140 mph.

RB222-16

IRC: R602.3, R803.2.3.

Proponent : James Smith (jsmith@awc.org)

2015 International Residential Code

TABLE R602.3 (1)
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Roof			
1	Blocking between ceiling joists or rafters to top plate	4-8d box ($2^1/_2$″ × 0.113″) or 3-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
2	Ceiling joists to top plate	4-8d box ($2^1/_2$″ × 0.113″); or 3-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Sections R802.3.1, R802.3.2 and Table R802.5.1(9)]	4-10d box (3″ × 0.128″); or 3-16d common ($3^1/_2$″ × 0.162″); or 4-3″ × 0.131″ nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Sections R802.3.1 and R802.3.2 and Table R802.5.1(9)]	Table R802.5.1(9)	Face nail
5	Collar tie to rafter, face nail or $1^1/_4$″ × 20 ga. ridge strap to rafter	4-10d box (3″ × 0.128″); or 3-10d common (3″ × 0.148″); or 4-3″ × 0.131″ nails	Face nail each rafter

6	Rafter or roof truss to plate	3-16d box nails (3 1/2 ″ × 0.135″); or 3-10d common nails (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss[i]
7	Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2″ ridge beam	4-16d (3 1/2 ″ × 0.135″); or 3-10d common (3 1/2 ″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box 3 1/2 ″ × 0.135″); or 2-16d common (3 1/2 ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
Wall			
8	Stud to stud (not at braced wall panels)	16d common (3 1/2 ″ × 0.162″)	24″ o.c. face nail
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	16″ o.c. face nail
9	Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d box (3 1/2 ″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
		16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail
10	Built-up header (2″ to 2″ header with 1/2 ″ spacer)	16d common (3 1/2 ″ × 0.162″)	16″ o.c. each edge face nail
		16d box (3 1/2 ″ × 0.135″)	12″ o.c. each edge face nail
11	Continuous header to stud	5-8d box (2 1/2 ″ × 0.113″); or 4-8d common (2 1/2 ″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toe nail
		16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail

12	Top plate to top plate	10d box (3″ × 0.128″); or 3″ × 0.131″ nails	12″ o.c. face nail
13	Double top plate splice for SDCs A-D2 with seismic braced wall line spacing	8-16d common ($3^1/_2$″ × 0.162″); or 12-16d box ($3^1/_2$″ × 0.135″); or 12-10d box (3″ × 0.128″); or 12-3″ × 0.131″ nails	Face nail on each side of end joint (minimum 24″ lap splice length each side of end joint)
	Double top plate splice SDCs D_0 , D_1 , or D_2 ; and braced wall line spacing ≥ 25′	12-16d ($3^1/_2$″ × 0.135″)	

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
14	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common ($3^1/_2$″ × 0.162″)	16″ o.c. face nail
		16d box ($3^1/_2$″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
15	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box ($3^1/_2$″ × 0.135″); or 2-16d common ($3^1/_2$″ × 0.162″); or 4-3″ × 0.131″ nails	3 each 16″ o.c. face nail 2 each 16″ o.c. face nail 4 each 16″ o.c. face nail
16	Top or bottom plate to stud	4-8d box ($2^1/_2$″ × 0.113″); or 3-16d box ($3^1/_2$″ × 0.135″); or 4-8d common ($2^1/_2$″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box ($3^1/_2$″ × 0.135″); or 2-16d common ($3^1/_2$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail

17	Top plates, laps at corners and intersections	3-10d box (3″ × 0.128″); or 2-16d common (3$^{1}/_{2}$ ″ × 0.162″); or 3-3″ × 0.131″ nails	Face nail
18	1″ brace to each stud and plate	3-8d box (2$^{1}/_{2}$ ″ × 0.113″); or 2-8d common (2$^{1}/_{2}$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples 1$^{3}/_{4}$ ″	Face nail
19	1″ × 6″ sheathing to each bearing	3-8d box (2$^{1}/_{2}$ ″ × 0.113″); or 2-8d common (2$^{1}/_{2}$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., 1$^{3}/_{4}$ ″ long	Face nail
20	1″ × 8″ and wider sheathing to each bearing	3-8d box (2$^{1}/_{2}$ ″ × 0.113″); or 3-8d common (2$^{1}/_{2}$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3 staples, 1″ crown, 16 ga., 1$^{3}/_{4}$ ″ long Wider than 1″ × 8″ 4-8d box (2$^{1}/_{2}$ ″ × 0.113″); or 3-8d common (2$^{1}/_{2}$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 4 staples, 1″ crown, 16 ga., 1$^{3}/_{4}$ ″ long	Face nail
Floor			
21	Joist to sill, top plate or girder	4-8d box (2$^{1}/_{2}$ ″ × 0.113″); or 3-8d common (2$^{1}/_{2}$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
		8d box (2$^{1}/_{2}$ ″ × 0.113″)	4″ o.c. toe nail

22	Rim joist, band joist or blocking to sill or top plate (roof applications also)	8d common (2 1/2 ″ × 0.131″); or 10d box (3″ × 0.128″); or 3″ × 0.131″ nails	6″ o.c. toe nail
23	1″ × 6″ subfloor or less to each joist	3-8d box (2 1/2 ″ × 0.113″); or 2-8d common (2 1/2 ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., 1 3/4 ″ long	Face nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Floor			
24	2″subfloor to joist or girder	3-16d box (3 1/2 ″× 0.135″); or 2-16d common (3 1/2 ″× 0.162″)	Blind and face nail
25	2″planks (plank & beam—floor & roof)	3-16d box (3 1/2 ″× 0.135″); or 2-16d common (3 1/2 ″× 0.162″)	At each bearing, face nail
26	Band or rim joist to joist	3-16d common (3 1/2 ″× 0.162″) 4-10 box (3″× 0.128″), or 4-3″× 0.131″nails; or	End nail

		4-3″× 14 ga. staples, 7 /16 ″crown		
27	Built-up girders and beams, 2-inch lumber layers	20d common (4″× 0.192″); or	Nail each layer as follows: 32″o.c. at top and bottom and staggered.	
		10d box (3″× 0.128″); or 3″× 0.131″nails	24″o.c. face nail at top and bottom staggered on opposite sides	
		And: 2-20d common (4″× 0.192″); or 3-10d box (3″× 0.128″); or 3-3″× 0.131″nails	Face nail at ends and at each splice	
28	Ledger strip supporting joists or rafters	4-16d box (3 1/2 ″× 0.135″); or 3-16d common (3 1/2 ″× 0.162″); or 4-10d box (3″× 0.128″); or 4-3″× 0.131″nails	At each joist or rafter, face nail	
29	Bridging to joist	2-10d (3″× 0.128″)	Each end, toe nail	
ITEM	**DESCRIPTION OF BUILDING ELEMENTS**	**NUMBER AND TYPE OF FASTENER[a, b, c]**	**SPACING OF FASTENERS**	
			Panel Edges (inches)[h]	**Intermediate supports[c, e] (inches)**
Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing [see Table R602.3(3) for wood structural panel *exterior* wall sheathing to wall framing]				

ICC COMMITTEE ACTION HEARINGS ::: April, 2016 RB528

30	3/8″– 1/2″	6d common (2″× 0.113″) nail (subfloor, wall)[i] 8d common (2 1/2″× 0.131″) nail (roof)	6	~~12~~6[f]
31	19/32″– 1″	8d common nail (2 1/2″× 0.131″)	6	~~12~~6[f]
32	1 1/8″–1 1/4″	10d common (3″× 0.148″) nail; or 8d (2 1/2″× 0.131″) deformed nail	6	12
Other wall sheathing[g]				
33	1/2″structural cellulosic fiberboard sheathing	1 1/2″galvanized roofing nail, 7/16″ head diameter, or 1″crown staple 16 ga., 1 1/4″ long	3	6
34	25/32″structural cellulosic fiberboard sheathing	1 3/4″galvanized roofing nail, 7/16″head diameter, or 1″crown staple 16 ga., 1 1/4″ long	3	6
		1 1/2		

35	1 /2 "gypsum sheathing[d]	"galvanized roofing nail; staple galvanized, 1[1] /2 "long; 1[1] /4 " screws, Type W or S	7	7
36	5 /8 "gypsum sheathing[d]	1[3] /4 "galvanized roofing nail; staple galvanized, 1[5] /8 " long; 1[5] /8 " screws, Type W or S	7	7
Wood structural panels, combination subfloor underlayment to framing				
37	3 /4 " and less	6d deformed (2"× 0.120") nail; or 8d common (2[1] /2 "× 0.131") nail	6	12
38	7 /8 "– 1"	8d common (2[1] /2 "× 0.131") nail; or 8d deformed (2[1] /2 "× 0.120") nail	6	12
39	1[1] /8 "– 1[1] /4 "	10d common (3"× 0.148") nail; or 8d deformed (2[1]	6	12

		/2 "× 0.120") nail		

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.

a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.

b. Staples are 16 gage wire and have a minimum 7 / 16 -inch on diameter crown width.

c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.

d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.

e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).

~~f. Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.~~

f. For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48" of roof end zones, eaves, and ridges, nails shall be spaced at 4" on center where the ultimate design wind speed is 120 mph or greater but less than 140 mph.

g. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.

h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.

i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

Revise as follows:

R803.2.3 Installation. Wood structural panel used as roof sheathing shall be installed with joints staggered or not staggered in accordance with Table R602.3(1), APA E30 for wood roof framing or with Table R804.3 for cold-formed steel roof framing. Wood structural panel roof sheathing shall not cantilever more than 9 inches beyond the gable end wall unless supported by gable overhang framing.

Reason: The nailing requirements provided in IRC Table R602.3(1) were reviewed using loads from the New ASCE 7-16 *Minimum Design Loads for Buildings and Other Structures*. As shown in the table below, calculated wind loads on elements and fasteners with small tributary areas like roof sheathing nails have increased dramatically, almost doubling in the interior portions of the roof (Roof Zone 1).

Roof Zone	ASCE 7-10			ASCE 7-16			Increase
	GC_p	Gc_{pi}	GC_p-Gc_{pi}	GC_p	Gc_{pi}	GC_p-Gc_{pi}	(%)
1	-1.0	-0.18	-1.2	-2.0	-0.18	-2.2	85%
2	-1.8	-0.18	-2.0	-3.0	-0.18	-3.2	61%
2 overhang	-2.8	0.00	-2.8	-3.5	0.00	-3.5	25%
3	-3.0	-0.18	-3.2	-3.6	-0.18	-3.8	19%
3 overhang	-3.7	0.00	-3.7	-4.7	0.00	-4.7	27%

To determine the impact of the new ASCE 7-16 loading provisions, nailing requirements for common species of roof framing with specific gravities of 0.42 or greater (e.g. SPF, Hem-Fir) were analyzed using ASCE 7-16 and it was found that the nail spacing requirements in Table R602.3(1) needed to be significantly modified, especially in the

interior portion of the roof. As shown in the tabulated results below, nailing at intermediate supports in the interior portions of the roof (Roof Zone 1) need to be reduced from 12" o.c. to 6" o.c. However, changes to loads in the end zone portions of the roof were less significant and required far less adjustment. In fact, the 6" o.c. spacing is appropriate for all connection in the end zone portions, except where ultimate wind speeds equal or exceed 120 mph.

WFCM Table 3.10 (Exposure C) - Based on ASCE 7-16
Roof Sheathing Attachment Requirements for Wind Loads

700-yr. Wind Speed 3-second gust (mph)			110		115		120		130		140	
			Wood Structural Panel Sheathing									
			E	F	E	F	E	F	E	F	E	F
Sheathing Location[1]	Rafter/Truss Framing Specific Gravity, G	Rafter/Truss Spacing (in.)	Maximum Nail Spacing for 8d Common Nails or 10d Box Nails (inches, o.c.)[2]									
Interior Zone	0.42	12	6	12	6	12	6	12	6	12	6	12
		16	6	12	6	12	6	12	6	12	6	6
		19.2	6	12	6	12	6	12	6	6	6	6
		24	6	12	6	6	6	6	6	6	6	6
Perimeter Edge Zone	0.42	12	6	12	6	12	6	6	6	6	6	6
		16	6	6	6	6	6	6	6	6	6	6
		19.2	6	6	6	6	6	6	6	6	6	4
		24	6	6	6	6	6	4	6	4	6	4
Gable Endwall Rake or Rake Truss with up to 9" Rake Overhang	0.42	-	6		6		4		4		4	

E - Nail spacing at panel edges (in.)
F - Nail spacing at intermediate supports in the panel field (in.)

1 For roof sheathing within 4 feet of the perimeter edge of the roof, including 4 feet on each side of the roof peak, the 4 foot perimeter edge zone attachment requirements shall be used.
2 For wind speeds greater than 130 mph, blocking is required which transfers shear load to two additional joi

The language in footnote "f" needed to be slightly modified to clarify that nail spacing for all sheathing to framing attached to gable end roof framing and intermediate supports within 48" of roof end zones, eaves and ridges must be reduced from 6" to 4" where ultimate wind speeds exceed 120 mph. Language was also added to clarify that ultimate wind speeds of 140 mph or greater is outside the scope of the IRC structural provisions. A sentence was also added to R803.2.3 to clarify the appropriate limit on the distance unsupported sheathing can cantilever past the gable end roof framing.

Cost Impact: Will increase the cost of construction
Even though much of the proposal is a clarification that should make it easier to use and thereby reduce cost, the change in fastener spacings from 12" to 6" in rows 30 and 31 of the table will increase the number of nails and the time to install, which will increase cost. This increase in cost is the direct result of compliance with the increased wind uplift loads in ASCE 7-16.

RB222-16 : TABLE R602.3-SMITH11567

Final Action: D (Disapproved)

RB222-16

Committee Action: **Disapproved**

Committee Reason: Based on the proponets request for disapproval and the committees previous action on RB20-16.

Assembly Action: **None**

RB222-16

IRC: R602.3, R803.2.3.

Proponent : James Smith (jsmith@awc.org)

2015 International Residential Code

TABLE R602.3 (1)
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Roof			
1	Blocking between ceiling joists or rafters to top plate	4-8d box (2$^1/_2$ ″ × 0.113″) or 3-8d common (2$^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
2	Ceiling joists to top plate	4-8d box (2$^1/_2$ ″ × 0.113″); or 3-8d common (2$^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Sections R802.3.1, R802.3.2 and Table R802.5.1(9)]	4-10d box (3″ × 0.128″); or 3-16d common (3$^1/_2$ ″ × 0.162″); or 4-3″ × 0.131″ nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Sections R802.3.1 and R802.3.2 and Table R802.5.1(9)]	Table R802.5.1(9)	Face nail
5	Collar tie to rafter, face nail or 1$^1/_4$ ″ × 20 ga. ridge strap to rafter	4-10d box (3″ × 0.128″); or 3-10d common (3″ × 0.148″); or 4-3″ × 0.131″ nails	Face nail each rafter

6	Rafter or roof truss to plate	3-16d box nails ($3^{1}/_{2}$″ × 0.135″); or 3-10d common nails (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss[i]
7	Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2″ ridge beam	4-16d ($3^{1}/_{2}$″ × 0.135″); or 3-10d common ($3^{1}/_{2}$″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box $3^{1}/_{2}$″ × 0.135″); or 2-16d common ($3^{1}/_{2}$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
Wall			
8	Stud to stud (not at braced wall panels)	16d common ($3^{1}/_{2}$″ × 0.162″)	24″ o.c. face nail
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	16″ o.c. face nail
9	Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d box ($3^{1}/_{2}$″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
		16d common ($3^{1}/_{2}$″ × 0.162″)	16″ o.c. face nail
10	Built-up header (2″ to 2″ header with $^{1}/_{2}$″ spacer)	16d common ($3^{1}/_{2}$″ × 0.162″)	16″ o.c. each edge face nail
		16d box ($3^{1}/_{2}$″ × 0.135″)	12″ o.c. each edge face nail
11	Continuous header to stud	5-8d box ($2^{1}/_{2}$″ × 0.113″); or 4-8d common ($2^{1}/_{2}$″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toe nail
		16d common ($3^{1}/_{2}$″ × 0.162″)	16″ o.c. face nail

12	Top plate to top plate	10d box (3″ × 0.128″); or 3″ × 0.131″ nails	12″ o.c. face nail
13	Double top plate splice for SDCs A-D2 with seismic braced wall line spacing	8-16d common ($3^1/_2$ ″ × 0.162″); or 12-16d box ($3^1/_2$ ″ × 0.135″); or 12-10d box (3″ × 0.128″); or 12-3″ × 0.131″ nails	Face nail on each side of end joint (minimum 24″ lap splice length each side of end joint)
	Double top plate splice SDCs D_0 , D_1 , or D_2 ; and braced wall line spacing ≥ 25′	12-16d ($3^1/_2$ ″ × 0.135″)	

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
14	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common ($3^1/_2$ ″ × 0.162″)	16″ o.c. face nail
		16d box ($3^1/_2$ ″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
15	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box ($3^1/_2$ ″ × 0.135″); or 2-16d common ($3^1/_2$ ″ × 0.162″); or 4-3″ × 0.131″ nails	3 each 16″ o.c. face nail 2 each 16″ o.c. face nail 4 each 16″ o.c. face nail
16	Top or bottom plate to stud	4-8d box ($2^1/_2$ ″ × 0.113″); or 3-16d box ($3^1/_2$ ″ × 0.135″); or 4-8d common ($2^1/_2$ ″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box ($3^1/_2$ ″ × 0.135″); or 2-16d common ($3^1/_2$ ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail

17	Top plates, laps at corners and intersections	3-10d box (3″ × 0.128″); or 2-16d common ($3^{1}/_{2}$″ × 0.162″); or 3-3″ × 0.131″ nails	Face nail
18	1″ brace to each stud and plate	3-8d box ($2^{1}/_{2}$″ × 0.113″); or 2-8d common ($2^{1}/_{2}$″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples $1^{3}/_{4}$″	Face nail
19	1″ × 6″ sheathing to each bearing	3-8d box ($2^{1}/_{2}$″ × 0.113″); or 2-8d common ($2^{1}/_{2}$″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1^{3}/_{4}$″ long	Face nail
20	1″ × 8″ and wider sheathing to each bearing	3-8d box ($2^{1}/_{2}$″ × 0.113″); or 3-8d common ($2^{1}/_{2}$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3 staples, 1″ crown, 16 ga., $1^{3}/_{4}$″ long	Face nail
		Wider than 1″ × 8″ 4-8d box ($2^{1}/_{2}$″ × 0.113″); or 3-8d common ($2^{1}/_{2}$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 4 staples, 1″ crown, 16 ga., $1^{3}/_{4}$″ long	
Floor			
21	Joist to sill, top plate or girder	4-8d box ($2^{1}/_{2}$″ × 0.113″); or 3-8d common ($2^{1}/_{2}$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
		8d box ($2^{1}/_{2}$″ × 0.113″)	4″ o.c. toe nail

22	Rim joist, band joist or blocking to sill or top plate (roof applications also)	8d common ($2^1/_2$ " × 0.131"); or 10d box (3" × 0.128"); or 3" × 0.131" nails	6" o.c. toe nail
23	1" × 6" subfloor or less to each joist	3-8d box ($2^1/_2$ " × 0.113"); or 2-8d common ($2^1/_2$ " × 0.131"); or 3-10d box (3" × 0.128"); or 2 staples, 1" crown, 16 ga., $1^3/_4$ " long	Face nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Floor			
24	2"subfloor to joist or girder	3-16d box ($3^1/_2$ "× 0.135"); or 2-16d common ($3^1/_2$ "× 0.162")	Blind and face nail
25	2"planks (plank & beam—floor & roof)	3-16d box ($3^1/_2$ "× 0.135"); or 2-16d common ($3^1/_2$ "× 0.162")	At each bearing, face nail
26	Band or rim joist to joist	3-16d common ($3^1/_2$ "× 0.162") 4-10 box (3"× 0.128"), or 4-3"× 0.131"nails; or	End nail

		4-3″× 14 ga. staples, 7/16 ″crown					
27	Built-up girders and beams, 2-inch lumber layers	20d common (4″× 0.192″); or	Nail each layer as follows: 32″o.c. at top and bottom and staggered.				
		10d box (3″× 0.128″); or 3″× 0.131″nails	24″o.c. face nail at top and bottom staggered on opposite sides				
		And: 2-20d common (4″× 0.192″); or 3-10d box (3″× 0.128″); or 3-3″× 0.131″nails	Face nail at ends and at each splice				
28	Ledger strip supporting joists or rafters	4-16d box (3 1/2 ″× 0.135″); or 3-16d common (3 1/2 ″× 0.162″); or 4-10d box (3″× 0.128″); or 4-3″× 0.131″nails	At each joist or rafter, face nail	29	Bridging to joist	2-10d (3″× 0.128″)	Each end, toe nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING OF FASTENERS	
			Panel Edges (inches)[h]	Intermediate supports[c, e] (inches)
Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing [see Table R602.3(3) for wood structural panel *exterior* wall sheathing to wall framing]				

ICC COMMITTEE ACTION HEARINGS ::: April, 2016 RB528

30	3 /8 "– 1 /2 "	6d common (2"× 0.113") nail (subfloor, wall)[i]8d common (2 1/2 "× 0.131") nail (roof)	6	~~12~~6[f]	31	19 /32 "– 1"	8d common nail (2 1/2 "× 0.131")	6	~~12~~6[f]
32	11 /8 "–11 /4 "	10d common (3"× 0.148") nail; or 8d (21 /2 "× 0.131") deformed nail	6	12					
Other wall sheathing[g]									
33	1 /2 "structural cellulosic fiberboard sheathing	1 1/2 "galvanized roofing nail, 7 /16 " head diameter, or 1"crown staple 16 ga., 1 1/4 " long	3	6					
34	25 /32 "structural cellulosic fiberboard sheathing	1 3/4 "galvanized roofing nail, 7 /16 "head diameter, or 1"crown staple 16 ga., 1 1/4 " long	3	6					
		1 1/2							

35	$^{1}/_{2}$ "gypsum sheathing[d]	"galvanized roofing nail; staple galvanized, $1^{1}/_{2}$ "long; $1^{1}/_{4}$ " screws, Type W or S	7	7
36	$^{5}/_{8}$ "gypsum sheathing[d]	$1^{3}/_{4}$ "galvanized roofing nail; staple galvanized, $1^{5}/_{8}$ " long; $1^{5}/_{8}$ " screws, Type W or S	7	7
Wood structural panels, combination subfloor underlayment to framing				
37	$^{3}/_{4}$ " and less	6d deformed (2"× 0.120") nail; or 8d common ($2^{1}/_{2}$ "× 0.131") nail	6	12
38	$^{7}/_{8}$ "– 1"	8d common ($2^{1}/_{2}$ "× 0.131") nail; or 8d deformed ($2^{1}/_{2}$ "× 0.120") nail	6	12
39	$1^{1}/_{8}$ "– $1^{1}/_{4}$ "	10d common (3"× 0.148") nail; or 8d deformed (2^{1}	6	12

		/2 "× 0.120") nail			

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.

a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.

b. Staples are 16 gage wire and have a minimum 7 / 16 -inch on diameter crown width.

c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.

d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.

e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).

~~f. Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.~~

f. For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48" of roof end zones, eaves, and ridges, nails shall be spaced at 4" on center where the ultimate design wind speed is 120 mph or greater but less than 140 mph.

g. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.

h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.

i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

Revise as follows:

R803.2.3 Installation. Wood structural panel used as roof sheathing shall be installed with joints staggered or not staggered in accordance with Table R602.3(1), APA E30 for wood roof framing or with Table R804.3 for cold-formed steel roof framing. Wood structural panel roof sheathing shall not cantilever more than 9 inches beyond the gable end wall unless supported by gable overhang framing.

Reason: The nailing requirements provided in IRC Table R602.3(1) were reviewed using loads from the New ASCE 7-16 *Minimum Design Loads for Buildings and Other Structures*. As shown in the table below, calculated wind loads on elements and fasteners with small tributary areas like roof sheathing nails have increased dramatically, almost doubling in the interior portions of the roof (Roof Zone 1).

Roof Zone	ASCE 7-10			ASCE 7-16			Increase
	GC_p	Gc_{pi}	GC_p-Gc_{pi}	GC_p	Gc_{pi}	GC_p-Gc_{pi}	(%)
1	-1.0	-0.18	-1.2	-2.0	-0.18	-2.2	85%
2	-1.8	-0.18	-2.0	-3.0	-0.18	-3.2	61%
2 overhang	-2.8	0.00	-2.8	-3.5	0.00	-3.5	25%
3	-3.0	-0.18	-3.2	-3.6	-0.18	-3.8	19%
3 overhang	-3.7	0.00	-3.7	-4.7	0.00	-4.7	27%

To determine the impact of the new ASCE 7-16 loading provisions, nailing requirements for common species of roof framing with specific gravities of 0.42 or greater (e.g. SPF, Hem-Fir) were analyzed using ASCE 7-16 and it was found that the nail spacing requirements in Table R602.3(1) needed to be significantly modified, especially in the

interior portion of the roof. As shown in the tabulated results below, nailing at intermediate supports in the interior portions of the roof (Roof Zone 1) need to be reduced from 12" o.c. to 6" o.c. However, changes to loads in the end zone portions of the roof were less significant and required far less adjustment. In fact, the 6" o.c. spacing is appropriate for all connection in the end zone portions, except where ultimate wind speeds equal or exceed 120 mph.

WFCM Table 3.10 (Exposure C) - Based on ASCE 7-16
Roof Sheathing Attachment Requirements for Wind Loads

700-yr. Wind Speed 3-second gust (mph)			110		115		120		130		140	
			Wood Structural Panel Sheathing									
			E	F	E	F	E	F	E	F	E	F
Sheathing Location[1]	Rafter/Truss Framing Specific Gravity, G	Rafter/Truss Spacing (in.)	Maximum Nail Spacing for 8d Common Nails or 10d Box Nails (inches, o.c.)[2]									
Interior Zone	0.42	12	6	12	6	12	6	12	6	12	6	12
		16	6	12	6	12	6	12	6	12	6	6
		19.2	6	12	6	12	6	12	6	6	6	6
		24	6	12	6	6	6	6	6	6	6	6
Perimeter Edge Zone	0.42	12	6	12	6	12	6	6	6	6	6	6
		16	6	6	6	6	6	6	6	6	6	6
		19.2	6	6	6	6	6	6	6	6	6	4
		24	6	6	6	6	6	4	6	4	6	4
Gable Endwall Rake or Rake Truss with up to 9" Rake Overhang	0.42	-	6		6		4		4		4	

E - Nail spacing at panel edges (in.)
F - Nail spacing at intermediate supports in the panel field (in.)

1 For roof sheathing within 4 feet of the perimeter edge of the roof, including 4 feet on each side of the roof peak, the 4 foot perimeter edge zone attachment requirements shall be used.
2 For wind speeds greater than 130 mph, blocking is required which transfers shear load to two additional joi

The language in footnote "f" needed to be slightly modified to clarify that nail spacing for all sheathing to framing attached to gable end roof framing and intermediate supports within 48" of roof end zones, eaves and ridges must be reduced from 6" to 4" where ultimate wind speeds exceed 120 mph. Language was also added to clarify that ultimate wind speeds of 140 mph or greater is outside the scope of the IRC structural provisions. A sentence was also added to R803.2.3 to clarify the appropriate limit on the distance unsupported sheathing can cantilever past the gable end roof framing.

Cost Impact: Will increase the cost of construction
Even though much of the proposal is a clarification that should make it easier to use and thereby reduce cost, the change in fastener spacings from 12" to 6" in rows 30 and 31 of the table will increase the number of nails and the time to install, which will increase cost. This increase in cost is the direct result of compliance with the increased wind uplift loads in ASCE 7-16.

RB222-16 : TABLE R602.3-SMITH11567

Final Action: D (Disapproved)

RB222-16

Committee Action: **Disapproved**

Committee Reason: Based on the proponets request for disapproval and the committees previous action on RB20-16.

Assembly Action: **None**

S8096

Date Submitted	12/13/2018	**Section**	602.3	**Proponent**	Paul Coats
Chapter	6	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

8073

Summary of Modification

Adjustment to roof sheathing nail spacing in accordance with the criteria of ASCE 7-16

Rationale

This proposal updates roof sheathing nailing to resist increased wind design pressures in accordance with ASCE 7-16. The prescribed minimum nailing spacing is 6” o.c. at panel edges and at intermediate supports. Closer nail spacing is required where sheathing is attached to gable end roof framing and within 48” of roof end zones, eaves, and ridges in accordance with footnote f. The proposed nailing schedule is based on calculations in accordance with ASCE 7-16 wind loads, NDS values for fastener withdrawal resistance and head pull through, and is consistent with the comprehensive roof sheathing nailing table (i.e. Table 3.10a) appearing in the Wood Frame Construction Manual (WFCM) 2018 edition.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Enforcement will remain the same with modified nail spacings.

Impact to building and property owners relative to cost of compliance with code

Will cost more for increased nailing of roof sheathing.

Impact to industry relative to the cost of compliance with code

Will cost more for increased nailing of roof sheathing.

Impact to small business relative to the cost of compliance with code

Will cost more for increased nailing of roof sheathing.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Nail spacings modified in accordance with design standards.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

Revise rows 30 and 31 and footnote "f" of Table R602.3(1) as follows:

30	3/8" – 1/2"	6d common (2" × 0.113") nail (subfloor, wall)i8d common (2 1/2" × 0.131") nail (roof)
31	19/32" – 1"	8d common nail (2 1/2" × 0.131")

~~f.Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.~~

For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48 inches of the roof edges and ridges, nails shall be spaced at 4 inches on center where the ultimate design wind speed is greater than 130 mph in Exposure B or greater than 115 mph in Exposure C.

RB222-16

IRC: R602.3, R803.2.3.

Proponent : James Smith (jsmith@awc.org)

2015 International Residential Code

TABLE R602.3 (1)
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
		Roof	
1	Blocking between ceiling joists or rafters to top plate	4-8d box (2 1/2 ″ × 0.113″) or 3-8d common (2 1/2 ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
2	Ceiling joists to top plate	4-8d box (2 1/2 ″ × 0.113″); or 3-8d common (2 1/2 ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Sections R802.3.1, R802.3.2 and Table R802.5.1(9)]	4-10d box (3″ × 0.128″); or 3-16d common (3 1/2 ″ × 0.162″); or 4-3″ × 0.131″ nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Sections R802.3.1 and R802.3.2 and Table R802.5.1(9)]	Table R802.5.1(9)	Face nail
5	Collar tie to rafter, face nail or 1 1/4 ″ × 20 ga. ridge strap to rafter	4-10d box (3″ × 0.128″); or 3-10d common (3″ × 0.148″); or 4-3″ × 0.131″ nails	Face nail each rafter

6	Rafter or roof truss to plate	3-16d box nails (3 1/2 ″ × 0.135″); or 3-10d common nails (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss[i]
7	Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2″ ridge beam	4-16d (3 1/2 ″ × 0.135″); or 3-10d common (3 1/2 ″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box 3 1/2 ″ × 0.135″); or 2-16d common (3 1/2 ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
Wall			
8	Stud to stud (not at braced wall panels)	16d common (3 1/2 ″ × 0.162″)	24″ o.c. face nail
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	16″ o.c. face nail
9	Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d box (3 1/2 ″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
		16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail
10	Built-up header (2″ to 2″ header with 1/2 ″ spacer)	16d common (3 1/2 ″ × 0.162″)	16″ o.c. each edge face nail
		16d box (3 1/2 ″ × 0.135″)	12″ o.c. each edge face nail
11	Continuous header to stud	5-8d box (2 1/2 ″ × 0.113″); or 4-8d common (2 1/2 ″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toe nail
		16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail

12	Top plate to top plate	10d box (3″ × 0.128″); or 3″ × 0.131″ nails	12″ o.c. face nail
13	Double top plate splice for SDCs A-D2 with seismic braced wall line spacing	8-16d common (3$^{1}/_{2}$″ × 0.162″); or 12-16d box (3$^{1}/_{2}$″ × 0.135″); or 12-10d box (3″ × 0.128″); or 12-3″ × 0.131″ nails	Face nail on each side of end joint (minimum 24″ lap splice length each side of end joint)
	Double top plate splice SDCs D_0 , D_1 , or D_2 ; and braced wall line spacing ≥ 25′	12-16d (3$^{1}/_{2}$″ × 0.135″)	

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
14	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common (3$^{1}/_{2}$″ × 0.162″)	16″ o.c. face nail
		16d box (3$^{1}/_{2}$″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
15	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box (3$^{1}/_{2}$″ × 0.135″); or 2-16d common (3$^{1}/_{2}$″ × 0.162″); or 4-3″ × 0.131″ nails	3 each 16″ o.c. face nail 2 each 16″ o.c. face nail 4 each 16″ o.c. face nail
16	Top or bottom plate to stud	4-8d box (2$^{1}/_{2}$″ × 0.113″); or 3-16d box (3$^{1}/_{2}$″ × 0.135″); or 4-8d common (2$^{1}/_{2}$″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box (3$^{1}/_{2}$″ × 0.135″); or 2-16d common (3$^{1}/_{2}$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail

17	Top plates, laps at corners and intersections	3-10d box (3″ × 0.128″); or 2-16d common ($3^1/_2$ ″ × 0.162″); or 3-3″ × 0.131″ nails	Face nail
18	1″ brace to each stud and plate	3-8d box ($2^1/_2$ ″ × 0.113″); or 2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples $1^3/_4$ ″	Face nail
19	1″ × 6″ sheathing to each bearing	3-8d box ($2^1/_2$ ″ × 0.113″); or 2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	Face nail
20	1″ × 8″ and wider sheathing to each bearing	3-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	Face nail
		Wider than 1″ × 8″ 4-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 4 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	
Floor			
21	Joist to sill, top plate or girder	4-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
		8d box ($2^1/_2$ ″ × 0.113″)	4″ o.c. toe nail

22	Rim joist, band joist or blocking to sill or top plate (roof applications also)	8d common ($2^1/_2$ " × 0.131"); or 10d box (3" × 0.128"); or 3" × 0.131" nails	6" o.c. toe nail
23	1" × 6" subfloor or less to each joist	3-8d box ($2^1/_2$ " × 0.113"); or 2-8d common ($2^1/_2$ " × 0.131"); or 3-10d box (3" × 0.128"); or 2 staples, 1" crown, 16 ga., $1^3/_4$ " long	Face nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
		Floor	
24	2"subfloor to joist or girder	3-16d box ($3^1/_2$ "× 0.135"); or 2-16d common ($3^1/_2$ "× 0.162")	Blind and face nail
25	2"planks (plank & beam—floor & roof)	3-16d box ($3^1/_2$ "× 0.135"); or 2-16d common ($3^1/_2$ "× 0.162")	At each bearing, face nail
26	Band or rim joist to joist	3-16d common ($3^1/_2$ "× 0.162") 4-10 box (3"× 0.128"), or 4-3"× 0.131"nails; or	End nail

		4-3″× 14 ga. staples, 7 /16 ″crown					
27	Built-up girders and beams, 2-inch lumber layers	20d common (4″× 0.192″); or	Nail each layer as follows: 32″o.c. at top and bottom and staggered.				
		10d box (3″× 0.128″); or 3″× 0.131″nails	24″o.c. face nail at top and bottom staggered on opposite sides				
		And: 2-20d common (4″× 0.192″); or 3-10d box (3″× 0.128″); or 3-3″× 0.131″nails	Face nail at ends and at each splice				
28	Ledger strip supporting joists or rafters	4-16d box (3 1/2 ″× 0.135″); or 3-16d common (3 1/2 ″× 0.162″); or 4-10d box (3″× 0.128″); or 4-3″× 0.131″nails	At each joist or rafter, face nail	29	Bridging to joist	2-10d (3″× 0.128″)	Each end, toe nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING OF FASTENERS	
			Panel Edges (inches)[h]	Intermediate supports[c, e] (inches)
Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing [see Table R602.3(3) for wood structural panel *exterior* wall sheathing to wall framing]				

30	3/8"– 1/2"	6d common (2"× 0.113") nail (subfloor, wall)[i]8d common (2 1/2"× 0.131") nail (roof)	6	~~12~~6[f]	31	19/32"– 1"	8d common nail (2 1/2"× 0.131")	6	~~12~~6[f]
32	11/8"–11/4"	10d common (3"× 0.148") nail; or 8d (21/2"× 0.131") deformed nail	6	12					
Other wall sheathing[g]									
33	1/2"structural cellulosic fiberboard sheathing	1 1/2"galvanized roofing nail, 7/16" head diameter, or 1"crown staple 16 ga., 1 1/4" long	3	6					
34	25/32"structural cellulosic fiberboard sheathing	1 3/4"galvanized roofing nail, 7/16"head diameter, or 1"crown staple 16 ga., 1 1/4" long	3	6					
		1 1/2							

35	1/2 "gypsum sheathing[d]	"galvanized roofing nail; staple galvanized, 1 1/2 "long; 1 1/4 " screws, Type W or S	7	7
36	5/8 "gypsum sheathing[d]	1 3/4 "galvanized roofing nail; staple galvanized, 1 5/8 " long; 1 5/8 " screws, Type W or S	7	7
Wood structural panels, combination subfloor underlayment to framing				
37	3/4 " and less	6d deformed (2"× 0.120") nail; or 8d common (2 1/2 "× 0.131") nail	6	12
38	7/8 "– 1"	8d common (2 1/2 "× 0.131") nail; or 8d deformed (2 1/2 "× 0.120") nail	6	12
39	1 1/8 "– 1 1/4 "	10d common (3"× 0.148") nail; or 8d deformed (2 1	6	12

		/2 "× 0.120") nail			

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.

a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.

b. Staples are 16 gage wire and have a minimum $^{7}/_{16}$ -inch on diameter crown width.

c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.

d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.

e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).

~~f. Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.~~

f. For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48" of roof end zones, eaves, and ridges, nails shall be spaced at 4" on center where the ultimate design wind speed is 120 mph or greater but less than 140 mph.

g. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.

h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.

i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

Revise as follows:

R803.2.3 Installation. Wood structural panel used as roof sheathing shall be installed with joints staggered or not staggered in accordance with Table R602.3(1), APA E30 for wood roof framing or with Table R804.3 for cold-formed steel roof framing. Wood structural panel roof sheathing shall not cantilever more than 9 inches beyond the gable end wall unless supported by gable overhang framing.

Reason: The nailing requirements provided in IRC Table R602.3(1) were reviewed using loads from the New ASCE 7-16 *Minimum Design Loads for Buildings and Other Structures*. As shown in the table below, calculated wind loads on elements and fasteners with small tributary areas like roof sheathing nails have increased dramatically, almost doubling in the interior portions of the roof (Roof Zone 1).

Roof Zone	ASCE 7-10			ASCE 7-16			Increase
	GC_p	Gc_{pi}	GC_p-Gc_{pi}	GC_p	Gc_{pi}	GC_p-Gc_{pi}	(%)
1	-1.0	-0.18	-1.2	-2.0	-0.18	-2.2	85%
2	-1.8	-0.18	-2.0	-3.0	-0.18	-3.2	61%
2 overhang	-2.8	0.00	-2.8	-3.5	0.00	-3.5	25%
3	-3.0	-0.18	-3.2	-3.6	-0.18	-3.8	19%
3 overhang	-3.7	0.00	-3.7	-4.7	0.00	-4.7	27%

To determine the impact of the new ASCE 7-16 loading provisions, nailing requirements for common species of roof framing with specific gravities of 0.42 or greater (e.g. SPF, Hem-Fir) were analyzed using ASCE 7-16 and it was found that the nail spacing requirements in Table R602.3(1) needed to be significantly modified, especially in the

interior portion of the roof. As shown in the tabulated results below, nailing at intermediate supports in the interior portions of the roof (Roof Zone 1) need to be reduced from 12" o.c. to 6" o.c. However, changes to loads in the end zone portions of the roof were less significant and required far less adjustment. In fact, the 6" o.c. spacing is appropriate for all connection in the end zone portions, except where ultimate wind speeds equal or exceed 120 mph.

WFCM Table 3.10 (Exposure C) - Based on ASCE 7-16
Roof Sheathing Attachment Requirements for Wind Loads

700-yr. Wind Speed 3-second gust (mph)			110		115		120		130		140	
			Wood Structural Panel Sheathing									
			E	F	E	F	E	F	E	F	E	F
Sheathing Location[1]	Rafter/Truss Framing Specific Gravity, G	Rafter/Truss Spacing (in.)	Maximum Nail Spacing for 8d Common Nails or 10d Box Nails (inches, o.c.)[2]									
Interior Zone	0.42	12	6	12	6	12	6	12	6	12	6	12
		16	6	12	6	12	6	12	6	12	6	6
		19.2	6	12	6	12	6	12	6	6	6	6
		24	6	12	6	6	6	6	6	6	6	6
Perimeter Edge Zone	0.42	12	6	12	6	12	6	6	6	6	6	6
		16	6	6	6	6	6	6	6	6	6	6
		19.2	6	6	6	6	6	6	6	6	6	4
		24	6	6	6	6	6	4	6	4	6	4
Gable Endwall Rake or Rake Truss with up to 9" Rake Overhang	0.42	-	6		6		4		4		4	

E - Nail spacing at panel edges (in.)
F - Nail spacing at intermediate supports in the panel field (in.)

1 For roof sheathing within 4 feet of the perimeter edge of the roof, including 4 feet on each side of the roof peak, the 4 foot perimeter edge zone attachment requirements shall be used.
2 For wind speeds greater than 130 mph, blocking is required which transfers shear load to two additional joi

The language in footnote "f" needed to be slightly modified to clarify that nail spacing for all sheathing to framing attached to gable end roof framing and intermediate supports within 48" of roof end zones, eaves and ridges must be reduced from 6" to 4" where ultimate wind speeds exceed 120 mph. Language was also added to clarify that ultimate wind speeds of 140 mph or greater is outside the scope of the IRC structural provisions. A sentence was also added to R803.2.3 to clarify the appropriate limit on the distance unsupported sheathing can cantilever past the gable end roof framing.

Cost Impact: Will increase the cost of construction
Even though much of the proposal is a clarification that should make it easier to use and thereby reduce cost, the change in fastener spacings from 12" to 6" in rows 30 and 31 of the table will increase the number of nails and the time to install, which will increase cost. This increase in cost is the direct result of compliance with the increased wind uplift loads in ASCE 7-16.

RB222-16 : TABLE R602.3-SMITH11567

Final Action: D (Disapproved)

RB222-16

Committee Action: **Disapproved**

Committee Reason: Based on the proponets request for disapproval and the committees previous action on RB20-16.

Assembly Action: **None**

S8151

Date Submitted	12/14/2018	**Section**	602.3	**Proponent**	T Stafford
Chapter	6	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

This proposal is intended to clarify the limits for using the prescriptive (non-high) wind criteria that's been carried forward in the FBCR from the IRC.

Rationale

This proposal is intended to clarify the applicability of the prescriptive criteria in the FBCR for wood, masonry, concrete and steel buildings. Since the first edition, the FBCR has limited the use of the prescriptive criteria that has been carried forward from the IRC. With the adoption of ASCE 7-10 in the 2010 FBCR, the prescriptive provisions have not been permitted to be used in any area of Florida. Recent editions of the FBCR have simply deleted this criteria. During the last cycle, language was added to specifically address the limits but was not as comprehensive as in previous editions. This proposal simply provides additional clarification.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with the code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to cost of compliance with the code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to cost of compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal clarifies requirements for wind design of buildings within the scope of the FBCR.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code by clarifying the wind design requirements of buildings within the scope of the FBCR.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Revises as follows:

R602.3 Design and construction. Where the ultimate design wind speed, V_{ult}, equals or exceeds 115 mph, exterior walls of wood-frame construction shall be designed in accordance with Section R301.2.1.1 or ANSI AWC NDS. Where ultimate design wind speed, V_{ult}, is less than 115 mph ~~E~~exterior walls of wood-frame construction shall be designed and constructed in accordance with the provisions of this chapter ~~and Figures R602.3(1) and R602.3(2), or in accordance with AWC NDS. Components of exterior walls shall be fastened in accordance with Tables R602.3(1) through R602.3(4)~~. Wall sheathing shall be fastened directly to framing members and, where placed on the exterior side of an exterior wall, shall be capable of resisting the wind pressures listed in Table R301.2(2) adjusted for height and exposure using Table R301.2(3) and shall conform to the requirements of Table R602.3(3). Wall sheathing used only for exterior wall covering purposes shall comply with Section R703.

Studs shall be continuous from support at the sole plate to a support at the top plate to resist loads perpendicular to the wall. The support shall be a foundation or floor, ceiling or roof diaphragm or shall be designed in accordance with accepted engineering practice.

Exception: Jack studs, trimmer studs and cripple studs at openings in walls that comply with Tables R602.7(1) and R602.7(2).

Delete without substitution:

~~**TABLE R602.3(1)**~~
~~**FASTENING SCHEDULE**~~

(table contents not shown for brevity)

~~**TABLE R602.3(2)**~~
~~**ALTERNATE ATTACHMENTS TO TABLE R602.3(1)**~~

(table contents not shown for brevity)

Date Submitted 12/14/2018 | **Section** 609.7.2.1 | **Proponent** Anthony Miller
Chapter 6 | **Affects HVHZ** No | **Attachments** No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No | **Alternate Language** Yes

Related Modifications

S7500

Summary of Modification

This modification revises the current language to be more in line with the language in Chapter 17 of the FBC, Building that is being proposed in modification S7500.

Rationale

This modification provides consistency between FBC, Residential and FBC, Building Codes.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to cost of compliance with the code.

Impact to industry relative to the cost of compliance with code

No impact to cost of compliance with the code.

Impact to small business relative to the cost of compliance with code

No impact to cost of compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Does not adversely affect the health, safety, or welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by providing consistency.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade effectiveness.

Alternate Language

1st Comment Period History

8222-A1

Proponent Anthony Miller **Submitted** 2/15/2019 **Attachments** Yes

Rationale

This modification provides consistency between FBC, Residential and FBC, Building Codes.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to cost of compliance with the code.

Impact to industry relative to the cost of compliance with code

No impact to cost of compliance with the code.

Impact to Small Business relative to the cost of compliance with code

No impact to cost of compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Does not adversely affect the health, safety, or welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by providing consistency.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade effectiveness.

R609.7.2.1 Masonry, concrete or other structural substrate.
Where the wood shim or buck thickness is less than 1-1/2 inches (38 mm), window and glass door assemblies shall be anchored through the jamb, or by jamb clip and anchors shall be embedded directly into the masonry, concrete or other substantial substrate material. Unless otherwise tested, bucks shall extend beyond the interior face of the window or door frame such that full support of the frame is provided. Anchors shall adequately transfer load from the window or door frame into the rough opening substrate [see Figures R609.7.2(1) and R6097.2(2)].

Where the wood shim or buck thickness is 1-1/2 inches (38 mm) or more, and the buck is securely fastened to the masonry, concrete or other substantial substrate~~, and the buck extends beyond the interior face of the window or door frame~~, window and glass door assemblies shall be anchored through the jamb, or by jamb clip, or through the flange to the secured wood buck. Unless otherwise tested, bucks shall extend beyond the interior face of the window or door frame such that full support of the frame is provided. Anchors shall be embedded into the secured wood buck to adequately transfer load from the window or door frame assembly [see Figures R609.7.2(3), R6097.2(4) and R609.7.2(5)].

R609.7.2.1 Masonry, concrete or other structural substrate.

Where the wood shim or buck thickness is less than 1-1/2 inches (38 mm), window and ~~glass~~ door assemblies shall be anchored through the jamb, or by jamb clip and anchors shall be embedded directly into the masonry, concrete or other substantial substrate material. Unless otherwise tested, bucks shall fully support the window or door frame. Anchors shall adequately transfer load from the window or door frame into the rough opening substrate [see Figures R609.7.2(1) and R6097.2(2)].

Where the wood shim or buck thickness is 1-1/2 inches (38 mm) or more, and the buck is securely fastened to the masonry, concrete or other substantial substrate, ~~and the buck extends beyond the interior face of the window or door frame~~, window and ~~glass~~ door assemblies shall be anchored through the jamb, or by jamb clip, or through the flange to the secured wood buck. Unless otherwise tested, bucks shall fully support the window or door frame. Anchors shall be embedded into the secured wood buck to adequately transfer load from the window or door frame assembly [see Figures R609.7.2(3), R6097.2(4) and R609.7.2(5)].

R609.7.2.1 Masonry, concrete or other structural substrate.

Where the wood shim or buck thickness is less than 1-1/2 inches (38 mm), window and ~~glass~~ door assemblies shall be anchored through the jamb, or by jamb clip and anchors shall be embedded directly into the masonry, concrete or other substantial substrate material. Unless otherwise tested, bucks shall fully support the window or door frame. Anchors shall adequately transfer load from the window or door frame into the rough opening substrate [see Figures R609.7.2(1) and R6097.2(2)].

Where the wood shim or buck thickness is 1-1/2 inches (38 mm) or more, and the buck is securely fastened to the masonry, concrete or other substantial substrate, ~~and the buck extends beyond the interior face of the window or door frame~~, window and ~~glass~~ door assemblies shall be anchored through the jamb, or by jamb clip, or through the flange to the secured wood buck. Unless otherwise tested, bucks shall fully support the window or door frame. Anchors shall be embedded into the secured wood buck to adequately transfer load from the window or door frame assembly [see Figures R609.7.2(3), R6097.2(4) and R609.7.2(5)].

S8227 254

Date Submitted	12/14/2018	**Section**	602.7	**Proponent**	Paul Coats
Chapter	6	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No **Alternate Language** No

Related Modifications

Summary of Modification

Update of Table R602.7(1) Girder and Header Spans Exterior Walls

Rationale

This modification was approved by the ICC committee and membership and appears in the 2018 International Residential Code. The update of Table R602.7(1) Girder Spans and Header Spans for Exterior Bearing Walls is proposed. Updated spans address use of Southern Pine No. 2 in lieu of Southern Pine No. 1. Footnote "e" is added to clarify that header spans are based on laterally braced assumption such as when the header is raised. For dropped headers consisting of 2x8, 2x10, or 2x12 sizes that are not laterally braced, a factor of 0.7 can be applied to determine the spans or alternatively the header or girder can be designed to include any adjustment for potential buckling. Laterally braced (raised) and not laterally braced (dropped) header conditions and building widths for which header spans are tabulated represent the same conditions used to develop header span tables in the Wood Frame Construction Manual (WFCM).

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will involve familiarization with new span tables and their provisions.

Impact to building and property owners relative to cost of compliance with code

Increased cost may be associated with reduced spans that result from the not laterally braced condition and application of footnote f. Due to certain conditions and options introduced by the revised table, there are also cases where this may reduce cost of construction.

Impact to industry relative to the cost of compliance with code

Increased cost may be associated with reduced spans that result from the not laterally braced condition and application of footnote f. Due to certain conditions and options introduced by the revised table, there are also cases where this may reduce cost of construction.

Impact to small business relative to the cost of compliance with code

Increased cost may be associated with reduced spans that result from the not laterally braced condition and application of footnote f. Due to certain conditions and options introduced by the revised table, there are also cases where this may reduce cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Girder and header spans updated for continued safety and serviceability.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code with updated header spans in accordance with changes in design values and evolving standards.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

Delete and replace entire Table R602.7(1):

~~TABLE R602.7(1)~~

~~GIRDER SPANSa AND HEADER SPANSa FOR EXTERIOR BEARING WALLS (Maximum spans for Douglas fir-larch, hem-fir, southern pine and spruce-pine-firb and required number of jack studs)~~

TABLE R602.7(1)

GIRDER SPANS[a] AND HEADER SPANS[a] FOR EXTERIOR BEARING WALLS (Maximum spans for Douglas fir-larch, hem-fir, southern pine, and spruce-pine-fir[b] and required number of jack studs)

See uploaded support file for content of replacement Table R602.7(1)

Revise as follows:

~~TABLE R602.7~~

~~GIRDER SPANS[a] AND HEADER SPANS[a] FOR EXTERIOR BEARING WALLS (Maximum spans for Douglas fir-larch, hem-fir, southern pine and spruce-pine-fir[b] and required number of jack studs)~~

-

~~GIRDERS AND HEADERS SUPPORTING~~	~~SIZE~~	~~GROUND SNOW LOAD (psf)[e]~~																	
		~~30~~						~~50~~						~~70~~					
		~~Building width[c] (feet)~~																	
		~~20~~		~~28~~		~~36~~		~~20~~		~~28~~		~~36~~		~~20~~		~~28~~		~~36~~	
		~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~
~~Roof and ceiling~~	~~1-2 × 8~~	~~4-6~~	~~1~~	~~3-10~~	~~1~~	~~3-5~~	~~1~~	~~3-9~~	~~1~~	~~3-2~~	~~1~~	~~2-10~~	~~2~~	—	—	—	—	—	—
	~~1-2 × 10~~	~~5-8~~	~~1~~	~~4-11~~	~~1~~	~~4-4~~	~~1~~	~~4-9~~	~~1~~	~~4-1~~	~~1~~	~~3-7~~	~~2~~	—	—	—	—	—	—
	~~1-2 × 12~~	~~6-11~~	~~1~~	~~5-11~~	~~2~~	~~5-3~~	~~2~~	~~5-9~~	~~2~~	~~4-8~~	~~2~~	~~3-8~~	~~2~~	—	—	—	—	—	—
	~~2-2 × 4~~	~~3-6~~	~~1~~	~~3-2~~	~~1~~	~~2-10~~	~~1~~	~~3-2~~	~~1~~	~~2-9~~	~~1~~	~~2-6~~	~~1~~	~~2-10~~	~~1~~	~~2-6~~	~~1~~	~~2-3~~	~~1~~
	~~2-2 × 6~~	~~5-5~~	~~1~~	~~4-8~~	~~1~~	~~4-2~~	~~1~~	~~4-8~~	~~1~~	~~4-1~~	~~1~~	~~3-8~~	~~2~~	~~4-2~~	~~1~~	~~3-8~~	~~2~~	~~3-3~~	~~2~~
	~~2-2 × 8~~	~~6-10~~	~~1~~	~~5-11~~	~~2~~	~~5-4~~	~~2~~	~~5-11~~	~~2~~	~~5-2~~	~~2~~	~~4-7~~	~~2~~	~~5-4~~	~~2~~	~~4-7~~	~~2~~	~~4-1~~	~~2~~
	~~2-2 × 10~~	~~8-5~~	~~2~~	~~7-3~~	~~2~~	~~6-6~~	~~2~~	~~7-3~~	~~2~~	~~6-3~~	~~2~~	~~5-7~~	~~2~~	~~6-6~~	~~2~~	~~5-7~~	~~2~~	~~5-0~~	~~2~~
	~~2-2 × 12~~	~~9-9~~	~~2~~	~~8-5~~	~~2~~	~~7-6~~	~~2~~	~~8-5~~	~~2~~	~~7-3~~	~~2~~	~~6-6~~	~~2~~	~~7-6~~	~~2~~	~~6-6~~	~~2~~	~~5-10~~	~~3~~
	~~3-2 × 8~~	~~8-4~~	~~1~~	~~7-5~~	~~1~~	~~6-8~~	~~1~~	~~7-5~~	~~1~~	~~6-5~~	~~2~~	~~5-9~~	~~2~~	~~6-8~~	~~1~~	~~5-9~~	~~2~~	~~5-2~~	~~2~~
	~~3-2 × 10~~	~~10-6~~	~~1~~	~~9-1~~	~~2~~	~~8-2~~	~~2~~	~~9-1~~	~~2~~	~~7-10~~	~~2~~	~~7-0~~	~~2~~	~~8-2~~	~~2~~	~~7-0~~	~~2~~	~~6-4~~	~~2~~
	~~3-2 × 12~~	~~12-2~~	~~2~~	~~10-7~~	~~2~~	~~9-5~~	~~2~~	~~10-7~~	~~2~~	~~9-2~~	~~2~~	~~8-2~~	~~2~~	~~9-5~~	~~2~~	~~8-2~~	~~2~~	~~7-4~~	~~2~~
	~~4-2 × 8~~	~~9-2~~	~~1~~	~~8-4~~	~~1~~	~~7-8~~	~~1~~	~~8-4~~	~~1~~	~~7-5~~	~~1~~	~~6-8~~	~~1~~	~~7-8~~	~~1~~	~~6-8~~	~~1~~	~~5-11~~	~~2~~
	~~4-2 × 10~~	~~11-8~~	~~1~~	~~10-6~~	~~1~~	~~9-5~~	~~2~~	~~10-6~~	~~1~~	~~9-1~~	~~2~~	~~8-2~~	~~2~~	~~9-5~~	~~2~~	~~8-2~~	~~2~~	~~7-3~~	~~2~~
	~~4-2 × 12~~	~~14-1~~	~~1~~	~~12-2~~	~~2~~	~~10-11~~	~~2~~	~~12-2~~	~~2~~	~~10-7~~	~~2~~	~~9-5~~	~~2~~	~~10-11~~	~~2~~	~~9-5~~	~~2~~	~~8-5~~	~~2~~
	~~1-2 × 8~~	~~3-11~~	~~1~~	~~3-5~~	~~1~~	~~3-0~~	~~1~~	~~3-7~~	~~1~~	~~3-0~~	~~2~~	~~2-8~~	~~2~~	—	—	—	—	—	—
	~~1-2 × 10~~	~~5-0~~	~~2~~	~~4-4~~	~~2~~	~~3-10~~	~~2~~	~~4-6~~	~~2~~	~~3-11~~	~~2~~	~~3-4~~	~~2~~	—	—	—	—	—	—
	~~1-2 × 12~~	~~5-10~~	~~2~~	~~4-9~~	~~2~~	~~4-2~~	~~2~~	~~5-5~~	~~2~~	~~4-2~~	~~2~~	~~3-4~~	~~2~~	—	—	—	—	—	—
	~~2-2 × 4~~	~~3-1~~	~~1~~	~~2-9~~	~~1~~	~~2-5~~	~~1~~	~~2-9~~	~~1~~	~~2-5~~	~~1~~	~~2-2~~	~~1~~	~~2-7~~	~~1~~	~~2-3~~	~~1~~	~~2-0~~	~~1~~
	~~2-2 × 6~~	~~4-6~~	~~1~~	~~4-0~~	~~1~~	~~3-7~~	~~2~~	~~4-1~~	~~1~~	~~3-7~~	~~2~~	~~3-3~~	~~2~~	~~3-9~~	~~2~~	~~3-3~~	~~2~~	~~2-11~~	~~2~~

Roof, ceiling and one center-bearing floor	2-2 × 8	5-9	2	5-0	2	4-6	2	5-2	2	4-6	2	4-1	2	4-9	2	4-2	2	3-9	2
	2-2 × 10	7-0	2	6-2	2	5-6	2	6-4	2	5-6	2	5-0	2	5-9	2	5-1	2	4-7	3
	2-2 × 12	8-1	2	7-1	2	6-5	2	7-4	2	6-5	2	5-9	3	6-8	2	5-10	3	5-3	3
	3-2 × 8	7-2	1	6-3	2	5-8	2	6-5	2	5-8	2	5-1	2	5-11	2	5-2	2	4-8	2
	3-2 × 10	8-9	2	7-8	2	6-11	2	7-11	2	6-11	2	6-3	2	7-3	2	6-4	2	5-8	2
	3-2 × 12	10-2	2	8-11	2	8-0	2	9-2	2	8-0	2	7-3	2	8-5	2	7-4	2	6-7	2
	4-2 × 8	8-1	1	7-3	1	6-7	1	7-5	1	6-6	1	5-11	2	6-10	1	6-0	2	5-5	2
	4-2 × 10	10-1	1	8-10	2	8-0	2	9-1	2	8-0	2	7-2	2	8-4	2	7-4	2	6-7	2
	4-2 × 12	11-9	2	10-3	2	9-3	2	10-7	2	9-3	2	8-4	2	9-8	2	8-6	2	7-7	2
Roof, ceiling and one clear span floor	1-2 × 8	3-6	1	3-0	1	2-8	1	3-5	1	2-11	1	2-7	2	—	—	—	—	—	—
	1-2 × 10	4-6	1	3-10	1	3-3	1	4-4	1	3-9	1	3-1	2	—	—	—	—	—	—
	1-2 × 12	5-6	1	4-2	2	3-3	2	5-4	2	3-11	2	3-1	2	—	—	—	—	—	—
	2-2 × 4	2-8	1	2-4	1	2-1	1	2-7	1	2-3	1	2-0	1	2-5	1	2-1	1	1-10	1
	2-2 × 6	3-11	1	3-5	2	3-0	2	3-10	2	3-4	2	3-0	2	3-6	2	3-1	2	2-9	2
	2-2 × 8	5-0	2	4-4	2	3-10	2	4-10	2	4-2	2	3-9	2	4-6	2	3-11	2	3-6	2
	2-2 × 10	6-1	2	5-3	2	4-8	2	5-11	2	5-1	2	4-7	3	5-6	2	4-9	2	4-3	3
	2-2 × 12	7-1	2	6-1	3	5-5	3	6-10	2	5-11	3	5-4	3	6-4	2	5-6	3	5-0	3
	3-2 × 8	6-3	2	5-5	2	4-10	2	6-1	2	5-3	2	4-8	2	5-7	2	4-11	2	4-5	2
	3-2 × 10	7-7	2	6-7	2	5-11	2	7-5	2	6-5	2	5-9	2	6-10	2	6-0	2	5-4	2
	3-2 × 12	8-10	2	7-8	2	6-10	2	8-7	2	7-5	2	6-8	2	7-11	2	6-11	2	6-3	2
	4-2 × 8	7-2	1	6-3	2	5-7	2	7-0	1	6-1	2	5-5	2	6-6	1	5-8	2	5-1	2
	4-2 × 10	8-9	2	7-7	2	6-10	2	8-7	2	7-5	2	6-7	2	7-11	2	6-11	2	6-2	2
	4-2 × 12	10-2	2	8-10	2	7-11	2	9-11	2	8-7	2	7-8	2	9-2	2	8-0	2	7-2	2

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GIRDERS AND HEADERS SUPPORTING	SIZE	GROUND SNOW LOAD (psf)[e]																	
		30						50						70					
		Building width[e] (feet)																	
		20		28		36		20		28		36		20		28		36	
		Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]
	2-2 × 4	2-7	1	2-3	1	2-0	1	2-6	1	2-2	1	1-11	1	2-4	1	2-0	1	1-9	1
	2-2 × 6	3-9	2	3-3	2	2-11	2	3-8	2	3-2	2	2-10	2	3-5	2	3-0	2	2-8	2
	2-2 × 8	4-9	2	4-2	2	3-9	2	4-7	2	4-0	2	3-8	2	4-4	2	3-9	2	3-5	2

	~~2-2 × 10~~	~~5-9~~	~~2~~	~~5-1~~	~~2~~	~~4-7~~	~~3~~	~~5-8~~	~~2~~	~~4-11~~	~~2~~	~~4-5~~	~~3~~	~~5-3~~	~~2~~	~~4-7~~	~~3~~	~~4-2~~	~~3~~
~~Roof, ceiling and two center-bearing floors~~	~~2-2 × 12~~	~~6-8~~	~~2~~	~~5-10~~	~~3~~	~~5-3~~	~~3~~	~~6-6~~	~~2~~	~~5-9~~	~~3~~	~~5-2~~	~~3~~	~~6-1~~	~~3~~	~~5-4~~	~~3~~	~~4-10~~	~~3~~
	~~3-2 × 8~~	~~5-11~~	~~2~~	~~5-2~~	~~2~~	~~4-8~~	~~2~~	~~5-9~~	~~2~~	~~5-1~~	~~2~~	~~4-7~~	~~2~~	~~5-5~~	~~2~~	~~4-9~~	~~2~~	~~4-3~~	~~2~~
	~~3-2 × 10~~	~~7-3~~	~~2~~	~~6-4~~	~~2~~	~~5-8~~	~~2~~	~~7-1~~	~~2~~	~~6-2~~	~~2~~	~~5-7~~	~~2~~	~~6-7~~	~~2~~	~~5-9~~	~~2~~	~~5-3~~	~~2~~
	~~3-2 × 12~~	~~8-5~~	~~2~~	~~7-4~~	~~2~~	~~6-7~~	~~2~~	~~8-2~~	~~2~~	~~7-2~~	~~2~~	~~6-5~~	~~3~~	~~7-8~~	~~2~~	~~6-9~~	~~2~~	~~6-1~~	~~3~~
	~~4-2 × 8~~	~~6-10~~	~~1~~	~~6-0~~	~~2~~	~~5-5~~	~~2~~	~~6-8~~	~~1~~	~~5-10~~	~~2~~	~~5-3~~	~~2~~	~~6-3~~	~~2~~	~~5-6~~	~~2~~	~~4-11~~	~~2~~
	~~4-2 × 10~~	~~8-4~~	~~2~~	~~7-4~~	~~2~~	~~6-7~~	~~2~~	~~8-2~~	~~2~~	~~7-2~~	~~2~~	~~6-5~~	~~2~~	~~7-7~~	~~2~~	~~6-8~~	~~2~~	~~6-0~~	~~2~~
	~~4-2 × 12~~	~~9-8~~	~~2~~	~~8-6~~	~~2~~	~~7-8~~	~~2~~	~~9-5~~	~~2~~	~~8-3~~	~~2~~	~~7-5~~	~~2~~	~~8-10~~	~~2~~	~~7-9~~	~~2~~	~~7-0~~	~~2~~
	~~2-2 × 4~~	~~2-1~~	~~1~~	~~1-8~~	~~1~~	~~1-6~~	~~2~~	~~2-0~~	~~1~~	~~1-8~~	~~1~~	~~1-5~~	~~2~~	~~2-0~~	~~1~~	~~1-8~~	~~1~~	~~1-5~~	~~2~~
	~~2-2 × 6~~	~~3-1~~	~~2~~	~~2-8~~	~~2~~	~~2-4~~	~~2~~	~~3-0~~	~~2~~	~~2-7~~	~~2~~	~~2-3~~	~~2~~	~~2-11~~	~~2~~	~~2-7~~	~~2~~	~~2-3~~	~~2~~
	~~2-2 × 8~~	~~3-10~~	~~2~~	~~3-4~~	~~2~~	~~3-0~~	~~3~~	~~3-10~~	~~2~~	~~3-4~~	~~2~~	~~2-11~~	~~3~~	~~3-9~~	~~2~~	~~3-3~~	~~2~~	~~2-11~~	~~3~~
	~~2-2 × 10~~	~~4-9~~	~~2~~	~~4-1~~	~~3~~	~~3-8~~	~~3~~	~~4-8~~	~~2~~	~~4-0~~	~~3~~	~~3-7~~	~~3~~	~~4-7~~	~~3~~	~~4-0~~	~~3~~	~~3-6~~	~~3~~
	~~2-2 × 12~~	~~5-6~~	~~3~~	~~4-9~~	~~3~~	~~4-3~~	~~3~~	~~5-5~~	~~3~~	~~4-8~~	~~3~~	~~4-2~~	~~3~~	~~5-4~~	~~3~~	~~4-7~~	~~3~~	~~4-1~~	~~4~~
~~Roof, ceiling, and two clear-span floors~~	~~3-2 × 8~~	~~4-10~~	~~2~~	~~4-2~~	~~2~~	~~3-9~~	~~2~~	~~4-9~~	~~2~~	~~4-1~~	~~2~~	~~3-8~~	~~2~~	~~4-8~~	~~2~~	~~4-1~~	~~2~~	~~3-8~~	~~2~~
	~~3-2 × 10~~	~~5-11~~	~~2~~	~~5-1~~	~~2~~	~~4-7~~	~~3~~	~~5-10~~	~~2~~	~~5-0~~	~~2~~	~~4-6~~	~~3~~	~~5-9~~	~~2~~	~~4-11~~	~~2~~	~~4-5~~	~~3~~
	~~3-2 × 12~~	~~6-10~~	~~2~~	~~5-11~~	~~3~~	~~5-4~~	~~3~~	~~6-9~~	~~2~~	~~5-10~~	~~3~~	~~5-3~~	~~3~~	~~6-8~~	~~2~~	~~5-9~~	~~3~~	~~5-2~~	~~3~~
	~~4-2 × 8~~	~~5-7~~	~~2~~	~~4-10~~	~~2~~	~~4-4~~	~~2~~	~~5-6~~	~~2~~	~~4-9~~	~~2~~	~~4-3~~	~~2~~	~~5-5~~	~~2~~	~~4-8~~	~~2~~	~~4-2~~	~~2~~
	~~4-2 × 10~~	~~6-10~~	~~2~~	~~5-11~~	~~2~~	~~5-3~~	~~2~~	~~6-9~~	~~2~~	~~5-10~~	~~2~~	~~5-2~~	~~2~~	~~6-7~~	~~2~~	~~5-9~~	~~2~~	~~5-1~~	~~2~~
	~~4-2 × 12~~	~~7-11~~	~~2~~	~~6-10~~	~~2~~	~~6-2~~	~~3~~	~~7-9~~	~~2~~	~~6-9~~	~~2~~	~~6-0~~	~~3~~	~~7-8~~	~~2~~	~~6-8~~	~~2~~	~~5-11~~	~~3~~

~~For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.~~

~~a. Spans are given in feet and inches.~~

~~b. No. 1 or better grade lumber shall be used for southern pine. Other tabulated values assume #2 grade lumber.~~

~~c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.~~

~~d. NJ = Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.~~

~~e. Use 30 psf ground snow load for cases in which ground snow load is less than 30 psf and the roof live load is equal to or less than 20 psf.~~

TABLE R602.7(1)

GIRDER SPANS[a] AND HEADER SPANS[a] FOR EXTERIOR BEARING WALLS (Maximum spans for Douglas fir-larch, hem-fir, southern pine, and spruce-pine-fir[b] and required number of jack studs)

GIRDERS AND HEADERS SUPPORTING	SIZE	GROUND SNOW LOAD (psf)[e]																	
		30						50						70					
		Building width[c] (feet)																	
		12		24		36		12		24		36		12		24		36	

		Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ
Roof and ceiling	1-2x6	4 - 0	1	3 - 1	2	2 - 7	2	3 - 5	1	2 - 8	2	2 - 3	2	3 - 0	2	2 - 4	2	2 - 0	2
	1-2x8	5 - 1	2	3 - 11	2	3 - 3	2	4 - 4	2	3 - 4	2	2 - 10	2	3 - 10	2	3 - 0	2	2 - 6	3
	1-2x10	6 - 0	2	4 - 8	2	3 - 11	2	5 - 2	2	4 - 0	2	3 - 4	3	4 - 7	2	3 - 6	3	3 - 0	3
	1-2x12	7 - 1	2	5 - 5	2	4 - 7	3	6 - 1	2	4 - 8	3	3 - 11	3	5 - 5	2	4 - 2	3	3 - 6	3
	2-2x4	4 - 0	1	3 - 1	1	2 - 7	1	3 - 5	1	2 - 7	1	2 - 2	1	3 - 0	1	2 - 4	1	2 - 0	1
	2-2x6	6 - 0	1	4 - 7	1	3 - 10	1	5 - 1	1	3 - 11	1	3 - 3	2	4 - 6	1	3 - 6	2	2 - 11	2
	2-2x8	7 - 7	1	5 - 9	1	4 - 10	2	6 - 5	1	5 - 0	2	4 - 2	2	5 - 9	1	4 - 5	2	3 - 9	2
	2-2x10	9 - 0	1	6 - 10	2	5 - 9	2	7 - 8	2	5 - 11	2	4 - 11	2	6 - 9	2	5 - 3	2	4 - 5	2
	2-2x12	10 - 7	2	8 - 1	2	6 - 10	2	9 - 0	2	6 - 11	2	5 - 10	2	8 - 0	2	6 - 2	2	5 - 2	3
	3-2x8	9 - 5	1	7 - 3	1	6 - 1	1	8 - 1	1	6 - 3	1	5 - 3	2	7 - 2	1	5 - 6	2	4 - 8	2
	3-2x10	11 - 3	1	8 - 7	1	7 - 3	2	9 - 7	1	7 - 4	2	6 - 2	2	8 - 6	1	6 - 7	2	5 - 6	2
	3-2x12	13 - 2	1	10 - 1	2	8 - 6	2	11 - 3	2	8 - 8	2	7 - 4	2	10 - 0	2	7 - 9	2	6 - 6	2
	4-2x8	10 - 11	1	8 - 4	1	7 - 0	1	9 - 4	1	7 - 2	1	6 - 0	1	8 - 3	1	6 - 4	1	5 - 4	2
	4-2x10	12 - 11	1	9 - 11	1	8 - 4	1	11 - 1	1	8 - 6	1	7 - 2	2	9 - 10	1	7 - 7	2	6 - 4	2
	4-2x12	15 - 3	1	11 - 8	1	9 - 10	2	13 - 0	1	10 - 0	2	8 - 5	2	11 - 7	1	8 - 11	2	7 - 6	2
Roof, ceiling and one center-bearing	1-2x6	3 - 3	1	2 - 7	2	2 - 2	2	3 - 0	2	2 - 4	2	2 - 0	2	2 - 9	2	2 - 2	2	1 - 10	2
	1-	4 - 1	2	3 - 3	2	2 - 9	2	3 - 9	2	3 - 0	2	2 - 6	3	3 - 6	2	2 - 9	2	2 - 4	3

floor	2x8																		
	1-2x10	4 - 11	2	3 - 10	2	3 - 3	3	4 - 6	2	3 - 6	3	3 - 0	3	4 - 1	2	3 - 3	3	2 - 9	3
	1-2x12	5 - 9	2	4 - 6	3	3 - 10	3	5 - 3	2	4 - 2	3	3 - 6	3	4 - 10	3	3 - 10	3	3 - 3	4
	2-2x4	3 - 3	1	2 - 6	1	2 - 2	1	3 - 0	1	2 - 4	1	2 - 0	1	2 - 8	1	2 - 2	1	1 - 10	1
	2-2x6	4 - 10	1	3 - 9	1	3 - 3	2	4 - 5	1	3 - 6	2	3 - 0	2	4 - 1	1	3 - 3	2	2 - 9	2
	2-2x8	6 - 1	1	4 - 10	2	4 - 1	2	5 - 7	2	4 - 5	2	3 - 9	2	5 - 2	2	4 - 1	2	3 - 6	2
	2-2x10	7 - 3	2	5 - 8	2	4 - 10	2	6 - 8	2	5 - 3	2	4 - 5	2	6 - 1	2	4 - 10	2	4 - 1	2
	2-2x12	8 - 6	2	6 - 8	2	5 - 8	2	7 - 10	2	6 - 2	2	5 - 3	3	7 - 2	2	5 - 8	2	4 - 10	3
	3-2x8	7 - 8	1	6 - 0	1	5 - 1	2	7 - 0	1	5 - 6	2	4 - 8	2	6 - 5	1	5 - 1	2	4 - 4	2
	3-2x10	9 - 1	1	7 - 2	2	6 - 1	2	8 - 4	1	6 - 7	2	5 - 7	2	7 - 8	2	6 - 1	2	5 - 2	2
	3-2x12	10 - 8	2	8 - 5	2	7 - 2	2	9 - 10	2	7 - 8	2	6 - 7	2	9 - 0	2	7 - 1	2	6 - 1	2
	4-2x8	8 - 10	1	6 - 11	1	5 - 11	1	8 - 1	1	6 - 4	1	5 - 5	2	7 - 5	1	5 - 11	1	5 - 0	2
	4-2x10	10 - 6	1	8 - 3	2	7 - 0	2	9 - 8	1	7 - 7	2	6 - 5	2	8 - 10	1	7 - 0	2	6 - 0	2
	4-2x12	12 - 4	1	9 - 8	2	8 - 3	2	11 - 4	2	8 - 11	2	7 - 7	2	10 - 4	2	8 - 3	2	7 - 0	2
Roof, ceiling and one clear span floor	1-2x6	2 - 11	2	2 - 3	2	1 - 11	2	2 - 9	2	2 - 1	2	1 - 9	2	2 - 7	2	2 - 0	2	1 - 8	2
	1-2x8	3 - 9	2	2 - 10	2	2 - 5	3	3 - 6	2	2 - 8	2	2 - 3	3	3 - 3	2	2 - 6	3	2 - 2	3
	1-2x10	4 - 5	2	3 - 5	3	2 - 10	3	4 - 2	2	3 - 2	3	2 - 8	3	3 - 11	2	3 - 0	3	2 - 6	3
	1-	5 - 2	2	4 - 0	3	3 - 4	3	4 - 10	3	3 - 9	3	3 - 2	4	4 - 7	3	3 - 6	3	3 - 0	4

	2x12																		
	2-2x4	2 - 11	1	2 - 3	1	1 - 10	1	2 - 9	1	2 - 1	1	1 - 9	1	2 - 7	1	2 - 0	1	1 - 8	1
	2-2x6	4 - 4	1	3 - 4	2	2 - 10	2	4 - 1	1	3 - 2	2	2 - 8	2	3 - 10	1	3 - 0	2	2 - 6	2
	2-2x8	5 - 6	2	4 - 3	2	3 - 7	2	5 - 2	2	4 - 0	2	3 - 4	2	4 - 10	2	3 - 9	2	3 - 2	2
	2-2x10	6 - 7	2	5 - 0	2	4 - 2	2	6 - 1	2	4 - 9	2	4 - 0	2	5 - 9	2	4 - 5	2	3 - 9	3
	2-2x12	7 - 9	2	5 - 11	2	4 - 11	3	7 - 2	2	5 - 7	2	4 - 8	3	6 - 9	2	5 - 3	3	4 - 5	3
	3-2x8	6 - 11	1	5 - 3	2	4 - 5	2	6 - 5	1	5 - 0	2	4 - 2	2	6 - 1	1	4 - 8	2	4 - 0	2
	3-2x10	8 - 3	2	6 - 3	2	5 - 3	2	7 - 8	2	5 - 11	2	5 - 0	2	7 - 3	2	5 - 7	2	4 - 8	2
	3-2x12	9 - 8	2	7 - 5	2	6 - 2	2	9 - 0	2	7 - 0	2	5 - 10	2	8 - 6	2	6 - 7	2	5 - 6	3
	4-2x8	8 - 0	1	6 - 1	1	5 - 1	2	7 - 5	1	5 - 9	2	4 - 10	2	7 - 0	1	5 - 5	2	4 - 7	2
	4-2x10	9 - 6	1	7 - 3	2	6 - 1	2	8 - 10	1	6 - 10	2	5 - 9	2	8 - 4	1	6 - 5	2	5 - 5	2
	4-2x12	11 - 2	2	8 - 6	2	7 - 2	2	10 - 5	2	8 - 0	2	6 - 9	2	9 - 10	2	7 - 7	2	6 - 5	2
Roof, ceiling and two center-bearing floors	1-2x6	2 - 8	2	2 - 1	2	1 - 10	2	2 - 7	2	2 - 0	2	1 - 9	2	2 - 5	2	1 - 11	2	1 - 8	2
	1-2x8	3 - 5	2	2 - 8	2	2 - 4	3	3 - 3	2	2 - 7	2	2 - 2	3	3 - 1	2	2 - 5	3	2 - 1	3
	1-2x10	4 - 0	2	3 - 2	3	2 - 9	3	3 - 10	2	3 - 1	3	2 - 7	3	3 - 8	2	2 - 11	3	2 - 5	3
	1-2x12	4 - 9	3	3 - 9	3	3 - 2	4	4 - 6	3	3 - 7	3	3 - 1	4	4 - 3	3	3 - 5	3	2 - 11	4
	2-2x4	2 - 8	1	2 - 1	1	1 - 9	1	2 - 6	1	2 - 0	1	1 - 8	1	2 - 5	1	1 - 11	1	1 - 7	1
	2-	4 - 0	1	3 - 2	2	2 - 8	2	3 - 9	1	3 - 0	2	2 - 7	2	3 - 7	1	2 - 10	2	2 - 5	2

	2x6																		
	2-2x8	5 - 0	2	4 - 0	2	3 - 5	2	4 - 10	2	3 - 10	2	3 - 3	2	4 - 7	2	3 - 7	2	3 - 1	2
	2-2x10	6 - 0	2	4 - 9	2	4 - 0	2	5 - 8	2	4 - 6	2	3 - 10	3	5 - 5	2	4 - 3	2	3 - 8	3
	2-2x12	7 - 0	2	5 - 7	2	4 - 9	3	6 - 8	2	5 - 4	3	4 - 6	3	6 - 4	2	5 - 0	3	4 - 3	3
	3-2x8	6 - 4	1	5 - 0	2	4 - 3	2	6 - 0	1	4 - 9	2	4 - 1	2	5 - 8	2	4 - 6	2	3 - 10	2
	3-2x10	7 - 6	2	5 - 11	2	5 - 1	2	7 - 1	2	5 - 8	2	4 - 10	2	6 - 9	2	5 - 4	2	4 - 7	2
	3-2x12	8 - 10	2	7 - 0	2	5 - 11	2	8 - 5	2	6 - 8	2	5 - 8	3	8 - 0	2	6 - 4	2	5 - 4	3
	4-2x8	7 - 3	1	5 - 9	1	4 - 11	2	6 - 11	1	5 - 6	2	4 - 8	2	6 - 7	1	5 - 2	2	4 - 5	2
	4-2x10	8 - 8	1	6 - 10	2	5 - 10	2	8 - 3	2	6 - 6	2	5 - 7	2	7 - 10	2	6 - 2	2	5 - 3	2
	4-2x12	10 - 2	2	8 - 1	2	6 - 10	2	9 - 8	2	7 - 8	2	6 - 7	2	9 - 2	2	7 - 3	2	6 - 2	2
Roof, ceiling and two clear span floors	1-2x6	2 - 3	2	1 - 9	2	1 - 5	2	2 - 3	2	1 - 9	2	1 - 5	3	2 - 2	2	1 - 8	2	1 - 5	3
	1-2x8	2 - 10	2	2 - 2	3	1 - 10	3	2 - 10	2	2 - 2	3	1 - 10	3	2 - 9	2	2 - 1	3	1 - 10	3
	1-2x10	3 - 4	2	2 - 7	3	2 - 2	3	3 - 4	3	2 - 7	3	2 - 2	4	3 - 3	3	2 - 6	3	2 - 2	4
	1-2x12	4 - 0	3	3 - 0	3	2 - 7	4	4 - 0	3	3 - 0	4	2 - 7	4	3 - 10	3	3 - 0	4	2 - 6	4
	2-2x4	2 - 3	1	1 - 8	1	1 - 4	1	2 - 3	1	1 - 8	1	1 - 4	1	2 - 2	1	1 - 8	1	1 - 4	2
	2-2x6	3 - 4	1	2 - 6	2	2 - 2	2	3 - 4	2	2 - 6	2	2 - 2	2	3 - 3	2	2 - 6	2	2 - 1	2
	2-2x8	4 - 3	2	3 - 3	2	2 - 8	2	4 - 3	2	3 - 3	2	2 - 8	2	4 - 1	2	3 - 2	2	2 - 8	3
	2-	5 - 0	2	3 - 10	2	3 - 2	3	5 - 0	2	3 - 10	2	3 - 2	3	4 - 10	2	3 - 9	3	3 - 2	3

	2x10																		
	2-2x12	5 - 11	2	4 - 6	3	3 - 9	3	5 - 11	2	4 - 6	3	3 - 9	3	5 - 8	2	4 - 5	3	3 - 9	3
	3-2x8	5 - 3	1	4 - 0	2	3 - 5	2	5 - 3	2	4 - 0	2	3 - 5	2	5 - 1	2	3 - 11	2	3 - 4	2
	3-2x10	6 - 3	2	4 - 9	2	4 - 0	2	6 - 3	2	4 - 9	2	4 - 0	2	6 - 1	2	4 - 8	2	4 - 0	3
	3-2x12	7 - 5	2	5 - 8	2	4 - 9	3	7 - 5	2	5 - 8	2	4 - 9	3	7 - 2	2	5 - 6	3	4 - 8	3
	4-2x8	6 - 1	1	4 - 8	2	3 - 11	2	6 - 1	1	4 - 8	2	3 - 11	2	5 - 11	1	4 - 7	2	3 - 10	2
	4-2x10	7 - 3	2	5 - 6	2	4 - 8	2	7 - 3	2	5 - 6	2	4 - 8	2	7 - 0	2	5 - 5	2	4 - 7	2
	4-2x12	8 - 6	2	6 - 6	2	5 - 6	2	8 - 6	2	6 - 6	2	5 - 6	2	8 - 3	2	6 - 4	2	5 - 4	3

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. Spans are given in feet and inches.

b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir.

c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.

d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.

e. Use 30 psf ground snow load for cases in which ground snow load is less than 30 psf and the roof live load is equal to or less than 20 psf.

f. Spans are calculated assuming the top of the header or girder is laterally braced by perpendicular framing. Where the top of the header or girder is not laterally braced (e.g. cripple studs bearing on the header), tabulated spans for headers consisting of 2x8, 2x10, or 2x12 sizes shall be multiplied by 0.70 or the header or girder shall be designed.

RB227-16

IRC: R602.7, R602.7(1) (New).

Proponent : David Tyree, representing American Wood Council (dtyree@awc.org)

2015 International Residential Code

Revise as follows:

~~**TABLE R602.7**~~

~~**GIRDER SPANS[a] AND HEADER SPANS[a] FOR EXTERIOR BEARING WALLS (Maximum spans for Douglas fir-larch, hem-fir, southern pine and spruce-pine-fir[b] and required number of jack studs)**~~

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GIRDERS AND HEADERS SUPPORTING	SIZE	GROUND SNOW LOAD (psf)[e]																	
		30						50						70					
		Building width[c] (feet)																	
		20		28		36		20		28		36		20		28		36	
		Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]
Roof and ceiling	1-2 × 8	4-6	1	3-10	1	3-5	1	3-0	1	3-2	1	2-10	2	—	—	—	—	—	—
	1-2 × 10	5-8	1	4-11	1	4-4	1	4-0	1	4-1	1	3-7	2	—	—	—	—	—	—
	1-2 × 12	6-11	1	5-11	2	5-3	2	5-0	2	4-8	2	3-8	2	—	—	—	—	—	—
	2-2 × 4	3-6	1	3-2	1	2-10	1	3-2	1	2-9	1	2-6	1	2-10	1	2-6	1	2-3	1
	2-2 × 6	5-5	1	4-8	1	4-2	1	4-8	1	4-1	1	3-8	2	4-2	1	3-8	2	3-3	2
	2-2 × 8	6-10	1	5-11	2	5-4	2	5-11	2	5-2	2	4-7	2	5-4	2	4-7	2	4-1	2
	2-2 × 10	8-5	2	+7-3	2	6-6	2	7-3	2	6-3	2	5-7	2	6-6	2	5-7	2	5-0	2
	2-2 × 12	9-9	2	8-5	2	7-6	2	8-5	2	7-3	2	6-6	2	7-6	2	6-6	2	5-10	3
	3-2 × 8	8-4	1	7-5	1	6-8	1	7-5	1	6-5	2	5-9	2	6-8	1	5-9	2	5-2	2
	3-2 × 10	10-6	1	9-1	2	8-2	2	9-1	2	7-10	2	7-0	2	8-2	2	7-0	2	6-4	2
	3-2 × 12	12-2	2	10-7	2	9-5	2	10-7	2	9-2	2	8-2	2	9-5	2	8-2	2	7-4	2
	4-2 × 8	9-2	1	8-4	1	7-8	1	8-4	1	7-5	1	6-8	1	7-8	1	6-8	1	5-11	2
	4-2 × 10	11-8	1	10-6	1	9-5	2	10-6	1	9-1	2	8-2	2	9-5	2	8-2	2	7-3	2
	4-2 × 12	14-1	1	12-2	2	10-11	2	12-2	2	10-7	2	9-5	2	10-11	2	9-5	2	8-5	2
	1-2 × 8	3-11	1	3-5	1	3-0	1	3-7	1	3-0	2	2-8	2	—	—	—	—	—	—
	1-2 × 10	5-0	2	4-4	2	3-10	2	4-6	2	3-11	2	3-4	2	—	—	—	—	—	—
	1-2 × 12	5-10	2	4-9	2	4-2	2	5-5	2	4-2	2	3-4	2	—	—	—	—	—	—
	2-2 × 4	3-1	1	2-9	1	2-5	1	2-9	1	2-5	1	2-2	1	2-7	1	2-3	1	2-0	1
	2-2 × 6	4-6	1	4-0	1	3-7	2	4-1	1	3-7	2	3-3	2	3-9	2	3-3	2	2-11	2

Roof, ceiling and one center-bearing floor	2-2 × 8	5-9	2	5-0	2	4-6	2	5-2	2	4-6	2	4-1	2	4-9	2	4-2	2	3-9	2
	2-2 × 10	7-0	2	6-2	2	5-6	2	6-4	2	5-6	2	5-0	2	5-9	2	5-1	2	4-7	3
	2-2 × 12	8-1	2	7-1	2	6-5	2	7-4	2	6-5	2	5-9	3	6-8	2	5-10	3	5-3	3
	3-2 × 8	7-2	1	6-3	2	5-8	2	6-5	2	5-8	2	5-1	2	5-11	2	5-2	2	4-8	2
	3-2 × 10	8-9	2	7-8	2	6-11	2	7-11	2	6-11	2	6-3	2	7-3	2	6-4	2	5-8	2
	3-2 × 12	10-2	2	8-11	2	8-0	2	9-2	2	8-0	2	7-3	2	8-5	2	7-4	2	6-7	2
	4-2 × 8	8-1	1	7-3	1	6-7	1	7-5	1	6-6	1	5-11	2	6-10	1	6-0	2	5-5	2
	4-2 × 10	10-1	1	8-10	2	8-0	2	9-1	2	8-0	2	7-2	2	8-4	2	7-4	2	6-7	2
	4-2 × 12	11-9	2	10-3	2	9-3	2	10-7	2	9-3	2	8-4	2	9-8	2	8-6	2	7-7	2
Roof, ceiling and one clear span floor	1-2 × 8	3-6	1	3-0	1	2-8	1	3-5	1	2-11	1	2-7	2	—	—	—	—	—	—
	1-2 × 10	4-6	1	3-10	1	3-3	1	4-4	1	3-9	1	3-1	2	—	—	—	—	—	—
	1-2 × 12	5-6	1	4-2	2	3-3	2	5-4	2	3-11	2	3-1	2	—	—	—	—	—	—
	2-2 × 4	2-8	1	2-4	1	2-1	1	2-7	1	2-3	1	2-0	1	2-5	1	2-1	1	1-10	1
	2-2 × 6	3-11	1	3-5	2	3-0	2	3-10	2	3-4	2	3-0	2	3-6	2	3-1	2	2-9	2
	2-2 × 8	5-0	2	4-4	2	3-10	2	4-10	2	4-2	2	3-9	2	4-6	2	3-11	2	3-6	2
	2-2 × 10	6-1	2	5-3	2	4-8	2	5-11	2	5-1	2	4-7	3	5-6	2	4-9	2	4-3	3
	2-2 × 12	7-1	2	6-1	3	5-5	3	6-10	2	5-11	3	5-4	3	6-4	2	5-6	3	5-0	3
	3-2 × 8	6-3	2	5-5	2	4-10	2	6-1	2	5-3	2	4-8	2	5-7	2	4-11	2	4-5	2
	3-2 × 10	7-7	2	6-7	2	5-11	2	7-5	2	6-5	2	5-9	2	6-10	2	6-0	2	5-4	2
	3-2 × 12	8-10	2	7-8	2	6-10	2	8-7	2	7-5	2	6-8	2	7-11	2	6-11	2	6-3	2
	4-2 × 8	7-2	1	6-3	2	5-7	2	7-0	1	6-1	2	5-5	2	6-6	1	5-8	2	5-1	2
	4-2 × 10	8-9	2	7-7	2	6-10	2	8-7	2	7-5	2	6-7	2	7-11	2	6-11	2	6-2	2
	4-2 × 12	10-2	2	8-10	2	7-11	2	9-11	2	8-7	2	7-8	2	9-2	2	8-0	2	7-2	2

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GIRDERS AND HEADERS SUPPORTING	SIZE	GROUND SNOW LOAD (psf)[e]																	
		30						50						70					
		Building width[e] (feet)																	
		20		28		36		20		28		36		20		28		36	
		Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]
	2-2 × 4	2-7	1	2-3	1	2-0	1	2-6	1	2-2	1	1-11	1	2-4	1	2-0	1	1-9	1
	2-2 × 6	3-9	2	3-3	2	2-11	2	3-8	2	3-2	2	2-10	2	3-5	2	3-0	2	2-8	2
	2-2 × 8	4-9	2	4-2	2	3-9	2	4-7	2	4-0	2	3-8	2	4-4	2	3-9	2	3-5	2

	2-2 × 10	5-9	2	5-1	2	4-7	3	5-8	2	4-11	2	4-5	3	5-3	2	4-7	3	4-2	3
Roof, ceiling and two center-bearing floors	2-2 × 12	6-8	2	5-10	3	5-3	3	6-6	2	5-9	3	5-2	3	6-1	3	5-4	3	4-10	3
	3-2 × 8	5-11	2	5-2	2	4-8	2	5-9	2	5-1	2	4-7	2	5-5	2	4-9	2	4-3	2
	3-2 × 10	7-3	2	6-4	2	5-8	2	7-1	2	6-2	2	5-7	2	6-7	2	5-9	2	5-3	2
	3-2 × 12	8-5	2	7-4	2	6-7	2	8-2	2	7-2	2	6-5	3	7-8	2	6-9	2	6-1	3
	4-2 × 8	6-10	1	6-0	2	5-5	2	6-8	1	5-10	2	5-3	2	6-3	2	5-6	2	4-11	2
	4-2 × 10	8-4	2	7-4	2	6-7	2	8-2	2	7-2	2	6-5	2	7-7	2	6-8	2	6-0	2
	4-2 × 12	9-8	2	8-6	2	7-8	2	9-5	2	8-3	2	7-5	2	8-10	2	7-9	2	7-0	2
	2-2 × 4	2-1	1	1-8	1	1-6	2	2-0	1	1-8	1	1-5	2	2-0	1	1-8	1	1-5	2
	2-2 × 6	3-1	2	2-8	2	2-4	2	3-0	2	2-7	2	2-3	2	2-11	2	2-7	2	2-3	2
	2-2 × 8	3-10	2	3-4	2	3-0	3	3-10	2	3-4	2	2-11	3	3-9	2	3-3	2	2-11	3
	2-2 × 10	4-9	2	4-1	3	3-8	3	4-8	2	4-0	3	3-7	3	4-7	3	4-0	3	3-6	3
	2-2 × 12	5-6	3	4-9	3	4-3	3	5-5	3	4-8	3	4-2	3	5-4	3	4-7	3	4-1	4
Roof, ceiling, and two clear-span floors	3-2 × 8	4-10	2	4-2	2	3-9	2	4-9	2	4-1	2	3-8	2	4-8	2	4-1	2	3-8	2
	3-2 × 10	5-11	2	5-1	2	4-7	3	5-10	2	5-0	2	4-6	3	5-9	2	4-11	2	4-5	3
	3-2 × 12	6-10	2	5-11	3	5-4	3	6-9	2	5-10	3	5-3	3	6-8	2	5-9	3	5-2	3
	4-2 × 8	5-7	2	4-10	2	4-4	2	5-6	2	4-9	2	4-3	2	5-5	2	4-8	2	4-2	2
	4-2 × 10	6-10	2	5-11	2	5-3	2	6-9	2	5-10	2	5-2	2	6-7	2	5-9	2	5-1	2
	4-2 × 12	7-11	2	6-10	2	6-2	3	7-9	2	6-9	2	6-0	3	7-8	2	6-8	2	5-11	3

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. Spans are given in feet and inches.

b. No. 1 or better grade lumber shall be used for southern pine. Other tabulated values assume #2 grade lumber.

c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.

d. NJ = Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full height wall stud and to the header.

e. Use 30 psf ground snow load for cases in which ground snow load is less than 30 psf and the roof live load is equal to or less than 20 psf.

TABLE R602.7(1)

GIRDER SPANS[a] AND HEADER SPANS[a] FOR EXTERIOR BEARING WALLS (Maximum spans for Douglas fir-larch, hem-fir, southern pine, and spruce-pine-fir[b] and required number of jack studs)

GIRDERS AND HEADERS SUPPORTING	SIZE	GROUND SNOW LOAD (psf)[e]																	
		30						50						70					
		Building width[c] (feet)																	
		12		24		36		12		24		36		12		24		36	

		Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ
Roof and ceiling	1-2x6	4 - 0	1	3 - 1	2	2 - 7	2	3 - 5	1	2 - 8	2	2 - 3	2	3 - 0	2	2 - 4	2	2 - 0	2
	1-2x8	5 - 1	2	3 - 11	2	3 - 3	2	4 - 4	2	3 - 4	2	2 - 10	2	3 - 10	2	3 - 0	2	2 - 6	3
	1-2x10	6 - 0	2	4 - 8	2	3 - 11	2	5 - 2	2	4 - 0	2	3 - 4	3	4 - 7	2	3 - 6	3	3 - 0	3
	1-2x12	7 - 1	2	5 - 5	2	4 - 7	3	6 - 1	2	4 - 8	3	3 - 11	3	5 - 5	2	4 - 2	3	3 - 6	3
	2-2x4	4 - 0	1	3 - 1	1	2 - 7	1	3 - 5	1	2 - 7	1	2 - 2	1	3 - 0	1	2 - 4	1	2 - 0	1
	2-2x6	6 - 0	1	4 - 7	1	3 - 10	1	5 - 1	1	3 - 11	1	3 - 3	2	4 - 6	1	3 - 6	2	2 - 11	2
	2-2x8	7 - 7	1	5 - 9	1	4 - 10	2	6 - 5	1	5 - 0	2	4 - 2	2	5 - 9	1	4 - 5	2	3 - 9	2
	2-2x10	9 - 0	1	6 - 10	2	5 - 9	2	7 - 8	2	5 - 11	2	4 - 11	2	6 - 9	2	5 - 3	2	4 - 5	2
	2-2x12	10 - 7	2	8 - 1	2	6 - 10	2	9 - 0	2	6 - 11	2	5 - 10	2	8 - 0	2	6 - 2	2	5 - 2	3
	3-2x8	9 - 5	1	7 - 3	1	6 - 1	1	8 - 1	1	6 - 3	1	5 - 3	2	7 - 2	1	5 - 6	2	4 - 8	2
	3-2x10	11 - 3	1	8 - 7	1	7 - 3	2	9 - 7	1	7 - 4	2	6 - 2	2	8 - 6	1	6 - 7	2	5 - 6	2
	3-2x12	13 - 2	1	10 - 1	2	8 - 6	2	11 - 3	2	8 - 8	2	7 - 4	2	10 - 0	2	7 - 9	2	6 - 6	2
	4-2x8	10 - 11	1	8 - 4	1	7 - 0	1	9 - 4	1	7 - 2	1	6 - 0	1	8 - 3	1	6 - 4	1	5 - 4	2
	4-2x10	12 - 11	1	9 - 11	1	8 - 4	1	11 - 1	1	8 - 6	1	7 - 2	2	9 - 10	1	7 - 7	2	6 - 4	2
	4-2x12	15 - 3	1	11 - 8	1	9 - 10	2	13 - 0	1	10 - 0	2	8 - 5	2	11 - 7	1	8 - 11	2	7 - 6	2
Roof, ceiling and one center-bearing	1-2x6	3 - 3	1	2 - 7	2	2 - 2	2	3 - 0	2	2 - 4	2	2 - 0	2	2 - 9	2	2 - 2	2	1 - 10	2
	1-	4 - 1	2	3 - 3	2	2 - 9	2	3 - 9	2	3 - 0	2	2 - 6	3	3 - 6	2	2 - 9	2	2 - 4	3

floor	2x8																		
	1-2x10	4 - 11	2	3 - 10	2	3 - 3	3	4 - 6	2	3 - 6	3	3 - 0	3	4 - 1	2	3 - 3	3	2 - 9	3
	1-2x12	5 - 9	2	4 - 6	3	3 - 10	3	5 - 3	2	4 - 2	3	3 - 6	3	4 - 10	3	3 - 10	3	3 - 3	4
	2-2x4	3 - 3	1	2 - 6	1	2 - 2	1	3 - 0	1	2 - 4	1	2 - 0	1	2 - 8	1	2 - 2	1	1 - 10	1
	2-2x6	4 - 10	1	3 - 9	1	3 - 3	2	4 - 5	1	3 - 6	2	3 - 0	2	4 - 1	1	3 - 3	2	2 - 9	2
	2-2x8	6 - 1	1	4 - 10	2	4 - 1	2	5 - 7	2	4 - 5	2	3 - 9	2	5 - 2	2	4 - 1	2	3 - 6	2
	2-2x10	7 - 3	2	5 - 8	2	4 - 10	2	6 - 8	2	5 - 3	2	4 - 5	2	6 - 1	2	4 - 10	2	4 - 1	2
	2-2x12	8 - 6	2	6 - 8	2	5 - 8	2	7 - 10	2	6 - 2	2	5 - 3	3	7 - 2	2	5 - 8	2	4 - 10	3
	3-2x8	7 - 8	1	6 - 0	1	5 - 1	2	7 - 0	1	5 - 6	2	4 - 8	2	6 - 5	1	5 - 1	2	4 - 4	2
	3-2x10	9 - 1	1	7 - 2	2	6 - 1	2	8 - 4	1	6 - 7	2	5 - 7	2	7 - 8	2	6 - 1	2	5 - 2	2
	3-2x12	10 - 8	2	8 - 5	2	7 - 2	2	9 - 10	2	7 - 8	2	6 - 7	2	9 - 0	2	7 - 1	2	6 - 1	2
	4-2x8	8 - 10	1	6 - 11	1	5 - 11	1	8 - 1	1	6 - 4	1	5 - 5	2	7 - 5	1	5 - 11	1	5 - 0	2
	4-2x10	10 - 6	1	8 - 3	2	7 - 0	2	9 - 8	1	7 - 7	2	6 - 5	2	8 - 10	1	7 - 0	2	6 - 0	2
	4-2x12	12 - 4	1	9 - 8	2	8 - 3	2	11 - 4	2	8 - 11	2	7 - 7	2	10 - 4	2	8 - 3	2	7 - 0	2
Roof, ceiling and one clear span floor	1-2x6	2 - 11	2	2 - 3	2	1 - 11	2	2 - 9	2	2 - 1	2	1 - 9	2	2 - 7	2	2 - 0	2	1 - 8	2
	1-2x8	3 - 9	2	2 - 10	2	2 - 5	3	3 - 6	2	2 - 8	2	2 - 3	3	3 - 3	2	2 - 6	3	2 - 2	3
	1-2x10	4 - 5	2	3 - 5	3	2 - 10	3	4 - 2	2	3 - 2	3	2 - 8	3	3 - 11	2	3 - 0	3	2 - 6	3
	1-	5 - 2	2	4 - 0	3	3 - 4	3	4 - 10	3	3 - 9	3	3 - 2	4	4 - 7	3	3 - 6	3	3 - 0	4

	2x12																		
	2-2x4	2 - 11	1	2 - 3	1	1 - 10	1	2 - 9	1	2 - 1	1	1 - 9	1	2 - 7	1	2 - 0	1	1 - 8	1
	2-2x6	4 - 4	1	3 - 4	2	2 - 10	2	4 - 1	1	3 - 2	2	2 - 8	2	3 - 10	1	3 - 0	2	2 - 6	2
	2-2x8	5 - 6	2	4 - 3	2	3 - 7	2	5 - 2	2	4 - 0	2	3 - 4	2	4 - 10	2	3 - 9	2	3 - 2	2
	2-2x10	6 - 7	2	5 - 0	2	4 - 2	2	6 - 1	2	4 - 9	2	4 - 0	2	5 - 9	2	4 - 5	2	3 - 9	3
	2-2x12	7 - 9	2	5 - 11	2	4 - 11	3	7 - 2	2	5 - 7	2	4 - 8	3	6 - 9	2	5 - 3	3	4 - 5	3
	3-2x8	6 - 11	1	5 - 3	2	4 - 5	2	6 - 5	1	5 - 0	2	4 - 2	2	6 - 1	1	4 - 8	2	4 - 0	2
	3-2x10	8 - 3	2	6 - 3	2	5 - 3	2	7 - 8	2	5 - 11	2	5 - 0	2	7 - 3	2	5 - 7	2	4 - 8	2
	3-2x12	9 - 8	2	7 - 5	2	6 - 2	2	9 - 0	2	7 - 0	2	5 - 10	2	8 - 6	2	6 - 7	2	5 - 6	3
	4-2x8	8 - 0	1	6 - 1	1	5 - 1	2	7 - 5	1	5 - 9	2	4 - 10	2	7 - 0	1	5 - 5	2	4 - 7	2
	4-2x10	9 - 6	1	7 - 3	2	6 - 1	2	8 - 10	1	6 - 10	2	5 - 9	2	8 - 4	1	6 - 5	2	5 - 5	2
	4-2x12	11 - 2	2	8 - 6	2	7 - 2	2	10 - 5	2	8 - 0	2	6 - 9	2	9 - 10	2	7 - 7	2	6 - 5	2
Roof, ceiling and two center-bearing floors	1-2x6	2 - 8	2	2 - 1	2	1 - 10	2	2 - 7	2	2 - 0	2	1 - 9	2	2 - 5	2	1 - 11	2	1 - 8	2
	1-2x8	3 - 5	2	2 - 8	2	2 - 4	3	3 - 3	2	2 - 7	2	2 - 2	3	3 - 1	2	2 - 5	3	2 - 1	3
	1-2x10	4 - 0	2	3 - 2	3	2 - 9	3	3 - 10	2	3 - 1	3	2 - 7	3	3 - 8	2	2 - 11	3	2 - 5	3
	1-2x12	4 - 9	3	3 - 9	3	3 - 2	4	4 - 6	3	3 - 7	3	3 - 1	4	4 - 3	3	3 - 5	3	2 - 11	4
	2-2x4	2 - 8	1	2 - 1	1	1 - 9	1	2 - 6	1	2 - 0	1	1 - 8	1	2 - 5	1	1 - 11	1	1 - 7	1
	2-	4 - 0	1	3 - 2	2	2 - 8	2	3 - 9	1	3 - 0	2	2 - 7	2	3 - 7	1	2 - 10	2	2 - 5	2

	2x6																		
	2-2x8	5 - 0	2	4 - 0	2	3 - 5	2	4 - 10	2	3 - 10	2	3 - 3	2	4 - 7	2	3 - 7	2	3 - 1	2
	2-2x10	6 - 0	2	4 - 9	2	4 - 0	2	5 - 8	2	4 - 6	2	3 - 10	3	5 - 5	2	4 - 3	2	3 - 8	3
	2-2x12	7 - 0	2	5 - 7	2	4 - 9	3	6 - 8	2	5 - 4	3	4 - 6	3	6 - 4	2	5 - 0	3	4 - 3	3
	3-2x8	6 - 4	1	5 - 0	2	4 - 3	2	6 - 0	1	4 - 9	2	4 - 1	2	5 - 8	2	4 - 6	2	3 - 10	2
	3-2x10	7 - 6	2	5 - 11	2	5 - 1	2	7 - 1	2	5 - 8	2	4 - 10	2	6 - 9	2	5 - 4	2	4 - 7	2
	3-2x12	8 - 10	2	7 - 0	2	5 - 11	2	8 - 5	2	6 - 8	2	5 - 8	3	8 - 0	2	6 - 4	2	5 - 4	3
	4-2x8	7 - 3	1	5 - 9	1	4 - 11	2	6 - 11	1	5 - 6	2	4 - 8	2	6 - 7	1	5 - 2	2	4 - 5	2
	4-2x10	8 - 8	1	6 - 10	2	5 - 10	2	8 - 3	2	6 - 6	2	5 - 7	2	7 - 10	2	6 - 2	2	5 - 3	2
	4-2x12	10 - 2	2	8 - 1	2	6 - 10	2	9 - 8	2	7 - 8	2	6 - 7	2	9 - 2	2	7 - 3	2	6 - 2	2
Roof, ceiling and two clear span floors	1-2x6	2 - 3	2	1 - 9	2	1 - 5	2	2 - 3	2	1 - 9	2	1 - 5	3	2 - 2	2	1 - 8	2	1 - 5	3
	1-2x8	2 - 10	2	2 - 2	3	1 - 10	3	2 - 10	2	2 - 2	3	1 - 10	3	2 - 9	2	2 - 1	3	1 - 10	3
	1-2x10	3 - 4	2	2 - 7	3	2 - 2	3	3 - 4	3	2 - 7	3	2 - 2	4	3 - 3	3	2 - 6	3	2 - 2	4
	1-2x12	4 - 0	3	3 - 0	3	2 - 7	4	4 - 0	3	3 - 0	4	2 - 7	4	3 - 10	3	3 - 0	4	2 - 6	4
	2-2x4	2 - 3	1	1 - 8	1	1 - 4	1	2 - 3	1	1 - 8	1	1 - 4	1	2 - 2	1	1 - 8	1	1 - 4	2
	2-2x6	3 - 4	1	2 - 6	2	2 - 2	2	3 - 4	2	2 - 6	2	2 - 2	2	3 - 3	2	2 - 6	2	2 - 1	2
	2-2x8	4 - 3	2	3 - 3	2	2 - 8	2	4 - 3	2	3 - 3	2	2 - 8	2	4 - 1	2	3 - 2	2	2 - 8	3
	2-	5 - 0	2	3 - 10	2	3 - 2	3	5 - 0	2	3 - 10	2	3 - 2	3	4 - 10	2	3 - 9	3	3 - 2	3

	2x10																		
	2-2x12	5 - 11	2	4 - 6	3	3 - 9	3	5 - 11	2	4 - 6	3	3 - 9	3	5 - 8	2	4 - 5	3	3 - 9	3
	3-2x8	5 - 3	1	4 - 0	2	3 - 5	2	5 - 3	2	4 - 0	2	3 - 5	2	5 - 1	2	3 - 11	2	3 - 4	2
	3-2x10	6 - 3	2	4 - 9	2	4 - 0	2	6 - 3	2	4 - 9	2	4 - 0	2	6 - 1	2	4 - 8	2	4 - 0	3
	3-2x12	7 - 5	2	5 - 8	2	4 - 9	3	7 - 5	2	5 - 8	2	4 - 9	3	7 - 2	2	5 - 6	3	4 - 8	3
	4-2x8	6 - 1	1	4 - 8	2	3 - 11	2	6 - 1	1	4 - 8	2	3 - 11	2	5 - 11	1	4 - 7	2	3 - 10	2
	4-2x10	7 - 3	2	5 - 6	2	4 - 8	2	7 - 3	2	5 - 6	2	4 - 8	2	7 - 0	2	5 - 5	2	4 - 7	2
	4-2x12	8 - 6	2	6 - 6	2	5 - 6	2	8 - 6	2	6 - 6	2	5 - 6	2	8 - 3	2	6 - 4	2	5 - 4	3

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. Spans are given in feet and inches.

b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir.

c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.

d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.

e. Use 30 psf ground snow load for cases in which ground snow load is less than 30 psf and the roof live load is equal to or less than 20 psf.

f. Spans are calculated assuming the top of the header or girder is laterally braced by perpendicular framing. Where the top of the header or girder is not laterally braced (e.g. cripple studs bearing on the header), tabulated spans for headers consisting of 2x8, 2x10, or 2x12 sizes shall be multiplied by 0.70 or the header or girder shall be designed.

Reason: The update of Table R602.7(1) Girder Spans and Header Spans for Exterior Bearing Walls is proposed. Updated spans address use of Southern Pine No. 2 in lieu of Southern Pine No. 1. Footnote "e" is added to clarify that header spans are based on laterally braced assumption such as when the header is raised. For dropped headers consisting of 2x8, 2x10, or 2x12 sizes that are not laterally braced, a factor of 0.7 can be applied to determine the spans or alternatively the header or girder can be designed to include any adjustment for potential buckling. Laterally braced (raised) and not laterally braced (dropped) header conditions and building widths for which header spans are tabulated represent the same conditions used to develop header span tables in the Wood Frame Construction Manual (WFCM).

Cost Impact: Will increase the cost of construction

Increased cost may be associated with reduced spans that result from the not laterally braced condition and application of footnote f. Due to smaller building width column (12'), permissible use of Southern Pine No. 2, and the laterally braced assumption for tabulated spans, there are also cases where this change will not increase the cost of construction and may reduce cost of construction.

RB227-16 : TABLE R602.7-TYREE12526

Final Action: AS (Approved as Submitted)

S8239

Date Submitted	12/14/2018	**Section**	602.7	**Proponent**	Paul Coats
Chapter	6	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Update of Table R602.7(1) Girder and Header Spans Interior Bearing Walls

Rationale

This modification was approved by the ICC committee and membership and appears in the 2018 International Residential Code. The update of Table R602.7(1) Girder Spans and Header Spans for Exterior Bearing Walls is proposed. Updated spans address use of Southern Pine No. 2 in lieu of Southern Pine No. 1. Footnote "e" is added to clarify that header spans are based on laterally braced assumption such as when the header is raised. For dropped headers consisting of 2x8, 2x10, or 2x12 sizes that are not laterally braced, a factor of 0.7 can be applied to determine the spans or alternatively the header or girder can be designed to include any adjustment for potential buckling. Laterally braced (raised) and not laterally braced (dropped) header conditions and building widths for which header spans are tabulated represent the same conditions used to develop header span tables in the Wood Frame Construction Manual (WFCM).

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will involve familiarization with new span tables and their provisions.

Impact to building and property owners relative to cost of compliance with code

Increased cost may be associated with reduced spans that result from the not laterally braced condition and application of footnote e. Due to certain conditions and options introduced by the revised table, there are also cases where this may reduce cost of construction.

Impact to industry relative to the cost of compliance with code

Increased cost may be associated with reduced spans that result from the not laterally braced condition and application of footnote e. Due to certain conditions and options introduced by the revised table, there are also cases where this may reduce cost of construction.

Impact to small business relative to the cost of compliance with code

Increased cost may be associated with reduced spans that result from the not laterally braced condition and application of footnote e. Due to certain conditions and options introduced by the revised table, there are also cases where this may reduce cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Girder and header spans updated for continued safety and serviceability.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code with updated header spans in accordance with changes in design values and evolving standards.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

Delete and replace entire Table R602.7(2):

~~**TABLE R602.7(2)**~~

~~**GIRDER SPANSa AND HEADER SPANSa FOR INTERIOR BEARING WALLS (Maximum spans for Douglas fir-larch, hem-fir, southern pine and spruce-pine-firb and required number of jack studs)**~~

TABLE R602.7(2)

GIRDER SPANS[a] AND HEADER SPANS[a] FOR INTERIOR BEARING WALLS (Maximum spans for

Douglas fir-larch, hem-fir, southern pine, and spruce-pine-fir[b] and required number of jack studs)

See uploaded support file for content of replacement Table R602.7(2)

Revise as follows:

~~TABLE R602.7~~

~~GIRDER SPANS[a] AND HEADER SPANS[a] FOR INTERIOR BEARING WALLS (Maximum spans for Douglas fir-larch, hem-fir, southern pine and spruce-pine-fir[b] and required number of jack studs)~~

-

~~HEADERS AND GIRDERS SUPPORTING~~	~~SIZE~~	~~BUILDING Width[c] (feet)~~					
		~~20~~		~~28~~		~~36~~	
		~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~
~~One floor only~~	~~2-2 × 4~~	~~3-1~~	~~1~~	~~2-8~~	~~1~~	~~2-5~~	~~1~~
	~~2-2 × 6~~	~~4-6~~	~~1~~	~~3-11~~	~~1~~	~~3-6~~	~~1~~
	~~2-2 × 8~~	~~5-9~~	~~1~~	~~5-0~~	~~2~~	~~4-5~~	~~2~~
	~~2-2 × 10~~	~~7-0~~	~~2~~	~~6-1~~	~~2~~	~~5-5~~	~~2~~
	~~2-2 × 12~~	~~8-1~~	~~2~~	~~7-0~~	~~2~~	~~6-3~~	~~2~~
	~~3-2 × 8~~	~~7-2~~	~~1~~	~~6-3~~	~~1~~	~~5-7~~	~~2~~
	~~3-2 × 10~~	~~8-9~~	~~1~~	~~7-7~~	~~2~~	~~6-9~~	~~2~~
	~~3-2 × 12~~	~~10-2~~	~~2~~	~~8-10~~	~~2~~	~~7-10~~	~~2~~
	~~4-2 × 8~~	~~9-0~~	~~1~~	~~7-8~~	~~1~~	~~6-9~~	~~1~~
	~~4-2 × 10~~	~~10-1~~	~~1~~	~~8-9~~	~~1~~	~~7-10~~	~~2~~
	~~4-2 × 12~~	~~11-9~~	~~1~~	~~10-2~~	~~2~~	~~9-1~~	~~2~~
~~Two floors~~	~~2-2 × 4~~	~~2-2~~	~~1~~	~~1-10~~	~~1~~	~~1-7~~	~~1~~
	~~2-2 × 6~~	~~3-2~~	~~2~~	~~2-9~~	~~2~~	~~2-5~~	~~2~~
	~~2-2 × 8~~	~~4-1~~	~~2~~	~~3-6~~	~~2~~	~~3-2~~	~~2~~
	~~2-2 × 10~~	~~4-11~~	~~2~~	~~4-3~~	~~2~~	~~3-10~~	~~3~~
	~~2-2 × 12~~	~~5-9~~	~~2~~	~~5-0~~	~~3~~	~~4-5~~	~~3~~
	~~3-2 × 8~~	~~5-1~~	~~2~~	~~4-5~~	~~2~~	~~3-11~~	~~2~~
	~~3-2 × 10~~	~~6-2~~	~~2~~	~~5-4~~	~~2~~	~~4-10~~	~~2~~
	~~3-2 × 12~~	~~7-2~~	~~2~~	~~6-3~~	~~2~~	~~5-7~~	~~3~~
	~~4-2 × 8~~	~~6-1~~	~~1~~	~~5-3~~	~~2~~	~~4-8~~	~~2~~
	~~4-2 × 10~~	~~7-2~~	~~2~~	~~6-2~~	~~2~~	~~5-6~~	~~2~~
	~~4-2 × 12~~	~~8-4~~	~~2~~	~~7-2~~	~~2~~	~~6-5~~	~~2~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.~~

~~a. Spans are given in feet and inches.~~

~~b. No. 1 or better grade lumber shall be used for southern pine. Other tabulated values assume #2 grade lumber.~~

~~c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.~~

~~d. NJ = Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.~~

TABLE <u>R602.7(2)</u>

<u>GIRDER SPANS[a] AND HEADER SPANS[a] FOR INTERIOR BEARING WALLS (Maximum spans for Douglas fir-larch, hem-fir, southern pine, and spruce-pine-fir[b] and required number of jack studs)</u>

<u>HEADERS AND GIRDERS SUPPORTING</u>	<u>SIZE</u>	<u>BUILDING Width[c] (feet)</u>		

		12		24		36	
		Span[e]	NJ[d]	Span[e]	NJ[d]	Span[e]	NJ[d]
One floor only	2-2x4	4 - 1	1	2 - 10	1	2 - 4	1
	2-2x6	6 - 1	1	4 - 4	1	3 - 6	1
	2-2x8	7 - 9	1	5 - 5	1	4 - 5	2
	2-2x10	9 - 2	1	6 - 6	2	5 - 3	2
	2-2x12	10 - 9	1	7 - 7	2	6 - 3	2
	3-2x8	9 - 8	1	6 - 10	1	5 - 7	1
	3-2x10	11 - 5	1	8 - 1	1	6 - 7	2
	3-2x12	13 - 6	1	9 - 6	2	7 - 9	2
	4-2x8	11 - 2	1	7 - 11	1	6 - 5	1
	4-2x10	13 - 3	1	9 - 4	1	7 - 8	1
	4-2x12	15 - 7	1	11 - 0	1	9 - 0	2
Two floors	2-2x4	2 - 7	1	1 - 11	1	1 - 7	1
	2-2x6	3 - 11	1	2 - 11	2	2 - 5	2
	2-2x8	5 - 0	1	3 - 8	2	3 - 1	2
	2-2x10	5 - 11	2	4 - 4	2	3 - 7	2
	2-2x12	6 - 11	2	5 - 2	2	4 - 3	3
	3-2x8	6 - 3	1	4 - 7	2	3 - 10	2
	3-2x10	7 - 5	1	5 - 6	2	4 - 6	2
	3-2x12	8 - 8	2	6 - 5	2	5 - 4	2

	4-2x8	7 - 2	1	5 - 4	1	4 - 5	2
	4-2x10	8 - 6	1	6 - 4	2	5 - 3	2
	4-2x12	10 - 1	1	7 - 5	2	6 - 2	2

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. Spans are given in feet and inches.

b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir.

c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.

d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.

e. Spans are calculated assuming the top of the header or girder is laterally braced by perpendicular framing. Where the top of the header or girder is not laterally braced (e.g. cripple studs bearing on the header), tabulated spans for headers consisting of 2x8, 2x10, or 2x12 sizes shall be multiplied by 0.70 or the header or girder shall be designed.

Revise as follows:

~~TABLE R602.7~~

~~GIRDER SPANS[a] AND HEADER SPANS[a] FOR INTERIOR BEARING WALLS (Maximum spans for Douglas fir-larch, hem-fir, southern pine and spruce-pine-fir[b] and required number of jack studs)~~

-

~~HEADERS AND GIRDERS SUPPORTING~~	~~SIZE~~	~~BUILDING Width[c] (feet)~~					
		~~20~~		~~28~~		~~36~~	
		~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~
~~One floor only~~	~~2-2 × 4~~	~~3-1~~	~~1~~	~~2-8~~	~~1~~	~~2-5~~	~~1~~
	~~2-2 × 6~~	~~4-6~~	~~1~~	~~3-11~~	~~1~~	~~3-6~~	~~1~~
	~~2-2 × 8~~	~~5-9~~	~~1~~	~~5-0~~	~~2~~	~~4-5~~	~~2~~
	~~2-2 × 10~~	~~7-0~~	~~2~~	~~6-1~~	~~2~~	~~5-5~~	~~2~~
	~~2-2 × 12~~	~~8-1~~	~~2~~	~~7-0~~	~~2~~	~~6-3~~	~~2~~
	~~3-2 × 8~~	~~7-2~~	~~1~~	~~6-3~~	~~1~~	~~5-7~~	~~2~~
	~~3-2 × 10~~	~~8-9~~	~~1~~	~~7-7~~	~~2~~	~~6-9~~	~~2~~
	~~3-2 × 12~~	~~10-2~~	~~2~~	~~8-10~~	~~2~~	~~7-10~~	~~2~~
	~~4-2 × 8~~	~~9-0~~	~~1~~	~~7-8~~	~~1~~	~~6-9~~	~~1~~
	~~4-2 × 10~~	~~10-1~~	~~1~~	~~8-9~~	~~1~~	~~7-10~~	~~2~~
	~~4-2 × 12~~	~~11-9~~	~~1~~	~~10-2~~	~~2~~	~~9-1~~	~~2~~
~~Two floors~~	~~2-2 × 4~~	~~2-2~~	~~1~~	~~1-10~~	~~1~~	~~1-7~~	~~1~~
	~~2-2 × 6~~	~~3-2~~	~~2~~	~~2-9~~	~~2~~	~~2-5~~	~~2~~
	~~2-2 × 8~~	~~4-1~~	~~2~~	~~3-6~~	~~2~~	~~3-2~~	~~2~~
	~~2-2 × 10~~	~~4-11~~	~~2~~	~~4-3~~	~~2~~	~~3-10~~	~~3~~
	~~2-2 × 12~~	~~5-9~~	~~2~~	~~5-0~~	~~3~~	~~4-5~~	~~3~~
	~~3-2 × 8~~	~~5-1~~	~~2~~	~~4-5~~	~~2~~	~~3-11~~	~~2~~
	~~3-2 × 10~~	~~6-2~~	~~2~~	~~5-4~~	~~2~~	~~4-10~~	~~2~~
	~~3-2 × 12~~	~~7-2~~	~~2~~	~~6-3~~	~~2~~	~~5-7~~	~~3~~
	~~4-2 × 8~~	~~6-1~~	~~1~~	~~5-3~~	~~2~~	~~4-8~~	~~2~~
	~~4-2 × 10~~	~~7-2~~	~~2~~	~~6-2~~	~~2~~	~~5-6~~	~~2~~
	~~4-2 × 12~~	~~8-4~~	~~2~~	~~7-2~~	~~2~~	~~6-5~~	~~2~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.~~

~~a. Spans are given in feet and inches.~~

~~b. No. 1 or better grade lumber shall be used for southern pine. Other tabulated values assume #2 grade lumber.~~

~~c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.~~

~~d. NJ = Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.~~

TABLE R602.7(2)

GIRDER SPANS[a] AND HEADER SPANS[a] FOR INTERIOR BEARING WALLS (Maximum spans for Douglas fir-larch, hem-fir, southern pine, and spruce-pine-fir[b] and required number of jack studs)

HEADERS AND GIRDERS SUPPORTING	SIZE	BUILDING Width[c] (feet)		

		12		24		36	
		Span[e]	NJ[d]	Span[e]	NJ[d]	Span[e]	NJ[d]
One floor only	2-2x4	4 - 1	1	2 - 10	1	2 - 4	1
	2-2x6	6 - 1	1	4 - 4	1	3 - 6	1
	2-2x8	7 - 9	1	5 - 5	1	4 - 5	2
	2-2x10	9 - 2	1	6 - 6	2	5 - 3	2
	2-2x12	10 - 9	1	7 - 7	2	6 - 3	2
	3-2x8	9 - 8	1	6 - 10	1	5 - 7	1
	3-2x10	11 - 5	1	8 - 1	1	6 - 7	2
	3-2x12	13 - 6	1	9 - 6	2	7 - 9	2
	4-2x8	11 - 2	1	7 - 11	1	6 - 5	1
	4-2x10	13 - 3	1	9 - 4	1	7 - 8	1
	4-2x12	15 - 7	1	11 - 0	1	9 - 0	2
Two floors	2-2x4	2 - 7	1	1 - 11	1	1 - 7	1
	2-2x6	3 - 11	1	2 - 11	2	2 - 5	2
	2-2x8	5 - 0	1	3 - 8	2	3 - 1	2
	2-2x10	5 - 11	2	4 - 4	2	3 - 7	2
	2-2x12	6 - 11	2	5 - 2	2	4 - 3	3
	3-2x8	6 - 3	1	4 - 7	2	3 - 10	2
	3-2x10	7 - 5	1	5 - 6	2	4 - 6	2
	3-2x12	8 - 8	2	6 - 5	2	5 - 4	2

	4-2x8	7 - 2	1	5 - 4	1	4 - 5	2
	4-2x10	8 - 6	1	6 - 4	2	5 - 3	2
	4-2x12	10 - 1	1	7 - 5	2	6 - 2	2

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. Spans are given in feet and inches.

b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir.

c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.

d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.

e. Spans are calculated assuming the top of the header or girder is laterally braced by perpendicular framing. Where the top of the header or girder is not laterally braced (e.g. cripple studs bearing on the header), tabulated spans for headers consisting of 2x8, 2x10, or 2x12 sizes shall be multiplied by 0.70 or the header or girder shall be designed.

S8243

Date Submitted	12/14/2018	**Section**	602.7.2	**Proponent**	Paul Coats
Chapter	6	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Replacement figure for Fig. R602.7.2 Rim Board Header Construction

Rationale

This revised figure was approved by the ICC committee and membership and appears in the 2018 edition of the International Residential Code. This figure revision clarifies requirements for joist hangers in rim board header applications. Joist hangers are always required for attachment of joist to header over the header span to ensure that the load is not transferred to the unsupported portion of the top plate. Joist ends that bear on the portion of the top plate that is directly supported below by full height studs, and with a bearing length of 1.5" or greater, do not require the use of joist hangers.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Provides better details in figure.

Impact to building and property owners relative to cost of compliance with code

No cost-related impact.

Impact to industry relative to the cost of compliance with code

No cost-related impact.

Impact to small business relative to the cost of compliance with code

No cost-related impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Better details will provide better code compliance.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code through better accuracy of detail.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

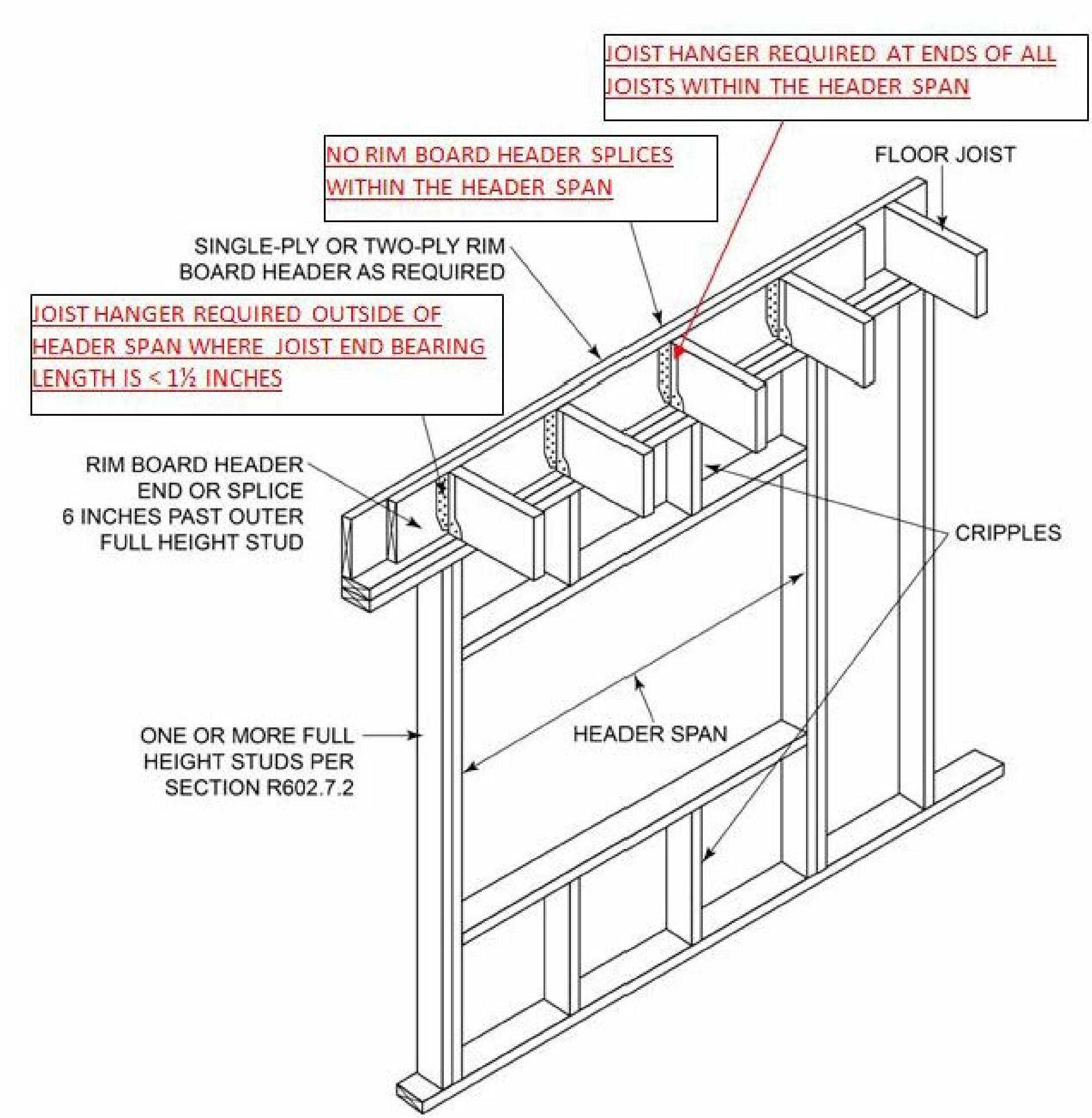
Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

Mod 8243

Replace Fig. R602.7.2 RIM BOARD HEADER CONSTRUCTION with the attached new figure and call-outs (underlined call-outs are new or corrected);



For SI: 25.4 mm = 1 inch.

RB228-16

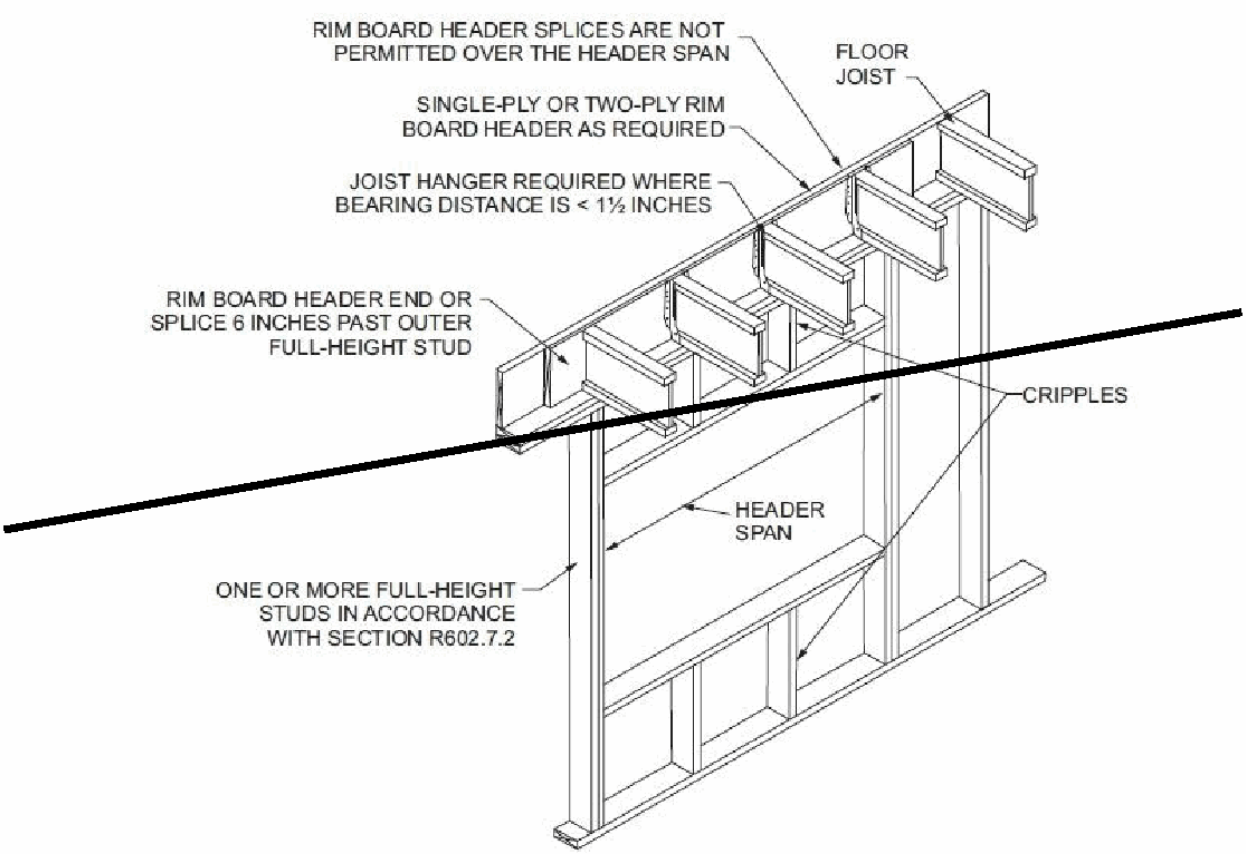
IRC: R602.7.2.

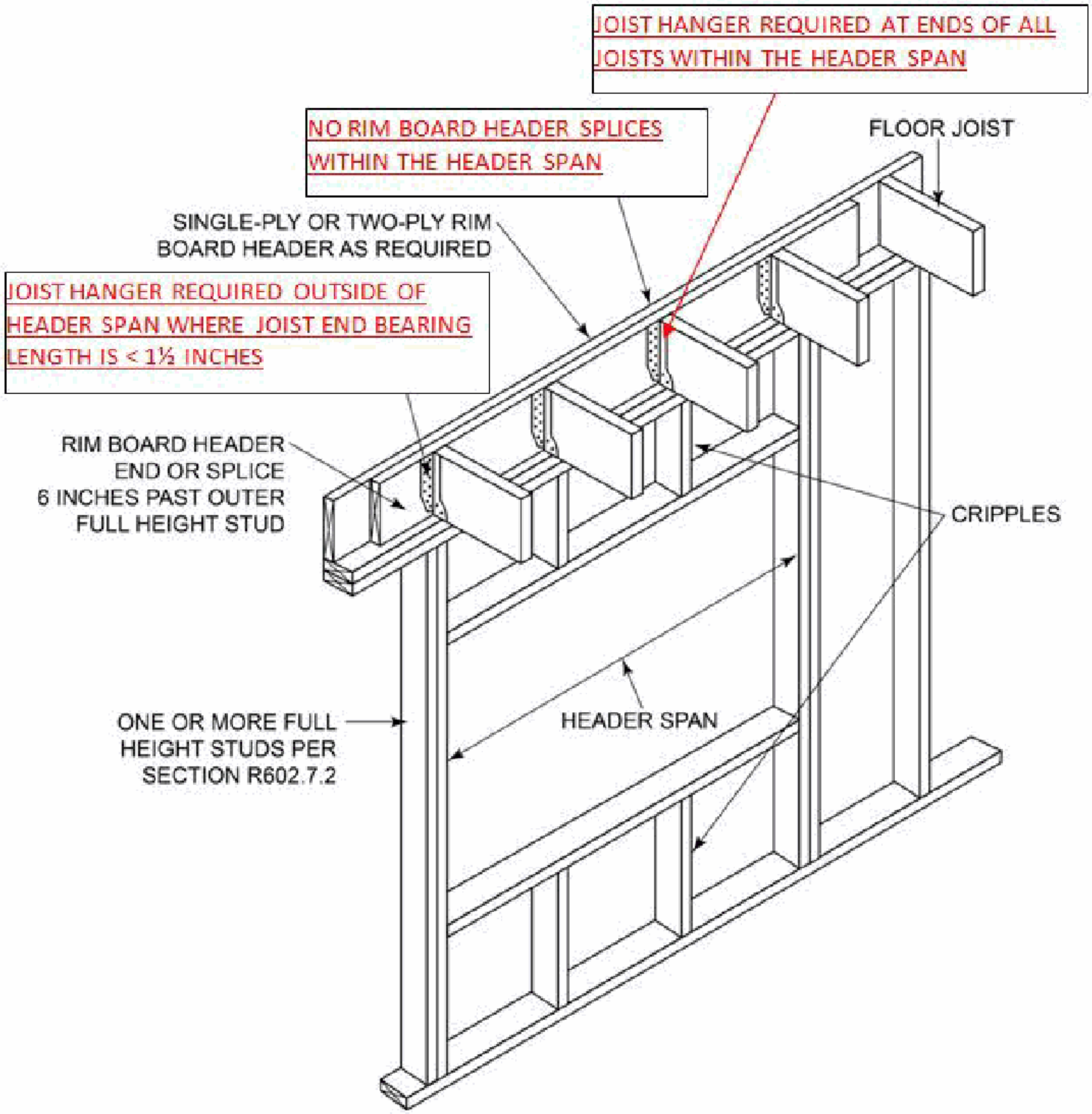
Proponent : Matthew Hunter, representing American Wood Council (mhunter@awc.org)

2015 International Residential Code

Revise as follows:

FIGURE R602.7.2
RIM BOARD HEADER CONSTRUCTION





For SI: 25.4 mm = 1 inch.

Reason: This figure revision clarifies requirements for joist hangers in rim board header applications. Joist hangers are always required for attachment of joist to header over the header span to ensure that the load is not transferred to the unsupported portion of the top plate. Joist ends that bear on the portion of the top plate that is directly supported below by full height studs, and with a bearing length of 1.5" or greater, do not require the use of joist hangers.

Cost Impact: Will not increase the cost of construction
This revision corrects the illustration detail in the previous code edition, and is primarily editorial in nature. Therefore, no increased cost are associated with this change.

RB228-16 : FIGURE R602.7.2 (NEW)-HUNTER11307

Final Action: AS (Approved as Submitted)

S8247

Date Submitted	12/14/2018	**Section**	602.7.5	**Proponent**	Paul Coats
Chapter	6	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Replacement table for Table R602.7.5 Full height studs at headers

Rationale

This modification was approved by the ICC committee and membership and appears in the 2018 edition of the International Residential Code. This change simplifies the full height stud (e.g. king stud) table while also removing conservatism and limited applicability of the 16" maximum stud spacing case. The number of full-height studs is based on out-of-plane wind resistance provided by the stud to plate nailing. The connection resistance has been increased from prior code editions based on RB272-13 in the ICC process. Wind loads are based on an assumption that full height studs on either side of the opening carry 100% of the out-of-plane wind loads. Reference conditions for the calculations assume a 9' w all height and w all Zone 4 pressures for header spans greater than 6 feet and wall Zone 5 pressures for header spans less than 6 feet. The number of full height studs required by calculation is limited to the maximum number displaced by the opening. Footnote "a" clarifies that the number of full-height studs for intermediate header spans is based on the next larger header span. Footnote "b" provides a basic assumption of the tabulated requirements--that headers are supported at each end by jack studs. When jack stud support is not provided, such as when an approved anchor is used in lieu of a jack stud, the full height stud on either side of the opening is carrying both out-of-plane wind loads and gravity loads. For that case, footnote "b" indicates that the ~ 140 mph Exposure B column associated with the number of studs displaced by the opening is applicable. The reduced number of full-height studs associated with 115 mph Exposure B applies only in those lower wind pressure areas w here jack stud support is provided to the header at each end.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Revised number of full height studs will no affect enforcement.

Impact to building and property owners relative to cost of compliance with code

May reduce the cost of construction in some cases since less full height studs are required in some cases.

Impact to industry relative to the cost of compliance with code

May reduce the cost of construction in some cases since less full height studs are required in some cases.

Impact to small business relative to the cost of compliance with code

May reduce the cost of construction in some cases since less full height studs are required in some cases.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Adjusts the studs needed for one key component of exterior walls.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by increasing efficiency while maintaining effectiveness.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness.

Delete and completely replace Table R602.7.5 MINIMUM NUMBER OF FULL HEIGHT STUDS AT EACH END OF HEADERS IN EXTERIOR WALLS:

~~**TABLE R602.7.5**~~

~~**MINIMUM NUMBER OF FULL-HEIGHT STUDS AT EACH END OF HEADERS IN EXTERIOR WALLS**~~

TABLE R602.7.5

MINIMUM NUMBER OF FULL-HEIGHT STUDS AT EACH END OF HEADERS IN EXTERIOR WALLS[a]

(See uploaded support file for new table)

R602.7.5 Supports for headers. Headers shall be supported on each end with one or more jack studs or with approved framing anchors in accordance with Table R602.7(1) or R602.7(2). The full-height stud adjacent to each end of the header shall be end nailed to each end of the header with four-16d nails (3.5 inches × 0.135 inches). The minimum number of full-height studs at each end of a header shall be in accordance with Table R602.7.5.

TABLE R602.7.5
MINIMUM NUMBER OF FULL HEIGHT STUDS AT EACH END OF HEADERS IN EXTERIOR WALLS[a]

HEADER SPAN (feet)	MAXIMUM STUD SPACING (inches) [per Table R602.3(5)]	
	16	24
≤3'	1	1
4'	2	1
8'	3	2
12'	5	3
16'	6	4

MAXIMUM HEADER SPAN (feet)	ULTIMATE DESIGN WIND SPEED AND EXPOSURE CATEGORY	
	< 140 mph, Exposure B or < 130 mph, Exposure C	≤ 115 mph, Exposure B[b]
4	1	1
6	2	1
8	2	1
10	3	2

12	3	2
14	3	2
16	4	2
18	4	2

a. For header spans between those given above, use the minimum number of full-height studs associated with the larger header span.

b. The tabulated minimum number of full-height studs is applicable where jack studs are provided to support the header at each end in accordance with Table R602.7.1(1). Where a framing anchor is used to support the header in lieu of a jack stud in accordance with footnote "d" of Table R602.7.(1), the minimum number of full-height studs at each end of a header shall be in accordance with requirements for wind speed < 140 mph, Exposure B.

Final Action: AS (Approved as Submitted)

S8252

Date Submitted	12/14/2018	**Section**	602.10.4	**Proponent**	Paul Coats
Chapter	6	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Removal of 8d common nails for attachment of structural fiberboard sheathing from Table R602.10.4

Rationale

This change was approved by the ICC committee and membership and appears in the 2018 edition of the International Residential Code. 8d common nails are no longer recommended for use with structural fiberboard sheathing. Removal of 8d common nails from Table R602.3.(1) for attachment of structural fiberboard sheathing was the result of proposal S75-06/07 Part II in the ICC process. Removal of the 8d common nail aligns with the prescribed attachment for fiberboard sheathing per fastener schedule Table R602.3(1).

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Removal of one alternative fastening--no effect.

Impact to building and property owners relative to cost of compliance with code

No cost related impact since there are current alternatives.

Impact to industry relative to the cost of compliance with code

No cost related impact since there are current alternatives.

Impact to small business relative to the cost of compliance with code

No cost related impact since there are current alternatives.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Maintains correct nailing according to standards.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

Remove "8d common (2-1/2" long x 0.131 dia. nails)" from the list of alternatives in Table R602.10.4 for attaching structural fiberboard sheathing, in two places on the table.

See uploaded support file for revisions to the table. The figures in the column labeled "Figure" are not to be deleted, but the figures in that column are to remain unchanged.

TABLE R602.10.4
BRACING METHODS

METHODS, MATERIAL		MINIMUM THICKNESS	FIGURE	CONNECTION CRITERIA[a]	
				Fasteners	Spacing
	LIB Let-in-bracing	1 × 4 wood or approved metal straps at 45° to 60° angles for maximum 16″ stud spacing		Wood: 2-8d common nails or 3-8d ($2\frac{1}{2}$″ long x 0.113″ dia.) nails	Wood: per stud and top and bottom plates
				Metal strap: per manufacturer	Metal: per manufacturer
	DWB Diagonal wood boards	$\frac{3}{4}$″(1″ nominal) for maximum 24″ stud spacing		2-8d ($2\frac{1}{2}$″ long × 0.113″ dia.) nails or 2 - $1\frac{3}{4}$″ long staples	Per stud
	WSP Wood structural panel (See Section R604)	$\frac{3}{8}$″		Exterior sheathing per Table R602.3(3)	6″ edges 12″ field
				Interior sheathing per Table R602.3(1) or R602.3(2)	Varies by fastener
	BV-WSP[e] Wood structural panels with stone or masonry	$\frac{7}{16}$″	See Figure R602.10.6.5	8d common ($2\frac{1}{2}$″ × 0.131) nails	4″ at panel edges 12″ at intermediate supports 4″ at braced

	veneer (See Section R602.10.6.5)				wall panel end posts
Intermittent Bracing Method	**SFB** Structural fiberboard sheathing	$^1/_2$ " or $^{25}/_{32}$ "for maximum 16" stud spacing	✖	$1^1/_2$ " long × 0.12" dia. (for $^1/_2$ " thick sheathing) or $1^3/_4$ " long × 0.12" dia. (for $^{25}/_{32}$ " thick sheathing) galvanized roofing nails ~~or 8d common (2 1/2"long x 0.131" dia.) nails~~	3" edges 6" field
	GB Gypsum board	$^1/_2$ "	✖	Nails or screws per Table R602.3(1) for exterior locations	For all braced wall panel locations: 7"edges (including top and bottom plates) 7"field
				Nails or screws per Table R702.3.5 for interior locations	
	PBS Particleboard sheathing (See Section R605)	$^3/_8$ " or $^1/_2$ " for maximum 16" stud spacing	✖	For $^3/_8$ ", 6d common (2" long × 0.113" dia.) nails For $^1/_2$ ", 8d common ($2^1/_2$ " long × 0.131" dia.) nails	3" edges 6" field
	PCP Portland cement plaster	See Section R703.6 for maximum 16" stud spacing	✖	$1^1/_2$ " long, 11 gage, $^7/_{16}$ " dia. head nails or $^7/_8$ " long, 16 gage staples	6" o.c. on all framing members
	HPS Hardboard	$^7/_{16}$ " for maximum 16"stud	✖	0.092" dia., 0.225" dia. head nails with length	4" edges 8" field

	panel siding	spacing		to accommodate 1 1/2 ″ penetration into studs	
	ABW Alternate braced wall	3/8 ″		See Section R602.10.6.1	See Section R602.10.6.1

METHODS, MATERIAL		MINIMUM THICKNESS	FIGURE	CONNECTION CRITERIA[a]	
				Fasteners	Spacing
Intermittent Bracing Methods	**PFH** Portal frame with hold-downs	3/8 ″		See Section R602.10.6.2	See Section R602.10.6.2
	PFG Portal frame at garage	7/16 ″		See Section R602.10.6.3	See Section R602.10.6.3
Continuous Sheathing Methods	**CS-WSP** Continuously sheathed wood structural panel	3/8 ″		Exterior sheathing per Table R602.3(3)	6″ edges 12″ field
				Interior sheathing per Table R602.3(1) or R602.3(2)	Varies by fastener
	CS-G[b, c] Continuously sheathed wood structural panel adjacent to garage openings	3/8 ″		See Method CS-WSP	See Method CS-WSP
	CS-PF Continuously sheathed portal frame	7/16 ″		See Section R602.10.6.4	See Section R602.10.6.4
				1 1/2 ″ long × 0.12″ dia. (for 1/2 ″ thick	

	CS-SFB[d] Continuously sheathed structural fiberboard	$^{1}/_{2}$" or $^{25}/_{32}$" for maximum 16" stud spacing		sheathing) or $1^{3}/_{4}$" long × 0.12" dia. (for $^{25}/_{32}$" thick sheathing) galvanized roofing nails ~~or 8d common (2 1/2" long x 0.131" dia.) nails~~	3" edges 6" field

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.0175 rad, 1 pound per square foot = 47.8 N/m ^{2} , 1 mile per hour = 0.447 m/s.

a. Adhesive attachment of wall sheathing, including Method GB, shall not be permitted in Seismic Design Categories C, D_0, D_1 and D_2.

b. Applies to panels next to garage door opening where supporting gable end wall or roof load only. Shall only be used on one wall of the garage. In Seismic Design Categories D_0, D_1 and D_2, roof covering dead load shall not exceed 3 psf.

c. Garage openings adjacent to a Method CS-G panel shall be provided with a header in accordance with Table R602.7(1). A full-height clear opening shall not be permitted adjacent to a Method CS-G panel.

d. Method CS-SFB does not apply in Seismic Design Categories D_0, D_1 and D_2.

e. Method applies to detached one- and two-family dwellings in Seismic Design Categories D_0 through D_2 only.

Final Action: AS (Approved as Submitted)

RB240-16

IRC: R602.10.4.

Proponent : Matthew Hunter, representing American Wood Council (mhunter@awc.org)

2015 International Residential Code

TABLE R602.10.4
BRACING METHODS

METHODS, MATERIAL		MINIMUM THICKNESS	FIGURE	CONNECTION CRITERIA[a] Fasteners	CONNECTION CRITERIA[a] Spacing
	LIB Let-in-bracing	1 × 4 wood or approved metal straps at 45° to 60° angles for maximum 16″ stud spacing		Wood: 2-8d common nails or 3-8d ($2\frac{1}{2}$″ long x 0.113″ dia.) nails	Wood: per stud and top and bottom plates
				Metal strap: per manufacturer	Metal: per manufacturer
	DWB Diagonal wood boards	$\frac{3}{4}$″(1″ nominal) for maximum 24″ stud spacing		2-8d ($2\frac{1}{2}$″ long × 0.113″ dia.) nails or 2 - $1\frac{3}{4}$″ long staples	Per stud
	WSP Wood structural panel (See Section R604)	$\frac{3}{8}$″		Exterior sheathing per Table R602.3(3)	6″ edges 12″ field
				Interior sheathing per Table R602.3(1) or R602.3(2)	Varies by fastener
	BV-WSP[e] Wood structural panels with stone or masonry	$\frac{7}{16}$″	See Figure R602.10.6.5	8d common ($2\frac{1}{2}$″ × 0.131) nails	4″ at panel edges 12″ at intermediate supports 4″ at braced

	veneer (See Section R602.10.6.5)				wall panel end posts
Intermittent Bracing Method	**SFB** Structural fiberboard sheathing	$\frac{1}{2}$″ or $\frac{25}{32}$″ for maximum 16″ stud spacing	✖	$1\frac{1}{2}$″ long × 0.12″ dia. (for $\frac{1}{2}$″ thick sheathing) or $1\frac{3}{4}$″ long × 0.12″ dia. (for $\frac{25}{32}$″ thick sheathing) galvanized roofing nails ~~or 8d common (2 1/2″long x 0.131″ dia.) nails~~	3″ edges 6″ field
	GB Gypsum board	$\frac{1}{2}$″	✖	Nails or screws per Table R602.3(1) for exterior locations Nails or screws per Table R702.3.5 for interior locations	For all braced wall panel locations: 7″edges (including top and bottom plates) 7″field
	PBS Particleboard sheathing (See Section R605)	$\frac{3}{8}$″ or $\frac{1}{2}$″ for maximum 16″ stud spacing	✖	For $\frac{3}{8}$″, 6d common (2″ long × 0.113″ dia.) nails For $\frac{1}{2}$″, 8d common ($2\frac{1}{2}$″ long × 0.131″ dia.) nails	3″ edges 6″ field
	PCP Portland cement plaster	See Section R703.6 for maximum 16″ stud spacing	✖	$1\frac{1}{2}$″ long, 11 gage, $\frac{7}{16}$″ dia. head nails or $\frac{7}{8}$″ long, 16 gage staples	6″ o.c. on all framing members
	HPS Hardboard	$\frac{7}{16}$″ for maximum 16″stud	✖	0.092″ dia., 0.225″ dia. head nails with length	4″ edges 8″ field

	panel siding	spacing		to accommodate 1 1/2 " penetration into studs	
	ABW Alternate braced wall	3/8 "		See Section R602.10.6.1	See Section R602.10.6.1

METHODS, MATERIAL		MINIMUM THICKNESS	FIGURE	CONNECTION CRITERIA[a]	
				Fasteners	Spacing
Intermittent Bracing Methods	**PFH** Portal frame with hold-downs	3/8 "		See Section R602.10.6.2	See Section R602.10.6.2
	PFG Portal frame at garage	7/16 "		See Section R602.10.6.3	See Section R602.10.6.3
Continuous Sheathing Methods	**CS-WSP** Continuously sheathed wood structural panel	3/8 "		Exterior sheathing per Table R602.3(3)	6″ edges 12″ field
				Interior sheathing per Table R602.3(1) or R602.3(2)	Varies by fastener
	CS-G[b, c] Continuously sheathed wood structural panel adjacent to garage openings	3/8 "		See Method CS-WSP	See Method CS-WSP
	CS-PF Continuously sheathed portal frame	7/16 "		See Section R602.10.6.4	See Section R602.10.6.4
				1 1/2 " long × 0.12″ dia. (for 1/2 " thick	

	CS-SFB[d] Continuously sheathed structural fiberboard	$^1/_2$ " or $^{25}/_{32}$ " for maximum 16" stud spacing		sheathing) or $1^3/_4$ " long × 0.12" dia. (for $^{25}/_{32}$ " thick sheathing) galvanized roofing nails ~~or 8d common (2 1/2" long x 0.131" dia.) nails~~	3" edges 6" field

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.0175 rad, 1 pound per square foot = 47.8 N/m^2 , 1 mile per hour = 0.447 m/s.

a. Adhesive attachment of wall sheathing, including Method GB, shall not be permitted in Seismic Design Categories C, D_0 , D_1 and D_2 .

b. Applies to panels next to garage door opening where supporting gable end wall or roof load only. Shall only be used on one wall of the garage. In Seismic Design Categories D_0 , D_1 and D_2, roof covering dead load shall not exceed 3 psf.

c. Garage openings adjacent to a Method CS-G panel shall be provided with a header in accordance with Table R602.7(1). A full-height clear opening shall not be permitted adjacent to a Method CS-G panel.

d. Method CS-SFB does not apply in Seismic Design Categories D_0 , D_1 and D_2 .

e. Method applies to detached one- and two-family dwellings in Seismic Design Categories D_0 through D_2 only.

Reason: 8d common nails are no longer recommended for use with structural fiberboard sheathing. Removal of 8d common nails from Table R602.3.(1) for attachement of structural fiberboard sheathing was the result of proposal S75-06/07 Part II. Removal of the 8d common nail aligns with the prescribed attachment for fiberboard sheathing per fastener schedule Table R602.3(1).

Cost Impact: Will not increase the cost of construction
Other code approved, prescriptive methods are permitted in lieu of the 8d nail size. Therefore there is no cost increase associated with this revision.

RB240-16 : TABLE R602.10.4-HUNTER11339

Final Action: AS (Approved as Submitted)

RB240-16

Errata: In Table R602,10.4, under column heading FIGURE, the figures are not to be deleted.

Committee Action: **Approved as Submitted**

Committee Reason: The committee approved this proposal based on the proponents published reason statement.

Assembly Action: **None**

S8363

Date Submitted	12/15/2018	**Section**	606.2.3	**Proponent**	Joseph Belcher for MAF
Chapter	6	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No | **Alternate Language** No

Related Modifications

Chapter 46 Referenced Standards as adopted by Commission in ADM94-16.

Summary of Modification

Modifies provisions to adopt current ASTM standards.

Rationale

ASTM C1386 was withdrawn n by ASTM in 2013, and AAC is now manufactured to different ASTM standards (ASTM C1691 for AAC masonry and ASTM C1693 for AAC in general).

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact on the cost of enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact on the cost to property owners.

Impact to industry relative to the cost of compliance with code

No impact on the cost to industry.

Impact to small business relative to the cost of compliance with code

No impact on thecost to small business.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The proposal deletes a defunct standard and adopts current standards promoting the health, safety, and welfare of the public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The proposal improves the code by deleting a defunct standard and adopting current standards.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The change does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not degrade the effectiveness of the code

The proposed change does not degrade the effectiveness of the code.

Revise as follows:

R606.2.3 AAC masonry. AAC masonry units shall conform to <u>ASTM C1691 and</u> ASTM ~~C 1386~~ <u>C1693</u> for the strength class specified.

Chapter 46 Referenced Standards.

Modify as follows:

~~ASTM C1386~~

<u>ASTM C1691- 11 Standard Specification for Unreinforced Autoclaved Aerated Concrete (AAC) Masonry Units</u>

<u>ASTM C1693-11 Standard Specification for Autoclaved Aerated Concrete (AAC)</u>

Date Submitted	12/15/2018	**Section**	606.2.6	**Proponent**	Joseph Belcher for MAF
Chapter	6	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No **Alternate Language** No

Related Modifications

Renumbering of following Sections, deletion of defunct standards from ACI and ASCE, and Chapter 46

Summary of Modification

Adopts ASTM standard for materials used in manufactured stone.

Rationale

(Note: The Reason is from original ICC proponent.)

While commonly used as a cladding material, adhered manufactured stone masonry has historically not had a national, consensus-based specification governing the minimum properties for these products; which in turn has been a source of performance issues in the field. Topics covered by ASTM C1670 include:

1) Minimum requirements for constituent materials.
2) Sampling and testing criteria.
3) Minimum compressive strength, maximum absorption, minimum freeze-thaw durability, minimum bond strength, and maximum drying shrinkage requirements.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact on the cost of enforcement of code. Will provide criteria for the manufacturer to use to ensure minimum requirements for the materials are met.

Impact to building and property owners relative to cost of compliance with code

No impact on cost to property owners. The addition of the new standard establishes minimum physical properties for manufactured stone veneer units consistent with existing industry practices.

Impact to industry relative to the cost of compliance with code

No impact on cost to industry. The industry has been following similar guidelines which were the basis for the standards.

Impact to small business relative to the cost of compliance with code

No impact on cost to small business. The industry has been following similar guidelines which were the basis for the standards.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The proposal adopts current standards to make certain there is some quality control of materials used to manufacture stone veneer units promoting the health, safety, and welfare of the public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The proposal improves the code by adopting current standards for a common product that formerly had no standards.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The change does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The proposed change does not degrade the effectiveness of the code

Revise as follows:

R606.2.6 ~~Second hand units~~. Adhered manufactured stone masonry veneer units. Adhered manufactured stone masonry veneer units shall conform to ASTM C1670.

RENUMBER AND MODIFY REMAINING SECTIONS AS INDICATED.

R606.2.~~6~~ 7 Second hand units. NO CHANGE TO TEXT.

R606.2.~~7~~ 8 Mortar. Except for mortars listed in Sections R606.2.~~8~~ 9, R606.2.~~9~~ 10 and R606.2.~~10~~ 11, mortar for use in masonry construction shall meet the proportion specifications of Table R606.2.~~7~~ 8 or the property specifications of ASTM C270. The type of mortar shall be in accordance with Sections R606.2.~~7~~ 8.1, R606.2.~~7~~ 8.2 and R606.2.~~7~~ 8.3.

R606.2.~~7~~ 8.1 Foundation walls. NO CHANGE TO TEXT.

R606.2.~~7~~ 8.2 Masonry in Seismic Design Categories A, B and C. NO CHANGE TO TEXT.

R606.2.~~7~~ 8.3 Masonry in Seismic Design Categories D0, D1 and D2. NO CHANGE TO TEXT.

R606.2.~~8~~ 9 Surface-bonding mortar. Surface-bonding mortar shall comply with ASTM C887. Surface bonding of concrete masonry units shall comply with ASTM C946.

R606.2.~~9~~ 10 Mortar for AAC masonry. Thin-bed mortar for AAC masonry shall comply with Article 2.1 C.1 of TMS 602~~/ACI 530.1/ASCE 6~~. Mortar used for the leveling courses of AAC masonry shall comply with Article 2.1 C.2 of TMS 602~~/ACI 530.1/ASCE 6~~.

R606.2.~~10~~ 11 Mortar for adhered masonry veneer. NO CHANGE TO TEXT.

R606.2.~~11~~ 12 Grout. Grout shall consist of cementitious material and aggregate in accordance with ASTM C476 or the proportion specifications of Table R606.2.~~11~~ 12. Type M or Type S mortar to which sufficient water has been added to produce pouring consistency shall be permitted to be used as grout.

R606.2.~~12~~ 13 Metal reinforcement and accessories. Metal reinforcement and accessories shall conform to Article 2.4 of TMS 602~~/ACI 530.1/ASCE 6~~. Where provided in exterior walls, joint reinforcement shall be a minimum No. 9-gauge ladder-type stainless steel, hot dipped galvanized, or epoxy coated in accordance with TMS 602~~/ACI 530.1/ ASCE 6~~ Section 2.4E1, 2.4F1b, or 2.4F2a as appropriate

TABLE R606.2.~~7~~ 8

MORTAR PROPORTIONS[a, b]

NO CHANGE TO TEXT OF TABLE.

TABLE R606.2.~~11~~ 12

GROUT PROPORTIONS BY VOLUME FOR MASONRY CONSTRUCTION

NO CHANGE TO TEXT OF TABLE.

Chapter 46 - ASTM

C207—06 (2011) Specification for Hydrated Lime for Masonry Purposes. . . . . .Table R606.2.~~7~~ 8

Add new standard as follows:

ASTM C1670/C1670M-18 Standard Specification for Adhered Manufactured Stone Masonry Veneer Units

Date Submitted	11/28/2018	**Section**	703.11.2	**Proponent**	T Stafford
Chapter	7	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

S7252

Summary of Modification

This proposal updates the design pressure requirements for vinyl siding installed over foam plastic sheathing alone based on changes to ASTM D 3679, the specification for vinyl siding.

Rationale

The main purpose of this proposal is to update Table R70311.2 to ensure that the adjusted vinyl siding design wind pressure ratings are based on the updated standard for vinyl siding (ASTM D3679) (See Mod S7252) which has changed the pressure equalization factor from 0.36 to 0.5 for design wind pressure rating of vinyl siding. Because the pressure equalization factor in ASTM D3679 is now more conservative (changed to 0.5 from 0.36), the adjustment for applications over foam sheathing are adjusted downward accordingly by multiplying existing table values by 0.36/0.5 = 0.72. This will ensure that the intended level of performance is maintained with use of newer vinyl siding products complying with ASTM D3679 as required by the code. Also, the design components and cladding wind pressures for walls (which the adjusted values in Table R703.11.2 are based) remain consistent with the newer ASCE 7-16 standard. The proposal also coordinates "wind load design pressure rating" with terminology as used in ASTM D3679.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with the code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to cost of compliance with the code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to cost of compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal adjusts the wind load design pressure rating for vinyl siding installed over foam plastic sheathing to be consistent with changes to ASTM D3679.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code by adjusting the wind load design pressure rating for vinyl siding installed over foam plastic sheathing to be consistent with changes to ASTM D3679.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Revise as follows:

R703.11.2 Installation over foam plastic sheathing. Where vinyl siding or insulated vinyl siding is installed over foam plastic sheathing, the vinyl siding shall comply with Section R703.11 and shall have a wind load design ~~wind~~ pressure rating ~~resistance~~ in accordance with Table R703.11.2.

Exceptions:

1. Where the foam plastic sheathing is applied directly over wood structural panels, fiberboard, gypsum sheathing or other *approved* backing capable of independently resisting the design wind pressure, the vinyl siding shall be installed in accordance with Sections R703.3.3 and R703.11.1.
2. Where the vinyl siding manufacturer's product specifications provide an *approved* ~~design~~ wind load design pressure rating for installation over foam plastic sheathing, use of this ~~design~~ wind load design pressure rating shall be permitted and the siding shall be installed in accordance with the *manufacturer's installation instructions*.
3. Where the foam plastic sheathing and its attachment has a design wind pressure resistance complying with Sections R316.8 and R301.2.1, the vinyl siding shall be installed in accordance with Sections R703.3.3 and R703.11.1.

TABLE R703.11.2
REQUIRED ~~ADJUSTED~~ MINIMUM WIND LOAD DESIGN ~~WIND~~ PRESSURE RATING ~~REQUIREMENT~~ FOR VINYL SIDING INSTALLED OVER FOAM PLASTIC SHEATHING ALONE

Ultimate Design Wind Speed (mph)	Adjusted Minimum Design Wind Pressure (ASD) (psf)[a,b]					
	Case 1: With interior gypsum wallboard[c]			Case 2: Without interior gypsum wallboard[c]		
	Exposure			Exposure		
	B	C	D	B	C	D
110	~~-44.0~~ -31.8	~~-61.6~~ -44.5	~~-73.1~~ -52.8	~~-62.9~~ -45.4	~~-88.1~~ -63.5	~~-104.4~~ -75.3
115	~~-49.2~~ -35.5	~~-68.9~~ -49.7	~~-81.7~~ -59.0	~~-70.3~~ -50.7	~~-98.4~~ -71.0	~~-116.7~~ -84.2
120	~~-51.8~~ -37.4	~~-72.5~~ -52.4	~~-86.0~~ -62.1	~~-74.0~~ -53.4	~~-103.6~~ -74.8	~~-122.8~~ -88.6
130	~~-62.2~~ -44.9	~~-87.0~~ -62.8	~~-103.2~~ -74.5	~~-88.8~~ -64.1	~~-124.3~~ -89.7	~~-147.4~~ -106
>130	See footnote ~~Not Allowed~~ d					

For SI: 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa.
a. Linear interpolation is permitted
b. The table values are based on a maximum 30-ft mean roof height, an effective wind area of 10 ft^2, Wall Zone 5 (corner), and the ASD design component and cladding wind pressure from Table R301.2(2), adjusted for exposure in accordance with Table R301.2(3), multiplied by the following adjustment factors: 1.87 ~~2.6~~ (Case 1) and 2.67 ~~3.7~~ (Case 2)~~for wind speeds less than 130 mph and 3.7 (Case 2) for wind speeds greater than 130 mph~~.
c. Gypsum wallboard, gypsum panel product or equivalent.

d. For the indicated wind speed condition, vinyl siding overfoam sheathing alone is permitted only if ~~on the exterior of frame walls with vinyl siding is not allowed unless the vinyl siding complies with an adjusted minimum design wind pressure requirement as determined in accordance with footnote b and~~ the wall assembly is capable of resisting an impact without puncture at least equivalent to that of a wood frame wall with minimum 7/16"OSB sheathing as tested in accordance with ASTM E1886. The vinyl siding shall comply with an adjusted minimum design wind pressure requirement as determined in accordance with footnote b, using an adjustment factor of 2.67.

S7627

Date Submitted	12/2/2018	**Section**	703.8.4	**Proponent**	Ann Russo8
Chapter	7	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

S376-16

Summary of Modification

This code change proposal is a clarification of the existing code language. It is intended to acknowledge and reflect more closely the common practice used in the field for the construction of anchored stone and masonry veneer construction.

Rationale

This code change is intended to acknowledge that the airspace behind a well-constructed, code-compliant brick veneer will never be completely devoid of mortar. No matter how careful an experienced, seasoned mason is in constructing the veneer, some small amount of mortar from construction will be found in the airspace.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will not impact enforcement of the code.

This proposal is a clarification of the existing code language. It is intended to acknowledge and reflect more closely the common practice used in the field for the construction of anchored stone and masonry veneer construction.

Impact to building and property owners relative to cost of compliance with code

This code change proposal is a clarification of the existing code language. It is intended to acknowledge and reflect more closely the common practice used in the field for the construction of anchored stone and masonry veneer construction. There should be no cost impact.

Impact to industry relative to the cost of compliance with code

This code change proposal is a clarification of the existing code language. It is intended to acknowledge and reflect more closely the common practice used in the field for the construction of anchored stone and masonry veneer construction. There should be no cost impact.

Impact to small business relative to the cost of compliance with code

This code change proposal is a clarification of the existing code language. It is intended to acknowledge and reflect more closely the common practice used in the field for the construction of anchored stone and masonry veneer construction. There should be no cost impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Has no impact on the code implementation.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This code change proposal is a clarification of the existing code language. It should improve the code by clarifying the intent.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This code change proposal is a clarification of the existing code language and does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This code change proposal is a clarification of the existing code language and does not degrade the effectiveness of the code.

Section: R703.8.4

Revise as follows:

TABLE R703.8.4

–

TIE ATTACHMENT AND AIRSPACE REQUIREMENTS

BACKING AND TIE	MINIMUM TIE	MINIMUM TIE FASTENER[a]	AIRSPACE[c]	
Wood stud backing with corrugated sheet metal	22 U.S. gauge (0.0299 in.) × $^{7}/_{8}$ in. wide	8d common nail [b] ($2^{1}/_{2}$ in. × 0.131 in.)	Nominal 1 in. between sheathing and veneer	
Wood stud backing with metal strand wire	W1.7 (No. 9 U.S. gauge; 0.148 in.) with hook embedded in mortar joint	8d common nail [b]($2^{1}/_{2}$ in. × 0.131 in.)	Minimum nominal 1 in. between sheathing and veneer	Maximum $4^{1}/_{2}$ in. between backing and veneer
Cold-formed steel stud backing with adjustable metal strand wire	W1.7 (No. 9 U.S. gauge; 0.148 in.) with hook embedded in mortar joint	No. 10 screw extending through the steel framing a minimum of three exposed threads	Minimum nominal 1 in. between sheathing and veneer	Maximum $4^{1}/_{2}$ in. between backing and veneer

For SI: 1 inch = 25.4 mm.

a. In Seismic Design Category D_0, D_1 or D_2, the minimum tie fastener shall be an 8d ring-shank nail ($2^{1}/_{2}$ in. × 0.131 in.) or a No. 10 screw extending through the steel framing a minimum of three exposedthreads.

b. All fasteners shall have rust-inhibitive coating suitable for the installation in which they are being used, or be manufactured from material not susceptible to corrosion.

c. An airspace that provides drainage shall be permitted to contain some mortar from construction.

S7707

Date Submitted	12/6/2018	**Section**	702.7.3	**Proponent**	Ann Russo1
Chapter	7	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Introducing new material/product that has similar characteristics as vinyl.

Rationale

Polypropylene siding is very similar to vinyl siding in its shape and design and has similar "vented cladding" characteristics.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No negative impact to enforcement of the code. This proposal is simply to include new material that has similar characteristics as vinyl which is already prescribed in the code.

Impact to building and property owners relative to cost of compliance with code

Will not increase cost of construction.

Impact to industry relative to the cost of compliance with code

Will not increase cost of construction.

Impact to small business relative to the cost of compliance with code

Will not increase cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal is simply to include new material that has similar characteristics as vinyl which is already prescribed in the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal will improve the application of the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal will not discriminate against materials, products, methods or system of construction.

Does not degrade the effectiveness of the code

This proposal will not degrade the effectiveness of the code.

Revise as follows:

R702.7.3 Minimum clear airspaces and vented openings for vented cladding.

For the purposes of this section, vented cladding shall include the following minimum clear airspaces. Other openings with the equivalent vent area shall be permitted.

1. Vinyl ~~lap~~, polypropylene, or horizontal aluminum siding applied over a weather-resistive barrier as specified in Table R703.3(1).
2. Brick veneer with a clear airspace as specified in Table R703.8.4.
3. Other approved vented claddings.

Date Submitted	12/6/2018	**Section**	703.7	**Proponent**	George Starks
Chapter	7	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

R202; R702.2.2; R702.2.2.1; R703.7; R703.7.2.14; R703.7.4; R703.7.5

Summary of Modification

Seeks to update the Referenced Standards to the current published versions: C 926-18b and C 1063-18b. Significant clarifications and reorganization, to produce more user-friendly documents, have been incorporated since the 15a and 15b versions of these standards.

Rationale

Significant changes to these Standards, in the form of reorganization and re-wording, have been instituted in an effort to make the Standards more user-friendly and less confusing. Comparison files are attached.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will not impact enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

Will not impact the cost to building and property owners relative to compliance with the code.

Impact to industry relative to the cost of compliance with code

Will not impact the cost to the industry relative to compliance with the code.

Impact to small business relative to the cost of compliance with code

Will not impact the cost to small business relative to compliance with the code.
Requirements

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Proper installation of exterior cladding systems have direct impact to the health and welfare of the general public as key elements in the building envelope.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by providing to the general public, as well as industry professionals, a more clear and concise standard through re-wording, reorganization and removal of some antiquated provisions.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Makes no discriminatory remarks or statements in regards to materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

Part IX

Chapter 46 Referenced Standards

C926-~~15b~~18b Specification for Application of Portland Cement-based Plaster R202, R702.2.2, R702.2.2.1, R703.7, R703.7.2.1, R703.7.4

C1063-~~15a~~18b Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-based Plaster R702.2.2, R703.7

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Designation: C926–~~18b~~15b

Disclaimer: This document is not an ASTM standard and is intended only to provide the user of an ASTM standard an indication of what changes have been made to the previous version. Because it may not be technically possible to adequately depict all changes accurately, ASTM recommends that users consult prior editions as appropriate. In all cases, only the current version of the standard as published by ASTM is to be considered the official document.

Standard Specification for Application of Portland Cement-Based Plaster [1]

This standard is issued under the fixed designation C926; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

IN THIS STANDARD:

1 SCOPE *A Summary of Changes section appears at the end of this standard.

1.1 This specification covers the requirements for the application of full thickness portland cement-based plaster for exterior (stucco) and interior work. ~~These requirements do not by default define a unit of work or assign responsibility for contractual purposes, which is the purview of a contract or contracts made between contracting entities.~~

1.2 This specification sets forth tables for proportioning of various plaster mixes and plaster thickness.

NOTE 1: General information will be found in Annex A1. Design considerations will be found in Annex A2.

1.3 The values stated in inch-pound units are to be regarded as the standard. The SI (metric) values given in parentheses are approximate and are provided for information purposes only.

1.4 The text of this specification references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the specification.

1.5 Details of construction for a specific assembly to achieve the required fire resistance shall be obtained from reports of fire-resistance tests, engineering evaluations, or listings from recognized fire testing laboratories. ~~1.6 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.~~

2 REFERENCED DOCUMENTS

2.1 ASTM Standards: [2]

C11 Terminology Relating to Gypsum and Related Building Materials and Systems

C25 Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime

C35 Specification for Inorganic Aggregates for Use in Gypsum Plaster

C91 Specification for Masonry Cement

C150 Specification for Portland Cement

C206 Specification for Finishing Hydrated Lime

C207 Specification for Hydrated Lime for Masonry Purposes

C219 Terminology Relating to Hydraulic Cement

C260 Specification for Air-Entraining Admixtures for Concrete

C578 Specification for Rigid, Cellular Polystyrene Thermal Insulation

C595 Specification for Blended Hydraulic Cements

C631 Specification for Bonding Compounds for Interior Gypsum Plastering

C897 Specification for Aggregate for Job-Mixed Portland Cement-Based Plasters

C932 Specification for Surface-Applied Bonding Compounds for Exterior Plastering

C1063 Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster

C1116 Specification for Fiber-Reinforced Concrete and Shotcrete

C1328 Specification for Plastic (Stucco) Cement ~~C1787 Specification for Installation of Non Metallic Plaster Bases (Lath) Used with Portland Cement Based Plaster in Vertical Wall Applications~~

E90 Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

E119 Test Methods for Fire Tests of Building Construction and Materials

E492 Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine

2.2 ANSI Standard:

A108.1 Specification for Installation of Ceramic Tile [3]

3 TERMINOLOGY

3.1 Terms shall be defined as in Terminologies C11 and C219, except as modified herein.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 accelerator, n—an admixture that will shorten the setting time of plaster.

3.2.2 admixture, n—a material other than water, aggregate, or basic cementitious material added to the batch before or during job mixing.

3.2.3 acid etching, n—the cleansing and controlled erosion of a solid surface, using an acid wash.

3.2.4 air entrainment, n—the use of an air-entraining admixture or air-entraining cementitious material in a plaster mix to yield a controlled quantity of minute (typically between 10 and 1000 µm in diameter) disconnected air bubbles in the plaster (see *entrapped air*).

3.2.5 back wrap, n—a means of terminating a polymer-modified, fabric reinforced cementitious base coat by wrapping the reinforcing mesh, which has been affixed to the substrate onto the outboard surface of the foam plastic core to provide continuity of the reinforced base coat and protection for the foam plastic core.

3.2.6 backplaster, n—plaster applied to the face of metal lath opposite a previously applied plaster.

3.2.7 barrier wall, n—type of wall system that is intended to block or interrupt the movement of water to the interior.

3.2.8 bond, n—the state of adhesion between plaster coats or between plaster and plaster base.

3.2.9 bonding compound or agent, n—compounds surface applied or integrally mixed with plaster to improve the quality of bond between plaster and plaster base or between plaster coats.

3.2.10 cementitious material, n—a material that, when mixed with water and with or without aggregate, provides the plasticity and the cohesive and adhesive properties necessary for placement and the formation of a rigid mass.

3.2.11 coat, n—a thickness of plaster applied in a single operation.

3.2.11.1 basecoat, n—all plaster applied before the application of the finish coat.

3.2.11.2 bedding coat, n—a plaster coat that receives aggregate or other decorative material impinged into its surface before it sets.

3.2.11.3 brown coat, n—in three-coat work, the second coat, applied over the scratch coat. In two-coat work, brown coat refers to the double-up basecoat. In either use, the brown coat is the coat directly beneath the finish coat.

3.2.11.4 dash-bond coat, n—a thick wet mixture of portland cement and water, with or without aggregate, dashed onto the surface of a plaster base such as smooth monolithic concrete or concrete block surfaces to improve the mechanical key for subsequent plaster coats.

3.2.11.5 double-up coat, n—the brown-coat plaster applied to the scratch coat plaster before the scratch-coat plaster has set.

3.2.11.6 finish coat, n—the final layer of plaster applied over basecoat plaster.

3.2.11.7 fog coat, n—a light coat of cement and water, with or without aggregate or color pigment, applied by machine spray to improve color consistency.

3.2.11.8 scratch coat, n—the first coat of plaster applied to a plaster base.

3.2.11.9 skim coat, n—a thin finish coat applied to an existing plaster surface or other substrate to improve appearance.

3.2.11.10 three-coat work, n—application of plaster in three successive coats with time between coats for setting or drying, or both.

3.2.12 cold joint ("joining" or "jointing"), n—the juncture of fresh plaster application adjacent to set plaster, in the same plane.

3.2.13 curing, v—the act or processes of producing a moisture environment favorable to cement hydration, resulting in the setting or hardening of the plaster.

3.2.14 drainage wall, n—a wall system in which the cladding provides a substantial barrier to water intrusion, and which also incorporates a concealed water-resistive barrier over which drainage will occur.

3.2.15 entrapped air, n—unintentional air voids in the plaster generally larger than 1 mm.

3.2.16 factory prepared ("mill-mixed" or "ready mixed"), adj—pertaining to material combinations that have been formulated and dry-blended by the manufacturer, requiring only the addition of and mixing with water to produce plaster.

3.2.17 fiber, natural or synthetic, n—an elongated fiber or strand admixture added to plaster mix to improve cohesiveness or pumpability, or both.

3.2.18 floating, v—act of compacting and leveling brown-coat plaster to a reasonably true surface plane using a float tool or the act of bringing the aggregate to the surface of finish-coat plaster.

3.2.19 key (also mechanical key), n—plaster that physically surrounds, penetrates, or deforms to lock onto the perforations or irregularities of the plaster base or previous coat of plaster.

3.2.20 metal plaster base, n—expanded metal lath, or welded or woven wire lath.

3.2.21 plaster, n—portland cement-based cementitious mixture (see *stucco*).

3.2.22 polymer modified cementitious base coat, n—A base coat containing portland cement modified with chemical admixtures (typically polymer latexes) to improve characteristics of the finished product, such as workability, plasticity, water resistance, and adhesion.

3.2.23 required, adj—pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.

3.2.24 rustication (also "break"), n—an interruption or change in plane of a plastered surface.

3.2.25 scoring (also known as "scratching"), n—the grooving of the surface of an unset plaster coat to provide a key for a subsequent coat.

3.2.26 set, n—the chemical and physical change in plaster as it goes from a plastic, workable state to a rigid state.

3.2.27 solid plaster bases, n—substrates that do not require a metal plaster base, including cast in place and precast concrete, concrete and stone masonry, clay brick, and tile.

3.2.28 stucco, n—portland cement-based plaster used on exterior locations.

3.2.29 stucco finish, n—a factory-prepared, dry blend of materials for finish coat applications.

3.2.30 temper, v—to mix or restore unset plaster with water to a workable consistency.

3.2.31 texture, n—any surface appearance as contrasted to a smooth surface. ~~3.3 Definitions of Terms Not Specific to This Standard 3.3.1 contract documents, n—a series of several individual items that generally include drawings and specifications. Either or both of these documents may exist for any particular project.~~

4 ~~DELIVERY AND STORAGE OF~~ MATERIALS

4.1 ~~Delivery: 4.1.1 Packaged materials shall be delivered in factory-sealed, unopened, and unbroken packages, containers, or bundles. 4.1.2 Bulk materials shall be delivered in clean transport vessels, free of contaminates. 4.2 Storage: 4.2.1 Weather-sensitive materials shall be kept in a dry condition until ready for use. (See A2.4.) 4.2.2 Bulk materials shall be stored to prevent subsequent contamination and segregation. 5~~ Materials ~~5.1 Materials~~ shall conform to the requirements of the referenced specifications and standards and to the requirements specified herein. ~~5.2~~

4.2 Cement: ~~5.2.1~~

4.2.1 *Portland Cement*—Specification C150, Type I, II, and III, as specified. White where specified. ~~5.2.2~~

4.2.2 *Air-Entraining Portland Cement*—Specification C150, type as specified. White where specified. ~~5.2.3~~

4.2.3 *Masonry Cement*—Specification C91, Types N, S, and M. White where specified. ~~5.2.4~~

4.2.4 *Blended Hydraulic Cement*—Specification C595, Type IP, IS(με70), IL, and IT(Sμε70), as specified. ~~5.2.5~~

4.2.5 *Air-Entraining Blended Hydraulic Cement*—Specification C595, Type IP-(A), IS(με70)-(A), IL-(A), and IT (Sμε70)-(A), as specified. ~~5.2.6~~

4.2.6 *Plastic Cement*—Plastic Cement shall meet the requirements of Specification C1328, Standard Specification for Plastic (Stucco) Cement.

NOTE 2: Plastic cements are not available nationally. ~~5.3~~

4.3 Type "S" Hydrated Lime—A hydrated lime that contains not more than 8 % unhydrated oxides when tested in accordance with Test Methods C25. See Specifications C206 and C207 for a complete description of a Type "S" hydrated lime. ~~5.4~~

4.4 Aggregates: ~~5.4.1~~

4.4.1 *Sand for Base Coats*—Specification C897. Aggregate failing to meet gradation limits in Specification C897 shall be permitted to be used, provided the plaster made with this sand has an acceptable demonstrated performance record in similar construction and climate conditions. ~~5.4.2~~

4.4.2 *Perlite*—Specification C35. ~~5.4.3~~

4.4.3 *Sand for Job-Mixed Finish Coats*—Specification C897. ~~5.5~~

4.5 Water—Water used in mixing, application, and finishing of plaster shall be clean, fresh, suitable for domestic water consumption, and free of such amounts of mineral or organic substances as would affect the set, the plaster, or any metal in the system. ~~5.6~~

4.6 Admixtures—See 3.2.2 and A2.5. ~~5.7~~

4.7 Fibers—Specification C1116 on alkali-resistant fibers, glass fibers, nylon, polypropylene or carbon fibers. ~~5.8~~

5 ~~PRODUCT MARKING—PACKAGED MATERIALS SHALL BE CLEARLY MARKED OR LABELED TO INDICATE PRODUCT, BRAND NAME, THE MANUFACTURER, AND THE WEIGHT OF THE MATERIAL CONTAINED THEREIN. SIMILAR INFORMATION SHALL BE PROVIDED IN THE SHIPPING ADVICES ACCOMPANYING THE SHIPMENT OF BULK MATERIALS. 6~~ REQUIREMENTS FOR BASES TO RECEIVE PORTLAND CEMENT-BASED PLASTER ~~6.1~~

5.1 Metal ~~plaster~~ bases ~~bases,~~ and ~~lathing accessories, furring~~ accessories ~~and fasteners~~ used to receive plaster shall be installed in conformance with Specification C1063, except as otherwise specified. ~~Non-metallic~~

NOTE ~~PLASTER~~ 3: bases All ~~used~~ metal, ~~to~~ or ~~receive~~ PVC, ~~plaster~~ or ~~shall~~ CPVC ~~be~~ plastic ~~installed~~ members ~~in~~ should ~~conformance with Specification C1787. Note 3: Plaster bases and lathing accessories shall~~ be free of deleterious amounts of rust, oil, or other foreign matter, which could cause bond failure or unsightly discoloration. ~~6.2~~

5.2 Surfaces of solid bases to receive plaster, such as masonry, stone, cast-in-place or precast concrete shall be straight and true within $^{1}/_{4}$ in. ~~(6 mm)~~ in 10 ft ~~(3~~ (2.1 ~~m)~~ mm/m) and shall be free of form oil or other elements, which would interfere with bonding. Conditions where the surfaces are out of tolerance shall be corrected prior to the application of the plaster. Ferrous-containing form ties or other obstructions shall be removed or receded a minimum ~~1~~ 1/8/~~8~~ in. (3 mm) below the surface of the solid base and treated with a corrosion-resistant coating. Non-ferrous protuberances shall be permitted to be trimmed back even with the surface of the solid base. ~~6.2.1~~

5.2.1 Solid surfaces shall have the suction (ability to absorb water) or surface roughness, or both, to provide the bond required for the plaster. ~~6.2.2~~

5.2.2 Smooth or nonabsorbent solid surfaces, such as cast-in-place or precast concrete, shall be prepared to receive portland cement plaster by one of the following methods: ~~6.2.2.1~~

5.2.2.1 Sandblasting, wire brushing, acid etching, or chipping or a combination thereof, ~~6.2.2.2~~

5.2.2.2 Application of a dash-bond coat applied forcefully against the surface, left untroweled, undisturbed, and moist cured for at least 24 h, or ~~6.2.2.3~~

5.2.2.3 Application of a bonding compound suitable for exterior or interior exposure solid surfaces in accordance with the manufacturer's written directions. ~~6.2.3~~

5.2.3 Where bond cannot be obtained by one or more of the methods in ~~6.2.2~~ 5.2.2, a furred or self-furring metal plaster base shall be installed in accordance with Specification C1063 ~~or~~. ~~C1787 as appropriate.~~ Where metal plaster base is used in areas where bond cannot be obtained by one or more of the methods in ~~6.2.2~~ 5.2.2, accessories shall be installed in accordance with Specification C1063 ~~or~~. ~~C1787~~

6 ~~AS~~ PLASTER ~~APPROPRIATE.~~ PROPORTIONS ~~7~~ AND ~~APPLICATION~~ MIXING ~~7.1~~

6.1 ~~Plaster~~ Proportions: ~~7.1.1~~

6.1.1 All portland cement plasters shall be mixed and proportioned in accordance with the following tables and accompanying requirements, using measuring devices of known volume with successive batches proportioned alike. ~~7.1.2~~

6.1.2 Plaster mix used shall be as designated and referenced to Table 1.

TABLE 1 Plaster Bases—Permissible Mixes

NOTE 1: See Table 2 for plaster mix symbols.

Property of Base	Mixes for Plaster Coats	
	First (Scratch)	Second (Brown)
Low absorption, such as dense, smooth clay tile, brick, or concrete	C	C, CL, M, or CM
	CM or MS	CM, MS, or M
	P	P
High Absorption, such as concrete masonry, absorptive brick, or tile	CL	CL
	M	M
	CM or MS	CM, MS, or M
	P	P
Metal plaster base	C	C, CL, M, CM, or MS
	CL	CL
	CM or MS	CM, MS, or M
	M	M
	CP	CP or P
	P	P ~~7.1.3~~

6.1.3 Base-coat proportions shall be as shown in Table 2 for the mix specified from Table 1.

TABLE 2 Base-Coat Proportions,[A] Parts by Volume[B]

Plaster Mix Symbols	Cementitious Materials					Volume of Aggregate per Sum of Separate Volumes of Cementitious Materials	
	Portland Cement or Blended Cement	Plastic Cement	Masonry Cement		Lime		
			N	M or S		1st Coat	2nd[C] Coat
C	1	. . .	. . .	. . .	$0\text{–}\frac{3}{4}$	$2\frac{1}{2}\text{–}4$	3–5
CL	1	. . .	. . .	. . .	$\frac{3}{4}\text{–}1\frac{1}{2}$	$2\frac{1}{2}\text{–}4$	3–5
M	. . .	. . .	1	. . .	. . .	$2\frac{1}{2}\text{–}4$	3–5
CM	1	. . .	1	. . .	. . .	$2\frac{1}{2}\text{–}4$	3–5
MS	. . .	. . .	. . .	1	. . .	$2\frac{1}{2}\text{–}4$	3–5

Plaster Mix Symbols	Cementitious Materials					Volume of Aggregate per Sum of Separate Volumes of Cementitious Materials	
	Portland Cement or Blended Cement	Plastic Cement	Masonry Cement		Lime	1st Coat	2nd Coat
			N	M or S			
P	. . .	1	. . .	. . .	. . .	$2^1/_2$–4	3–5
CP	1	1	. . .	. . .	. . .	$2^1/_2$–4	3–5

(A) The mix proportions for plaster scratch and brown coats to receive ceramic tile shall be in accordance with the applicable requirements of ANSI A108.1 series applicable to specified method of setting time.

(B) Variations in lime, sand, and perlite contents are allowed due to variation in local sands and insulation and weight requirements. A higher lime content will generally support a higher aggregate content without loss of workability. The workability of the plaster mix will govern the amounts of lime, sand, or perlite.

(C) The same or greater sand proportion shall be used in the second coat than is used in the first coat.~~7.1.3.1~~

6.1.3.1 *Measurement of Materials*—**The method of measuring materials for the plaster shall be such that the specified proportions are controlled and accurately maintained. The weights per cubic foot of the materials are considered to be as follows:**

Material	Weight, lb/ft³ (kg/m³)
Portland cement	94 (1505)
Blended cement	Weight printed on bag
Masonry or plastic cement	Weight printed on bag
Hydrated Lime	40 (640)
Lime Putty	80 (1280)
Sand, Damp and Loose (~~7.1.3.2~~**6.1.3.2**)	80 (1280) of dry sand~~7.1.3.2~~

6.1.3.2 **For purposes of this specification, a weight of 80 lb (1280 kg) of oven-dried sand shall be used. This is, in most cases, equivalent to one cubic foot of loose, damp sand.~~7.1.4~~**

6.1.4 **Finish-coat proportions for job-mixed finish coats shall be as specified in Table 3.**

TABLE 3 Job-Mixed Finish Coat Proportion Parts by Volume

Plaster Mix Symbols[A]	Cementitious Materials					Volume of Aggregate per Sum of Separate Volumes of Cementitious Materials[B]
	Portland Cement or Blended Cement	Plastic Cement	Masonry Cement[A]		Lime	
			N	M or S		
F	1	. . .	. . .	. . .	$^3/_4$–$1^1/_2$	$1^1/_2$–3
FL	1	. . .	. . .	. . .	$1^1/_2$–2	$1^1/_2$–3
FM	. . .	. . .	1	. . .	. . .	$1^1/_2$–3
FCM	1	. . .	1	. . .	. . .	$1^1/_2$–3
FMS	. . .	. . .	. . .	1	. . .	$1^1/_2$–3

Plaster Mix Symbols	Cementitious Materials					Volume of Aggregate per Sum of Separate Volumes of Cementitious Materials
	Portland Cement or Blended Cement	Plastic Cement	Masonry Cement		Lime	
			N	M or S		
FP	. . .	1	. . .	. . .	. . .	$1^1/_2$–3

(A) Additional portland cement is not required when Type S or M masonry cement is used.

(B) In areas not subject to impact, perlite aggregate shall be permitted to be used over base-coat plaster containing perlite aggregate. ~~7.1.5~~

6.1.5 ***Factory-Prepared Finish Coats***—See 3.2.16. ~~7.1.6~~

6.1.6 Dash-bond coat proportions shall be 1 volume part portland cement and not more than 2 volume parts of aggregate mixed to a consistency that will permit application as specified in ~~7.3.5~~ 7.1.5. ~~7.1.7~~

6.1.7 Admixtures shall be proportioned, mixed, and applied in accordance with the printed directions of the manufacturer. (See A2.5.) ~~7.1.8~~

6.2 ~~Where specified, natural or synthetic fibers shall be free of contaminants and used only in the base coat(s). The quantities per batch shall be in accordance with the published directions of the fiber manufacturer. 7.2~~ Mixing: ~~7.2.1~~

6.2.1 All plaster shall be prepared in a mechanical mixer, using sufficient water to produce a workable consistency and uniform color. (See X1.1.) ~~7.2.2~~

6.2.2 Base-coat plasters that have stiffened because of evaporation of water shall be permitted to be tempered one time only to restore the required consistency. Plaster not used within $1^1/_2$ h from start of initial mixing shall be discarded.

NOTE 4: Severe hot, dry climate conditions accelerate the stiffening of plaster and require reduction of this limit. The use of cold waters will slow the stiffening process. ~~7.2.3~~

6.2.3 Finish-coat plaster shall not be tempered. ~~7.3~~

7 ~~GENERAL~~ APPLICATION ~~APPLICATION:~~

7.1 ~~7.3.1~~ General:

7.1.1 Portland cement plaster shall be applied by hand ~~trowel~~ or machine to the nominal thickness specified in Table 4. The nominal values expressed in Table 4 represent neither a maximum nor minimum value. They consider the inherent variation of thickness due to the nature of the application process, and the allowable variation of the substrate and the finished plane of the plaster.

TABLE 4 Nominal Plaster Thickness[A] for Three- and Two-Coat Work, in. (mm)

BASE	Vertical				Horizontal			
	1st Coat	2nd Coat	3rd Coat[B]	Total	1st Coat	2nd Coat	3rd Coat[B]	Total
	Interior/Exterior							
Three-coat work:[C]								
Metal plaster base	$^3/_8$ ~~(10)~~ (9.5)	$^3/_8$ ~~(10)~~ (9.5)	$^1/_8$ (3)	$^7/_8$ (22)	$^1/_4$ (6)	$^1/_4$ (6)	$^1/_8$ (3)	$^5/_8$ (16)
Solid plaster base:								

BASE	Vertical				Horizontal			
	1st Coat	2nd Coat	3rd Coat	Total	1st Coat	2nd Coat	3rd Coat	Total
	Interior/Exterior							
Unit masonry	1/4 (6)	1/4 (6)	1/8 (3)	5/8 (16)	Use two-coat work			
Cast-in-place or precast concrete	1/4 (6)	1/4 (6)	1/8 (3)	5/8 (16)				3/8 ~~(10),~~ (9.5), max
Metal plaster base over solid base	1/2 ~~(13)~~ (12.5)	1/4 (6)	1/8 (3)	7/8 (22)	1/2 ~~(13)~~ (12.5)	1/4 (6)	1/8 (3)	7/8 (22)
Two-coat work:								
Solid plaster base:								
Unit masonry	3/8 ~~(10)~~ (9.5)	1/8 (3)		1/2 ~~(13)~~ (12.5)				3/8 ~~(10)~~ (9.5)
Cast-in-place or pre-cast concrete	1/4 (6)	1/8 (3)		3/8 ~~(10)~~ (9.5)				3/8 ~~(10)~~ (9.5)

(A) Exclusive of texture.

(B) For solid plaster partitions, additional coats shall be applied to meet the finished thickness specified.

(C) For exposed aggregate finishes, the second (brown) coat shall become the "bedding" coat and shall be of sufficient thickness to receive and hold the aggregate. ~~7.3.2~~

7.1.2 Plaster nominal thickness shall be measured from the back plane of the metal plaster base, exclusive of ribs or dimples, or from the face of the solid backing with or without metal plaster base, to the outer surface exclusive of texture variations. ~~7.3.3~~

7.1.3 Portland cement-based plaster shall be applied on furred metal plaster base when the surface of solid backing consists of gypsum board, gypsum plaster, wood, or rigid foam board-type products.

NOTE 5: On horizontal ceiling supports or roof soffits protected by a drip ~~edge~~ edge, ~~or designated drainage screed,~~ gypsum board products shall be permitted to be used as backing for metal base to receive portland cement plaster. ~~7.3.4~~

7.1.4 Separation shall be provided where plaster abuts dissimilar construction materials or openings. (See ~~A2.1.3~~ A2.1.4.) ~~7.3.5~~

7.1.5 Each plaster coat shall be applied to an entire wall or ceiling panel without interruption to avoid cold joints and abrupt changes in the uniform appearance of succeeding coats. Wet plaster shall abut set plaster at naturally occurring interruptions in the plane of the plaster, such as corner angles, rustications, openings, expansion joints, and control joints where this is possible. Joinings, where necessary, shall be cut square and straight and not less than 6 in. (152 mm) away from a joining in the preceding coat. ~~7.3.6~~

7.1.6 Metal plaster base shall be covered with three-coat work with or without solid backing. The combined total nominal thickness shall be as shown in Table 4. A dash-bond coat shall not replace one of the specified number of coats. ~~7.3.7~~

7.1.7 Two-coat work shall be used only over solid bases meeting the requirements of ~~6.2~~ 5.2. The combined total nominal thickness shall be as shown in Table 4. A dash-bond coat shall not replace one of the specified number of coats. ~~7.3.8~~

7.1.8 Backplaster where required, shall be applied only after the coat on the opposite side has set sufficiently to resist breaking or cracking the plaster keys. ~~7.3.9~~

7.1.9 Each coat shall be permitted to set before the next coat is applied. (See X1.5.2.) ~~7.3.10~~

7.1.10 Plaster coats that have become dry shall be evenly dampened with water prior to applying subsequent coats to obtain uniform suction. There shall be no visible water on the surface when plaster is applied. ~~7.4~~

7.2 Plaster Application on Metal ~~and Non-Metallic~~ Plaster Bases: ~~7.4.1~~

7.2.1 The first (scratch) coat shall be applied with sufficient material and pressure to form full keys through, and to embed the metal base, and with sufficient thickness of material over the metal to allow for scoring the surface. ~~7.4.1.1~~

7.2.1.1 As soon as the first (scratch) coat becomes firm, the entire surface shall be scored in one direction only. The vertical surfaces shall be scored horizontally. ~~7.4.1.2~~

7.2.1.2 The first (scratch) coat shall become sufficiently rigid to support the application of the second (brown) coat without damage to the monolithic continuity of the first (scratch) coat or its key. ~~7.4.2~~

7.2.2 The second (brown) coat shall be applied with sufficient material and pressure to ensure tight contact with the first (scratch) coat and to bring the combined thickness of the base coat to the nominal thickness shown in Table 4. ~~7.4.2.1~~

7.2.2.1 The surface of the second (brown) coat shall be brought to a true, even plane with a rod or straightedge, filling surface defects in plane with plaster. Dry rodding the surface of the brown coat shall be permitted. ~~7.4.2.2~~

7.2.2.2 The surface shall be floated uniformly to promote densification of the coat and to provide a surface receptive to bonding of the finish coat. ~~7.4.3~~

7.2.3 The third (finish) coat shall be applied with sufficient material and pressure to ensure tight contact with, and complete coverage of the base coat and to the nominal thickness shown in Table 4 and ~~7.5.1.1~~ 7.3.1.1. ~~7.5~~

7.3 Plaster Application on Solid Plaster Bases: ~~7.5.1~~

7.3.1 High-suction bases shall be evenly dampened with clean water prior to the application of plaster. Do not dampen low-suction solid bases, such as dense concrete or smooth brick. ~~7.5.1.1~~

7.3.1.1 Where masonry or concrete surfaces vary in plane, plaster thickness required to produce level surfaces shall not be required to be uniform. ~~7.5.2~~

7.3.2 *Three-Coat Application on Solid Bases:* ~~7.5.2.1~~

7.3.2.1 The first (scratch) coat shall be applied with sufficient material and pressure to ensure tight contact and complete coverage of the solid base, to the nominal thickness shown in Table 4. As soon as the first (scratch) coat becomes firm, the entire surface shall be scored in one direction only. The vertical surfaces shall be scored horizontally. ~~7.5.2.2~~

7.3.2.2 The second (brown) coat shall be applied using the same procedures specified in ~~7.4.2~~ 7.2.2 and ~~7.4.2.1~~ 7.2.2.1, bringing the surface to a true, even plane with a rod or straightedge, filling any defects in plane with plaster and darbying. The surface shall be floated uniformly to provide a surface receptive to the application of the third (finish) coat. ~~7.5.2.3~~

7.3.2.3 The third (finish) coat shall be applied as specified in ~~7.4.3~~ 7.2.3. ~~7.5.3~~

7.3.3 *Two-Coat Application on Solid Plaster Bases:* ~~7.5.3.1~~

7.3.3.1 The first (scratch) coat shall be applied as specified in ~~7.5.2.1~~ 7.3.2.1. ~~7.5.3.2~~

7.3.3.2 The second (finish) coat shall be applied as specified in ~~7.4.3~~ 7.2.3. ~~7.6~~

7.4 Finish-Coat Application: ~~7.6.1~~

7.4.1 Job-mixed or factory-prepared finish coats shall be applied, by machine or by hand, as specified in 7.4.3 7.2.3. 7.6.2

7.4.2 The use of excessive water during the application and finishing of finish-coat plaster shall be avoided. 7.7

7.5 Fog-Coat Application—Job-mixed or factory-prepared fog coats shall be applied in accordance with the directions of the manufacturer. 7.8

8 CURING AND TIME BETWEEN COATS 7.8.1

8.1 Provide sufficient moisture in the plaster mix or by moist or fog curing to permit continuous hydration of the cementitious materials. The most effective procedure for curing and time between coats will depend on climatic and job conditions. (See X1.5.2.) 7.8.2

8.2 Sufficient time between coats shall be allowed to permit each coat to cure or develop enough rigidity to resist cracking or other physical damage when the next coat is applied. (See X1.5.2.) 7.9

9 PRODUCT MARKING

9.1 Packaged materials shall be clearly marked or labeled to indicate product, brand name, the manufacturer, and the weight of the material contained therein. Similar information shall be provided in the shipping advices accompanying the shipment of bulk materials.

10 DELIVERY OF MATERIALS

10.1 Packaged materials shall be delivered in factory-sealed, unopened, and unbroken packages, containers, or bundles.

10.2 Bulk materials shall be delivered in clean transport vessels, free of contaminates.

11 PROTECTION OF MATERIALS

11.1 Weather-sensitive materials shall be kept in a dry condition until ready for use. (See A2.4.)

11.2 Bulk materials shall be stored to prevent subsequent contamination and segregation.

12 ENVIRONMENTAL CONDITIONS: CONDITIONS 7.9.1

12.1 Portland cement-based plaster shall not be applied to frozen base or to a base containing frost. Plaster mixes shall not contain frozen ingredients. Plaster coats shall be protected from freezing for a period of not less than 24 h after set has occurred. 7.9.2

12.2 Portland cement plaster shall be protected from uneven and excessive evaporation during dry weather and from strong blasts of dry air. 7.9.3

12.3 Plaster Application—When artificial heat is required, heaters shall be located to prevent a concentration of heat on uncured plaster. Heaters shall be vented to the outside to prevent toxic fumes and other products of combustion from adhering to or penetrating plaster bases and plaster. Adequate ventilation shall be maintained in all areas, particularly in interior areas with little or no natural air movement. 7.9.3.1

12.3.1 Interior environment shall be maintained at a temperature above 40 °F not less than 48 h prior to and during application of portland cement-based plaster. Interior temperature shall be maintained above 40 °F until normal occupancy. 7.9.3.2

12.3.2 For exteriors, plaster shall be applied when the ambient temperature is higher than 40 °F (4.4 °C), unless the work area is enclosed and heat is provided as described in ~~7.9.3~~ 12.3. ~~8~~

13 KEYWORDS ~~8.1~~

13.1 bond; brown coat; cementitious; exterior plaster; fog coat; portland cement; scratch coat; stucco

ANNEXES

(Mandatory Information)

A1 GENERAL INFORMATION

A1.1 The work shall include all labor, materials, services, equipment, and scaffolding required to complete the plastering of the project in accordance with the drawings and specifications, except heat, electric power, and potable water.

A1.2 Where a specific degree of fire resistance is required for plastered assemblies and constructions, details of construction shall be in accordance with official reports of fire tests conducted by recognized testing laboratories, in accordance with Test Methods E119. ~~A1.2~~

A1.3 Where a specific degree of sound control is required for plastered assemblies and constructions, details of construction shall be in accordance with official reports of tests conducted by recognized testing laboratories, in accordance with applicable sound tests of Test Methods E90 or E492. ~~A1.3~~

A1.4 Scaffolding shall be constructed and maintained in strict conformity with applicable laws and ordinances. ~~A1.4~~

A1.5 Work schedules shall provide for completion of work affecting supports, framework or lath of a suspended ceiling (such as loading) before plastering work is accomplished. ~~A1.5~~

A1.6 Surfaces and ~~lathing~~ accessories to receive plaster shall be examined before plastering is applied thereto. The proper authorities shall be notified and unsatisfactory conditions shall be corrected prior to the application of plaster. The plastering contractor shall use this portion of the construction specifications for acceptance or rejection of such surfaces. ~~A1.5.1~~

A1.6.1 Metal plaster bases, backing, attachment, and ~~lathing~~ accessories to receive plaster shall be examined to determine if the applicable requirements of Specification C1063 have been met unless otherwise required by the contract specifications. ~~A1.5.2~~

A1.6.2 ~~Lathing~~ Accessories ~~accessories~~ shall be installed prior to the application of plaster; therefore, their type, ~~location;~~ depth, ~~ground dimension;~~ and ~~orientation~~ location shall be included in the project contract documents. ~~Where~~

A1.6.3 ~~masonry or concrete surfaces vary in plane, plaster thickness required to produce level surfaces shall not be required to be uniform. A1.5.3~~ The construction specifier shall describe, in the proper section of the contract specifications, the physical characteristics of solid surface bases to receive plaster, including measures to promote bond. The plane tolerance shall be not more than $^1/_4$ in. ~~(6 mm)~~ in 10 ft ~~(3~~ (3.1 ~~m).~~ mm/m). The mortar joints shall be flush and not struck. Dissimilar ferrous-containing materials such as ties, reinforcing steel, and so forth, shall be cut back a minimum $^1/_8$ in. (3 mm) below the surface and treated with a corrosion-resistant coating. Dissimilar non-ferrous protuberances shall be permitted to be trimmed back even with the surface of the solid base. Masonry shall be solid at corners and where masonry changes thickness in a continuous construction. Form release compounds shall be compatible with plaster or be completely removed from surfaces to receive plaster.

A2 DESIGN CONSIDERATIONS

A2.1 Exterior plaster (stucco) is applied to outside surfaces of all types of structures to provide a durable, fire-resistant covering. Interior plaster is applied to inside surfaces that will be subjected to various exposures, such as abrasion, vibration, or to continuous or frequent moisture and wetting, or to freezing or thawing.

A2.1.1 Sufficient slope on faces of plastered surfaces shall be provided to prevent water, snow, or ice from accumulating or standing. Air-entrained portland cement plaster provides improved resistance to freeze/thaw deterioration. Resistance to rain penetration is improved where plaster has been adequately densified during application and properly cured. Plaster shall not, however, be considered to be "waterproof."

A2.1.2 The construction specifier shall describe, in the appropriate section of the contract specifications, the requirements for furnishing and application of flashing. Flashing shall be specified at openings, perimeters, and terminations to prevent water from getting behind plaster. Flashing shall be corrosion-resistant material. Aluminum flashing shall not be used. Flashing supplemented with sealant shall be permitted.~~ provided the flashing and sealant are designed in a manner that does not inhibit drainage.~~

A2.1.3 Sealing or caulking of V-grooves, exposed ends, and edges of plaster panels or exterior work to prevent entry of water shall be provided.

A2.1.4 To reduce spalling where interior plaster abuts openings, such as wood or metal door or window frames, or fascia boards, the edge of three-coat plaster shall be tooled through the second and finish coats to produce a continuous small V-joint of uniform depth and width. On two-coat work, the V-joint shall be tooled through the finish coat only.

A2.1.5 Provide in the appropriate project specification section that solid bases to receive plaster shall not be treated with bond breakers, parting compounds, form oil, or other material that will prevent or inhibit the bond of the plaster to the base.

A2.1.6 Maximum allowable deflection for vertical or horizontal framing for plaster, not including cladding, shall be L/360.

A2.2 *Provisions for Drainage Behind Exterior Plaster:*

A2.2.1 At the bottom of exterior~~ drainage~~ walls where the~~ drainage~~ wall~~ plane~~ is~~ interrupted~~ supported by a~~ floor,~~ floor ~~supporting structure,~~ or foundation,~~ or~~ a~~ when~~ drip~~ drainage~~ screed~~ wall~~ and~~ assemblies~~ throughwall~~ are~~ flashing ~~constructed~~ or~~ above~~ weep~~ barrier~~ holes~~ wall assemblies, a designated drainage screed, flashing,~~ or other effective means to drain away any water that may get behind the plaster shall be provided.

A2.2.2 Where vertical and horizontal exterior plaster surfaces meet, both surfaces shall be terminated with casing beads with the vertical surface extending at least $^1/_4$ in. (6 mm) below the intersecting horizontal plastered surface, thus providing a drip edge. The casing bead for the horizontal surface shall be terminated not less than $^1/_4$ in.~~ (6 mm)~~ from the back of the vertical surface to provide drainage.

A2.3 *Relief from Stresses:*

A2.3.1 For information on the requirements for control joints and perimeter relief, where a metal plaster base is installed; see the Installation Section of~~ Specifications~~ Specification C1063~~ or~~.~~ C1787 as applicable.~~ Solid plaster bases are exempt from these criteria, except as stated in Specification C1063, subsection 7.11.4.3.

A2.3.1.1~~ Clean~~ Control~~ cement~~ joints~~ plaster~~ shall~~ residue~~ be~~ from~~ cleaned~~ the~~ and~~ movement~~ clear~~ gaps~~ of~~ expansion~~ plaster~~ joints~~ within~~ and from~~ the~~ flexible~~ control~~ pleats~~ area~~ of~~ after~~ control~~ plaster~~ joints~~ application and before ~~cement~~ final plaster~~ hardens.~~ set.

A2.3.1.2 Prefabricated control joints and expansion joint members shall be installed prior to the application of plaster. Their type, location,~~ ground~~ depth,~~ dimension, orientation,~~ and method of installation shall be determined by the characteristics of the substrate and included in the project contract documents.

A2.3.1.3 A groove or cut in plaster only shall not be considered a control or expansion joint.

A2.3.2 Where plaster and metal plaster base continues across the face of a concrete column, or other structural member, a water-resistive barrier building paper or felt shall be placed between the metal plaster base and the structural member (paper or plastic-backed metal plaster base shall be permitted). Where the width of the structural member exceeds the approved span capability of the metal plaster base, self-furring metal plaster base shall be used and sparingly scatter nailed to bring the paper plaster and metal base to general plane.

A2.3.3 Where dissimilar base materials abut and are to receive a continuous coat of plaster: (*1*) a two-piece expansion joint, casing beads back-to-back, or premanufactured control-expansion joint member shall be installed; or (*2*) the juncture shall be covered with a 6-in. (152 mm) wide strip of galvanized, self-furring metal plaster base extending 3 in. (76 mm) on either side of the juncture; or (*3*) where one of the bases is metal plaster base, self-furring metal plaster base shall be extended 4 in. (102 mm) onto the abutting base.

A2.4 *Weather-Sensitive Materials*—Water-sensitive materials shall be stored off the ground or floor and under cover, avoiding contact with damp floor or wall surfaces. Temperature-sensitive materials shall be protected from freezing. Bulk materials shall be stored in the area of intended use and caution shall be exercised to prevent contamination and segregation of bulk materials prior to use.

A2.5 *Admixtures*—Admixtures shall be proportioned and mixed in accordance with the published directions of the admixture manufacturer.

A2.5.1 The quantity of admixtures required to impart the desired performance is generally very small in relation to the quantities of the other mix ingredients. Batch-to-batch quantities shall be measured accurately.

A2.5.2 Air-entraining agents cause air to be incorporated in the plaster in the form of minute bubbles, usually to improve frost or freeze-thaw resistance, or workability of the plaster during application. Air-entraining agents for portland cement-based plaster shall meet the requirements of Specification C260.

A2.6 *Design and Application of Ornamental Features*:

A2.6.1 The design and construction requirements of ornamental features that project beyond the surface of the cement plaster scratch and brown coat assembly (including quoins, bands, or other similar ornamentation) are to be described in the contract Contract documents. Documents. The contract Contract documents Documents shall provide details to indicate the location, nature, and extent of the ornamental feature. The design Design authority Authority shall be responsible for compliance with applicable building code(s) and prescribed design loads. The design Design authority Authority shall also consider fire ratings and combustibility requirements in the design and selection of the ornamental feature.

A2.6.2 Ornamental features with sky-facing top surfaces that are exposed to the elements shall include sufficient slope for drainage as required by A2.1.1 or as minimally acceptable to the finish coat manufacturer, whichever is more restrictive.

A2.6.3 Ornamental features shall be isolated from load-bearing members, penetrating elements, and wall openings (such as fenestrations) as required by Specification C1063 to avoid the transfer of structural loads and to provide separation from dissimilar materials.

A2.6.4 Ornamental features shall not obstruct the function of control joints or expansion joints. The design Design authority Authority shall provide details as to how to the ornamental feature shall interact with applicable joints.

A2.6.5 Application of Field-Coated Foam Core Ornamental Features—Field-finished ornamental features consist of foam plastic cores encapsulated with a polymer-modified cementitious base coat with an acrylic finish coat or other approved manufactured finish. The foam plastic cores are adhesively attached to the brown coat either before or after encapsulation in the field.

A2.6.5.1 Ornamental features shall be adhered to the plaster brown coat with an adhesive compatible with portland cement plaster and the ornamental core manufacturer. The ornamental feature shall be integrated with the plaster brown coat with consideration provided to crack control and moisture infiltration. The base coat of the material that encapsulates the core of the ornamental feature shall continue onto the surface of the plaster brown coat without interruption. Crack control and moisture penetration resistance of the ornamental feature shall be addressed in the ~~contract~~ Contract ~~documents~~ Documents for plaster thickness that is less than those values provided in Table 4.

A2.6.5.2 Cores of ornamental features shall be permitted to be fabricated of expanded polystyrene (EPS) conforming to Specification C578 Type I or II having a minimum density of 0.9 lb/ft^3 (14.4 kg/m^3). The thickness of the core shall be no less than ¾ in. (19 mm).

A2.6.5.3 Foam core ornamental features shall be permitted to be covered with a variety of materials. A polymer-modified, fabric reinforced cementitious base coat and an acrylic finish coat shall be an acceptable finish over the ornamental feature. The design authority shall give consideration to profile differences in the finish coat (such as variation in shade, color, and sheen) that may result at the transition of the polymer-modified and portland cement base coat materials.

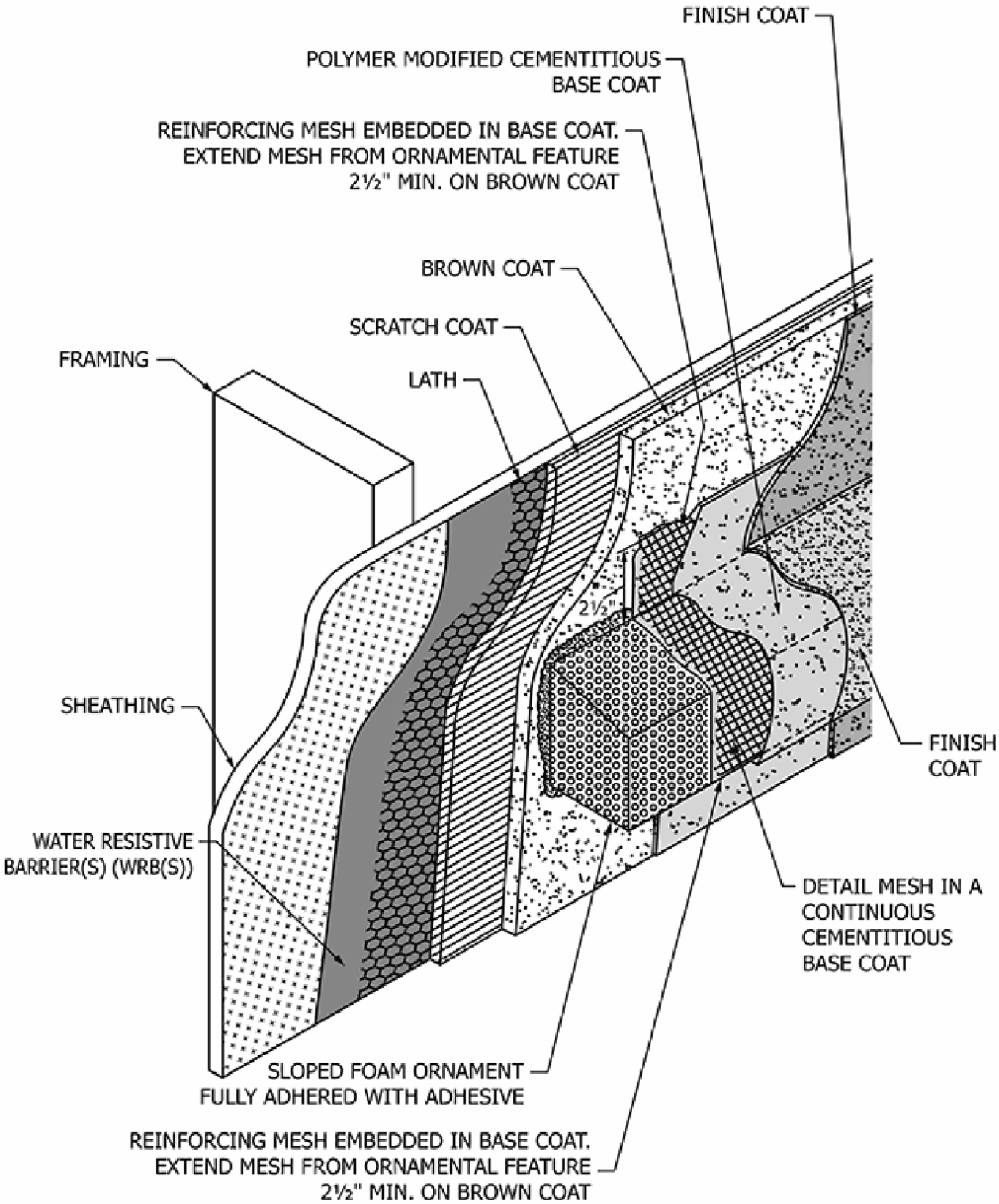
Nominal thickness for standard impact resistant base coats shall range from ~~1~~ 1/16~~/16~~ to ~~3~~ 3/32~~/32~~ in. ~~(2~~ (1.58 to ~~3~~ 2.38 mm) and be applied over nominal 4 oz/yd^2 (135.6 g/m^2) standard impact mesh. Thickness of impact-resistant base coats and nominal weight of impact-resistant mesh shall follow the manufacturer's installation instructions. The design authority shall give consideration to prevent impact damage to ornamental features.

Mesh shall be embedded in the base coat and extend a minimum of 2.5 in. ~~(64~~ (63.5 mm) beyond the ornamental feature. Where extension beyond the ornamental feature is not possible, backwrapping shall be provided.

A2.6.5.4 Application of the finish coat shall follow the manufacturer's installation instructions for the specific finish type. When cement-based finishes are applied, a bonding agent or admixture shall be used to insure proper adhesion to the polymer-modified base coat.

A2.6.5.5 A sample detail of an ornamental feature encapsulated with an exterior polymermodified cementitious base coat and detailing mesh is provided in Fig. A2.1. As depicted in the sample detail, the encapsulating material is continuous onto the surface of the plaster brown coat without interruption, providing a seamless transition between the ornamental feature and wall surface.

FIG. A2.1 Sample Detail of Ornamental Feature Consisting of Foam Plastic Core Encapsulated with Polymer Modified Cementitious Base Coat and Finish Coat



APPENDIX

(Nonmandatory Information)

X1 GENERAL INFORMATION

X1.1 *Additions*—Bonding compounds or agents may be pre-applied to a surface to receive plaster. In this usage it is not considered an admixture. Bonding compounds that are integrally mixed with plaster prior to its application are considered admixtures. Where exterior exposure and cyclic wetting are anticipated, the re-emulsification capability of the bonding material must be considered. Bonding agents are only as good as the material surface to which they are applied; therefore, form release materials must be removed from concrete or be compatible with the bonding material used. Bonding ~~agents,~~ agents in plaster mixes may increase the cohesive properties of the plaster. Bonding ~~agents,~~ agents ~~where used,~~ should meet the requirements of Specifications C631 ~~for interior plastering~~ or C932 ~~for~~. ~~exterior plastering.~~

X1.1.1 By the use of a suitable admixture or additive, it is possible to improve plaster's resistance to moisture movement. However, the use of the terms dampproofing or water proofing is misleading, and their use shall be discouraged.

X1.1.2 Natural or synthetic ~~fibers~~ fibers, $^{1}/_{2}$ to 2 in. (13 to 51 mm) in length and free of contaminates may be specified to ~~mitigate~~ improve resistance to cracking or to impart improved pumpability characteristics. The quantities per batch shall be in accordance with the ~~formation~~ published directions of ~~visible~~ the ~~cracking~~ fiber ~~during~~ manufacturer. ~~hydration.~~ No more than 2 lb (0.90 kg) of fiber should be used per cubic foot of cementitious material. Asbestos fibers should not be used. Alkaline-resistant glass fibers are recommended where glass fiber is used.

X1.1.3 Plasticizers containing hydrated lime putty, air-entraining agents, or approved fatteners to increase the workability of a portland cement plaster may be used. Plaster consistency and workability are affected by plasticizers that are beneficial in proper quantities from an economic standpoint, but in excess can be detrimental to the long-term performance of the plaster in place.

X1.1.4 Color material for integral mixing with plaster should not significantly alter the setting, strength development, or durability characteristics of the plaster. Natural or mineral pigments that are produced by physical processing of materials mined directly from the earth appear to offer the best long-term performance with respect to resistance to fading. Plaster color is determined by the natural color of the cementitious materials, aggregate, and any color pigment, and their proportions to each other. The use of white cement with the desired mineral oxide pigment color material may result in truer color.

X1.1.4.1 The uniformity of color cannot be guaranteed by the materials manufacturer of the component materials or by the applicating contractor. Color uniformity is affected by the uniformity of proportioning, thoroughness of mixing, cleanliness of equipment, application technique, and curing conditions and procedure, which are generally under the control of the applicator. Color uniformity is affected to an even greater degree by variations in thickness and differences in the suction of the base coat from one area or location to another, the type of finish selected, the migration of color pigments with moisture, and with job site climatic and environmental conditions. These factors are rarely under the control of the applicator.

X1.1.5 Corrective measures for conditions cited in ~~6.2~~ 5.2 include ~~sandblasting,~~ the ~~chipping,~~ installation ~~or~~ of ~~grinding~~ a ~~of~~ furred ~~the~~ or ~~solid~~ self-furring metal plaster ~~base,~~ base; application of a repair/build-out ~~mortar,~~ mortar; ~~installation~~ grinding/chipping of ~~a~~ the ~~self-furring~~ concrete ~~plaster~~ base; ~~base,~~ or combinations thereof. Because these measures may have structural or integrity consequences, they should be considered by all concerned parties with the ultimate selection left to the discretion of the design authority as defined by the Owner-Contractor Agreement.

X1.1.6 The ~~contract~~ "Project ~~documents~~ Documents" consist of many individual items but includes both the ~~specifications~~ Project Specifications and the ~~contract~~ Contract ~~drawings.~~ Drawings. It is the intent of this standard to have the type, location, depth, and orientation of control and expansion joints both stated in the ~~specifications~~ Project Specifications as well as shown and detailed on the ~~contract~~ Contract ~~drawings~~ Drawings where either or both of these documents exist for any particular project.

X1.2 *Finish Coat Categories* (applicable to both natural and colored finishes):

X1.2.1 Texture, as a description of surface appearance, is identified generally with the method and tools used to achieve the finish. Texture can be varied by the size and shape of the aggregate used, the equipment or tools employed, the consistency of the finish coat mix, the condition of the base to which it is applied, and by subsequent decorative or protective treatment.

X1.2.2 There are many factors that affect the ultimate appearance of textured and integrally colored plaster. A suitably sized sample panel should be submitted for approval by the architect and the owner. Once approved, the sample should be maintained on site for reference and comparison.

X1.2.3 With the almost limitless variations possible for finish appearance or texture, the same term may not have the same meaning to the specifier, the contractor, and the actual applicator. The specifier is cautioned to use an approved range of sample panels. To provide some guidance, the following categories are generally understood and recognized to imply a particular method of application technique or resulting finished appearance:

X1.2.4 Smooth Trowel—Hand- or machine-applied plaster floated as smooth as possible and then steel-troweled. Steel troweling should be delayed as long as possible and used only to eliminate uneven points and to force aggregate particles into the plaster surface. Excessive troweling should be avoided.

X1.2.5 Float—A plaster devoid of coarse aggregate applied in a thin coat completely covering the base coat, followed by a second coat that is floated to a true plane surface yielding a relatively smooth to fine-textured finish, depending on the size of aggregate and technique used. It is also known as sand finish.

X1.2.6 Trowel-Textured (such as Spanish Fan, Trowel Sweep, English Cottage)—A freshly applied plaster coat is given various textures, designs, or stippled effects by hand troweling. The effects achieved may be individualized and may be difficult to duplicate by different applicators.

X1.2.7 Rough-Textured (such as Rough Cast, Wet Dash, Scottish Harl)—Coarse aggregate is mixed intimately with the plaster and is then propelled against the base coat by trowel or by hand tool. The aggregate is largely unexposed and deep textured.

X1.2.8 Exposed Aggregate (also known at Marblecrete)—Varying sizes of natural or manufactured stone, gravel, shell, or ceramic aggregates are embedded by hand or machine propulsion into a freshly applied finish "bedding" coat. The size of the aggregate determines the thickness of the "bedding" coat. It is generally thicker than a conventional finish coat.

X1.2.9 Spray-Textured—A machine-applied plaster coat directed over a previously applied thin smooth coat of the same mix. The texture achieved depends on the consistency of the sprayed mixture, moisture content of the base to which it is applied, the angle and distance of the nozzle to the surface, and the pressure of the machine.

X1.2.10 Brush-Finish—A method of surfacing or resurfacing new or existing plaster. The plaster is applied with a brush to a thickness of not less than $^1/_{16}$ in. ~~(2~~ (1.6 mm). For an existing plaster surface the bond capability must be determined by test application or a bonding compound must be applied prior to the brush application.

X1.2.11 Miscellaneous Types—This finish coat category is somewhat similar to trowel-textured finishes, except that the freshly applied plaster is textured with a variety of instruments other than the trowel, such as swept with a broom or brush, corrugated by raking or combing, punched with pointed or blunt instrument, scored by aid of a straightedge into designs of simulated brick, block, stone, and so forth. A variation of texturing a finish coat involves waiting until it has partially set and then flattening by light troweling of the unevenly applied plaster or by simulating architectural terracotta.

X1.2.12 Scraffitto—A method of applying two or more successive coats of different colored plaster and then removing parts of the overlaid coats to reveal the underlaying coats, usually following a design or pattern. This is not generally considered a finish coat operation because of the number of thickness of coats.

X1.3 When specified as alternate for final coat, trowel- or plaster machine-applied textured acrylic finishes containing aggregate may be substituted for portland cement finish coats, provided brown coat is properly prepared and finish is applied according to the manufacturer's directions.

X1.4 *Staining of Plaster*—Staining and discoloration of plaster, caused by free water draining from one plane of plaster to another or from a dissimilar material onto a plaster surface, can be minimized by providing sufficient depth and angle for drip caps and the use of water-resistive surface coatings.

X1.4.1 Staining of plaster due to entrapment of moisture behind the plaster, can be avoided or minimized by providing an air space for ventilation between the back of the plaster and adjacent material. This type of staining may occur where insulation with or without vapor barrier, or other material containing asphaltic or coal tar derivatives, fireproofing salts, and so forth, can migrate with moisture movement to the finished plaster surface.

X1.4.2 Integrally colored plaster can be discolored or altered in shade if subjected to moisture, either from uncured base coats or external sources, such as rain, too soon after applications.

X1.5 *Installation Instructions:*

X1.5.1 Hand mixing should not be permitted, except as approved by the contract specifier.

X1.5.1.1 After all ingredients are in the mixer, mix the plaster for 3 to 5 min.

X1.5.1.2 The amount of water used in the plaster mix should be determined by the plasterer. Factors such as the suction of the base, or of the previous coat, water content of the aggregate, drying conditions, and finishing operations should be considered in determining water usage. Use of excessive water may result in dropouts, fall or slide off, excessive shrinkage, high porosity, and lower strength.

X1.5.2 Time Between Coats and Curing for Portland Cement-Based Plaster:

X1.5.2.1 The timing between coats will vary with climatic conditions and types of plaster base. Temperature and relative humidity extend or reduce the time between consecutive operations. Cold or wet weather lengthens and hot or dry weather shortens the time period. Moderate changes in temperature and relative humidity can be overcome by providing additional heating materials during cold weather and by reducing the absorption of the base by pre-wetting during hot or dry weather.

X1.5.2.2 In order to provide more intimate contact and bond between coats and to reduce rapid water loss, the second coat should be applied as soon as the first coat is sufficiently rigid to resist cracking, the pressures of the second coat application, and the leveling process.

X1.5.2.3 The amount of water and the timing for curing portland cement plaster will vary with the climatic conditions, the type of base, and use or nonuse of water-retentive admixtures.

X1.5.2.4 Some moisture must be retained in or added back to freshly applied portland cement-based plaster. If the relative humidity is relatively high (above 75 %), the frequency for rewetting a surface may be reduced. If it is hot, dry, and windy, the frequency of rewetting must be increased.

X1.5.2.5 Consider the physical characteristics of the structure as well as the previously mentioned conditions when selecting the method of curing. The method can be one or a combination of the following:

(1) Moist curing is accomplished by applying a fine fog spray of water as frequently as required, generally twice daily in the morning and evening. Care must be exercised to avoid erosion damage to portland cement-based plaster surfaces. Except for severe drying conditions, the wetting of finish coat should be avoided, that is, wet the base coat prior to application of the finish coat.

(2) Plastic film, when taped or weighted down around the perimeter of the plastered area, can provide a vapor barrier to retain the moisture between the membrane and plaster. Care must be exercised in placing the film: if too soon, the film may damage surface texture; if too late, the moisture may have already escaped.

(3) Canvas, cloth, or sheet material barriers can be erected to deflect sunlight and wind, both of which will reduce the rate of evaporation. If the humidity is very low, this option alone may not provide adequate protection.

X1.5.2.6 Application of Plaster Basecoats:

(1) Conventional, three-coat plaster is applied over a metal plaster base in two, nominal $^3/_8$ in. ~~(10 mm)~~ coats. The traditional application brings the plaster brown coat out to the lathing ~~accessory~~ accessories ~~grounds~~ which are ~~installed~~ set to approximately $^3/_4$ in. ~~(19~~ of ~~mm) from~~ the substrate. ~~Lathing~~ The lathing accessories that traditionally provide ~~cement~~ the plaster thickness ~~grounds~~ screed point include ~~weep screeds at~~ the ~~base of drainage wall assemblies,~~ casing ~~beads~~ beads, used to terminate the plaster into a dissimilar ~~materials,~~ material, control ~~joints~~ and expansion ~~joints,~~ joints ~~designated~~ installed ~~drainage~~ in ~~screeds~~ accordance with Specification C1063, corner transition trims, typically used at a vertical to horizontal ~~transitions,~~ transition, and ~~external~~ outside corner reinforcement (corner aids and corner beads).

(2) The interface of other exterior wall envelope systems, such as door and window frames, metal flashings and surrounds, drift joint framing, and other components often create build up that the lathing and plastering must cover. Further impacting this build-up are self-adhering flashing and multiple layers of water-resistive barriers used to enhance the ability of the exterior wall to provide a weather-resistive exterior wall envelope.

(3) In load-bearing wood framed and wood sheathed walls, build-up can occur from the wood and sheathing and any structural connection plates and bolts required to complete the structure.

(4) As a result of these factors that can impact the thickness of the plaster and are usually out of the control of the plastering contractor, references to plaster thickness use the term nominal to qualify the required thickness. The term nominal is intentionally ambiguous so as not to unnecessarily burden the plastering contractor with an expectation to provide a thickness of plaster that cannot reliably be achieved. Nominal is a term commonly associated with lumber that was many years ago actually a dimensional reference, but due to changes in the manufacturing of studs and timber, has become simply a name, and not an exact dimension.

X1.6 Design Considerations

X1.6.1 Provisions for Drainage Behind Exterior Plaster Base Systems:

X1.6.1.1 A barrier wall system where the plaster is applied directly to a solid substrate will not require any provisions for drainage to the exterior of the wall assembly.

X1.6.1.2 A drainage wall system where plaster is applied to a metal ~~or non metallic plaster~~ base shall include a water resistive barrier and a defined drainage plane, including provisions for moisture to escape to the exterior of the wall.

SUMMARY OF CHANGES

Committee C11 has identified the location of selected changes to this standard since the last issue (C926 – ~~18a)~~ 15) that may impact the use of this standard. (Approved ~~Aug.~~ July ~~1,~~ 15, ~~2018.)~~ 2015.)

(1) Revised ~~6.1,~~ subsections ~~7.3.4,~~ 5.2 ~~A1.5 A1.5.2, A2.2.1, A2.3.1.1, A2.3.1.2,~~ and ~~X1.5.2.6(1).~~ A1.6.3 ~~(2).~~ ~~Revised Notes 3 and 5.~~

Committee C11 has identified the location of selected changes to this standard since the last issue (C926 – ~~18)~~ 15) that may impact the use of this standard. (Approved ~~March~~ June 1, ~~2018.)~~ 2015.)

(1) ~~*Revised*~~ Added ~~A2.1.2.~~ Specification ~~Committee~~ C578 ~~C11 has identified the location of selected changes~~ to ~~this~~ Referenced ~~standard~~ Documents ~~since~~ subsection ~~the~~ 2.1 ~~last issue (C926 17) that may impact the use of this standard. (Approved Jan. 1, 2018.) (1) Revised X1.5.2.6. Committee C11 has identified the location of selected changes to this standard since the last issue (C926 16c) that may impact the use of this standard. (Approved Jan. 1, 2017.) (1) Revised X1.1 and X1.1.1~~.

(2) Added ~~X1.1.2~~ "back~~.~~ wrap" ~~Committee~~ (~~C11~~3.2.5 ~~has~~) ~~identified~~ and ~~the~~ "polymer ~~location~~ modified ~~of~~ cementitious ~~selected~~ base ~~changes~~ coat" ~~to this standard since the last issue~~ (~~C926~~3.2.22) ~~16b) that may impact the use of this standard. (Approved Dec. 1, 2016.) (1) Removed previous Subsection A1.1. (2) Added "contract~~

documents" to Terminology (Subsection Section. 3.3).

(3) *Revised* Added 1.1 subsections, A2.6 A1.5.2 , A2.6.5.5 A2.3.1.2, and X1.1.6 Fig. A2.1 Committee C11 has identified the location of selected changes to this standard since the last issue (C926-16a) that may impact the use of this standard. (Approved Sept. 1, 2016.) (1) Revised Subsection 7.3.1.

Committee C11 has identified the location of selected changes to this standard since the last issue (C926 – 16) 14a) that may impact the use of this standard. (Approved March Feb. 1, 2016.) 2015.)

(1) *Added Specification C1787 to 2.1.* *(2)* Revised 6.1 4.2.4, 6.2.3 4.2.5, 7.4, A2.3.1, A2.3.2, and X1.6.1.2 6.1.5. (3)

(2) *Revised* Renumbered Note X1.4 3 . X1.4.2 (4) (formerly Revised X1.3.1 A2.3.2 through: X1.3.3).

Committee C11 has identified the location of selected changes to this standard since the last issue (C926 – 15b 14)e1) that may impact the use of this standard. (Approved Jan. April 1, 15, 2016.) 2014.)

(1) Revised A1.5.2 5.2.3, A2.2.1, and X1.1.5.

FOOTNOTES

(1) This specification is under the jurisdiction of ASTM Committee C11 on Gypsum and Related Building Materials and Systems and is the direct responsibility of Subcommittee C11.03 on Specifications for the Application of Gypsum and Other Products in Assemblies.

Current edition approved Aug. July 1, 15, 2018. 2015. Published August July 2018. 2015. Originally approved in 1981. Last previous edition approved in 2018 2015 as **C926** – 18a. 15a. DOI: 10.1520/C0926-18B. 10.1520/C0926-15b.

(2) For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

(3) Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

Designation: C1063 – ~~18b~~15a

Disclaimer: This document is not an ASTM standard and is intended only to provide the user of an ASTM standard an indication of what changes have been made to the previous version. Because it may not be technically possible to adequately depict all changes accurately, ASTM recommends that users consult prior editions as appropriate. In all cases, only the current version of the standard as published by ASTM is to be considered the official document.

Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster [1]

This standard is issued under the fixed designation C1063; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

IN THIS STANDARD:

SUMMARY OF CHANGES

Footnotes

1 SCOPE *A Summary of Changes section appears at the end of this standard.

1.1 This specification covers the minimum technical requirements for lathing and furring for the application of exterior and interior portland cement cement-based a hydraulic cement produced by pulverizing clinker consisting essentially of hydraulic calcium silicates, and usually containing one or more forms of calcium sulfate as an interground addition.Subcommittee: C11.91 Standard: C11-based plaster, as in Specifications C841 or C926. These requirements do not by default define a unit of work or assign responsibility for contractual purposes, which is the purview of a contract or contracts made between contracting entities.

1.2 Where a fire resistance rating is required pertaining to a mandatory obligation imposed by a force outside this standard, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C840pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C926 for plastered assemblies and constructions, details of construction shall be in accordance with reports of fire tests of assemblies that have met the requirements of the fire rating imposed.

1.3 Where a specific degree of sound control is required pertaining to a mandatory obligation imposed by a force outside this standard, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C840pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C926 for plastered assemblies and constructions, details of construction shall be in accordance with official reports of tests conducted in recognized testing laboratories in accordance with the applicable requirements of Test Method E90.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard. 1.5

2 THIS REFERENCED INTERNATIONAL DOCUMENTS STANDARD

2.1 was ASTM developed Standards: in [2] accordance

A641/A641M with Specification internationally for recognized Zinc-Coated principles (Galvanized) on Carbon standardization Steel established Wire in

A653/A653M the Specification Decision on Principles for the Steel Development Sheet, of Zinc-Coated International (Galvanized) Standards, or Guides Zinc-Iron and Alloy-Coated Recommendations (Galvannealed) issued by the World Hot-Dip Trade Process Organization

B69 Technical Specification Barriers for to Rolled Trade Zinc (TBT)

B221 Committee. 2 Referenced Documents 2.1 ASTM Standards:2 A653/A653M Specification for Steel Aluminum Sheet, and Zinc-Coated Aluminum-Alloy (Galvanized) Extruded or Bars, Zinc-Iron Rods, Alloy-Coated Wire, (Galvannealed) Profiles, by and the Tubes Hot-Dip Process

C11 Terminology Relating to Gypsum and Related Building Materials and Systems

C841 Specification for Installation of Interior Lathing and Furring

C847 Specification for Metal Lath

C926 Specification for Application of Portland Cement-Based Plaster

C933 Specification for Welded Wire Lath C1032

C954 Specification for Woven Steel Wire Drill Plaster Screws Base C1280 Specification for the Application of Exterior Gypsum Panel Products for or Use Metal as Plaster Sheathing Bases C1861 to Specification Steel for Studs Lathing from and 0.033 Furring in. Accessories, (0.84 and mm) Fasteners, to for 0.112 Interior in. and (2.84 Exterior mm) Portland in Cement-Based Thickness Plaster

C1002 E90 Specification Test Method for Laboratory Steel Measurement Self-Piercing of Tapping Airborne Screws Sound for Transmission Application Loss of Building Gypsum Partitions Panel and Products Elements or 2.2 Metal US Plaster Department Bases of to Commerce Wood (DOC) Studs Standards or PS Steel 1 Studs Voluntary

C1032 Product Specification Standard for PS Woven 1, Wire Structural Plaster Plywood Base PS

D1784 2 Specification Voluntary for Product Rigid Standard Poly(Vinyl PS Chloride) 2, (PVC) Performance Compounds Standard and for Chlorinated Wood-Based Poly(Vinyl Structural Chloride) Use (CPVC) Panels Compounds 3

D4216 Terminology Specification 3.1 for Definitions: Rigid 3.1.1 Poly(Vinyl For Chloride) definitions (PVC) relating and to Related ceilings PVC and walls, Chlorinated see Poly(Vinyl Terminology Chloride) C11 (CPVC). Building 3.1.2 Products For Compounds definitions

E90 relating Test to Method lathing accessories products fabricated for the Laboratory purpose Measurement of forming Airborne corners, Sound edges, Transmission control Loss joints, of or Building decorative Partitions effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control Elements joints,

3 SUCH TERMINOLOGY AS

3.1 casing *Definitions*—For beads, definitions bull relating noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form ceilings corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516. furring accessories and fasteners, walls, see Specification Terminology C1861 C11.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 building *barrier enclosure wall, system n*—type of building wall assemblies system and that materials is designed intended and to installed block in or such interrupt a the manner movement as of water to provide the a interior. barrier

3.2.2 between *building different enclosure, environments.Subcommittee: C11.03 Standard: C1063, n—system*—system of building assemblies and materials designed and installed in such a manner as to provide a barrier between different environments. 3.2.2

3.2.3 control joint joint, n—a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee:

3.2.4 C11.03 *drainage Standard: plane, C1063 n a*—surface formed product used for designed or required separations between adjacent the surfaces back of gypsum the boards cladding or and gypsum the veneer front base. ofSubcommittee: the C11.02 water Standard: resistive C1047 barrier, which n resists—a liquid joint moisture that infiltration accommodates and movement provides of for plaster gravitational shrinkage flow and to curing a the collection act or processes exhaust of location. producing

3.2.5 a *drainage moisture space, environment n favorable*—volumetric to area cement that hydration, allows resulting in the setting gravitational or flow hardening of the liquid plaster. moistureSubcommittee: to C11.03 a Standard: collection C926 or along exhaust predetermined, location. usually

3.2.6 straight, *drainage lines. wall, 3.2.3 n expansion joint*—a joint wall that system accommodates in movement which beyond the plaster cladding shrinkage provides and a curing. substantialNote barrier 1—For to design water consideration intrusion, of control and expansion which joints, also see incorporates Annex A2.3.1.2 of Specification C926.Subcommittee: C11.03 Standard: C1063see control (expansion-contraction) joint.Subcommittee: C11.91 Standard: C11 a structural concealed separation water between resistive building barrier elements over that which allows drainage independent will movement occur. without

3.2.7 damage *expansion to joint, the assembly.Subcommittee: C11.05 Standard: C1516, n—a*—a joint that accommodates movement beyond plaster shrinkage and curing. the act or processes of producing a moisture environment favorable to cement hydration, resulting in the setting or hardening of the plaster.Subcommittee: C11.03 Standard: C926.

NOTE 1: For design consideration of control and expansion joints, see Annex A2.3.1.2 of Specification C926. 3.2.4

3.2.8 framing member member, n—studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee:

3.2.9 C11.03 *hangers*, *Standard: n C1063*—wiresstud, or plate, steel track, rods joist, or furring, straps and used other to support to main which runners a for gypsum suspended panel ceilings product, beneath floor or metal roof plaster constructions. base

3.2.10 is *inserts*, *attached. n Subcommittee:*—devices C11.91 embedded Standard: in C11 concretemetal structural studs, members runners (track), and rigid furring channels designed to receive provide screw-attached a gypsum loop panel or products. openingSubcommittee: for C11.03 attachment Standard: of C754 hangers.that

3.2.11 portion *saddle of tie, the n framing*, —see furring, Figs. blocking, 1 and so 2 forth., to

FIG. which 1 the Saddle gypsum Tie base

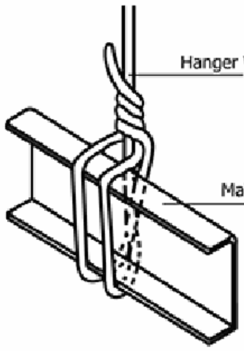
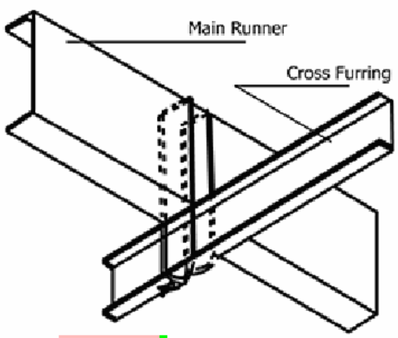


FIG. is 2 attached. Saddle Unless Tie otherwise



3.2.12 specified, *self-furring, the adj surface*—a to metal which plaster abutting base edges manufactured or with ends evenly-spaced are indentations attached that shall hold be the not body less of than the 1 lath1 approximately2 in. (38 mm) wide for wood members, not less than $^{11}/_4$ in. (32 (6.4 mm) wide away for from steel solid members, surfaces and to not which less it than is 6 applied. in.

3.2.13 (152 *water mm) resistive wide barrier, for n gypsum*—a studs. material For that internal resists corners or angles, the bearing infiltration surface of shall liquid be moisture not through less the than building 3 enclosure system.4

3.2.14 in. *water (19 resistive mm). barrierSubcommittee: system, C11.03 n Standard:*—a C844 combinationstuds, of headers, water bracing, resistive and barrier blocking assemblies that serve resist to receive the gypsum infiltration panel of product. liquidSubcommittee: moisture C11.03 through Standard: the C1280 buildingstuds, enclosure joist, system, runners (tracks), bridging, bracing, and related facilitates accessories its manufactured gravitational or flow supplied to in a wood collection or hot drainage or location. cold

4 FORMED DELIVERY STEEL. OFSUBCOMMITTEE: MATERIALS C11.05

4.1 Standard: All C1516 materialssee shall Specification be C1063. deliveredSubcommittee: in C11.03 the Standard: original C1787 packages,, containers, n or—studs, bundles joist, bearing runners the (track), brand-name bridging, bracing, and related manufacturer's accessories (or products supplier's) fabricated identification. for

5 THE STORAGE PURPOSE OF FORMING MATERIALS CORNERS,

5.1 edges, All control materials joints, shall or be decorative kept effects. dry.Subcommittee: Materials C11.91 shall Standard: be C11 stackedcornerbeads, off edge the trims, ground, and supported control on joints, a such level as platform, casing and beads, protected bull from noses, the weather and stops. surfaceSubcommittee: contamination. C11.02

5.2 Standard: Materials C1047 shallpreformed be metal, neatly fiberglass stacked or with plastic care members taken used to form avoid corners, damage to edges, control ends, joints, or decorative surfaces. effects.

5.3Subcommittee: Paper C11.05 backed Standard: metal C1516 plaster manufactured bases or shall supplied be in handled wood carefully or in light delivery, gauge storage, steel: and 3.2.5 erection hangers to wires prevent or puncturing steel rods or straps removal used of to paper. support

6 MAIN MATERIALS RUNNERS

6.1 for Metal suspended Plaster ceilings Bases: beneath

6.1.1 floor *Expanded or Metal roof Lath*—Specification constructions. C847Subcommittee: C11.03 Standard: C1063, n galvanized. —wires

6.1.2 or Wire steel Laths: rods

6.1.2.1 or *Welded straps Wire used Lath*—Specification to C933 support. main

6.1.2.2 runners *Woven the Wire members Lath*—Specification that C1032 are, attached

6.1.2.3 to *Paper or Backed suspended Plaster from Bases*—Specification the C847 construction. above

6.2 for Accessories: the

6.2.1 support *General*—All of accessories cross shall furring. haveSubcommittee: perforated C11.03 or Standard: expanded C841 flanges for suspended ceilings beneath floor or roof clips constructions. shaped 3.2.6 to inserts, permit n complete—devices embedment embedded in concrete the framing plaster, members to provide a means loop for or accurate opening alignment, for and to secure attachment of hangers the wires accessory or to steel the rods underlying or surface. straps Accessories used shall be designed to support receive main application runners of for the suspended specified ceilings plaster beneath thickness. floor

6.2.2 or Accessories roof shall constructions. beSubcommittee: fabricated C11.03 from Standard: Zinc C1063 Alloy: (99 3.2.7 % saddle pure tie zinc), see galvanized Figs. (zinc-coated) 1 steel, and rigid 2. PVCSubcommittee: or C11.03 CPVC Standard: plastic, C1063 or; anodized n aluminum—see alloy Figs. (see 1 Specification and B221 2).; (See FIG. Table 1 Saddle for Tie minimum FIG. allowable 2 thicknesses.) Saddle

TABLE Tie 1 3.2.8 Minimum self-furring Thickness a of metal Accessories plaster

Accessory base	Base manufactured Material, with in. evenly spaced (mm) indentations		
	Steel that	Zinc hold Alloy the	P.V.C. body
Corner of Beads the	0.0172 lath (0.44) approximately	0.0207 1 (0.53)	0.0354 (0.89) in.
Casing (6 Beads mm)	0.0172 away (0.44) from	0.0207 solid (0.53) surfaces	0.035 to (0.89) which
Weep it Screeds is	0.0172 installed. (0.44)Subcommittee:	0.0207 C11.03 (0.53) Standard:	0.050 C1063 (1.27).
Control adj Joints — a	0.0172 metal (0.44) plaster	0.018 base (0.46) manufactured	0.050 with (1.27) evenly spaced

NOTE INDENTATIONS 2: that The hold selection the body of the an lath appropriate see type gypsum of lath materialSubcommittee: for C11.01 accessories Standard: shall C11 be approximately determined 1 by! applicable4 surrounding in. climatic (6 and mm) environmental away conditions from specific solid surfaces to which the it project is location, installed. such 3.2.9 as water salt resistive air, barrier industrial a pollution, material high that moisture, resists or the humidity. infiltration

6.2.3 of *Steel*—Specification liquid A653/A653M moisture and through shall the have building a enclosure G60 system. coating.Subcommittee:

6.2.4 C11.03 *PVC* *Standard:* *Plastic*—Specification C1063 D1784; or n D4216—a. material

6.2.5 that *Zinc* *resists* *Alloy*—Specification the B69 infiltration, of 99 liquid % moisture pure through zinc. the

6.2.6 building Thickness enclosure system of building base assemblies material and shall materials be designed as and shown installed in such Table a 1 manner. as

6.2.7 to *Cornerite*—1.75 provide lb/yd a[2 barrier] (0.059 between kg/m different[2 environments.]),Subcommittee: galvanized C11.03 expanded Standard: metal C1063 lath, system. 1.7 4 lb/yd Delivery[2 and] (0.057 Storage kg/m of[2 Materials]) 4.1 galvanized Delivery woven of or Materials: welded 4.1.1 wire All fabric materials of shall 0.0410 be delivered in. the (1.04 original mm) packages, wire. containers, When or shaped bundles for bearing angle the reinforcing, brand-name it and shall manufacturer's have (or outstanding supplier's) flanges identification. (legs) 4.2 Storage of Materials: not 4.2.1 less All than materials 2 shall in. be (51 kept mm). dry.

6.3 Materials Channels—Shall shall be stacked cold-formed off from the steel ground with the minimum element 33 of 000 a psi lathing (228 accessory MPa) that yield provides strength an and edge, 0.0538 end, in. or (1.37 termination mm) for minimum a bare cement steel plaster thickness. panel Channel area, shall with have a ground protective dimension coating conforming to assist Specification in A653/A653M cement–G60, plaster or thickness have control.Subcommittee: C11.02 Standard: C1861, supported on a level protective platform, coating and with protected an from equivalent the corrosion weather resistance and for surface exterior contamination. applications, 4.2.2 or Materials shall be neatly coated stacked with care a taken rust to inhibitive avoid paint, damage for to interior edges, applications, ends and the shall end have perpendicular to the paper-bound following edge minimum or weights long in edge. poundsSubcommittee: per C11.01 1000 Standard: linear C473 ft, (kg/m). or

Sizes, surfaces. in. 4.2.3 (mm) Paper	Weight, backed lb/1000 metal ft plaster (kg/m) bases	Flange expanded Width, metal in. lath, (mm) sheet
3 metal/lath, 4 welded (19) or	277 woven (0.412) wire	1 lath, /Subcommittee: 2 C11.03 (13) Standard:
1 C841 1 shall/be 2 handled (38) carefully	414 in (0.616) delivery,	1 storage, /and 2 erection (13) to
2 prevent (51) puncturing	506 or (0.753) removal	1 of/paper. 2 5 (13) Materials
2 5.1 1 Metallic/materials 2 including (64) lathing,	597 lathing (0.888) accessories	1 products/fabricated 2 for (13) the

NOTE PURPOSE 3 of Channels forming used corners, in edges, areas control subject joints, to or corrosive decorative action effects. ofSubcommittee: salt C11.01 air Standard: shall C11 becornerbeads, hot-dipped edge galvanized, trims, G60 and coating control

6.3.1 joints, *External* *such* *Corner* *as* *Reinforcement*—Expanded casing lath, beads, welded bull wire, noses, or and woven stops. wireSubcommittee: mesh C11.02 bent Standard: to C1047 approximatelypreformed 90 metal, ° fiberglass or plastic members used to form reinforce corners, portland edges, cement control stucco joints, at or external decorative corners. effects. ThisSubcommittee: accessory C11.05 Standard: C1516, furring, furring accessories, and fasteners shall be selected fully for embedded compatibility in to the minimize stucco. galvanic

6.3.2 corrosion *Weep* *between* *Screed*—Accessory adjacent used metallic to materials terminate installed portland in the cement plaster based see stucco gypsum at plaster, the gypsum bottom neat of plaster. exteriorSubcommittee: framed C11.91 walls. Standard: This C11 accessoryportland shall cement-based have cementitious a mixture sloped, (see solid, stucco). orSubcommittee: perforated, C11.03 ground, Standard: or C926 screed cladding flange assembly. to 5.2 facilitate Metal the Plaster removal Bases: of 5.2.1 moisture Expanded from Metal the Lath—Specification wall C847 cavity., and galvanized. a 5.2.2 vertical Wire attachment Laths: flange 5.2.2.1 not Welded less Wire than Lath—Specification 3 C933[1]/ 5.2.2.2 2 Woven in. Wire (89 Lath—Specification mm) C1032 long.

6.4 5.2.2.3 Wire—As Paper specified Backed in Plaster Specification Bases—Specification A641/A641M C847 with, a 5.3 Class Lathing I Accessories, zinc-coated Furring (galvanized), Accessories soft-temper and steel. Fasteners: Wire 5.3.1 diameters Lathing (uncoated) Accessories, specified Furring herein Accessories correspond and with Fasteners—Specification United C1861 States. Steel 5.3.2 Wire The Gauge selection numbers of as an follows: appropriate

Wire type Gauge of (US material Steel for Wire lathing Gauge) accessories	Diameter products (in.) fabricated	mm for

No. the 20 purpose	0.0348 of	.88 forming
No. corners, 19 edges,	0.0410 control	1.04 joints,
No. or 18 decorative	0.0475 effects.	1.21 Subcommittee:
No. C11.01 17 Standard:	0.0540 C11	1.37 cornerbeads,
No. edge 16 trims,	0.0625 and	1.59 control
No. joints, 14 such	0.0800 as	2.03 casing
No. beads, 13 bull	0.0915 noses,	2.32 and
No. stops. 12 Subcommittee:	0.1055 C11.02	2.68 Standard:
No. C1047 11 preformed	0.1205 metal,	3.06 fiberglass
No. or 10 plastic	0.1350 members	3.43 used
No. to 9 form	0.1483 corners,	3.77 edges,
No. control 8 joints,	0.1620 or	4.12 decorative

6.5 effects. Rod Subcommittee: and C11.05 Strap Standard: Hangers—Mild C1516 steel, shall zinc be or based cadmium upon plated, applicable or surrounding protected climatic with and a environmental rust-inhibiting conditions paint. specific

6.6 to Clips—Form the from project steel location, wire, such Specification as A641/A641M salt zinc-coated air, (galvanized), industrial Specification pollution, A641/A641M high moisture, or humidity. steel 6 sheet, Requirements Specification for A653/A653M Substrates, to depending Receive on Metal use Lathing and Furring manufacturer's 6.1 requirements. Framed,

6.7 or Fasteners: Framed

6.7.1 and *Nails*—For Sheathed attaching Substrates: metal 6.1.1 plaster Framing bases member to deflection wood shall supports, not 0.1205-in. exceed 11 L/360 gauge (0.33 (3.06 in. mm) in diameter, 10 7.4) / 6.1.2 16 Plywood in. and (11.1 oriented mm) strand head, board barbed, sheathing galvanized panels roofing shall nails be marked in accordance with DOC PS1 or DOC galvanized PS common 2 nails.

6.7.1.1 6.1.3 Nails Plywood for and attaching oriented metal strand plaster board bases sheathing to panels solid substrates shall be installed not with less 1 than $^3/8_4$ in. (3 (19 mm) minimum panel edge the paper-bound edge, or long. edge,

6.7.2 as Screws manufactured. for Subcommittee: attaching C11.01 metal Standard: plaster C473 base the bound edge as manufactured.Subcommittee: C11.01 Standard: C1177/C1177M, C1178/C1178M, C1396/C1396M gaps, and panel edges shall be offset fabricated 4 in (10 accordance cm) with minimum either from Specification wall C954 opening or reentrant C1002 corners. 6.1.4 Wood framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007, plywood and oriented strand board sheathing panels shall have a moisture 7 content / not 16 to in. exceed (11.1 19 mm) % diameter immediately pan before wafer plastering. head 6.1.5 and Exterior a gypsum 0.120 sheathing in. a (3.0 gypsum mm) board diameter used shank. as Screws a used backing for exterior attachment surface to materials, metal manufactured framing with members water-repellant shall paper and may be manufactured self-drilling with and a self-tapping. water-resistant Screws core. used Subcommittee: for C11.91 attachment Standard: to C11 wood panels framing members shall be installed sharp-point. in compliance with Specification C1280.

7 INSTALLATION

7.1 Workmanship—Metal Workmanship—Metal lathing, furring lathing accessories, furring, and furring lathing accessories shall be erected so that the finished cement plaster surfaces are true to line (allowable tolerance of $^1/_4$ in. (6 (6.4 mm) in 10 ft (3 (3.05 m)), level, plumb, square, or curved as required to receive the specified pertaining to a mandatory requirement of this standard or a referenced requirement (see 3.2.17).Subcommittee: C11.03 Standard: C840 pertaining to a mandatory requirement of this specification or a referenced requirement.Subcommittee: C11.03 Standard: C1280 cement plaster see gypsum plaster, gypsum neat plaster.Subcommittee: C11.91 Standard: C11 portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926 thickness.

7.2 Hangers and Inserts:

7.2.1 **Hangers shall be of ample length and shall conform to the requirements of** Table~~1~~ 2**, both as to size and maximum** ~~**cement plaster panel**~~ **area to be supported, except as modified in this section.**

TABLE ~~1~~ 2 Allowable Support or Hanger Wire Spacing ft-in. (mm) and Cold-Rolled Channel ~~Furring~~ Main Runner Spans, ft-in. (mm)~~1—7~~ 1–10

NOTE 1: 1 in. = 25.4 mm; 1 ft^2 = 0.093 m^2

Member Size, in. (mm)	Member Weight, lb/1000 ft (kg/m)	Span Condition~~6,7~~ 9,10	Uniform Load = 12 psf (0.479 kPa)				
			Member Spacing, in. (mm)				
			24 (610)	36 (914)	48 (1220)	60 (1520)	72 (1830)
			Allowable Hanger Wire or Support Spacing, ft-in. (mm)				
$1^1/_2$	414	Single	3-6 (1070)	3-1 (940)	2-9 (840)	2-9 (790)	2-5 (740) ~~(38)~~
(38.1)	(0.615)	2 or More	4-11 (1500)	4-2 (1270)	3-7 (1090)	3-2 (970)	2-11 (890)
2	506	Single	3-9 (1140)	3-3 (990)	3-0 (910)	2-9 (840)	2-8 (810) ~~(51)~~
(50.8)	(0.753)	2 or More	5-2 (1570)	4-6 (1370)	4-1 (1240)	3-10 (1170)	3-7 (1090)
$2^1/_2$	597	Single	3-11 (1190)	3-5 (1040)	3-2 (970)	2-11 (890)	2-9 (840) ~~(64)~~
(63.5)	(0.888)	2 or More	5-5 (1650)	4-9 (1450)	4-4 (1320)	4.0 (1220)	3-10 (1170)

Member Size, in. (mm)	Member Weight, lb/1000 ft (kg/m)	Span Condition~~6,7~~ 9,10	Uniform Load = 15 psf (0.287 kPa)				
			Member Spacing, in. (mm)				
			24 (610)	36 (914)	48 (1220)	60 (1520)	72 (1830)
$1^1/_2$	414	Single	3-3 (990)	2-10 (860)	2-7 (790)	2-4 (710)	2-2 (660) ~~(38)~~
(38.1)	(0.616)	2 or More	4-6 (1370)	3-8 (1120)	3-2 (970)	2-10 (860)	2-7 (790)
2	506	Single	3-6 (1070)	3-1 (940)	2-10 (880)	2-7 (790)	2-5 (740) ~~(51)~~
(50.8)	(0.753)	2 or More	4-10 (1470)	4-3 (1300)	3-10 (1170)	3-6 (1070)	3-3 (990)
$2^1/_2$	597	Single	3-8 (1120)	3-3 (990)	2-11 (890)	2-9 (840)	2-7 (790) ~~(64)~~
(63.5)	(0.888)	2 or More	5-0 (1520)	4-5 (1350)	4-0 (1220)	3.9 (1140)	3-6 (1070)

Allowable Spans Notes:

1 ~~Spans~~ Bare ~~based~~ metal ~~on~~ thickness ~~upper flange~~ of cold-rolled main runners ~~the~~ shall ~~members~~ be ~~that~~ not ~~are~~ less ~~attached~~ than ~~to~~ 0.0538 ~~or~~ in. ~~suspended~~ (1.367 ~~from~~ mm). ~~the~~

2 ~~construction~~ Inside ~~above~~ corner ~~for~~ radii ~~the~~ shall ~~support~~ not ~~of~~ be ~~cross~~ greater ~~furring.~~ than ~~Subcommittee:~~ 1 ~~C11.03~~ / ~~Standard:~~ 8 ~~C841~~ in. (3.19 mm).

3 Spans based on upper flange of main runners laterally unbraced. ~~2~~

4 Maximum deflection limited to 1/360 of the span length. ~~3~~

5 ~~Uniform~~ Steel ~~load~~ yield ~~12~~ stress, ~~psf~~ Fy, ~~(dry density)~~ shall be ~~used~~ not ~~for~~ less ~~portland~~ than ~~cement~~ 33 ~~plaster~~ 000 ~~a~~ psi ~~plaster~~ (228 ~~mix~~ MPa). ~~in~~

6 ~~which~~ Uniform ~~portland~~ load ~~cement~~ 12 ~~or~~ psf ~~combinations~~ (dry ~~of~~ density) ~~portland~~ shall ~~and~~ be ~~masonry~~ used ~~cements~~ for ~~or~~ portland cement ~~and~~ plaster ~~lime are the principal cementitious materials mixed with aggregate.Subcommittee: C11.01 Standard: C11~~ ceilings with plaster thicknesses up to $^7/_8$ in. (22 mm) and 15 psf shall be used for ceilings with plaster ~~see gypsum plaster, gypsum neat plaster.Subcommittee: C11.01 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926~~ thicknesses over $^7/_8$ in. (22 mm) and not more than $1^1/_4$ in. (32 mm). ~~4~~

7 ~~"2~~ "2 or ~~More"~~ More" spans refers to two or more continuous, equal spans. ~~5~~

8 For the "2 "2 or More" More" span condition, listed spans represent the center-to-center distance between adjacent framing supports. members 9 studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007. 6 These tables are designed for dead loads. Specific conditions such as exterior installations in high wind areas require to mandate by a force outside this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C1280 additional engineering. 7

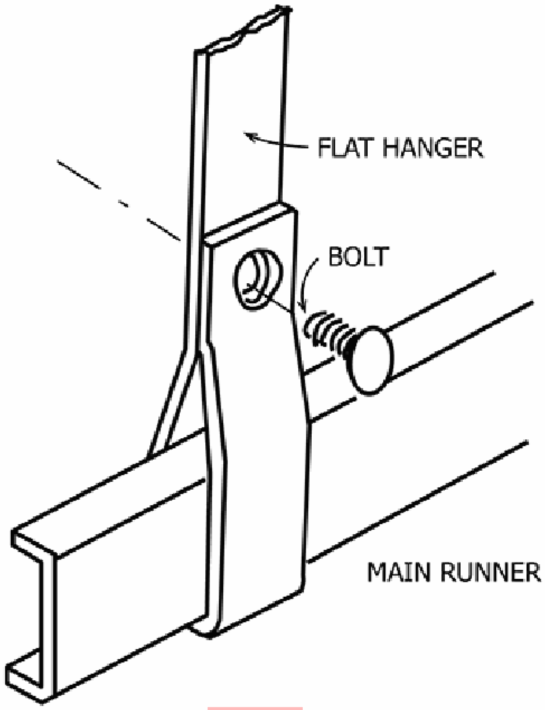
10 Where uplift resistance is required pertaining to a mandatory obligation imposed by a force outside this standard, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C840pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C926 for suspended ceilings to resist negative forces, the architect or engineer of record shall select the method to be used. TABLE

7.2.2 2 When Spans 1 and by Spacing of Cold-Rolled Channel Cross-Furring MembersA, B, C Design Load, 12 psf (575 Pa) Allowable Span, Main Runners or Supports Ft-in. (mm) Member Depth Spacing, in. (mm) Simple Span Two or More SpansD, E 3/4 (19) 13.5 (343) 2-9 (840) 3-5 (1040)16 (406) -in. 2-7 (25 (790) by 3-3 4.8 (990) mm) 19 flat (483) inserts 2-7 (740) 3-0 (910) 24 (610) 2-3 (690) 2-10 (860) 11/2 (38) 13.5 (343) 4-6 (1370) 5-8 (1730) 16 (406) 4-3 (1300) 5-5 (1650) 19 (483) 4-0 (1220) 5-1 (1550) 24 (610) 3-8 (1120) 4-9 (1450)(A) Spans based on upper flange of cross-furring laterally unbraced.(B) Maximum deflection limited to 1/360 th of span length unbraced.(C) Tabulated spans apply only to cross-furring with webs oriented vertically.(D) "Two or more" spans refers to two or more continuous, equal spans.(E) For the "two or more" span conditions, listed spans represent the center-to-center distance between adjacent framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007. TABLE 3 Types and Weights of Metal Plaster Bases and Corresponding Maximum Permissible Spacing of Wall and Ceiling Framing Members or Furring Type of Metal Plaster Base Minimum Weight of Metal Plaster Base, lb/yd2 (kg/m2) Specific Installation Requirements and Maximum Permissible Spacing of Wall and Ceiling Framing Members or Furring, Center to Center, in. (mm) Walls Ceilings 24 (610) 16 (406) 24 (610) 16 (406) 12 (305) Expanded Sheet Metal 2.5 (1.4) Permitted only for self-furred lath on sheathed wall framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 or solid wall bases Permitted Not Permitted Not Permitted Permitted 3.4 (1.8) Permitted Flat Rib 2.75 (1.5) Not Permitted Permitted only for unsheathed wall framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 3/8 in. Rib 3.4 (1.8) Not Permitted Permitted 4.0 (2.1) Welded Wire 1.14 (0.618) Not Permitted Permitted Not Permitted 1.95 (1.058) Permitted Permitted Woven Wire 1.4 (0.76) Permitted only for wood wall framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007, wood furring preparing a wall or ceiling with framing or furring members to provide a level surface or airspace.Subcommittee: C11.03 Standard: C754spacer strips fastened to a wall, ceiling, or planar element that create an even surface for the application of metal plaster bases or gypsum lath.Subcommittee: C11.03 Standard: C841spacer elements added to a building structure to facilitate fastening of gypsum panel products.Subcommittee: C11.03 Standard: C1546 Permitted Permitted only for wood and concrete ceiling framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 Not Permitted Permitted only for steel ceiling framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 7.2.2 When strap hangers are used, $^{7}/_{16}$-in. (11 (11.1 mm) diameter holes shall be provided on the center line at the upper lower end of the strap insert hanger and to upper permit end the attachment of the strap hanger The to edge permit the paper-bound attachment edge, of or the long hanger edge, to as manufactured.Subcommittee: C11.01 Standard: C473 the bound insert. The edge as manufactured.Subcommittee: C11.01 Standard: C1177/C1177M, C1178/C1178M, C1396/C1396M of the holes in both the strap inserts and the hangers shall be not less than $^{3}/_{8}$ in. (10 (9.5 mm) from the ends. the end perpendicular to the paper-bound edge or long edge.Subcommittee: C11.01 Standard: C473.

7.2.3 In concrete, rod or strap hangers shall be attached to inserts devices embedded in concrete framing members to provide a loop or opening for attachment of hangers.Subcommittee: C11.03 Standard: C1063 embedded in the concrete, or to other attachment devices designed for this purpose, and able to develop full strength of the hanger.

7.2.4 Strap Flat, steel hangers shall be bolted to 1 by $^{3}/_{16}$-in. (25 by 4.8 mm) inserts with machine $^{3}/_{8}$-in. (9.5 mm) diameter round-head stove bolts. (See Fig. 3.)

FIG. 3 Flat (Strap) Hanger Attached to Cold-rolled Channel Furring Main Runner Using Machine Round-head Stove Bolt



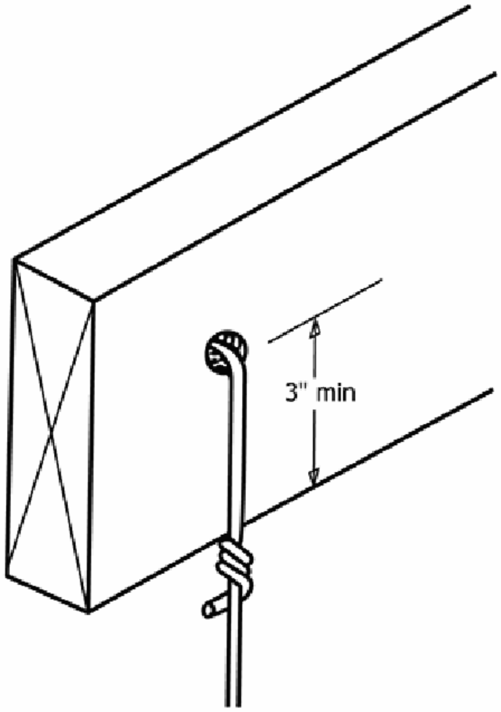
7.2.5 The nuts of the machine bolts shall be drawn up tight.

NOTE 2: 4: Hangers required pertaining to a mandatory obligation imposed by a force outside this standard, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C840pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C926 to withstand upward wind pressures shall be of a type to resist compression. Struts of formed channels shall be permitted.

7.3 Installation of Hangers for Suspended Ceilings Under Wood Constructions—Hangers Constructions—Hangers shall be attached to framing supports members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 by any of the following methods:

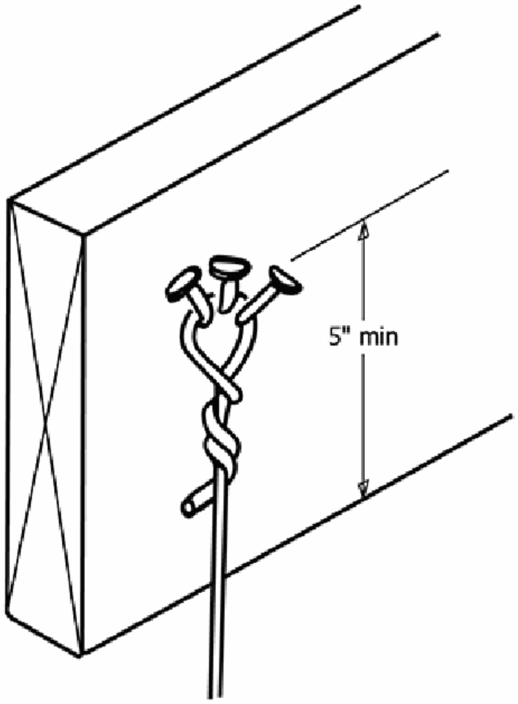
7.3.1 A hole shall be drilled through the wood framing member studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold-formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787 not less than 3 in. (76 mm) above the bottom, with the upper end of the wire hanger passed through the hole and twisted three times around itself. (See Fig. 4.)

FIG. 4 Hanger Attached to Framing Support Member Through Drilled Hole



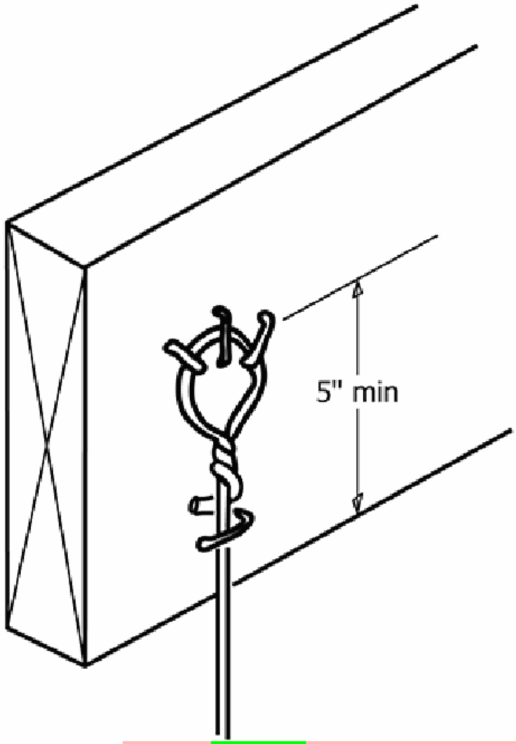
7.3.2 Three 12d nails shall be driven, on a downward slant, into the sides of the wood framing member studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787 with not less than $1^1/_4$ in. (32 (31.8 mm) penetration and not less than 5 in. (127 mm) from the bottom edges, and not more than 36 in. (914 mm) on the center with the upper end of the wire hanger wrapped around the nails and twisted three times around itself. (See Fig. 5.)

FIG. 5 Hanger Attached to Framing Support Member Using Nails



7.3.3 A loop shall be formed in the upper end of the wire hanger and secured to the wood ~~framing~~ member ~~studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787~~ by four $1^1/_2$-in. ~~(38~~ (38.1 mm), not less than 9 gauge, 0.1483-in. (3.77 mm) diameter wire staples driven horizontally or on a downward slant into the sides of the wood ~~framing~~ members, three near the upper end of the loop and the fourth to fasten the loose end. (See Fig. 6.)

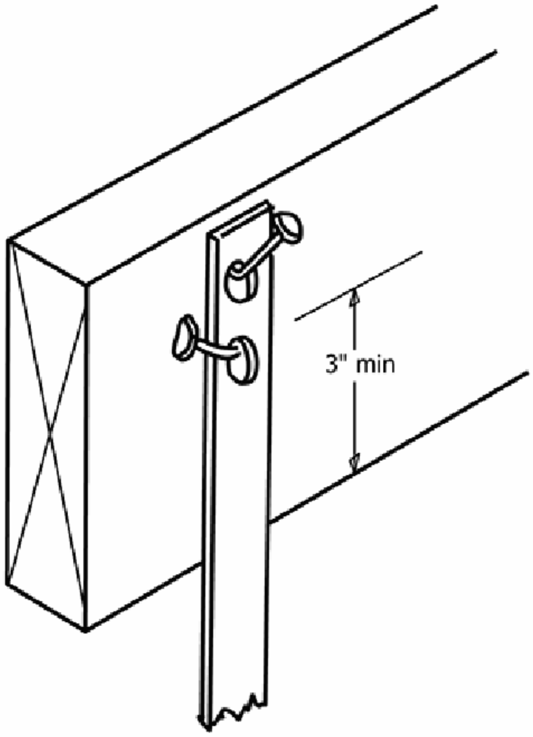
FIG. 6 Hanger Attached to ~~Framing~~ Support ~~Member~~ Using Staples



7.3.4 Where framing supports members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 for flooring are thicker than $1^1/_2$ in. (38 (38.1 mm) and are spaced more than 4 ft (1.2 m) on center, $1^1/_2$ in. (38.1 mm) No. 1/0 (0.3065 in.) (7.78 mm) eye screws (or equivalent), spaced not more than 3 ft (914 (0.9 mm) m) on centers shall be screwed into the flooring framing supports members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 with the upper end of the wire hanger inserted through the eye screws and twisted three times around itself.

7.3.5 Two holes shall be drilled in the upper end of the flat hangers and nailed to the sides of the wood framing members with 12d nails driven through the holes and clinched. Nails shall be not less than 3 in. (76 mm) above the bottom edge of the framing member. studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787. (See Fig. 7.)

FIG. 7 Flat (Strap) Hanger Attached to Framing Support Member Using Nails



7.4 Attachment of Hangers to ~~Cold-rolled Channel Furring~~ Main Runners:

7.4.1 Wire hangers shall be saddle-tied to ~~cold-rolled~~ the ~~channel furring main~~ runners. ~~the members that are attached to or suspended from the construction above for the support of cross furring.Subcommittee: C11.03 Standard: C841.~~ (See Fig. 1.)

7.4.2 Smooth or threaded rod hangers shall be fastened to ~~cold-rolled~~ the ~~channel furring main~~ runners ~~the members that are attached to or suspended from the construction above for the support of cross furring.Subcommittee: C11.03 Standard: C841~~ with special attachments appropriate to the design.

7.4.3 The lower ends of ~~strap~~ flat hangers shall be bolted to ~~cold-rolled~~ the ~~channel furring~~ main ~~runners~~ runners, ~~the members that are attached to~~ or ~~suspended from the construction above for the support of cross furring.Subcommittee: C11.03 Standard: C841, or~~ bent tightly around the ~~cold-rolled channel furring main~~ runners and carried up and above the ~~cold-rolled channel furring main~~ runners ~~the~~ and ~~members~~ bolted ~~that are attached~~ to ~~or suspended from~~ the ~~construction~~ main ~~above~~ part ~~for~~ of the ~~support~~ hanger. ~~of~~ Bolts ~~cross~~ shall ~~furring.~~ be~~Subcommittee:~~ 3 ~~C11.03~~/~~Standard:~~ 8 ~~C841~~ -in. ~~and~~ (9.5 ~~bolted~~ mm) ~~to~~ diameter, ~~the~~ round-head ~~main~~ stove ~~part~~ bolts. ~~of the hanger.~~ (See Fig. 3.)

7.5 Installation of ~~Cold-rolled Channel Furring~~ Main Runners:

7.5.1 Minimum sizes and maximum spans and spacings of ~~cold-rolled channel furring~~ main runners for the various spans between hangers or other ~~framing~~ supports ~~members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ shall be in accordance with the requirements of Table ~~1~~ 2.

7.5.2 A clearance of not less than 1 in. (25 mm) shall be maintained between the ends of the ~~cold-rolled channel furring~~ main runners ~~the members that are attached to or suspended from the construction above for the support of cross furring.Subcommittee: C11.03 Standard: C841~~ and the abutting masonry or the concrete walls, partitions, and columns. Where special conditions require that ~~cold-rolled channel furring~~ main runners let into abutting masonry or concrete construction, within such constructions maintain a clearance of not less than 1 in. (25 mm) from the ends and not less than $^1/_4$ in. ~~(6~~ (6.4 mm) from the tops and sides of the ~~cold-rolled channel furring main~~ runners. ~~the members that are attached to or suspended from the construction above for the support of cross furring.Subcommittee: C11.03 Standard: C841.~~

7.5.3 A ~~cold-rolled channel furring~~ main runner shall be located within 6 in. (152 mm) of the paralleling walls to support the ends of the ~~cold-rolled channel~~ cross furring. ~~furring member attached perpendicular to main runners or framing members.Subcommittee: C11.03 Standard: C754furring members that are attached at right angles to the underside of the main~~

runners or construction above for support of the lath.Subcommittee: C11.03 Standard: C841. The ends of cold-rolled channel furring main runners shall be supported by hangers located not more than 6 in. (152 mm) from the ends. the end perpendicular to the paper-bound edge or long edge.Subcommittee: C11.01 Standard: C473.

7.5.4 Where cold-rolled channel furring main runners are spliced, the ends shall be overlapped not less than 12 in. (305 mm) with flanges of cold-rolled channels channel furring main runners interlocked and securely tied near each end of the splice, with double loops of 0.0625 in. (1.59 mm) or double loops of twin strands of 0.0475-in. (1.21 mm) galvanized wire. However, when the splice occurs at an expansion joint or control joint joint, a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047, the cold-rolled channel furring preparing a wall or ceiling with framing or furring members to provide a level surface or airspace.Subcommittee: C11.03 Standard: C754spacer strips fastened to a wall, ceiling, or planar element that create an even surface for the application of metal plaster bases or gypsum lath.Subcommittee: C11.03 Standard: C841spacer elements added to a building structure to facilitate fastening of gypsum panel products.Subcommittee: C11.03 Standard: C1546 shall be nested and loosely tied to hold together but still allow movement.

7.5.5 Hanger wires shall hang straight down. If an obstacle prevents this, a trapeze type device shall be used to allow hanger wires to hang straight.

7.6 Installation of Cold-rolled Channel Cross Furring:

7.6.1 Minimum size and maximum spans and spacings of various types of cold-rolled channel cross furring for various spans between cold-rolled channel furring main runners and framing supports members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 shall conform to the requirements of Table 2.

7.6.2 Cold-rolled Cross channel cross furring furring member attached perpendicular to main runners or framing members.Subcommittee: C11.03 Standard: C754furring members that are attached at right angles to the underside of the main runners or construction above for support of the lath.Subcommittee: C11.03 Standard: C841 shall be saddle-tied to cold-rolled channel furring main runners with 0.0625-in. 16 gauge (1.59 mm) galvanized wire, or a double strand of 0.0475-in. 18 gauge (1.21 mm) galvanized wire or with special galvanized clips, or equivalent attachments. (See Fig. 2.)

7.6.3 Where cold-rolled channel cross furring furring member attached perpendicular to main runners or framing membersSubcommittee: C11.03 Standard: C754furring members that are attached at right angles to the underside of the main runners or construction above for support of the lath.Subcommittee: C11.03 Standard: C841 members are spliced, the ends shall be overlapped not less than 8 in. (203 mm), with flanges of cold-rolled channels channel cross furring furring member attached perpendicular to main runners or framing members.Subcommittee: C11.03 Standard: C754furring members that are attached at right angles to the underside of the main runners or construction above for support of the lath.Subcommittee: C11.03 Standard: C841 interlocked, and securely tied near each end of the splice with double loops of 0.0625-in. (1.59 mm) 16 gauge galvanized wire or twin strands of 0.0475-in. 18 gauge (1.21 mm) galvanized wire.

7.6.4 Cold-rolled Cross channel cross furring furring member attached perpendicular to main runners or framing members.Subcommittee: C11.03 Standard: C754furring members that are attached at right angles to the underside of the main runners or construction above for support of the lath.Subcommittee: C11.03 Standard: C841 shall not come into contact with abutting masonry or reinforced concrete walls or partitions, except, where special conditions require that cold-rolled channel cross furring be let into abutting masonry or concrete construction, the applicable provisions of 7.5.2 shall apply.

7.6.5 Cold-rolled Main channel furring main runners and cold-rolled channel cross furring runners shall be interrupted at expansion joints or control joints. However when the splice occurs at an expansion joint or control joint joint, a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047, the cold-rolled channel furring preparing a wall or ceiling with framing or furring members to provide a level surface or airspace.Subcommittee: C11.03 Standard: C754spacer strips fastened to a wall, ceiling, or planar element that create an even surface for the application of metal plaster bases or gypsum lath.Subcommittee: C11.03 Standard: C841spacer elements added to a building structure to facilitate fastening of gypsum panel products.Subcommittee: C11.03 Standard: C1546 shall be nested and loosely tied to hold together but still allow movement.

7.7 Metal Furring for Walls:

7.7.1 Attachments for furring accessories shall products be fabricated concrete for nails the driven purpose securely of into forming concrete corners, edges, control joints, or decorative into effects. masonrySubcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints, such short as pieces casing of beads, 3 bull / noses, 4 and in. stops. (19.1Subcommittee: mm) C11.02 channels Standard: C1047preformed metal, fiberglass or plastic members used to as form anchors corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516 shall be concrete nails driven securely into concrete or into masonry joints, power-actuated fasteners, or other devices specifically designed as spacer elements, spaced horizontally not more than 2 ft (610 (0.6 mm) m) on centers. They shall be spaced vertically in accordance with horizontal stiffener spacing so that they project from the face the surface designed to be left exposed to view or to receive decoration or additional finishes.Subcommittee: C11.91 Standard: C11the coated surface.Subcommittee: C11.01 Standard: C1178/C1178M of the wall in order for ties to be made.

7.7.2 Horizontal stiffeners shall be not less than $^3/_4$ in. (19 (19.5 mm) cold-rolled channel channels, furring, spaced not to exceed 54 in. (1372 mm) on centers vertically, with the lower and upper cold-rolled channels channel furring not more than 6 in. (152 mm) from the ends of vertical framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 and not less than $^1/_4$ in. (6 (6.4 mm) clear from the wall face, securely tied to attachments with three loops of galvanized, soft-annealed wire, or equivalent devices. Approved furring preparing a wall or ceiling with framing or furring members to provide a level surface or airspace.Subcommittee: C11.03 Standard: C754spacer strips fastened to a wall, ceiling, or planar element that create an even surface for the application of metal plaster bases or gypsum lath.Subcommittee: C11.03 Standard: C841spacer elements added to a building structure to facilitate fastening of gypsum panel products.Subcommittee: C11.03 Standard: C1546 is not prohibited from use in this application.

7.7.3 Vertical framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 shall be not less than $^3/_4$ in. (19 (19.5 mm) cold-rolled channel channels furring in accordance with the requirements of Table 3. Vertical framing members shall be saddle-tied to horizontal stiffeners with three loops of 0.0475-in. (1.21 mm) galvanized soft-annealed wire, or equivalent devices, at each crossing, and securely anchored to the floor and ceiling constructions. Where cold-rolled furring channel is furring not preparing in a contact wall with or the ceiling wall, with channel framing braces or shall furring be members installed to between provide horizontal a stiffeners level and surface the or wall, airspace. spacedSubcommittee: horizontally C11.03 not Standard: more C754 thanspacer 2 strips ft fastened (600 to mm) a on wall, centers. ceiling,

TABLE or 3 planar Types element and that Weights create of an Metal even Plaster surface Bases for and the Corresponding application Maximum Permissible Spacing of metal Supports plaster

Type bases of or Metal gypsum Plaster lath. BaseSubcommittee:	Minimum C11.03 Weight Standard: of C841 Metal spacer Plaster elements Base added lb/yd² to a (kg/m²) building structure) to	Maximum facilitate Permissible fastening Spacing of gypsum Supports panel Center products. to Subcommittee: Center, C11.03 in. Standard: (mm) C1546				
		Walls is (Partitions) not			Ceilings in	
		Wood contact Studs with or the Furring wall,	Solid cold-rolled Partitions channel furring A	Steel preparing Studs a or wall Furring	Wood or ceiling Concrete with	Metal framing
U.S. or Nominal furring Weights: members						
Diamond to Mesh provide B a	2.5 level (1.4) surface	16 or (406) airspace. C Subcommittee:	16 C11.03 (406) Standard:	16 C754 (406) spacer strips C	12 fastened (305) to	12 a (305) wall,
	3.4 ceiling, (1.8) or	16 planar (406) element that C	16 create (406) an	16 even (406) surface C for	16 the (406) application	16 of (406) metal
Flat plaster Rib bases	2.75 or (1.5) gypsum	16 lath. (406) Subcommittee:	16 C11.03 (406) Standard:	16 C841 (406) spacer	16 elements (406) added	16 to (406) a
	3.4 building (1.8) structure	19 to (482) facilitate	24 fastening (610) of	19 gypsum (482) panel	19 products. (482) Subcommittee:	19 C11.03 (482) Standard:

		of				
					or	
Flat C1546 Rib braces (large shall opening) be	1.8 installed (0.95) between	24 horizontal (610) stiffeners	24 and (610) the	24 wall, (610) spaced	16 horizontally (406) not	16 more (406) than
3-2 / ft 8 (610 in. mm) Rib on	3.4 centers. (1.8) 7.7.4	24 Where (610) the	N/A water D resistive	24 barrier (610) a	24 material (610) that	24 resists (610) the
	4.0 infiltration (2.1) of	24 liquid (610) moisture	N/A through	24 the (610) building	24 enclosure (610) system.	24 Subcommittee: (610) C11.03
3 Standard: / C1063 4 has in. been Rib damaged	5.4 during (2.9) installation	24 of (610) attachments,	N/A the	24 water (610) resistive	36 barrier (914) shall	36 be (914) repaired
Welded with Wire the B same	1.14 or (0.62) an	16 alternative (406) material,	16 compatible (406) with	16 the (406) water	16 resistive (406) barrier	16 a (406) material
	1.95 that (1.1) resists	24 the (610) infiltration	24 of (610) liquid	24 moisture (610) through	24 the (610) building	24 enclosure (610) system.
Woven Subcommittee: Wire C11.03 B Standard:	1.4 C1063 (0.6) ;	24 before (610) proceeding	16 with (406) the	16 installation (406) of	24 the (610) furring	16 preparing (406) a
Canadian wall Nominal or Weights: ceiling						
Diamond with Mesh framing B or	2.5 furring (1.4) members	16 to (406) provide	12 a (305) level	12 surface (305) or	12 airspace. (305) Subcommittee:	12 C11.03 (305) Standard:
	3.0 C754 (1.6) spacer	16 strips (406) fastened	12 to (305) a	12 wall, (305) ceiling,	12 or (305) planar	12 element (305) that
	3.4 create (1.8) an	16 even (406) surface	16 for (406) the	16 application (406) of	16 metal (406) plaster	16 bases (406) or
Flat gypsum Rib lath.	2.5 Subcommittee: (1.4) C11.03	16 Standard: (406) C841	12 spacer (305) elements	12 added (305) to	12 a (305) building	12 structure (305) to
	3.0 facilitate (1.6) fastening	16 of (406) gypsum	16 panel (406) products.	16 Subcommittee: (406) C11.03	16 Standard: (406) C1546	13 1 7.8 / Z-furring 2 used (343) to
3 support / lathing 8 and in. lathing Rib accessories	3.0 and (1.6) its	19 fasteners (482) for	N/A fastening	16 to (406) framing	16 members (406) studs	16 joist, (406) runners
	3.5 (tracks), (1.9) bridging	24 and (610) bracing	N/A and	19 related (482) accessories.	19 Subcommittee: (482) C11.03	19 Standard: (482) C1007
	4.0 or (2.1) solid	24 bases, (610)	N/A	24 (610)	24 (610)	24 (610)

(A) Where plywood is used for sheathing, a customized minimum furring of preparing 1 a / wall 8 or in. ceiling (3.2 with mm) framing separation or shall furring be members provided to between provide adjoining a sheets level to surface allow or for airspace. expansion Subcommittee:

(B) C11.03 Metal Standard: plaster C754 bases spacer shall strips be fastened furred to away a from wall, vertica ceiling, supports or planar solid element surfaces that at create least an 1 even / surface 4 for in. the Self-furring application lath of meets metal furring plaster requirements, bases except or furring gypsum of lath. expandedSubcommittee: metal C11.03 lath Standard: is C841 notspacer required elements on added supports to having a building bearing structure surface to of facilitate 1 fastening 5 of / gypsum8 pane in. products. oSubcommittee: less. C11.03

(C) Standard: These C1546 spacings system are which based shall on be unsheathed engineered. walls. 7.9 Where Lapping self-furring of lath Metal is Plaster placed Bases: over 7.9.1 sheathing Side or laps a of solid metal surface, plaster the bases permissible expanded spacing metal of lath, supports sheet shall metal be lath, no welded more or than woven 24 wire in. lath. (610Subcommittee: mm). C11.03

(D) Standard: Not C841 applicable shall

7.7.4 be Where secured the to water framing resistive members. barrier They has shall been be damaged tied during between installation framing of members attachments, studs the joist, water runners resistive (tracks), barrier bridging shall and be bracing repaired and with related the accessories. sameSubcommittee: or C11.03 an Standard: alternative C1007 material, compatible with 0.0475-in. the (1.21 water mm) resistive wire barrier, at before intervals proceeding not with more the than installation 9 of in. the (229 furring. mm).

[redacted]

TABLE 7.9.2 4 Side Spans laps and Spacing of expanded Cold-Rolled metal Channel lath Cross-Furring shall Members be A lapped, 2 B in. (50 C mm), nominal D and, not E less, than F 1

Design/ Load 2 12 in. psi (13 (575 mm). Pa) Side		Allowable laps Span, of Main rib Runners lath or shall Supports be Ft-in. lapped (mm) 2	
Member Depth	Spacing, in. (50 (mm) mm)	Simple nominal Span and	Two not or less More than Spans 1 in. G/ 2 H
3 (13/ mm). 4 or (19) nest	13.5 the (343) edge	2-9 ribs. (840) End	3-5 laps (1040) of
	16 expanded (406) metal	2-7 lath (790) and	3-3 rib (990) metal
	19 lath (483) 2	2-7 in. (740) (50	3-0 mm) (910) nominal
	24 and (610) not	2-3 less (690) than	2-10 (860)
1 in. 1 (25/ mm). 2 Wire (38) lath	13.5 shall (343) be	4-6 lapped (1370) minimum	5-8 one (1730) mesh
	16 at (406) the	4-3 sides (1300) and	5-5 ends. (1650) Where
	19 end (483) laps	4-0 occur (1220) between	5-1 the (1550) framing
	24 members, (610) the	3-8 ends (1120) of	4-9 the (1450) sheets

(A) of Bare all metal plaster thickness bases of expanded cold-rolled metal members lath, shall sheet not metal be lath, less welded than or 0.0538 woven in. wire (1.367 lath. mm).Subcommittee:

(B) C11.03 Inside Standard: corner C841 radii shall not be laced greater or than wire 1 tied/ with8 0.0475 in. in. (1.21 (3.17 mm). wire.

(C) 7.9.3 Spans Where based metal on plaster upper base flange with of an cross-furring attached laterally water unbraced resistive

(D) barrier Maximum a deflection material limited that to resists 1 the/ infiltration360 th of liquid span moisture length through unbraced. the

(E) building Steel enclosure yield system stress Subcommittee: *Fy*, C11.03 shall Standard: not C1063 be is less installed. than the 33 vertical 000 and psi horizontal (228 lap MPa). joints

(F) shall Tabulated be spans water apply resistive only barrier to on cross-furring water with resistive webs barrier oriented a vertically material

(G) that "Two resists or the more" infiltration spans of refers liquid to moisture two through or the more building continuous enclosure equal system spans.Subcommittee:

(H) C11.03 For Standard: the C1063 "two and or metal more" plaster span base conditions, expanded listed metal spans lath, represent or the welded center-to-center or distance woven between wire adjacent lath. supports.Subcommittee:

7.8 C11.03 Lapping Standard: of C926 Metal on Plaster metal Bases: plaster

7.8.1 base Side expanded laps of metal lath, plaster or bases welded shall or be woven secured wire to lath. framingSubcommittee: members. C11.03 They Standard: shall C926 be: tied 7.9.3.1 between Where supports metal with plaster 0.0475-in. base (1.21 with mm) an wire attached at water intervals resistive not barrier more a than material 9 that in. resists (229 the mm). infiltration

7.8.2 of Metal liquid lath moisture shall through be the lapped building 1 enclosure/ system.2Subcommittee: in. C11.03 minimum Standard: (12.7 C1063 mm) is at installed, the sides, or nest the water edge resistive ribs. barrier Wire lath shall be lapped not minimum less one than mesh 2 at in. the (51 sides mm). and shall the be ends. lapped Lap not metal less lath than minimum 2

1 in. (51 (25 mm) On at walls, ends, the Where water end resistive laps barrier occur a between material the that framing resists members, the infiltration ends of liquid the moisture sheets through of the all building metal enclosure plaster system. basesSubcommittee: shall C11.03 be Standard: laced C1063 or shall wire be tied lapped with so 0.0475-in. water (1.21 will mm) flow galvanized, to annealed steel wire.

7.8.3 Where metal plaster base with backing is used, the exterior. vertical Except and for horizontal weep lap screeds, joints designated shall drainage be screeds, backing on backing and drainage metal flashings, on the metal. water

7.8.3.1 resistive Backing barrier shall a be material lapped that not resists less than 2 in. (50 mm). On walls, the infiltration backing of shall liquid be moisture lapped through so water will flow to the building exterior. enclosure Except system. forSubcommittee: weep C11.03 screeds Standard: (as C1063 described in 7.11.5), backing shall not be placed between metal plaster base (lath) and lath flanges accessory of attachment accessories. flanges. Metal plaster lath base to lath accessory key attachment flange contact shall be required to ensure that the flanges metal are plaster mechanically base locked expanded together. metal

7.9 lath, Spacing or of welded Attachments or for woven Metal wire Plaster lath. Bases—AttachmentsSubcommittee: for C11.03 securing Standard: metal C926 plaster and bases lath to accessory framing key members the shall grip be or spaced mechanical not bond more of than one 7 coat in. of (178 plaster mm) to apart another for coat, diamond or mesh to and a flat substrate. ribSubcommittee: laths C11.91 and Standard: at C11 each attachment rib flanges for are 3 mechanically/ locked8 together. in. (9.5 mm) rib lath.

7.10 Installation Application of Metal Plaster Bases:

7.10.1 General:

7.10.1.1 Metal plaster bases shall be furred away from vertical framing supports members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 or solid surfaces at least $^1/_4$ in. (6 mm). Self furring lath meets furring requirements; except, furring of expanded metal lath is not required on framing supports members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 having a bearing surface of $1^5/_8$ in. (41 mm) or less.

7.10.1.2 The spacing of framing members for the type and weight of metal plaster base expanded metal lath, or welded or woven wire lath.Subcommittee: C11.03 Standard: C926 shall conform to the requirements of Table 3. Metal plaster bases shall be attached to framing members at not more than 7 in. (178 mm) on center, along framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 except for $^3/_8$-in. (10 (9.5 mm) rib metal lath that shall be attached at each rib. Attachment penetrations between the framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 shall be avoided.

7.10.1.3 Lath shall be installed applied with the long dimension at right angles to the framing supports, members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007, unless otherwise specified. pertaining to a mandatory requirement of this standard or a referenced requirement (see 3.2.17).Subcommittee: C11.03 Standard: C840pertaining to a mandatory requirement of this specification or a referenced requirement.Subcommittee: C11.03 Standard: C1280.

7.10.1.4 Ends of adjoining plaster bases shall be staggered.

7.10.1.5 Lath shall not be continuous through control joints, but shall be stopped and tied at each side.

7.10.1.6 Where furred or suspended ceilings butt into or are penetrated by columns, walls, beams, or other elements, the edges and ends of the ceiling lath shall be terminated at the horizontal internal corners angles with a casing bead bead, lathing accessory, control joint joint, a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessory, or similar device designed to keep the edges and ends of the ceiling lath and plaster free of the adjoining vertically oriented, or penetrating elements. Internal Cornerite corner reinforcement lathing accessories shall not be used at these locations. A clearance of not less than $^3/_8$ in. (10 (9.5 mm) shall be maintained between the casing bead lathing accessory, control joint a joint that accommodates movement of plaster shrinkage and curing all along such predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessory, or similar device and penetrating elements.

7.10.1.7 Where load bearing walls or partitions butt into structural walls, columns, or floor or roof slabs, the sides or ends of the wall or partition lath shall be terminated at the internal ~~corners~~ angles with a casing ~~bead~~ bead, ~~lathing accessory,~~ expansion joint ~~lathing~~ or ~~accessory,~~ control ~~joint~~ joint, ~~a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed~~ or ~~required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessory, or~~ similar device designed to keep the sides and ends of the wall or partition lath free of the adjoining elements. ~~Internal~~ Cornerite ~~corner reinforcement lathing accessories products fabricated for the purpose of forming corners, edges, control joints, or decorative effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints, such as casing beads, bull noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516~~ shall not be used at these internal ~~corners.~~ angles. A clearance of not less than $^3/_8$ in. ~~(10~~ (9.5 mm) shall be maintained from all abutting walls, columns, or other vertical elements.

7.10.2 Attachments for Metal Plaster Bases to Wood Framing Members:

7.10.2.1 Lath shall be attached to framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ with attachments spaced not more than 7 in. (178 mm) on center along framing members. Attachment penetrations between the framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ shall be avoided.

7.10.2.2 Diamond-mesh expanded metal lath, flat-rib expanded metal lath, and wire lath shall be attached to horizontal wood framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ with $1^1/_2$-in. ~~(38~~ (38.1 mm) roofing nails driven flush with the plaster base and attached to vertical wood framing members with 6d common nails, or 1-in. (25 mm) roofing nails driven to a penetration of not less than $^3/_4$ in. ~~(19~~ (19.1 mm), or 1-in. (25 mm) wire staples driven flush with the plaster base. Staples shall have crowns not less than $^3/_4$ in. (19.05 mm) and shall engage not less than three strands of diamond mesh and flat rib expanded metal lath or not less than two strands of wire lath and penetrate the wood framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ not less than $^3/_4$ in. ~~(19~~ (19.05 mm). When metal lath is ~~installed~~ applied over sheathing, use fasteners that will penetrate the ~~framing~~ structural members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ not less than $^3/_4$ in. (19 mm).

7.10.2.3 Expanded $^3/_8$ in. ~~(10~~ (9.5 mm) rib lath shall be attached to horizontal and vertical wood framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ with nails or staples to provide not less than $1^3/_4$-in. ~~(44~~ (44.5 mm) penetration into horizontal wood framing ~~members~~ members, ~~studs~~ and ~~joist,~~ ^{3} ~~runners~~/ ~~(tracks),~~ $_4$ ~~bridging~~ -in. ~~and~~ (19.1 ~~bracing~~ mm) ~~and~~ penetration ~~related~~ into ~~accessories.~~ vertical~~Subcommittee:~~ wood ~~C11.03~~ framing ~~Standard:~~ members. ~~C1007.~~

7.10.2.4 Common nails shall be bent over to engage not less than three strands of diamond mesh and flat rib expanded metal lath ~~see gypsum lath.Subcommittee: C11.91 Standard: C11~~ or not less than two strands of wire lath, or be bent over a rib when rib lath ~~see gypsum lath.Subcommittee: C11.91 Standard: C11~~ is installed.

7.10.2.5 Screws used to attach metal plaster base ~~expanded metal lath, or welded or woven wire lath.Subcommittee: C11.03 Standard: C926~~ to horizontal and vertical wood framing members shall penetrate not less than $^5/_8$ in. ~~(16~~ (15.9 mm) into the member when the lath ~~see gypsum lath.Subcommittee: C11.91 Standard: C11~~ is installed. For expanded metal ~~lath~~ lath, ~~see gypsum lath.Subcommittee: C11.91 Standard: C11,~~ the screw shall engage not less than three strands of lath. For wire laths, screws shall engage not less than two strands of diamond mesh and flat rib expanded metal lath ~~see gypsum lath.Subcommittee: C11.91 Standard: C11~~ or not less than two strands of wire lath. ~~see gypsum lath.Subcommittee: C11.91 Standard: C11.~~ When installing expanded metal rib lath, the screw shall pass through, but not deform, the rib. When installing wire rib ~~lath~~ lath, ~~see gypsum lath.Subcommittee: C11.91 Standard: C11,~~ the screw may deform the rib.

7.10.3 Attachments for Metal Plaster Bases to Metal Framing Members:

7.10.3.1 Except as described in 7.10.3.2, all metal plaster bases shall be securely attached to metal framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ with 0.0475-in. 18 gauge (1.21 mm) wire ties, clips, or by other means of attachment which afford carrying strength and resistance to corrosion equal to or superior to that of the wire.

7.10.3.2 Rib metal lath shall be attached to open-web steel joists by single ties of galvanized, annealed steel wire, not less than 0.0475 in. (1.21 mm), with the ends the end perpendicular to the paper-bound edge or long edge.Subcommittee: C11.01 Standard: C473 of each tie twisted together $1^1/_2$ times.

7.10.3.3 Screws used to attach metal plaster base to metal framing members shall project not less than $^3/_8$ in. (10 (9.5 mm) through the metal framing member studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787 when the lath is installed and for expanded metal laths shall engage not less than three strands of lath. see gypsum lath.Subcommittee: C11.91 Standard: C11. For wire laths, screws shall engage not less than two strands of diamond mesh and flat rib expanded metal lath see gypsum lath.Subcommittee: C11.91 Standard: C11 or not less than two strands of wire lath. When installing expanded metal rib lath lath, see gypsum lath.Subcommittee: C11.91 Standard: C11, the screw shall pass through, but not deform, the rib. When installing wire rib lath lath, see gypsum lath.Subcommittee: C11.91 Standard: C11, the screw may deform the rib.

*7.10.4 Attachments for Metal Plaster Bases to Concrete Joists—Rib Joists—*Rib metal lath shall be attached to concrete joists by loops of 0.0800-in. (2.03 mm) galvanized, annealed steel wire, with the ends the end perpendicular to the paper-bound edge or long edge.Subcommittee: C11.01 Standard: C473 of each loop twisted together.

7.10.5 Metal plaster bases shall be attached to masonry or concrete with power or powder actuated fasteners, or a combination of power or powder actuated fasteners and hardened concrete stub nails. One power or powder actuated fastener shall be located at each corner and one at the mid point of the long dimension adjacent to the edge of the metal plaster base expanded metal lath, or welded or woven wire lath.Subcommittee: C11.03 Standard: C926 sheet. The balance of the sheet shall be fastened with power or powder actuated fasteners, or hardened concrete stub nails. The fasteners shall be installed in rows not more than 16 in. (406 mm) on center and spaced vertically along each row not more 7 in. (178 mm) on center. Power-actuated All fasteners and shall concrete be stub corrosion nails resistant and shall be be not less than $^3/_4$ in. (19 mm) long, with heads not less than $^3/_8$ in. (10 (9.5 mm) wide. Where the head diameter of the power actuated fastener or concrete stub nail is smaller than 3/8-in. (10 mm), fastener nails, screws, or staples used for the application of the gypsum base or backing board.Subcommittee: C11.03 Standard: C844nails, staples, or screws used for application of the gypsum panel product.Subcommittee: C11.03 Standard: C1280a nail, screw, staple or power actuated fastener.Subcommittee: C11.02 Standard: C1861 shall use a 7/8-in. (22 mm) diameter minimum corrosion resistant metal washer, which shall be perforated when washer diameter exceeds 1 in. (25 mm).

7.11 Installation Application of Lathing Accessories:

*7.11.1 Lathing General—*All Accessory metal General Requirements—The type, location, ground dimension, and orientation of lathing accessories shall be indicated installed in the contract documents a series of several individual items that generally include drawings and specifications. Either or both of these documents may exist for any particular project.Subcommittee: C11.03 Standard: C926. 7.11.2 Install lathing accessories products fabricated for the purpose of forming corners, edges, control joints, or decorative effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints, such as casing beads, bull noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516 before cement plaster application to facilitate lathing installation, cement plaster see gypsum plaster, gypsum neat plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926 application, and functionality of the completed stucco a portland manner cement-aggregate than plaster mix designed for use on exterior surfaces. See portland cement plaster.Subcommittee: C11.91 Standard: C11portland cement-based plaster used on exterior locations.Subcommittee: C11.03 Standard: C926 cladding assembly. 7.11.3 Lathing Accessory Attachment Requirements: 7.11.3.1 Attach lathing accessory attachment flanges to substrate to ensure proper alignment during application of cement plaster. Secure lathing accessory attachment flanges at 7 in. (178 mm) maximum intervals along framing members studs joist, runners (tracks), bridging and bracing clips and provided related accessories.Subcommittee: C11.03 Standard: C1007. 7.11.3.2 Install lathing accessories products fabricated for the their purpose of forming corners, edges, control joints, or decorative effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints, such as casing beads, bull noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516 with key attachment flanges are to completely embed embedded the flanges in cement the plaster. see

7.11.1.1 gypsum Accessories plaster, shall gypsum be neat attached plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926. 7.11.3.3 Alternatively for solid plaster base substrates, adhere lathing accessory key attachment flanges directly to solid substrate plaster bases with adhesive applied in nominal 1 in. (25 mm) dabs at intervals in accordance with 7.11.3.1 or in a semi-continuous bead between the solid plaster base and the solid portion of the key attachment flange the attachment flange element of a lathing accessory that is full of holes or is expanded sheet metal that provides a means for accurate alignment, facilitates complete embedment of the key attachment flange and adjacent lath by cement plaster, and is used to attach the lathing accessory.Subcommittee: C11.02 Standard: C1861. 7.11.4 Lathing Accessory Water Management Requirements: 7.11.4.1 Where a defined drainage space is provided over the water-resistive barrier under lath and cement plaster, the ground dimension of lathing accessories with solid attachment flanges installed behind the water resistive barrier a material that resists the infiltration of liquid moisture through the building enclosure system.Subcommittee: C11.03 Standard: C1063 and defined drainage space to facilitate drainage, such as weep screeds, designated drainage screeds, expansion joints and drainage flashings, shall accommodate the defined drainage space dimension and specified cement plaster see gypsum plaster, gypsum neat plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926 thickness. 7.11.4.2 Install the water-resistive barrier and lathing to entirely cover the vertical solid attachment flange the solid attachment flange element of a lathing manner or furring accessory that provides a means for accurate alignment, facilitates drainage where drainage is required by integration of the solid attachment flange with the water-resistive barrier, and which has no holes except for optional fastener holes used to fasten the lathing accessory.Subcommittee: C11.02 Standard: C1861 of lathing accessories with a drainage function and drainage flashings such as weep screeds, designated drai nage screeds, expansion joints, and drainage flashings. Terminate lathing within 1/2 in. (13 mm) nominal above the lathing accessory drainage surface the sloped or non-sloped, perforated or non-perforated surface element of a lathing accessory that facilitates a drainage function, by directing water from behind the stucco cladding to the ensure exterior proper of alignment the during stucco application cladding.Subcommittee: C11.02 Standard: C1861. 7.11.4.3 At intersections of lathing plaster. accessories Flanges products fabricated for the purpose of forming corners, edges, control joints, or decorative effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints, such as casing beads, bull noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516 exposed at the cement plaster cladding finished surface, install the vertical lathing accessory continuously through the intersection unless the horizontally intersecting lathing accessory performs an expansion or drainage function, or both. Where vertical lathing accessories terminate above a drainage screed synonymous with ground.Subcommittee: C11.02 Standard: C1861 lathing accessory or drainage flashing, the intersection shall be kept secured free of sealant or other materials that will impede drainage. 7.11.4.4 Lathing accessories products fabricated for the purpose of forming corners, edges, control joints, or decorative effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints, such as casing beads, bull noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516 installed over the water-resistive barrier shall not impede drainage. 7.11.5 Foundation Weep Screed—install a weep screed lathing accessory at the bottom of steel or wood framed exterior walls. Locate the bottom edge of the weep screed lathing accessory not less more than 1 7 in. (25 (178 mm) below intervals the along joint supports. formed

7.11.2 by Corner the Beads—Corner foundation beads and shall framing. be Locate installed the weep screed lathing accessory ground the element of a lathing accessory that provides an edge, end, or termination for a cement plaster panel area, with a ground dimension to assist protect in all cement external plaster corners thickness control.Subcommittee: C11.02 Standard: C1861 a of 4 in. (102 mm) minimum above raw earth or 2 in. (51 mm) above paved surfaces. 7.11.6 Designated Drainage Screed—Install a designated drainage screed lathing accessory at locations indicated in the contract documents a series of several individual items that generally include drawings and specifications. Either or both of these documents may exist for any particular project.Subcommittee: C11.03 Standard: C926 and follow specified requirements in the contract documents a series of several individual items that generally include drawings and specifications. Either or both of these documents may exist for any particular project.Subcommittee: C11.03 Standard: C926. 7.11.7 Casing Bead—Install a casing bead lathing accessory or other suitable means, at locations to separate establish cement grounds. plaster

7.11.2.1 see External gypsum plaster, gypsum neat plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926 from dissimilar materials, penetrating elements, load bearing members in screw application of gypsum board, studs, runners (track), hat furring channels, main beams, and cross furring members of grid suspension systems or other items manufactured in accordance with this specification.Subcommittee: C11.02 Standard: C645studs, runners, tracks, bracing, bridging, accessories, or other items manufactured in accordance with this specification.Subcommittee: C11.02 Standard: C955 and to avoid transfer of structural loads. 7.11.8 Internal Corner Reinforcement—Install Reinforcement—External an internal corner reinforcement lathing shall accessory be at internal cement plaster corner locations except where lathing is installed continuously to through reinforce the all internal external corner, corners or where an corner expansion bead joint is lathing not accessory or control joint a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used. for Where designed no or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessory is installed at the internal corner location. 7.11.9 External Corner Reinforcement—Install an external corner reinforcement lathing or accessory at external cement plaster corner locations. bead Alternatively, where no external corner reinforcement lathing accessory is used used, on lath framed, and framed and sheathed construction, lathing shall be furred away out from the substrate and installed carried continuously around external corners for not a less minimum than distance of one framing member studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to on which frame a construction. gypsum

7.11.3 panel Casing product, Beads—Non-load-bearing or members metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not isolated less from than load-bearing 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not all less penetrating than elements, 6 with in. casing (152 beads mm) wide for gypsum studs. For internal corners or angles, other the suitable bearing means, surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive avoid the transfer gypsum of panel structural product. loads,Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787 beyond the corner. 7.11.10 Expansion Joint—Install an expansion joint lathing accessory at an expansion joint location in the building, the substrate surface to which separate the from DEFS dissimilar is materials. applied.

7.11.4Subcommittee: C11.05 Standard: C1516, or its components. 7.11.11 Control Joints—Install Joints control (General)—Control joint joints a shall joint be that formed accommodates by movement using of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063 a formed single product prefabricated used member, for designed or required fabricated separations by between installing adjacent casing surfaces beads of back gypsum to boards back or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessories in conformance with 7.10.1.5. 7.11.11.1 Form control joints by attaching a prefabricated flexible control barrier joint membrane a behind joint the that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessory, or alternatively by attaching a pair of casing beads. with The key attachment flanges, back to back, with a separation spacing shall be not less than $^1/_8$ in. (3 (3.2 mm) or as required pertaining to a mandatory obligation imposed by a force outside this standard, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C840pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C926 by the anticipated thermal exposure range range, and a flexible barrier membrane behind the casing beads. Wall or partition height door frames shall be considered in as conformance control with joints. 7.10.1.5 7.11.11.2. Install

7.11.4.1 control Control joint Joints—Control a (expansion joint that accommodates movement of plaster shrinkage and curing contraction) along joints predetermined, shall usually be straight, installed lines. inSubcommittee: walls C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessories at locations to delineate cement areas plaster not see more gypsum than plaster, gypsum neat plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926 panel areas of 144 ft^2 (13 (13.4 m^2) maximum and for to walls delineate and areas not more than 100 ft^2 (9 (9.30 m^2) maximum for all horizontal installations, applications, that is, ceilings, curves, or angle type structures. 7.11.11.3

7.11.4.2 Install The control distance joint between a control joint joints that shall accommodates not movement exceed of 18 plaster ft shrinkage (5.5 and m) curing in along either predetermined, direction usually or straight, lines.Subcommittee: C11.03 Standard: C1063 a formed length-to-width product ratio used for designed or required separations between adjacent surfaces of gypsum 2 boards[1] or / gypsum 2 veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessories at locations to delineate 1. cement A plaster control see joint gypsum shall plaster, be gypsum installed neat where plaster. theSubcommittee: ceiling C11.91 framing Standard: or C11 furringportland changes cement-based direction. cementitious

7.11.4.3 mixture An (see expansion stucco). jointSubcommittee: shall C11.03 be Standard: installed C926 where panel an areas expansion of joint 18 occurs ft in (5 the m) base maximum exterior dimension, wall. in

7.11.4.4 either Wall direction, or a partition maximum height length-to-width door ratio frames of shall 2 be1 considered/ as2 to 1. 7.11.11.4 Install a control joint joints. a

7.11.5 joint *Foundation that Weep accommodates Screed*—Foundation movement weep of screed plaster shall shrinkage be and installed curing at along the predetermined; bottom usually of straight, all lines. steelSubcommittee: or C11.03 wood Standard: framed C1063 exteriora walls formed to product receive used lath for and designed plaster. or Place required the separations bottom between edge adjacent surfaces of gypsum the boards foundation or weep gypsum screed veneer not base. lessSubcommittee: than C11.02 1 Standard: in. C1047 (25 lathing mm) accessory below at locations where the ceiling joint framing formed or by furring the preparing foundation a and wall or ceiling with framing. or The furring nose members of to the provide screed a shall level be surface placed or not airspace. lessSubcommittee: than C11.03 4 Standard: in. C754 (102spacer mm) strips above fastened raw to earth a wall, ceiling, or planar 2 element in. that (51 create mm) an above even paved surface surfaces. for The the weather application resistive of barrier metal and plaster bases or gypsum lathSubcommittee: shall C11.03 entirely Standard: cover C841 thespacer vertical elements attachment added flange to and a terminate building at structure the to top facilitate edge fastening of gypsum the panel nose products. orSubcommittee: ground C11.03 flange. Standard: C1546 changes direction.

8 KEYWORDS

8.1 ceiling; expansion control joints; lath; plaster; screed; suspended ceiling; walls

ANNEX

(Mandatory Information)

A1 GENERAL INFORMATION

A1.1 All wood-based sheathing shall be installed with a minimum $^1/_8$-in. (3 (3.2 mm) minimum gap around all panel edges and between openings for doors and windows.

NOTE A1.1: This $^1/_8$-in. (3 (3.2 mm) gap is intended to accommodate expansion. Linear expansion that is not accommodated by an expansion gap can cause stress on the stucco a portland cement aggregate plaster mix designed for use on exterior surfaces. See portland cement plaster.Subcommittee: C11.91 Standard: C11portland cement-based plaster used on exterior locations.Subcommittee: C11.03 Standard: C926 membrane resulting in stucco cracks.

APPENDIX

A1.2 (Nonmandatory *Expansion Information) Joints* X1.1 shall The be nominal used lap values specified pertaining to a accommodate mandatory some requirement degree of this movement standard or a referenced requirement (see 3.2.17).Subcommittee: C11.03 Standard: C840pertaining to a mandatory requirement of this specification or a referenced requirement.Subcommittee: C11.03 Standard: C1280 in 7.9.2 do not represent a maximum threshold value. Experience has shown that excessive lapping of expanded metal lath can inhibit proper embedment of the plaster in the underlying layer of lath which, in turn, can result in attendant corrosion and cracking of the stucco a membrane portland caused cement-aggregate by plaster movement mix designed for use on exterior surfaces. See portland cement plaster.Subcommittee: C11.91 Standard: C11portland cement-based plaster used on exterior locations.Subcommittee: C11.03 Standard: C926 finishes. The nominal value provided in

7.9.2 has been shown to perform successfully; lath see gypsum lath.Subcommittee: C11.91 Standard: C11 laps greater than this value may also perform successfully, but represent a heightened risk of embedment and cracking problems. SUMMARY OF CHANGES Committee C11 has identified the location building of or selected its changes components to this minimize standard damage since the last issue (C1063 — 18a) that may impact the use of this standard. (Approved April 1, 2018.) (1) Revised 7.9.2. (2) Added new Appendix X1. Committee C11 has identified the location of selected changes to this standard since the last stucco issue (C1063 — 18) that may impact the use of this standard. (Approved April 1, 2018.) (1) Removed A0641_A0641M, B0069, B0221, C0954, C1002, D1784, and D4216 water from resistive list barrier. of

A1.3 referenced *Control documents Joints* (Section shall 2). be (2) installed Added to Specifications minimize C1280 stress and due C1861 to list stucco of curing referenced documents (Section 2). (3) Added new 3.1.2 and renumbered drying subsequent shrinkage sections accordingly. (4) Removed previous 6.3 — 6.3.2 with new 6 — 6.3.2. (5) Removed previous 6.3.4 — 6.8.3. (6) Revised 7.1, 7.2.1 — 7.2.5, 7.3.4, 7.4 — 7.5.4, 7.6 — 7.6.2, 7.7.1 — 7.7.3. (7) Added new 7.8 and renumbered minor subsequent movement, sections along accordingly. predetermined, (8) usually Revised straight 7.9.2, lines 7.10.1.6, 7.10.1.7, 7.10.2.3, 7.10.3.2, 7.10.4, and 7.10.5. as (9) a Removed screed previous to 7.11 aid in 7.11.5 stucco and thickness replaced control. with

SUMMARY NEW OF 7.11 CHANGES — 7.11.11.4. (10) SWITCHED PREVIOUS TABLES 2 AND 3 (AND UPDATED IN TEXT TABLE REFERENCES ACCORDINGLY). (11) REVISED TABLE 3 AND TITLE OF FIG. 3. (12) REMOVED PREVIOUS A1.2 AND A1.3.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 — –17b) 15) that may impact the use of this standard. (Approved Jan. Aug. 1, 2018.) 2015.)

(1) Revised 7.8.3, definition 7.8.3.1, 7.10.4.1. (2) Replaced previous Table 3 with new Table 3. (3) Added new 2.2. (4) Added new Section 6, renumbered other sections accordingly. (5) Updated titles of Sections "water 4 resistive and barrier 5. system" Committee (formerly C11 "water has barrier identified system") the in location Terminology of (Section selected 3 changes). to this standard since the last issue (C1063 — 17a) that may impact the use of this standard. (Approved Dec. 1, 2017.) (1) Revised 7.9.2.3 and 7.10.4.1. (2) Combined previous Sections 4 and 5, added new Section 6, and renumbered subsequent sections accordingly.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 — –17a) 14d) that may impact the use of this standard. (Approved June 1, 2017.) 2015.)

(1) Added Definition new for 7.10.1.3. "drainage Committee plane" C11 has identified the location of selected changes to this standard since the last issue (C10633.2.4 —) 16c) was that revised. may impact the use of this standard. (Approved April 1, 2017.) (1) Removed previous 3.2.1, 3.2.4 — 3.2.6, , 3.2.14, 7.9, and renumbered subsequent sections accordingly.

(2) Replaced the terms "member" and "support" with " framing member studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787" throughout. (3) Replaced the term "support" with " framing member studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in.

(38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787". (4) Replaced the terms "application" and "applied" with "installation" and "installed" throughout. (5) Removed previous Note 2 and placed its contents in new 5.3.3. (6) Revised 7.10.1.4 7.10.2.2 and, 7.9.2.2. 7.10.2.4 (7), Added 7.10.2.5 new, 5.1 and renumbered 7.10.3.3 subsequent. sections accordingly. (8) Added new 5.8.3.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063— –16b) 14c) that may impact the use of this standard. (Approved Sept. Aug. 15, 2016.) 2014.)

(1) Revised 5.3.2 subsection and 7.10.1.7 7.10.1..

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063— –16a) 14b) that may impact the use of this standard. (Approved Sept. June 1, 2016.) 2014.)

(1) Corrected Definition table for reference water in resistive 7.6.1. barrier (2) was Added revised. 7.10.1.4. Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 — 16) that may impact the use of this standard. (Approved March 1, 2016.) (1) Revised 1.1.

(2) Revised Revisions 7.10.1.2. were Committee made C11 in has 7.7.4, identified 7.8.3.1, the location of selected changes to this standard since the last issue (C1063 — 15a) that may impact the use of this standard. (Approved Jan. 1, 2016.) (1) Revised 3.2.6 and 7.9.2.2. A1.2.

Committee C11 has identified the location of selected changes to this standard specification since the last issue (C1063— –15) 14a) that may impact the use of this standard. specification. (Approved Aug. April 1, 2015.) 2014.)

(1) Revised Addition definition of " the water exception resistive in barrier 7.8.3.1 a for material backing that to resists be the placed infiltration outboard of liquid moisture through the building weep enclosure screed system. flangeSubcommittee: to C11.03 be Standard: consistent C1063 with system" 7.11.5 (formerly. "water barrier system") in Terminology (Section 3).

FOOTNOTES

(1) This specification is under the jurisdiction of ASTM Committee C11 on Gypsum and Related Building Materials and Systems and is the direct responsibility of Subcommittee C11.03 on Specifications for the Application of Gypsum and Other Products in Assemblies.

Current edition approved June Aug. 1, 2018. 2015. Published July September 2018. 2015. Originally approved in 1986. Last previous edition approved in 2018 2015 as **C1063**— –18a. 15. DOI: 10.1520/C1063-18B. 10.1520/C1063-15A.

(2) For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

S7716

Date Submitted	12/6/2018	**Section**	702.2.2	**Proponent**	Borrone Jeanette
Chapter	7	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** | **Alternate Language** **No**

Related Modifications

R702.2.2 Cement plaster

Summary of Modification

corrects a standard pointer to the installation portion and eliminates erroneous statements about the veneer thickness at the end of the section

Rationale

There is an misplacement error in the reference standards as listed in the current section. ASTM C 926, Standard Specification for Application of Portland Cement - Based Plaster, is an application standard and belongs after "...in compliance with" prior to "ASTM C 1063."

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will not impact local entity

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction. There is no cost of construction significance in this item

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction. There is no cost of construction significance in this item

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction. There is no cost of construction significance in this item

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by corrects a standard pointer to the installation portion and eliminates erroneous statements about the veneer thickness at the end of the section

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by corrects a standard pointer to the installation portion and eliminates erroneous statements about the veneer thickness at the end of the section

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials, products, methods, or systems of construction corrects a standard pointer to the installation portion and eliminates erroneous statements about the veneer thickness at the end of the section

Does not degrade the effectiveness of the code

Increases the effectiveness of the code by corrects a standard pointer to the installation portion and eliminates erroneous statements about the veneer thickness at the end of the section

R702.2.2 Cement plaster.

Cement plaster materials shall conform to ASTM C 91 (Type M, S or N), C 150 (Type I, II and III), C 595 Type IP, I (PM), IS and I (SM), C 847, C 897, ~~C 926~~, C 933, C 1032, C 1047 and C 1328, and shall be installed or applied in compliance with ASTM C 926andC 1063. Gypsum lath shall conform to ASTM C 1396. Plaster shall be not less than three coats where applied over metal lath and not less than two coats where applied over other bases permitted by this section, ~~except that veneer plaster shall be applied in one coat not to exceed 3/16 inch (4.76 mm) thickness, provided the total thickness is in accordance with Table R702.1(1).~~

S7719

Date Submitted	12/6/2018	**Section**	702.2.1	**Proponent**	Borrone Jeanette
Chapter	7	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

R702.2.1 Gypsum plaster - This reference standard is new to the ICC Code Books

Summary of Modification

Add new standard to Gypsum plaster

Rationale

As currently written, the Code eliminates the use of full-depth plaster in favor of veneer plaster. However, the values in Table R702.1(1) Thickness of Plaster, reflect the values of ASTM C 842, Standard Specification for Application of Interior Gypsum Plaster. Thickness values for C 843, Standard Specification for Application of Gypsum Veneer Plaster, are much thinner. In addition, application of gypsum base is covered in the current reference standard, ASTM C 844.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will not impact local entity

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction. There is no cost of construction significance in this item

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction. There is no cost of construction significance in this item

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction. There is no cost of construction significance in this item

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by adding a new standard Specification for Installation of Interior Lathing and Furring and for Application of Interior Gypsum Plaster

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by adding a new standard Specification for Installation of Interior Lathing and Furring and for Application of Interior Gypsum Plaster

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials, products, methods, or systems of construction adding a new standard Specification for Installation of Interior Lathing and Furring and for Application of Interior Gypsum Plaster

Does not degrade the effectiveness of the code

Increases the effectiveness of the code by adding a new standard Specification for Installation of Interior Lathing and Furring and for Application of Interior Gypsum Plaster

R702.2.1 Gypsum plaster.

Gypsum plaster materials shall conform to ASTM C 5, C 22, C 28, C 35, C 59, C 61, C 587, C 631, C 847, C 933, C 1032 and C 1047, and shall be installed or applied in compliance with ASTM C841, C ~~843~~ 842 and C ~~844~~ 843. Gypsum lath or gypsum base for veneer plaster shall conform to ASTM C 1396 and shall be installed in compliance with ASTM C 844. Plaster shall be not less than three coats where applied over metal lath and not less than two coats where applied over other bases permitted by this section, except that veneer plaster shall be applied in one coat not to exceed 3/16 inch (4.76 mm) thickness, provided the total thickness is in accordance with Table R702.1(1).

Reference standards type:

This reference standard is new to the ICC Code Books

Add new standard(s) as follows:

ASTM C 841-03 (Reapproved 2013) Standard Specification for Installation of Interior Lathing and Furring;

ASTM C 842-05 (Reapproved 2015) Standard Specification for Application of Interior Gypsum Plaster;

S7746

Date Submitted	12/7/2018	**Section**	703.11.2.3	**Proponent**	Ann Russo1
Chapter	7	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

Summary of Modification

Deleting the code section.

Rationale

Section R703.11.2.3 is deleted because it is included as Exception #2 in Section R703.11.2.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal simply deletes duplication in the code.

Impact to building and property owners relative to cost of compliance with code

Will not increase construction cost.

Impact to industry relative to the cost of compliance with code

Will not increase construction cost.

Impact to small business relative to the cost of compliance with code

Will not increase construction cost.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal simply deletes duplication in the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal will improve the application of the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal will not discriminate against materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This proposal will not degrade the effectiveness of the code.

Delete without substitution:

~~**R703.11.2.3 Manufacturer specification.**~~

~~Where the vinyl siding manufacturer's product specifications provide an approved design wind pressure rating for installation over foam plastic sheathing, use of this design wind pressure rating shall be permitted and the siding shall be installed in accordance with the manufacturer's instructions.~~

Date Submitted	12/8/2018	**Section**	703.1.1	**Proponent**	Borjen Yeh
Chapter	7	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

Summary of Modification

Clarify wording in this Section.

Rationale

The term "veneer" can be misleading as its original meaning refers to a thin decorative covering. Certain siding products can exhibit structural and thermal properties which go beyond being decorative. "Cladding," on the other hand, is a more general term that can be applied to a wider range of products. The term "enters the assembly" can be misleading as it may suggest water penetrating into the structural assembly (i.e., stud cavity), which can no longer be drained to the exterior. Draining of exterior water should only apply to the water that has penetrated or passed through the first line of defense, the cladding. This change has been published in the 2018 IRC.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with code

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with code

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal clarifies the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

R703.1.1Water resistance. The exterior wall envelope shall be designed and constructed in a manner that prevents the accumulation of water within the wall assembly by providing a water-resistant barrier

behind the exterior ~~veneer~~ cladding as required by Section R703.2 and a means of draining to the exterior water that ~~enters the assembly. Protection against condensation in the exterior wall assembly shall be provided in accordance with Section R702.7 of this code~~ penetrate the exterior cladding.

Date Submitted	12/10/2018	Section	704	Proponent	T Stafford
Chapter	7	Affects HVHZ	No	Attachments	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

A new stand alone section is proposed for soffits with new language addressing other common materials and a new prescriptive option for wood structural panel soffits.

Rationale

The purpose of this code change proposal is to improve the high wind performance of soffits by clarifying FBCR installation requirements for the most common types of manufactured soffits and by providing a prescriptive alternative for wood structural panel soffits that comply with design wind pressures specified in the Florida Building Code and ASCE 7. See uploaded support file for additional rationale and justification.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with the code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to cost of compliance with the code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to cost of compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal clarifies wind requirements for soffits which should result in improved performance wand reduced water infiltration during design wind events.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal strengthens the code by clarifying the wind requirements for soffits which should result in improved performance wand reduced water infiltration during design wind events.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Mod 7821

Revise as follows:

R703.1.2.1 Wind resistance of soffits. Soffits and their attachments shall comply with Section R704. be capable of resisting wind loads specified in Tables R301.2(2) and R301.2(3) for walls using an effective wind area of 10 square feet.

Delete without substitution:

R703.11.1.4 Vinyl soffit panels. Soffit panels shall be individually fastened to a supporting component such as a nailing strip, fascia or subfascia component or as specified by the manufacturer's instructions.

Add new Section as follows:

SECTION R704

SOFFITS

R704.1 Wind resistance of soffits. Soffits and their attachments shall be capable of resisting wind loads specified in Tables R301.2(2) and R301.2(3) for walls using an effective wind area of 10 square feet.

R704.2 Soffit installation. Soffit installation shall comply with Section R704.2.1, Section R704.2.2, Section R704.2.3, Section R704.2.4.

R704.2.1 Vinyl soffit panels. Vinyl soffit panels shall be installed using fasteners specified by the manufacturer and shall be fastened at both ends to a supporting component such as a nailing strip, fascia or subfascia component. Where the unsupported span of soffit panels is greater than 12 inches, intermediate nailing strips shall be provided in accordance with Figure R704.2 unless a larger span is permitted in accordance with the manufacturer's product approval specification. Vinyl soffit panels shall be installed in accordance with the manufacturer's product approval specification and limitations of use. Fascia covers shall be installed in accordance with the manufacturer's product approval specification and limitations of use.

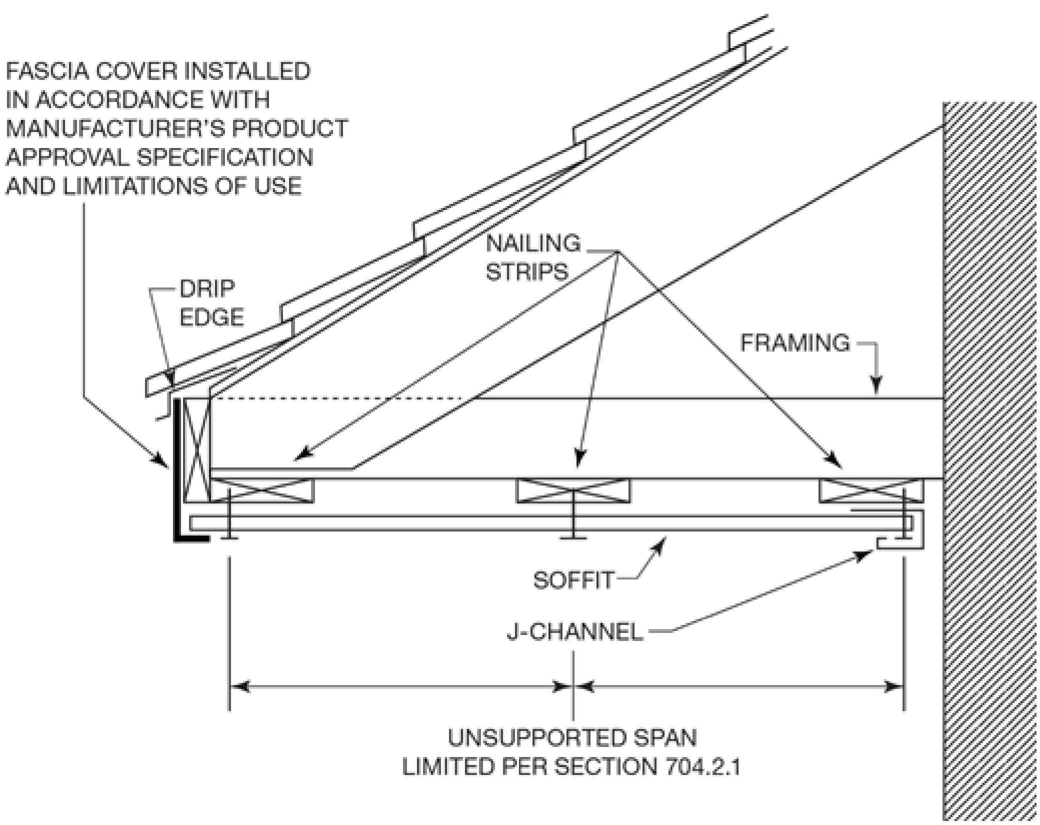


Figure R704.2 Typical vinyl soffit panel support

R704.2.2 Fiber-cement soffit panels. Fiber-cement soffit panels shall be a minimum of 1/4 inch thick and shall comply with the requirements of ASTM C1186, Type A, minimum Grade II or ISO 8336, Category A, minimum Class 2. Panel joints shall occur over framing or over wood structural panel sheathing. Soffit panels shall be installed with spans and fasteners in accordance with the manufacturer's product approval specification and limitations of use.

R704.2.3 Hardboard soffit panels. Where the design wind pressure is 30 psf or less, soffit panels shall be a minimum of 7/16 inch in thickness and shall be fastened to framing or nailing strips with 2 ½ " x 0.113" siding nails spaced not more than 6 inches on center at panel edges and 12 inches on center at intermediate supports. Where the design wind pressure is greater than 30 psf, hardboard soffit panels shall be installed in accordance with the manufacturer's product approval specification and limitations of use.

R704.2.4 Wood structural panel soffit prescriptive alternative. Wood structural panel soffit panels are permitted to be installed in accordance with Table R704.2.4.

Table 704.2.4

Installation Requirements for Wood Structural Panel, Closed Soffit[b,c,d,e,f]

Maximum Design Pressure (- or + psf)	Minimum Panel Span Rating	Minimum Panel Performance Category	Nail Type and Size (inch)	Fastener[a] Spacing along Edges and Intermediate Supports (inch)	
				Galvanized Steel	Stainless Steel
30	24/0	3/8	6d box (2 x 0.099 x 0.266 head diameter)	6[f]	4
40	24/0	3/8	6d box (2 x 0.099 x 0.266 head diameter)	6	4
50	24/0	3/8	6d box (2 x 0.099 x 0.266 head diameter)	4	4
			8d common (2½ x 0.131 x 0.281 head diameter)	6	6
60	24/0	3/8	6d box (2 x 0.099 x 0.266 head diameter)	4	3
			8d common (2½ x 0.131 x 0.281 head diameter)	6	4
70	24/16	7/16	8d common (2½ x 0.131 x 0.281 head diameter)	4	4
			10d box (3 x 0.128 x 0.312 head diameter)	6	4
80	24/16	7/16	8d common (2½ x 0.131 x 0.281 head diameter)	4	4
			10d box (3 x 0.128 x 0.312 head diameter)	6	4
90	32/16	15/32	8d common (2½ x 0.131 x 0.281 head diameter)	4	3
			10d common (3 x 0.148 x 0.312 head diameter)	6	4

a. Fasteners shall comply with Sections R703.3.2 and R703.3.3.

b. Maximum spacing of soffit framing members shall not exceed 24 inches.

c. Wood structural panels shall be of an exterior exposure grade.

d. Wood structural panels shall be installed with strength axis perpendicular to supports with a minimum of two continuous spans.

e. Wood structural panels shall be attached to soffit framing members with specific gravity of at least 0.42. Framing members shall be minimum 2x3 nominal with the larger dimension in the cross section aligning with the length of fasteners to provide sufficient embedment depths.

f. Spacing at intermediate supports is permitted to be 12 inches on center.

S7833

Date Submitted	12/10/2018	**Section**	702	**Proponent**	Ann Russo1
Chapter	7	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Modification correlates the requirements for exterior lath and plaster (stucco) with the requirements of ASTM C926 and C1063 and ACI 524R-08 Guide to Portland Cement-Based Plaster

Rationale

The purpose of this code change is to correlate the requirements for exterior lath and plaster (stucco) with the requirements of ASTM C926 and C1063 and ACI 524R-08 Guide to Portland Cement-Based Plaster The code requirements in the FBC Residential are not in alignment with the reference standards and industry recommended practice. This change clarifies that lath is not required for stucco to be applied to masonry, concrete or stone surfaces and updates the acceptable types of cement to current ASTM designations.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

The change corrects the designations for acceptable, currently available cement types and clarifies that lath is not required where stucco is permitted to be placed directly on concrete or masonry surfaces. No negative impact to local entity relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal simply corrects the designations for acceptable, currently available cement types clarifies that lath is not required where stucco is permitted to be placed directly on concrete or masonry surfaces.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal will improve the application of the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal will not discriminate against materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This proposal will not degrade the effectiveness of the code.

Revise as follows:

TABLE R702.1(3)
CEMENT PLASTER PROPORTIONS, PARTS BY VOLUME

COAT	CEMENT PLASTER TYPE	CEMENTITIOUS MATERIALS				VOLUME OF AGGREGATE PER SUM OF SEPARATE VOLUMES OF CEMENTITIOUS MATERIALS[b]
		Portland Cement Type I, II or III or Blended Hydraulic Cement Type IP, I(S<70), IL, or IT(S<70); or Hydraulic Cement Type GU, HE, MS, HS, or MH~~(PM), IS or I (SM)~~	Plastic Cement	Masonry Cement Type M, S or N	Lime	
First	Portland or blended	1			$^3/_4$ - $1^1/_2$[a]	$2^1/_2$- 4
	Masonry			1	~~1~~	$2^1/_2$- 4
	Plastic		1			$2^1/_2$- 4
Second	Portland or blended	1			$^3/_4$ - $1^1/_2$	3 -5
	Masonry			1		3 -5
	Plastic		1			3- 5
Finish	Portland or blended	1			~~$^3/_4$ - 2~~ 1 ½ - 2	$1^1/_2$ -3
	Masonry			1		$1^1/_2$- 3
	Plastic		1			$1^1/_2$- 3

(no change to the notes below)

Revise as follows:

R703.7 Exterior plaster (stucco).

(no change to the text)

R703.7.1 Lath.

Lath and lath attachments shall be of corrosion-resistant materials. Expanded metal or woven wire lath shall be attached with ~~11/2~~1 1/2-inch-long (38 mm), 11 gage nails having a 7/16-inch (11.1 mm) head, or 7/8-~~inchlong~~inch-long (22.2 mm), 16 gage staples, spaced not more than 6 inches (152mm) or as otherwise approved.

Exception: Lath is not required over masonry, cast-in-place concrete, precast concrete or stone substrates prepared in accordance with ASTM C1063.

R703.7.2 Plaster.

Plastering with ~~portland~~ cement plaster shall be ~~not less than three coats where applied over metal lath or wire lath and shall be not less than two coats where applied over masonry, concrete, pressure-preservativetreated wood or decay-resistant wood as specified on Section R317.1 or gypsum backing. If the plaster surface is completely covered by veneer or other facing materials or is completely concealed, plaster application need be only two coats, provided the total thickness is as set forth in Table R702.1(1).~~in accordance with ASTM C926. Cement materials shall be in accordance with one of the following:

1. Masonry cement conforming to ASTM C91 Type M, S or N.

2. Portland cement conforming to ASTM C150 Type I, II or III.

3. Bleanded hydraulic cement conforming to ASTM C595 Type IP, IS(S<70), IL or IT(S<70).

4. Hydraulic cement conforming to ASTM C1157 Type GU, HE, MS, HS or MH.

5. Plaster (stucco) cement conforming to ASTM C1328.

Plaster shall be not less than three coats where applied over metal lath or wire lath and shall be not less than two coats where applied over masonry, concrete, pressure-preservative-treated wood or decay- resistant wood as specified in Section R317.1 or gypsum backing. If the plaster surface is completely covered by veneer or other facing material or is completely concealed, plaster application need be only two coats, provided the total thickness is as set forth in Table R702.1(1).

On wood-frame construction with an on-grade floor slab system, exterior plaster shall be applied to cover, but not extend below, lath, paper and screed.

The proportion of aggregate to cementitious materials shall be as set forth in Table R702.1(3).

S7844

Date Submitted	12/10/2018	**Section**	703.8.4	**Proponent**	Borjen Yeh
Chapter	7	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

Summary of Modification

Revise Section R703.8.4 and add a new table.

Rationale

The trend toward using more foam sheathing along with the use of advanced framing techniques in an effort to conserve energy has made it increasingly difficult to install wall cladding. Not only is the framing difficult to find under 2 inches of foam and building paper or house wrap, but it may not even be present near corners and around openings because it may be completely masked by trim at corners and around windows. The attachment of brick veneer brick-ties can similarly be a problem as the current attachment recommendations assume the brick ties are going to be nailed directly to those scarce framing members. The proposed table provided brick-tie attachment recommendations for attachment directly to a minimum 7/16 performance category wood structural panels. As the wood structural panel thickness does not permit the full use of the nail's shank, it is essential that either ring-shank nails or screws be used to keep the brick veneer in place. The added table provides this information. We think that while the use of ring shank fasteners will not be appropriate for every installation, the table provided is a tool that the mason may use if faced with the attachment of brick to a fully sheathed, energy efficient home. The proposed changes have been published in the 2018 IRC.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal provides a practical and alternative provision for brick tie attachment directly to wood structural panel sheathing

Impact to building and property owners relative to cost of compliance with code

The code change will slightly increase the cost of construction, which may be readily offset by a number of factors. Based on Housewyse.com estimates, the increase in building costs is about $0.07 per square foot, which can be offset at least partially by the advantage of this code provision.

Impact to industry relative to the cost of compliance with code

The code change will slightly increase the cost of construction but may be offset by other advantages of this provision. See comments above.

Impact to small business relative to the cost of compliance with code

The code change will slightly increase the cost of construction but may be offset by other advantages of this provision. See comments above.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal has a reasonable and substantial connection with the health, safety, and welfare of the general public

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Mod 7844

R703.8.4 Anchorage.

Masonry veneer shall be anchored to the supporting wall studs with corrosion-resistant metal ties embedded in mortar or grout and extending into the veneer a minimum of 11/2 inches (38 mm), with not less than 5/8-inch (15.9 mm) mortar or grout cover to outside face. Masonry veneer shall conform to Table R703.8.4(1). For masonry veneer tie attachment through insulating sheathing not greater than 2 inches (51 mm) in thickness to not less than 7/16 performance category wood structural panel, see Table R703.8.4(2).

TABLE R703.8.4(1)

TIE ATTACHMENT AND AIRSPACE REQUIREMENTS

TIE ATTACHMENT AND AIRSPACE REQUIREMENTS

BACKING AND TIE	MINIMUM TIE	MINIMUM TIE FASTENER[a]	AIRSPACE[c]	
Wood stud backing with corrugated sheet metal	22 U.S. gage (0.0299 in.) × $^{7}/_{8}$ in. wide	8d common nail [b] ($2^{1}/_{2}$ in. × 0.131 in.)	Nominal 1 in. between sheathing and veneer	
Wood stud backing with metal strand wire	W1.7 (No. 9 U.S. gage; 0.148 in.) with hook embedded in mortar joint	8d common nail b ($2^{1}/_{2}$ in. × 0.131 in.)	Minimum nominal 1 in. between sheathing and veneer	Maximum $4^{1}/_{2}$in. between backing and veneer
Cold-formed steel stud backing with adjustable metal strand wire	W1.7 (No. 9 U.S. gage; 0.148 in.) with hook embedded in mortar joint	No. 10 screw extending through the steel framing a minimum of three exposed threads	Minimum nominal 1 in. between sheathing and veneer	Maximum $4^{1}/_{2}$in. between backing an

For SI: 1 inch = 25.4 mm.

a. In Seismic Design Category D_0, D_1 or D_2, the minimum tie fastener shall be an 8d ring-shank nail ($2^1/_2$ in. × 0.131 in.) or a No. 10 screw extending through the steel framing a minimum of three exposed threads.

b. All fasteners shall have rust-inhibitive coating suitable for the installation in which they are being used, or be manufactured from material not susceptible to corrosion.

c. An airspace that provides drainage shall be permitted to contain mortar from construction.

Add the following new Table R703.8.4(2)

TABLE R703.8.4(2) REQUIRED BRICK TIE SPACING FOR DIRECT APPLICATION TO WOOD STRUCTURAL PANEL SHEATHING[a,b,c]

FASTENER TYPE[d]	SIZE (DIA. OR SCREW #)	REQUIRED BRICK-TIE SPACING (VERTICAL-TIE SPACING/HORIZONTAL-TIE SPACING) (inches/inches)											
		110 mph V Ultimate			115 mph V Ultimate			130 mph V Ultimate			140 mph V Ultimate		
		Zone 5, Exposure B	Zone 5, Exposure C	Zone 5, Exposure D	Zone 5, Exposure B	Zone 5, Exposure C	Zone 5, Exposure D	Zone 5, Exposure B	Zone 5, Exposure C	Zone 5, Exposure D	Zone 5, Exposure B	Zone 5, Exposure C	Zone 5, Exposure D
Ring Shank Nails	0.091	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	12/12	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	12/12	16/12, 12/16, 12/12	12/12	—	12/12	—	—
	0.148	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	12/12
Screws	#6	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	12/12
	#8	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/12, 12/16, 12/12
	#10	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12
	#14	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12

For SI: 1 inch = 25.4 mm, 1 mph = 0.447 m/s.

a. This table is based on attachment of brick ties directly to wood structural panel sheathing only. Additional attachment of the brick tie to lumber framing is not required. The brick ties shall be permitted to be placed over any insulating sheathing, not to exceed 2 inches in thickness. Wood structural panel sheathing shall be a minimum 7/16 performance category. The table is based on a building height of 30 feet or less.

b. Wood structural panels shall have a specific gravity of 0.42 or greater in accordance with NDS.

c. Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C578 or ASTM C1289.

d. Fasteners shall be sized such that the tip of the fastener passes completely through the wood structural panel sheathing by not less than $^1/_4$ inch.

S7943 272

Date Submitted	12/11/2018	**Section**	703.2	**Proponent**	Ann Russo8
Chapter	7	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No **Alternate Language** No

Related Modifications

RB283-16 & RB284-16

Summary of Modification

This proposal is to remove the exception for accessory buildings and requires them to have the water-resistive barrier.

Rationale

The wall sheathing and framing will experience the same damaging affect of moisture as a SFD will experience.

- Virtually all exterior wall covering manufacturers require a water resistive barrier under their products.
- Vinyl siding installer typically seek to use this except to allow installation of vinyl siding over sheathing on exterior walls of detached garages and storage sheds; however the siding manufacturers installation instructions specifically state their product should not be considered a water resistive barrier.
- Eliminating this exception will provide clarity to the code in that the water-resitive barrier is required by the manufacturers, insuring the products are installed correctly.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Eliminating this exception will provide clarity to the code in that the water-resitive barrier is required by the manufacturers, insuring the products are installed correctly.

Impact to building and property owners relative to cost of compliance with code

Eliminating this exception will provide clarity to the code in that the water-resitive barrier is required by the manufacturers, insuring the products are installed correctly and should not increase the cost of construction.

Impact to industry relative to the cost of compliance with code

Eliminating this exception will provide clarity to the code in that the water-resitive barrier is required by the manufacturers, insuring the products are installed correctly and should not increase the cost of construction.

Impact to small business relative to the cost of compliance with code

Eliminating this exception will provide clarity to the code in that the water-resitive barrier is required by the manufacturers, insuring the products are installed correctly and should not increase the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Eliminating this exception will provide clarity to the code in that the water-resitive barrier is required by the manufacturers, insuring the products are installed correctly and will provide better protection of property.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Eliminating this exception will provide clarity to the code in that the water-resitive barrier is required by the manufacturers, insuring the products are installed correctly and will provide better protection of property.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This is a clarification only and does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code but actually enhances the effectiveness of the code.

Section: R703.2

Revise as follows:

R703.2 Water-resistive barrier. One layer of No. 15 asphalt felt, free from holes and breaks, complying with ASTM D 226 for Type 1 felt or other approved water-resistive barrier shall be applied over studs or sheathing of all exterior walls. ~~Such~~ No.15 asphalt felt ~~or material~~ shall be applied horizontally, with the upper layer lapped over the lower layer not less than 2 inches (51 mm). Where joints occur, felt shall be lapped not less than 6 inches (152 mm). Other approved materials shall be installed in accordance with the *water-resistive barrier* manufacturer's installation instructions. The No. 15 asphalt felt or other approved *water-resistive barrier* material shall be continuous to the top of walls and terminated at penetrations and building appendages in a manner to meet the requirements of the exterior wall envelope as described in Section R703.1. ~~The water-resistive barrier is not required for detached accessory buildings.~~

Date Submitted	12/11/2018	**Section**	703	**Proponent**	Ann Russo8
Chapter	7	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

RB308-16

Summary of Modification

This proposal updates the table values to a consistent rounding approach by rounding the values down to the nearest 0.05" to address actual thicknesses of foam sheathing materials that often vary from nominal dimensions such as 0.5", 1", 1.5" 2", 3" and 4".

Rationale

This proposal updates the table values to a consistent rounding approach by rounding the values down to the nearest 0.05" to address actual thicknesses of foam sheathing materials that often vary from nominal dimensions such as 0.5", 1", 1.5" 2", 3" and 4" & 18psf cladding weight category was added.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

The proposal adds an additional option (18 psf cladding weight) and does not increase cost of enforcement.

Impact to building and property owners relative to cost of compliance with code

The proposal adds an additional option (18 psf cladding weight) and does not increase cost.

Impact to industry relative to the cost of compliance with code

The proposal adds an additional option (18 psf cladding weight) and does not increase cost.

Impact to small business relative to the cost of compliance with code

The proposal adds an additional option (18 psf cladding weight) and does not increase cost.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The proposal adds an additional option (18 psf cladding weight) and improves the code by adding the additional option.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The proposal adds an additional option (18 psf cladding weight) and improves the code by adding the additional option.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The proposal adds an additional option (18 psf cladding weight) and improves the code by adding the additional option. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not degrade the effectiveness of the code

The proposal adds an additional option (18 psf cladding weight) and improves the code by adding the additional option. Does not degrade the effectiveness of the code

Section: R703.15.1, R703.15.2

Revise as follows:

TABLE R703.15.1

CLADDING MINIMUM FASTENING REQUIREMENTS FOR DIRECT ATTACHMENT OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[a]

CLADDING FASTENER THROUGH FOAD SHEATHING	CLADDING FASTENER TYPE AND MINIMUM SIZE[b]	CLADDING FASTENER VERTICAL SPACING (inches)	MAXIMUM THICKNESS OF FOAM SHEATHING[c] (inches)							
			16? o.c. Fastener Horizontal Spacing				24? o.c. Fastener Horizontal Spacing			
			Cladding Weight:				Cladding Weight:			
			3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Wood Framing (minimum 1 1/4 -inch penetration)	0.113? diameter nail	6	2.00	1.45	0.75	DR	2.00	0.85 ~~75~~	DR	DR
		8	2.00	1.00	DR	DR	2.00	0.55	DR	DR
		12	2.00	0.55	DR	DR	1.85~~2~~	DR	DR	DR
	0.120? diameter nail	6	3.00	1.70 ~~5~~	0.90	0.55	3.00	1.05 ~~75~~	0.50	DR
		8	3.00	1.20	0.60	DR	3.00	0.70 ~~5~~	DR	DR
		12	3.00	0.70 ~~5~~	DR	DR	2.15	DR	DR	DR
	0.131? diameter nail	6	4.00	2.15	1.20	0.75	4.00	1.35	0.70	DR
		8	4.00	1.55	0.80	DR ~~0.5~~	4.00	0.90 ~~75~~	DR	DR
		12	4.00	0.90 ~~75~~	DR	DR	2.70	0.50	DR	DR
	0.162? diameter nail	6	4.00	3.55 4	2.05	1.40 ~~5~~	4.00	2.25	1.25	0.80 ~~1~~
		8	4.00	2.55 ~~3~~	1.45	0.95 ~~1~~	4.00	1.60 ~~5~~	0.85	0.50 ~~75~~
		12	4.00	1.60 ~~2~~	0.85	0.50 ~~75~~	4.00	0.95 ~~1~~	DR	DR

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa. DR = Design required.

o.c. = on center

Wood framing shall be Spruce-pine-fir or any wood species with a specific gravity of 0.42 or greater in accordance with AWC NDS.

b. Nail fasteners shall comply with ASTM F 1667, except nail length shall be permitted to exceed ASTM F 1667 standardlengths.

Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C 578 or ASTM C1289.

TABLE R703.15.2

FURRING MINIMUM FASTENING REQUIREMENTS FOR APPLICATION OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[a, b]

FURRING MATERIAL	FRAMING MEMBER	FASTENER TYPE AND MINIMUM SIZE	MINIMUM PENETRATION INTO WALL FRAMING (inches)	FASTENER SPACING IN FURRING (inches)	MAXIMUM THICKNESS OF FOAM SHEATHING[d] (inches)							
					16? o.c. Furring[e]				24? o.c. Furring[e]			
					Siding Weight:				Siding Weight:			
					3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Minimum 1× Wood Furring[c]	Minimum 2× Wood Stud	0.131? diameter nail	$1^1/_4$	8	4.00	2.45	1.45	0.95 ~~1~~	4.00	1.60 ~~5~~	0.85	DR
				12	4.00	1.605	0.85	DR	4.003	0.95 ~~1~~	DR	DR
				16	4.00	1.10	DR	DR	3.05	0.60 ~~5~~	DR	DR
		0.162? diameter nail	$1^1/_4$	8	4.00	4.00	2.45	1.60~~5~~	4.00	2.75	1.45	0.85 ~~75~~
				12	4.00	2.75	1.45	0.85 ~~75~~	4.00	1.65	0.75	DR
				16	4.00	1.90~~5~~	0.95	DR	4.00	1.05	DR	DR
		No.10 wood screw	1	12	4.00	2.30	1.20	0.70 ~~5~~	4.00	1.40 ~~5~~	0.60	DR
				16	4.00	1.6 5	0.75	DR	4.00	0.90 ~~1~~	DR	DR
				24	4.00	0.90~~1~~	DR	DR	2.85~~3~~	DR	DR	DR
		$^1/_4$? lag screw	$1^1/_2$	12	4.00	2.6 5~~3~~	1.50	0.90 ~~1~~	4.00	1.65 ~~2~~	0.80	DR ~~0.5~~
				16	4.00	1.9 5	0.95	0.50 ~~DR~~	4.00	1.105	DR	DR
				24	4.00	1.10 ~~5~~	DR	DR	3.25 4	0.50 ~~75~~	DR	DR

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa. DR = Design required.

o.c. = on center

Wood framing and furring shall be Spruce-pine-fir or any wood species with a specific gravity of 0.42 or greater in accordance with AWCNDS.

b. Nail fasteners shall comply with ASTM F 1667, except nail length shall be permitted to exceed ASTM F 1667 standardlengths.

c. Where the required cladding fastener penetration into wood material exceeds $^3/_4$ inch and is not more than $1^1/_2$ inches, a minimum 2× wood furring or an approved design shall beused.

d. Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C 578 or ASTM C1289. Furring shall be spaced not more than 24 inches on center, in a vertical or horizontal orientation. In a vertical orientation, furring shall be located over wall studs and attached with the required fastener spacing. In a horizontal orientation, the indicated 8-inch and 12-inch fastener spacing in furring shall be achieved by use of two fasteners into studs at 16 inches and 24 inches on center, respectively.

S7945

Date Submitted	12/11/2018	**Section**	703.16	**Proponent**	Ann Russo8
Chapter	7	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

RB309-16

Summary of Modification

This proposal updates the table values to a consistent rounding approach by rounding the values down to the nearest 0.05" to address actual thicknesses of foam sheathing materials that often vary from nominal dimensions such as 0.5", 1", 1.5", 2", 3", and 4".

Rationale

This proposal updates the table values to a consistent rounding approach by rounding the values down to the nearest 0.05" to address actual thicknesses of foam sheathing materials that often vary from nominal dimensions such as 0.5", 1", 1.5", 2", 3", and 4" as used in the existing table & 18 psf cladding weight category was added.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal adds an additional option (18 psf cladding weight) and does not increase cost.

Impact to building and property owners relative to cost of compliance with code

This proposal adds an additional option (18 psf cladding weight) and does not increase cost.

Impact to industry relative to the cost of compliance with code

This proposal adds an additional option (18 psf cladding weight) and does not increase cost.

Impact to small business relative to the cost of compliance with code

This proposal adds an additional option (18 psf cladding weight) and does not increase cost.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal adds an additional option (18 psf cladding weight) and does not effect the enforcement of the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal adds an additional option (18 psf cladding weight) and provides an additional option to the table.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal adds an additional option (18 psf cladding weight) and provides an additional option to the table and does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal adds an additional option (18 psf cladding weight) and provides an additional option to the table and does not degrade the effectiveness of the code.

Section: R703.16.1, R703.16.2

Revise as follows:

TABLE R703.16.1

CLADDING MINIMUM FASTENING REQUIREMENTS FOR DIRECT ATTACHMENT OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[a]

CLADDING FASTENER THROUGH FOAM SHEATHING INTO:	CLADDING FASTENER TYPE AND MINIMUM SIZE[b]	CLADDING FASTENER VERTICAL SPACING (inches)	MAXIMUM THICKNESS OF FOAM SHEATHING[c] (inches)							
			16? o.c. Fastener Horizontal Spacing				24" o.c. Fastener Horizontal Spacing			
			Cladding Weight:				Cladding Weight:			
			3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Steel Framing (minimum penetration of steel thickness + 3 threads)	No. 8 screw into 33 mil steel or thicker	6	3.00	2.953	2.20	1.45	3.00	2.35	1.25	DR
		8	3.00	2.55	1.60	0.605	3.00	1.805	DR	DR
		12	3.00	1.805	DR	DR	3.00	0.6575	DR	DR
	No. 10 screw into 33 mil steel	6	4.00	3.50	2.70	1.952	4.00	2.903	1.70	0.55
		8	4.00	3.10	2.05	1.00	4.00	2.25	0.70	DR
		12	4.00	2.25	0.70	DR	3.70	1.05	DR	DR
	No. 10 screw into 43 mil steel or thicker	6	4.00	4.00	4.00	3.60	4.00	4.00	3.45	2.70
		8	4.00	4.00	3.70	3.002	4.00	3.85	2.80	1.805
		12	4.00	3.85	2.80	1.805	4.00	3.05	1.50	DR

For SI: 1 inch = 25.4 mm, 1 mil = 0.0254 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa. DR = Design required.

o.c. = on center

a. Steel framing shall be minimum 33 ksi steel for 33 mil and 43 mil steel, and 50 ksi steel for 54 mil steel orthicker.

b. Screws shall comply with the requirements of ASTM C1513.

c. Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C 578 or ASTM C1289.

TABLE R703.16.2
FURRING MINIMUM FASTENING REQUIREMENTS FOR APPLICATION OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[a]

FURRING MATERIAL	FRAMING MEMBER	FASTENER TYPE AND MINIMUM SIZE[b]	MINIMUM PENETRATION INTO WALL FRAMING (inches)	FASTENER SPACING IN FURRING (inches)	MAXIMUM THICKNESS OF FOAM SHEATHING[d] (inches) 16? o.c. Furringe Cladding Weight: 3 psf	11 psf	18 psf	25 psf	24? o.c. Furringe Cladding Weight: 3 psf	11 psf	18 PSF	25 psf
Minimum 33 mil Steel Furring or Minimum 1 × Wood Furring[c]	33 mil Steel Stud	No. 8 screw	Steel thickness + 3 threads	12	3.00	1.805	DR	DR	3.00	0.65	DR	DR
				16	3.00	1.00	DR	DR	2.85	DR	DR	DR
				24	2.85	DR	DR	DR	2.20	DR	DR	DR
		No. 10 screw	Steel thickness + 3 threads	12	4.00	2.25	0.70	DR	3.704	1.05	DR	DR
				16	3.85 4	1.45	DR	DR	3.40	DR	DR	DR
				24	3.40	DR	DR	DR	2.70	DR	DR	DR
	43 mil or thicker SteelStud	No. 8 Screw	Steel thickness + 3 threads	12	3.00	1.805	DR	DR	3.00	0.65	DR	DR
				16	3.00	1.00	DR	DR	2.85	DR	DR	DR
				24	2.85	DR	DR	DR	2.20	DR	DR	DR
		No. 10 screw	Steel thickness + 3 threads	12	4.00	3.85	2.80	1.805	4.00	3.05	1.50	DR
				16	4.00	3.30	1.95	0.605	4.00	2.25	DR	DR
				24	4.00	2.25	DR	DR	4.00	0.65	DR	DR

For SI: 1 inch = 25.4 mm, 1 mil = 0.0254 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa. DR = Design required.

o.c. = on center

Wood furring shall be Spruce-pine-fir or any softwood species with a specific gravity of 0.42 or greater. Steel furring shall be minimum 33 ksi steel. Steel studs shall be minimum 33 ksi steel for 33mil and 43 mil thickness, and 50 ksi steel for 54 mil steel or thicker.

Screws shall comply with the requirements of ASTM C1513.

c. Where the required cladding fastener penetration into wood material exceeds $^{3}/_{4}$ inch and is not more than $1^{1}/_{2}$ inches, a minimum 2-inch nominal wood furring or an approved design shall beused.

d. Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C 578 or ASTM C1289.

Furring shall be spaced not more than 24 inches (610 mm) on center, in a vertical or horizontal orientation. In a vertical orientation, furring shall be located over wall studs and attached with the required fastener spacing. In a horizontal orientation, the indicated 8-inch and 12-inch fastener spacing in furring shall be achieved by use of two fasteners into studs at 16 inches and 24 inches on center,respectively

S7989

Date Submitted	12/12/2018	**Section**	702.3.3	**Proponent**	Bonnie Manley
Chapter	7	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

7856, 7857, 7858, 7991

Summary of Modification

This proposal is one in a series adopting the latest generation of AISI standards for cold-formed steel.

Rationale

Modifies text of Section R702.3.3 Cold-formed steel framing by adding a reference to the new standard AISI S240-15; AISI S200 has been incorporated into AISI S240. Reference to ASTM C955 is no longer necessary.

Additionally, the screw penetration test, as referenced to ASTM C645, Section 10, has been incorporated into AISI S220-15, North American Standard for Cold-Formed Steel Framing - Non-Structural Members. Reference to AISI S220 is sufficient to cover those requirements.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

R702.3.3 Cold-formed steel framing.

Cold-formed steel framing supporting gypsum board and gypsum panel products shall be not less than 1 $^{1}/_{4}$ inches (32 mm) wide in the least dimension. Nonload-bearing cold-formed steel framing shall comply with AISI S220 ~~and ASTM C645, Section 10~~. Load-bearing cold-formed steel framing shall comply with AISI S240 ~~S200 and ASTM C 955, Section 8~~.

S8346

Date Submitted	12/15/2018	**Section**	703.15.1	**Proponent**	John Woestman
Chapter	7	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

This proposal updates the existing tables by applying a consistent rounding down to the nearest 0.05" for foam sheathing thickness to better and more efficiently accommodate various foam sheathing products that have actual thickness that vary from nominal thickness currently in the table.

Rationale

This proposal updates the existing tables by applying a consistent rounding down to the nearest 0.05" for foam sheathing thickness to better and more efficiently accommodate various foam sheathing products that have actual thickness that vary from nominal thickness currently in the table. The same rounding is applied to the addition of an 18 psf cladding weight category at the request of the brick industry. All of the values were determined using the same analysis and research basis of the original tables, including capping foam thicknesses at 2" for 0.113-in diameter nail in wood framing and 3" for 0.120-in diameter nail in wood framing was done for the existing tables based on availability of fastener lengths and practicality considerations.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Revisions to the entries in the table should not have an impact on code enforcement.

Impact to building and property owners relative to cost of compliance with code

This proposal should not increase cost of code compliance. This proposal may actually decrease cost as a result of more efficient design for foam thickness and fastener sizing.

Impact to industry relative to the cost of compliance with code

This proposal should not increase cost of code compliance. This proposal may actually decrease cost as a result of more efficient design for foam thickness and fastener sizing.

Impact to small business relative to the cost of compliance with code

This proposal should not increase cost of code compliance. This proposal may actually decrease cost as a result of more efficient design for foam thickness and fastener sizing.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Appropriate requirements for maximum thickness of foam sheathing and fastening of cladding over this foam help assure long-term performance of the cladding.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code with refinements in requirements.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials - provides choices and options.

Does not degrade the effectiveness of the code

Improves the effectiveness of the code.

Revise the body of Table R703.15.1 by inserting the 18 psf column, and modifying most cells. Revisions are shown as replacing existing entries in the cells.

TABLE R703.15.1 CLADDING MINIMUM FASTENING REQUIREMENTS

FOR DIRECT ATTACHMENT OVER FOAM PLASTIC SHEATHING

TO SUPPORT CLADDING WEIGHT[a]

Cladding Fastener Through Foam Sheathing into:	Cladding Fastener -Type and Minimum Size[b]	Cladding Fastener Vertical Spacing (inches)	Maximum Thickness of Foam Sheathing[c] (inches)							
			16" o.c. Fastener Horizontal Spacing				24" o.c. Fastener Horizontal Spacing			
			Cladding Weight:				Cladding Weight:			
			3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Wood Framing (minimum 1-1/4 inch penetration)	0.113" diameter nail	6	2.00	1.45	0.75	DR	2.00	0.85	DR	DR
		8	2.00	1.00	DR	DR	2.00	0.55	DR	DR
		12	2.00	0.55	DR	DR	1.85	DR	DR	DR
	0.120" diameter nail	6	3.00	1.70	0.90	0.55	3.00	1.05	0.50	DR
		8	3.00	1.20	0.60	DR	3.00	0.70	DR	DR
		12	3.00	0.70	DR	DR	2.15	DR	DR	DR
	0.131" diameter nail	6	4.00	2.15	1.20	0.75	4.00	1.35	0.70	DR
		8	4.00	1.55	0.80	DR	4.00	0.90	DR	DR
		12	4.00	0.90	DR	DR	2.70	0.50	DR	DR
	0.162" diameter nail	6	4.00	3.55	2.05	1.40	4.00	2.25	1.25	0.80
		8	4.00	2.55	1.45	0.95	4.00	1.60	0.85	0.50
		12	4.00	1.60	0.85	0.50	4.00	0.95	DR	DR

(Table Notes unchanged)

Revise the body of Table R703.15.2 by inserting the 18 psf column, and modifying most cells. Revisions are shown as replacing existing entries in the cells.

TABLE R703.15.2 FURRING MINIMUM FASTENING REQUIREMENTS FOR APPLICATION

OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[a,b]

Furring Material	Framing Member	Fastener Type and Minimum Size	Minimum Penetration into Wall Framing (inches)	Fastener Spacing in Furring (inches)	Maximum Thickness of Foam Sheathing[d] (inches)							
					16"oc Furring[e]				24"oc Furring[e]			
					Siding Weight:				Siding Weight:			
					3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Minimum 1x Wood Furring[c]	Minimum 2x Wood Stud	0.131" diameter nail	1-1/4	8	4.00	2.45	1.45	0.95	4.00	1.60	0.85	DR
				12	4.00	1.60	0.85	DR	4.00	0.95	DR	DR
				16	4.00	1.10	DR	DR	3.05	0.60	DR	DR
		0.162" diameter nail	1-1/4	8	4.00	4.00	2.45	1.60	4.00	2.75	1.45	0.85
				12	4.00	2.75	1.45	0.85	4.00	1.65	0.75	DR
				16	4.00	1.90	0.95	DR	4.00	1.05	DR	DR
		No. 10 wood screw	1	12	4.00	2.30	1.20	0.70	4.00	1.40	0.60	DR
				16	4.00	1.65	0.75	DR	4.00	0.90	DR	DR
				24	4.00	0.90	DR	DR	2.85	DR	DR	DR
		¼" lag screw	1-1/2	12	4.00	2.65	1.50	0.90	4.00	1.65	0.80	DR
				16	4.00	1.95	0.95	0.50	4.00	1.10	DR	DR
				24	4.00	1.10	DR	DR	3.25	0.50	DR	DR

(Table notes unchanged)

S8348

Date Submitted	12/15/2018	**Section**	703.16.1	**Proponent**	John Woestman
Chapter	7	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

8346

Summary of Modification

This proposal updates the existing tables by applying a consistent rounding down to the nearest 0.05" for foam sheathing thickness to better and more efficiently accommodate various foam sheathing products that have actual thickness that vary from nominal thickness currently in the table.

Rationale

This proposal updates the existing tables by applying a consistent rounding down to the nearest 0.05" for foam sheathing thickness to better and more efficiently accommodate various foam sheathing products that have actual thickness that vary from nominal thickness currently in the table. The same rounding is applied to the addition of an 18 psf cladding weight category at the request of the brick industry. All of the values were determined using the same analysis and research basis of the original tables, including capping foam thicknesses at and 3" for #8 screw in steel framing was done for the existing tables based on availability of fastener lengths and practicality considerations.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Revisions to the entries in the table should not have an impact on code enforcement.

Impact to building and property owners relative to cost of compliance with code

This proposal should not increase cost of code compliance. This proposal may actually decrease cost as a result of more efficient design for foam thickness and fastener sizing.

Impact to industry relative to the cost of compliance with code

This proposal should not increase cost of code compliance. This proposal may actually decrease cost as a result of more efficient design for foam thickness and fastener sizing.

Impact to small business relative to the cost of compliance with code

This proposal should not increase cost of code compliance. This proposal may actually decrease cost as a result of more efficient design for foam thickness and fastener sizing.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Appropriate requirements for maximum thickness of foam sheathing and fastening of cladding over this foam help assure long-term performance of the cladding.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code with refinements in requirements.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials - provides choices and options.

Does not degrade the effectiveness of the code

Improves the effectiveness of the code.

Revise the body of Table R703.16.1 by inserting the 18 psf column, and modifying most cells. Revisions are shown as replacing existing entries in the cells.

TABLE R703.16.1 CLADDING MINIMUM FASTENING REQUIREMENTS FOR DIRECT ATTACHMENT OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[1]

Cladding Fastener Through Foam Sheathing into:	Cladding Fastener -Type and Minimum Size[2]	Cladding Fastener Vertical Spacing (inches)	Maximum Thickness of Foam Sheathing[3] (inches)							
			16"oc Fastener Horizontal Spacing				24"oc Fastener Horizontal Spacing			
			Cladding Weight:				Cladding Weight:			
			3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Steel Framing (minimum penetration of steel thickness + 3 threads)	#8 screw into 33 mil steel or thicker	6	3.00	2.95	2.20	1.45	3.00	2.35	1.25	DR
		8	3.00	2.55	1.60	0.60	3.00	1.80	DR	DR
		12	3.00	1.80	DR	DR	3.00	0.65	DR	DR
	#10 screw into 33 mil steel	6	4.00	3.50	2.70	1.95	4.00	2.90	1.70	0.55
		8	4.00	3.10	2.05	1.00	4.00	2.25	0.70	DR
		12	4.00	2.25	0.70	DR	3.70	1.05	DR	DR
	#10 screw into 43 mil steel or thicker	6	4.00	4.00	4.00	3.60	4.00	4.00	3.45	2.70
		8	4.00	4.00	3.70	3.00	4.00	3.85	2.80	1.80
		12	4.00	3.85	2.80	1.80	4.00	3.05	1.50	DR

(Table notes unchanged)

Revise the body of Table R703.16.2 by inserting the 18 psf column, and modifying most cells. Revisions are shown as replacing existing entries in the cells.

TABLE R703.16.2 FURRING MINIMUM FASTENING REQUIREMENTS FOR APPLICATION OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[1]

Furring Material	Framing Member	Fastener Type and Minimum Size[2]	Minimum Penetration into Wall Framing (inches)	Fastener Spacing in Furring (inches)	Maximum Thickness of Foam Sheathing[4] (inches)							
					16"oc FURRING[5]				24"oc FURRING[5]			
					Cladding Weight:				Cladding Weight:			
					3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Minimum 33mil Steel Furring or Minimum 1x Wood Furring[3]	33 mil Steel Stud	#8 screw	Steel thickness + 3 threads	12	3.00	1.80	DR	DR	3.00	0.65	DR	DR
				16	3.00	1.00	DR	DR	2.85	DR	DR	DR
				24	2.85	DR	DR	DR	2.20	DR	DR	DR
		#10 screw	Steel thickness + 3 threads	12	4.00	2.25	0.70	DR	3.70	1.05	DR	DR
				16	3.85	1.45	DR	DR	3.40	DR	DR	DR
				24	3.40	DR	DR	DR	2.70	DR	DR	DR
	43 mil or thicker Steel Stud	#8 Screw	Steel thickness + 3 threads	12	3.00	1.80	DR	DR	3.00	0.65	DR	DR
				16	3.00	1.00	DR	DR	2.85	DR	DR	DR
				24	2.85	DR	DR	DR	2.20	DR	DR	DR
		#10 screw	Steel thickness + 3 threads	12	4.00	3.85	2.80	1.80	4.00	3.05	1.50	DR
				16	4.00	3.30	1.95	0.60	4.00	2.25	DR	DR
				24	4.00	2.25	DR	DR	4.00	0.65	DR	DR

(Table notes unchanged)

S8352

Date Submitted	12/15/2018	**Section**	703.2	**Proponent**	John Woestman
Chapter	7	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

This proposal clarifies requirements for No. 15 asphalt felt and distinguishes requirements for other approved water-resistive barriers (WRBs) to improve application and enforceability.

Rationale

This proposal clarifies requirements for No. 15 asphalt felt and distinguishes requirements for other approved water-resistive barriers (WRBs) to improve application and enforceability. The specific installation instructions currently provided in the code apply only to a traditional application of No.15 asphalt felt (and some types of membrane WRBs, but not always) and are exclusionary if applied to all other approved WRB materials as the code currently implies. While some other approved materials may use the same or similar installation details, they are frequently different. Also, the lapping method is impractical and exclusionary for some other approved materials, such as sheathing-type WRBs, that rely on approved sealed joints (e.g., adhered flashing or joint sealing tape) which also are used to enhance minimally lapped joints on membrane-type WRBs (and are often required at intersections with penetrations to provide continuity of the WRB). Thus, the phrase "or material" is stricken to avoid the unintended (and exclusionary) implication that all "other approved materials" (as mentioned in the first sentence) must be installed like No. 15 asphalt felt with lapped joints (as indicated in the second sentence for other materials than No. 15 felt). In coordination with the above change, it is made clear that other approved materials shall be installed in accordance with the manufacturer's installation instructions. Finally, it is made clear that continuity of the WRB (last sentence) applies to both No. 15 asphalt felt and any other approved WRB material.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal clarifies requirements for No. 15 asphalt felt and distinguishes requirements for other approved water-resistive barriers (WRBs) to improve application and enforceability.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of code compliance. The proposal clarifies requirements and may actually help avoid unintended cost impacts or material choice limitations.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of code compliance. The proposal clarifies requirements and may actually help avoid unintended cost impacts or material choice limitations.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of code compliance. The proposal clarifies requirements and may actually help avoid unintended cost impacts or material choice limitations.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The proposal should help improve performance of exterior walls regarding moisture management.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code with appropriate technical revisions to WRB requirements.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Allows approved WRB materials - does not discriminate.

Does not degrade the effectiveness of the code

Improves the effectiveness of the code.

Revise as follows:

R703.2 Water-resistive barrier. One layer of No. 15 asphalt felt, free from holes and breaks, complying with ASTM D226 for Type 1 felt or other approved water-resistive barrier shall be applied over studs or sheathing of all exterior walls. ~~Such~~No.15 asphalt felt ~~or material~~ shall be applied horizontally, with the upper layer lapped over the lower layer not less than 2 inches (51 mm). Where joints occur, felt shall be lapped not less than 6 inches (152 mm). ~~The~~Other approved materials shall be installed in accordance with the water-resistive barrier manufacturer's installation instructions. The No. 15 asphalt felt or other approved water-resistive barrier material shall be continuous to the top of walls and terminated at penetrations and building appendages in a manner to meet the requirements of the exterior wall envelope as described in Section R703.1. The water-resistive barrier is not required for detached accessory buildings.

S8353

Date Submitted	12/15/2018	**Section**	703.7.2	**Proponent**	Joseph Crum
Chapter	7	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

RB296

Summary of Modification

The purpose of this code change is to correlate the requirements for exterior lath and plaster (stucco) with the requirements of ASTM C926 and C1063 and ACI 524R-08 Guide to Portland Cement-Based Plaster.

Rationale

The purpose of this code change is to correlate the requirements for exterior lath and plaster (stucco) with the requirements of ASTM C926 and C1063 and ACI 524R-08 Guide to Portland Cement-Based Plaster.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

The change corrects the designations for acceptable, currently available cement types clarifies that lath is not required where stucco is permitted to be placed directly on concrete or masonry surfaces. This change makes the requirement more clear for consistent enforcement.

Impact to building and property owners relative to cost of compliance with code

The code change will not increase the cost of construction. The change corrects the designations for acceptable, currently available cement types clarifies that lath is not required where stucco is permitted to be placed directly on concrete or masonry surfaces.

Impact to industry relative to the cost of compliance with code

The code change will not increase the cost of construction. The change corrects the designations for acceptable, currently available cement types clarifies that lath is not required where stucco is permitted to be placed directly on concrete or masonry surfaces.

Impact to small business relative to the cost of compliance with code

The code change will not increase the cost of construction. The change corrects the designations for acceptable, currently available cement types clarifies that lath is not required where stucco is permitted to be placed directly on concrete or masonry surfaces.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The change corrects the designations for acceptable, currently available cement types clarifies that lath is not required where stucco is permitted to be placed directly on concrete or masonry surfaces. This change makes the requirement more clear for consistent enforcement.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The change corrects the designations for acceptable, currently available cement types clarifies that lath is not required where stucco is permitted to be placed directly on concrete or masonry surfaces. This change makes the requirement more clear for consistent enforcement.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The change clarifies that lath is not required where stucco is permitted to be placed directly on concrete or masonry surfaces. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The change clarifies that lath is not required where stucco is permitted to be placed directly on concrete or masonry surfaces. Does not degrade the effectiveness of the code.

Section: R702.1, R703.7, R703.7.1, R703.7.2

Revise as follows:

TABLE R702.1 (3)

CEMENT PLASTER PROPORTIONS, PARTS BY VOLUME

COAT	CEMENT PLASTER TYPE	CEMENTITIOUS MATERIALS				VOLUME OF AGGREGATE PER SUM OF SEPARATE VOLUMES OF CEMENTITIOUS MATERIALS[b]
		Portland Cement Type I, II or III; Blended Hydraulic Cement Type IP, ~~PM~~ I(S<70), IL, or IT(S<70); or Hydraulic Cement Type GU, HE, MS, HS, or MH	Plastic Cement	Masonry Cement Type M, S or N	Lime	
First	Portland or blended	1			3/4 - 1 1/2[a]	2 1/2 - 4
	Masonry			1	~~1~~	2 1/2 - 4
	Plastic		1			2 1/2 - 4
Second	Portland or blended	1			3/4 - 1 1/2	3 - 5
	Masonry			1		3 - 5
	Plastic		1			3 - 5
Finish	Portland or blended	1			~~3/4 - 2~~ 1 1/2 - 2	1 1/2 - 3
	Masonry			1		1 1/2 - 3
	Plastic		1			1 1/2 - 3

For SI: 1 inch = 25.4 mm, 1 pound = 0.454 kg.

a. Lime by volume of 0 to 3/4 shall be used where the plaster will be placed over low-absorption surfaces such as dense clay tile or brick.

b. The same or greater sand proportion shall be used in the second coat than used in the firstcoat.

Revise as follows:

R703.7 Exterior plaster (stucco). *No change to text.*

R703.7.1 Lath. Lath and lath attachments shall be of corrosion-resistant materials. Expanded metal or woven wire lath shall be attached with 1 1/2-

inch-long (38 mm), 11 gage nails having a $^7/_{16}$-inch (11.1 mm) head, or $^7/_8$-inch-long (22.2 mm), 16 gage staples, spaced not more than 6 inches (152 mm), or as otherwise approved.

Exception: Lath is not required over masonry, cast-in-place concrete, precast concrete or stone substrates prepared in accordance with ASTM C1063.

R703.7.2 Plaster. Plastering with ~~portland~~ cement plaster shall be in accordance with ASTM C926. Cement materials shall be in accordance with one of the following:

Masonry cement ~~plaster~~ conforming to ASTM C91 Type M, S or N
Portland cement conforming to ASTM C150 Type I, II, or III;
Blended hydraulic cement conforming to ASTM C595 Type IP, IS(<70), IL, or IT(S<70);
Hydraulic cement conforming to C1157 Type GU, HE, MS, HS, or MH; or
Plastic (stucco) cement conforming to C 1328.

Plaster shall be not less than three coats where applied over metal lath or wire lath and shall be not less than two coats where applied over masonry, concrete, pressure-preservative-treated wood or decay-resistant wood as specified in Section R317.1 or gypsum backing. If the plaster surface is completely covered by veneer or other facing material or is completely concealed, plaster application need be only two coats, provided the total thickness is as set forth in Table R702.1(1).

On wood-frame construction with an on-grade floor slab system, exterior plaster shall be applied to cover, but not extend below, lath, paper and screed.

The proportion of aggregate to cementitious materials shall be as set forth in Table R702.1(3).

S8355

Date Submitted	12/15/2018	**Section**	702.3.3	**Proponent**	Joseph Crum
Chapter	7	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

RB265-16

Summary of Modification

This proposal is one in a series intended to update the content of the cold-formed steel (CFS) light-framed construction provisions of the FBC.

Rationale

This proposal is one in a series intended to update the content of the cold-formed steel (CFS) light-framed construction provisions of the IRC. The screw penetration test, as referenced to ASTM C645, Section 10, has been incorporated into AISI S220- 15, North American Standard for Cold-Formed Steel Framing - Non-Structural Members. Therefore, the reference to AISI S220 is adequate to cover those requirements.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal is intended to update the referenced AISI standards and does not effect the intended prescribed construction requirements.

Impact to building and property owners relative to cost of compliance with code

This proposal is intended to update the referenced AISI standards and does not effect the intended prescribed construction requirements and will not increase the cost of construction.

Impact to industry relative to the cost of compliance with code

This proposal is intended to update the referenced AISI standards and does not effect the intended prescribed construction requirements and will not increase the cost of construction.

Impact to small business relative to the cost of compliance with code

This proposal is intended to update the referenced AISI standards and does not effect the intended prescribed construction requirements and will not increase the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal is intended to update the referenced AISI standards and does not effect the intended prescribed construction requirements.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal is intended to update the referenced AISI standards and does not effect the intended prescribed construction requirements.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal is intended to update the referenced AISI standards and does not effect the intended prescribed construction requirements. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal is intended to update the referenced AISI standards and does not effect the intended prescribed construction requirements. Does not degrade the effectiveness of the code.

Section: R702.3.3

Revise as follows:

R702.3.3 Cold-formed steel framing. Cold-formed steel framing supporting gypsum board and gypsum panel products shall be not less than 1 1/4 inches (32 mm) wide in the least dimension. Non-load-bearing cold-formed steel framing shall comply with AISI S220 ~~and ASTM C645, Section 10~~. Load-bearing cold- formed steel framing shall comply with AISI ~~S200 and ASTM C 955, Section 8~~ S240.

Reference standards type: This reference standard is new to the FBC Code Books

Add new standard(s) as follows:

AISI S240-15, North American Standard for Cold-Formed Steel Structural Framing (2015)

Standards Available for free download at www.aisistandards.org

S8387

Date Submitted	12/15/2018	**Section**	703.1.1	**Proponent**	Joseph Belcher for FHBA
Chapter	7	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

N/A

Summary of Modification

Deletes incorrect section reference

Rationale

This is an incorrect section reference. Section R703.8 addresses anchored stone and masonry veneer and has nothing to do with flashing.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact on cost of enforcement of code.

Impact to building and property owners relative to cost of compliance with code

No impact on cost to property owners.

Impact to industry relative to the cost of compliance with code

No impact on cost to industry.

Impact to small business relative to the cost of compliance with code

No impact on cost to small business.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The proposal corrects an erroneous section reference.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The proposal improves the code because it corrects an erroneous section reference.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The change does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The proposed change does not degrade the effectiveness of the code.

R703.1.1 Water resistance. The exterior wall envelope shall be designed and constructed in a manner that prevents the accumulation of water within the wall assembly by providing a water-resistant barrier behind the exterior veneer as required by Section R703.2 and a means of draining to the exterior water that enters the assembly. Protection against condensation in the exterior wall assembly shall be provided in accordance with Section R702.7 of this code.

Exceptions:

1. A weather-resistant exterior wall envelope shall not be required over concrete or masonry walls designed in accordance with Chapter 6 and flashed in accordance with Section R703.4. ~~or R703.8.~~

2. Compliance with the requirements for a means of drainage, and the requirements of Sections R703.2 and R703.4, shall not be required for an exterior wall envelope that has been demonstrated to resist wind-driven rain through testing of the exterior wall envelope, including joints, penetrations and intersections with dissimilar materials, in accordance with ASTM E331 under the following conditions:

REMAINDER OF SECTION UNCHANGED.

S8396

Date Submitted	12/15/2018	**Section**	703.4	**Proponent**	Joseph Belcher for FHBA
Chapter	7	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments Yes | **Alternate Language** No

Related Modifications

Summary of Modification

Modify flashing requirements

Rationale

The lead sentence indicates only corrosion-resistant flashing materials may be used and then immediately refers to self-adhering, flexible, and liquid flashings. Any or all of these materials may be used in accordance with their manufacturer's instruction. The current language has caused serious confusion in the field.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact.

Impact to building and property owners relative to cost of compliance with code

No impact.

Impact to industry relative to the cost of compliance with code

No impact.

Impact to small business relative to the cost of compliance with code

No impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Will reduce confusion as to what types of flashing may be used.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by clearing up what materials may be used for flashing.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

1st Comment Period History

S8396-G1

Proponent Dick Wilhelm **Submitted** 2/8/2019 **Attachments** No

Comment:

No change needed, current language in FBC Residential covers the flashing material specifications.

R703.4 Flashing. Approved corrosion-resistant flashing, self-adhered membranes, mechanically attached flexible flashings, or fluid-applied membranes used as flashing shall be applied shingle-fashion or in accordance with the manufacturer's instructions in a manner to prevent entry of water into the wall cavity or penetration of water to the building structural framing components. Self-adhered membranes used as flashing shall comply with AAMA 711. All exterior fenestration products shall be sealed at the juncture with the building wall with a sealant complying with AAMA 800 or ASTM C920 Class 25 Grade NS or greater for proper joint expansion and contraction, ASTM C1281, AAMA 812, or other approved standard as appropriate for the type of sealant. Fluid-applied membranes used as flashing in exterior walls shall comply with AAMA 714. The flashing shall extend to the surface of the exterior wall finish. Approved corrosion resistant flashings self-adhered membranes, mechanically attached flexible flashings, or fluid-applied membranes used as flashing shall be installed at the following locations:

REMAINDER OF SECTION UNCHANGED.

S7714

Date Submitted	12/6/2018	**Section**	806.2	**Proponent**	Ann Russo1
Chapter	8	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

The proposed modification will provide flexibility for the placement of the required roof ventilation.

Rationale

Due to property line separation requirements, restricting the lower vents to the eave or cornice, may not be achievable. The intent of this change does not restrict the use of eave or cornice vents when they are located in the bottom 1/3 of the attic space. Installing ventilation at the bottom 1/3 of the attic space achieves similar cross ventilation effect as eave and cornice vents. Allowing the lower ventilators to be placed on the roof, allows the designer flexibility, without creating a conflict with Table R302.1(1) or R302.1(2), where opening may not be allowed.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal will have positive impact to local entity and designer relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal will provide design flexibility without creating conflict with other provisions of the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal will improve the application of the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal will not discriminate against materials, products, methods, or systems of construction.

Does not degrade the effectiveness of the code

This proposal will not degrade the effectiveness of the code.

Revise as follows:

R806.2 Minimum vent area.

The minimum net free ventilating area shall be $^1/_{150}$ of the area of the vented space.

Exception: The minimum net free ventilation area shall be $^1/_{300}$ of the vented space provided one or more of the following conditions are met:

1. In Climate Zones 6, 7 and 8, a Class I or II vapor retarder is installed on the warm-in-winter side of the ceiling.
2. Not less than 40 percent and not more than 50 percent of the required ventilating area is provided by ventilators located in the upper portion of the attic or rafter space. Upper ventilators shall be located not more than 3 feet (914 mm) below the ridge or highest point of the space, measured vertically~~, with the~~. The balance of the required ventilation provided ~~by eave or cornice vents~~ shall be located in the bottom one-third of the attic space. Where the location of wall or roof framing members conflicts with the installation of upper ventilators, installation more than 3 feet (914 mm) below the ridge or highest point of the space shall be permitted.

Date Submitted	12/6/2018	Section	803.2	Proponent	T Stafford
Chapter	8	Affects HVHZ	No	Attachments	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments	No	Alternate Language	No

Related Modifications

Summary of Modification

Updates the roof sheathing fastening requirements for correlation with ASCE 7-16.

Rationale

This proposal updates the prescriptive roof sheathing attachment requirements in the FBCR to comply with ASCE 7-16. During Phase I of the 2020 update of the FBC, the Commission voted to update ASCE 7 from the 2010 edition to the 2016 edition (ASCE 7-16). For buildings with mean roof heights of 60 feet and less, the roof component and cladding pressure coefficients have increased in ASCE 7-16. For Exposure B, a larger nail size is required for sheathing thicknesses that exceed 15/32 inches but the spacing of the fasteners is generally similar to what is required in the 6th Edition (2017) FBCR. For Exposures C and D, the nail spacing is required to be increased for higher wind speeds where roof framing has a specific gravity of 0.42. For roof framing with a specific gravity of 0.49 and greater, the nail spacing is similar to the 6th Edition (2017) FBCR. Therefore, for trusses manufactured with SYP (SG = 0.55), the nail spacing will be largely unchanged. While, two nails are specified for sheathing thicknesses greater than 15/32 inches, the RSRS-04 (3” x 0.120”) appears to be widely available in local hardware stores in Florida.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This proposal will slightly increase costs. While the nail size has increased for some situations, the cost for the larger nails are similarly priced as the cost of the nail size specified in the 6th Ed. (2017) FBCR. A tighter nail spacing is required for higher wind speeds in Exposures C and D.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to cost of compliance with the code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to cost of compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This code change simply correlates the code with the previous action by the Commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal strengthens the code by revising the roof sheathing fastening requirements to comply with the previous action by the Commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code

Mod 7715

Revise as follows:

R803.2.2 Allowable spans. The minimum thickness and span rating ~~maximum allowable spans~~ for wood structural panel roof sheathing shall not exceed the values set forth in Table R803.2.2 ~~R503.2.1.1(1), or APA E30~~.

R803.2.3 Installation.
Wood structural panel used as roof sheathing shall be installed with joints staggered in accordance with Section R803.2.3.1 for wood roof framing or with Table R804.3 for cold-formed steel roof framing.

R803.2.3.1 Sheathing fastenings.
Wood structural panel sheathing shall be fastened to roof framing in accordance with Table R803.2.3.1. ~~with~~ Where the sheathing thickness is 15/32 inches and less, sheathing shall be fastened with ASTM F1667 RSRS-01 (2 $^{3}/_{8}$" × 0.113") nails. Where the sheathing thickness is greater than 15/32 inches, sheathing shall be fastened with ASTM F1667 RSRS-03 (2 ½" × 0.131") nails or ASTM F1667 RSRS-04 (3" × 0.120") nails. ~~at 6 inches (152 mm) on center at edges and 6 inches (152 mm) on center at intermediate framing, unless roof diaphragm design requires a closer spacing~~. RSRS-01, RSRS-03, and RSRS-04 ~~is~~ are ring shank ~~roof sheathing~~ nails meeting the specifications in ASTM F1667.

~~Where roof framing with a specific gravity, 0.42 = G < 0.49 is used, spacing of ring-shank fasteners shall be 4 inches on center in nailing zone 3 in accordance with Figure R803.2.3.1 where V_{ult} is 165 mph or greater.~~

~~**Exceptions:**~~

~~1.Where roof framing with a specific gravity, 0.42 = G < 0.49 is used, spacing of ring-shank fasteners shall be permitted at 12 inches (305 mm) on center at intermediate framing in nailing zone 1 for any V_{ult} and in nailing zone 2 for V_{ult} less than or equal to 140 mph in accordance with Figure R803.2.3.1.~~

~~2.Where roof framing with a specific gravity, G = 0.49 is used, spacing of ring-shank fasteners shall be permitted at 12 inches (305 mm) on center at intermediate framing in nailing zone 1 for any V_{ult} and in nailing zone 2 for V_{ult} less than or equal to 150 mph in accordance with Figure R803.2.3.1.~~

~~3.Where roof framing with a specific gravity, G = 0.49 is used, 8d common or 8d hot-dipped galvanized box nails at 6 inches (152 mm) on center at edges and 6 inches (152 mm) on center at intermediate framing shall be permitted for V_{ult} less than or equal to 130 mph in accordance with Figure R803.2.3.1.~~

Table R803.2.2
Minimum Roof Sheathing Thickness

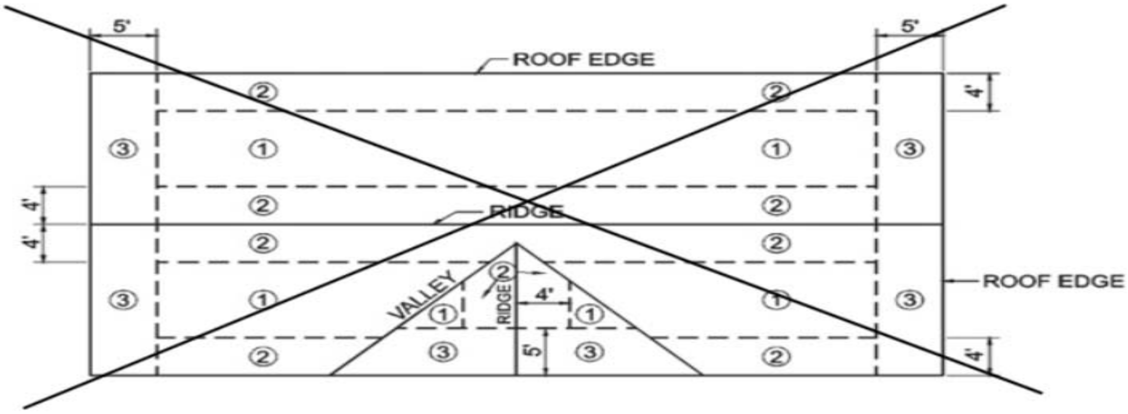
Roof Sheathing Thickness								
Rafter/Truss Spacing 24 in. o.c.	Wind Speed							
	115 mph	120 mph	130 mph	140 mph	150 mph	160 mph	170 mph	180 mph
Minimum Sheathing Thickness, inches (Panel Span Rating) Exposure B	7/16 (24/16)	7/16 (24/16)	7/16 (24/16)	7/16 (24/16)	15/32 (32/16)	19/32 (40/20)	19/32 (40/20)	19/32 (40/20)
Minimum Sheathing Thickness, inches (Panel Span Rating)	7/16 (24/16)	7/16 (24/16)	15/32 (32/16)	19/32 (40/20)	19/32 (40/20)	19/32 (40/20)	19/32 (40/20)	23/32 (48/24)

Exposure C								
Minimum Sheathing Thickness, inches (Panel Span Rating) Exposure D	15/32 (32/16)	19/32 (40/20)	19/32 (40/20)	19/32 (40/20)	19/32 (40/20)	19/32 (40/20)	23/32 (48/24)	23/32 (48/24)

Table R803.2.1
Roof Sheathing Attachment[a,b]

Roof Sheathing Attachment																
Rafter/Truss Spacing 24 in. o.c.	**Wind Speed**															
	115 mph		**120 mph**		**130 mph**		**140 mph**		**150 mph**		**160 mph**		**170 mph**		**180 mph**	
	E	**F**	**E**	**F**	**E**	**F**	**E**	**F**	**E**	**F**	**E**	**F**	**E**	**F**	**E**	**F**
Exposure B																
Rafter/Truss SG = 0.42	6	6	6	6	6	6	6	6	6	6	4	4	4	4	4	4
Rafter/Truss SG = 0.49	6	12	6	12	6	6	6	6	6	6	6	6	6	6	6	6
Exposure C																
Rafter/Truss SG = 0.42	6	6	6	6	6	6	4	4	4	4	4	4	3	3	3	3
Rafter/Truss SG = 0.49	6	6	6	6	6	6	6	6	6	6	6	6	4	4	4	4
Exposure D																
Rafter/Truss SG = 0.42	6	6	6	6	4	4	4	4	4	4	3	3	3	3	3	3
Rafter/Truss SG = 0.49	6	6	6	6	6	6	6	6	4	4	4	4	4	4	4	4

E = Nail spacing along panel edges (inches)
F = Nail spacing along intermediate supports in the panel field (inches)
a. For sheathing located a minimum of 4 feet from the perimeter edge of the roof, including 4 feet on each side of ridges and hips, nail spacing is permitted to be 6 inches on center along panel edges and 6 inches on center along intermediate supports in the panel field.
b. Where rafter/truss spacing is less than 24 inches on center, roof sheathing fastening is permitted to be in accordance with the AWC WFCM or the AWC NDS.



~~FIGURE R803.2.3.1~~

~~ROOF SHEATHING NAILING ZONES~~

S7726

Date Submitted	12/6/2018	**Section**	806.5	**Proponent**	Ann Russo1
Chapter	8	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Editorial improvement.

Rationale

This is an editorial improvement, which makes the code clearer. There is no change in the requirements.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No negative impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal is simply an editorial improvement which makes the code clearer.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal will make to code clearer which will improve the application of the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal will not discriminate against materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This proposal will not degrade the effectiveness of the code.

Revise as follows to make the code clearer:

R806.5 Unvented attic and unvented enclosed rafter assemblies.

(no change to the text in between)

5.1.2 Where air-permeable insulation is ~~provided inside the building thermal envelope, it shall be installed in accordance withSection 5.1.1. In addition to the air-permeable insulation~~ installed directly below the structural sheathing, rigid board or sheet insulation shall be installed directly above the structural roof sheathing in accordance with the R-values in Table R806.5 for condensation control.

(no change to the text below)

S7764

Date Submitted	12/7/2018	**Section**	802.1	**Proponent**	Borjen Yeh
Chapter	8	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Add prefabricated wood I-joists for wood roof framing

Rationale

This proposal adds prefabricated wood I-joists to the list of wood and wood-based products listed in the FBC-Residental for roof framing. Prefabricated wood I-joists have been used in roof framing in commercial and residential projects for over 25 years. Prefabricated wood I-joists are already recognized in Section R802.7.2 as part of a description of engineered wood products. As is customary in the FBC-Residential, recognition of the product and its relevant manufacturing standard is provided at the beginning of relevant chapters. This links the I-joist product to the relevant standard. Note that the language proposed is exactly the same as used in R502.1.2.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to Impact to local entity relative to enforcement of code

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with code

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with code

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code, and provides equivalent products

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials or products

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code

R802.1.8 Prefabricated wood I-joists. Structural capacities and design provisions for prefabricated wood I-joists shall be established and monitored in accordance with ASTM D5055.

S7858

Date Submitted	12/12/2018	**Section**	804	**Proponent**	Bonnie Manley
Chapter	8	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

7856, 7857, 7989, 7991

Summary of Modification

Deletes Section R804 and replaces it with a reference to AISI S230 in accordance with Section R301.2.1.1.

Rationale

In Florida, Section R301.2.1.1 of the residential code exempts the prescriptive provisions for cold-formed steel light frame construction in Section R804. Rather than continue to maintain the prescriptive provisions of Section R804, which aren't used anywhere in the state, we recommend deleting the provisions in favor of a direct reference to AISI S230, as is currently contained in Section R301.2.1.1. Similar modifications will be recommended for Section R505 and Section R603.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

Delete Section R804, Cold-Formed Steel Roof Framing, in its entirety and replace with the following:

SECTION R804 COLD-FORMED STEEL ROOF FRAMING

R804.1 General. In accordance with Section R301.2.1.1, the design of cold-formed steel roof framing shall be in accordance with AISI S230, *Standard for Cold-Formed Steel Framing— Prescriptive Method For One- and Two-Family Dwellings*.

S7950

Date Submitted	12/12/2018	**Section**	802.1.2	**Proponent**	Borjen Yeh
Chapter	8	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Update the referenced standards for structural glued laminated timber.

Rationale

This proposal updates the references standard for ANSI A190.1 for structural glued laminated timber (glulam). ANSI/AITC A190.1 is now designed as ANSI A190.1. It also adds ANSI 117 to the code because the glulam layup combinations and laminating lumber grading requirements are included in ANSI 117.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal updates the referenced standards for glulam.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

R802.1.2 Structural glued laminated timbers.

Glued laminated timbers shall be manufactured and identified as required in ANSI/~~AITC~~ A190.1, ANSI 117 and ASTM D3737.

S7972

289

Date Submitted	12/12/2018	**Section**	802	**Proponent**	Ann Russo8
Chapter	8	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

RB310-16

Summary of Modification

This code proposal is a rewrite with minor technical changes. It is intended to reorganize the roof and ceiling assembly by separating out the requirements of the components.

Rationale

This code proposal is a rewrite with minor technical changes. It is intended to reorganize the section by separating out the requirements of the components & clarifies the continuous ties, provides a pointer for the ridge strap back to the fastener table and adds the requirement for bearing for beams of roofs with slope less than 3:12.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Code section reorganization only and should make enforcement of the code easier.

Impact to building and property owners relative to cost of compliance with code

Code section reorganization only and will not increase the cost of construction.

Impact to industry relative to the cost of compliance with code

Code section reorganization only and will not increase the cost of compliance with the code.

Impact to small business relative to the cost of compliance with code

Code section reorganization only and will not increase the cost of compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Code section reorganization only and should help with code interpretation and implementation.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Code section reorganization only and should help with code interpretation and implementation.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Code section reorganization only and does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

Code section reorganization only and does not degrade the effectiveness of the code.

- **?Delete existing section 802.2 and replace with new Revised section.**

~~R802.2 Design and construction.~~

~~The framing details required in Section R802 apply to roofs having a minimum slope of three units vertical in 12 units horizontal (25-percent slope) or greater. Roof-ceilings shall be designed and constructed in accordance with the provisions of this chapter and Figures R606.11(1), R606.11(2) and R606.11(3) or in accordance with AWC NDS. Components of roof-ceilings shall be fastened in accordance with Table R602.3(1).~~

~~R802.3 Framing details.~~

~~Rafters shall be framed not more than $1^1/_2$-inches (38 mm) offset from each other to ridge board or directly opposite from each other with a gusset plate as a tie. Ridge board shall be not less than 1-inch (25 mm) nominal thickness and not less in depth than the cut end of the rafter. At valleys and hips there shall be a valley or hip rafter not less than 2-inch (51 mm) nominal thickness and not less in depth than the cut end of the rafter. Hip and valley rafters shall be supported at the ridge by a brace to a bearing partition or be designed to carry and distribute the specific load at that point. Where the roof pitch is less than three units vertical in 12 units horizontal (25-percent slope), structural members that support rafters and ceiling joists, such as ridge beams, hips and valleys, shall be designed as beams.~~

~~R802.3.1 Ceiling joist and rafter connections.~~

~~Ceiling joists and rafters shall be nailed to each other in accordance with Table R802.5.1(9), and the rafter shall be nailed to the top wall plate in accordance with Table R602.3(1). Ceiling joists shall be continuous or securely joined in accordance with Table R802.5.1(9) where they meet over interior partitions and are nailed to adjacent rafters to provide a continuous tie across the building where such joists are parallel to the rafters.~~

~~Where ceiling joists are not connected to the rafters at the top wall plate, joists connected higher in the attic shall be installed as rafter ties, or rafter ties shall be installed to provide a continuous tie. Where ceiling joists are not parallel to rafters, rafter ties shall be installed. Rafter ties shall be not less than 2 inches by 4 inches (51 mm by 102 mm) (nominal), installed in accordance with the connection requirements in Table R802.5.1(9), or connections of equivalent capacities shall be provided. Where ceiling joists or rafter ties are not provided, the ridge formed by these rafters shall be supported by a wall or girder designed in accordance with accepted engineering practice.~~

~~Collar ties or ridge straps to resist wind uplift shall be connected in the upper third of the attic space in accordance with Table R602.3(1).~~

~~Collar ties shall be not less than 1 inch by 4 inches (25 mm by 102 mm) (nominal), spaced not more than 4 feet (1219 mm) on center.~~

~~R802.3.2 Ceiling joists lapped.~~

~~Ends of ceiling joists shall be lapped not less than 3 inches (76 mm) or butted over bearing partitions or beams and toenailed to the bearing member. Where ceiling joists are used to provide resistance to rafter thrust, lapped joists shall be nailed together in accordance with Table R802.5.1(9) and butted joists shall be tied together in a manner to resist such thrust. Joists that do not resist thrust shall be permitted to be nailed in accordance with Table R602.3(1).~~

~~R802.3.3 Blocking.~~

~~Blocking shall be a minimum of utility grade lumber.~~

~~R802.4 Allowable ceiling joist spans.~~

~~Spans for ceiling joists shall be in accordance with Tables R802.4(1) and R802.4(2). For other grades and species and for other loading conditions, refer to the AWC STJR.~~

~~R802.5 Allowable rafter spans.~~

~~Spans for rafters shall be in accordance with Tables R802.5.1(1) through R802.5.1(8). For other grades and species and for other loading conditions, refer to the AWC STJR. The span of each rafter shall be measured along the horizontal projection of the rafter.~~

~~R802.5.1 Purlins.~~

~~Installation of purlins to reduce the span of rafters is permitted as shown in Figure R802.5.1. Purlins shall be sized not less than the required size of the rafters that they support. Purlins shall be continuous and shall be supported by 2-inch by 4-inch (51 mm by 102 mm) braces installed to bearing walls at a slope not less than 45 degrees (0.79 rad) from the horizontal. The braces shall be spaced not more than 4 feet (1219 mm) on center and the unbraced length of braces shall not exceed 8 feet (2438 mm).~~

Revise as follows:

SECTION R802 WOOD ROOF FRAMING

-

R802.2 Design and construction. The roof and ceiling assembly shall provide continuous ties across the structure to prevent roof thrust from being applied to the supporting walls. The assembly shall be designed and constructed in accordance with the provisions of this chapter and Figures R606.11(1), R606.11(2) and R606.11(3) or in accordance with AWC NDS.

R802.3 Ridge. A ridge board used to connect opposing rafters shall be not less than 1 inch (nominal) thickness and not less in depth than the cut end of the rafter. Where ceiling joist or rafter ties do not provide continuous ties across the structure, a ridge beam shall be provided and supported on each end by a wall or girder.

R802.4 Rafters. Rafters shall be in accordance with this section.

R802.4.1 Allowable rafter spans Rafter size. Spans for rafters Rafters shall be sized based on the rafter spans in accordance with Tables R802.5.1(1R802.4.1(1) through R802.5.1(8) R802.4.1(8).
Rafter spans shall be measured along the horizontal projection of the rafter. For other grades and species and for other loading conditions, refer to the AWC STJR. The span of each rafter shall be measured along the horizontal projection of therafter.

R802.4.2 Framing details. Rafters shall be framed not more than 1$^1/_2$-inch (38 mm) offset from each other to a ridge board or directly opposite from each other with a collar tie, gusset plate or ridge strap in accordance with Table R602.3(1). Rafters shall be nailed to the top wall plates in accordance with Table R602.3 (1) unless the roof assembly is required to comply with the uplift requirements of Section R802.11.

R802.4.3 Hips and Valleys. Hip and valley rafters shall be not less than 2-inch nominal thickness and not less in depth than the cut end of the rafter. Hip and valley rafters shall be supported at the ridge by a brace to a bearing partition or be designed to carry and distribute the specific load at that point.

R802.4.4 Rafter supports. Where the roof pitch is less than 3 units vertical in 12 units horizontal (25-percent slope), structural members that support rafters, such as ridges, hips and valleys, shall be designed as beams, and bearing shall be provided for rafters in accordance with R802.6.

-

R802.4.5 Purlins. Installation of purlins to reduce the span of rafters is permitted as shown in Figure R802.5.1R802.4.5. Purlins shall be sized not less than the required size of the rafters that they support. Purlins shall be continuous and shall be supported by 2-inch by 4-inch (51 mm by 102 mm) braces installed to bearing walls at a slope not less than 45 degrees (0.785 rad) from the horizontal. The braces shall be spaced not more than 4 feet (1219 mm) on center and the unbraced length of braces shall not exceed 8 feet (2438 mm).

-

R802.4.6 Collar ties. Where collar ties are used to connect opposing rafters, they shall be located in the upper third of the attic space and fastened in accordance with Table R602.3(1). Collar ties shall be not less than 1 inch by 4 inch (nominal), spaced not more than 4 feet on center. Ridge straps in accordance with Table R602.3(1) shall be permitted to replace collar ties.

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R802.5 Ceiling joists. Ceiling joists shall be continuous across the structure or securely joined where they meet over interior partitions in accordance with Table R802.5.2.

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R802.5.1 Allowable ceiling Ceiling joist spans size. Spans for ceiling Ceiling joists shall be sized based on the joist spans in accordance with Tables R802.4(1R802.5.1(1)

and R802.4(2R802.5.1(2). For other grades and species and for other loading conditions, refer to the AWC STJR..

ADD NEW SECTION:

R802.5.2 Ceiling joist and rafter connections. Ceiling Where ceilings joists and run parallel to rafters, they shall be nailed connected to each other in accordance with Table R802.5.1(9), and the rafter shall be nailed to rafters at the top wall plate in accordance with Table R602.3(1)R802.5.2.. Ceiling joists shall be continuous or securely joined in accordance with Table R802.5.1(9) where they meet over interior partitions and are nailed to adjacent rafters to provide a continuous tie across the building where such joists are parallel to the rafters. Where ceiling joists are not connected to the rafters at the top wall plate, joists connected higher in the attic shall be installed as rafter ties, or rafter ties they shall be installed to provide a continuous tie in the bottom third of the rafter height in accordance with Figure R802.4.5. and Table R802.5.2.
Where the ceiling joists are installed above the bottom third of the rafter height, the ridge shall be designed as a beam.

-

Where ceiling joists do not run parallel to rafters, rafter ties shall be installed. Rafter ties shall be not less than 2 inches by 4 inches (51 mm by 102 mm) (nominal), installed in accordance with the connection requirements in Table R802.5.1(9), or connections of equivalent capacities shall be provided.
Where ceiling joists or rafter ties are not provided, the ridge formed by these rafters shall be supported by a wall or girder designed in accordance with accepted engineering practice.
Collar ties or ridge straps to resist wind uplift shall be connected into the upper third of the attic space top plates in accordance with Table R602.3(1).
Collar ties Each rafter shall be not less than 1 inch by 4 inches (25 mm by 102 mm) (nominal), spaced not more than 4 feet (1219 mm) on center tied across the structure with a rafter tie or a 2x4 kicker connected to the ceiling diaphragm with nails equivalent in capacity to TableR802.5.2.

-

valleys, shall be designed as beams, and bearing shall be provided for rafters in accordance with R802.6.

R802.4.5 Purlins. Installation of purlins to reduce the span of rafters is permitted as shown in Figure R802.5.1R802.4.5. Purlins shall be sized not less than the required size of the rafters that they support. Purlins shall be continuous and shall be supported by 2-inch by 4-inch (51 mm by 102 mm) braces installed to bearing walls at a slope not less than 45 degrees (0.785 rad) from the horizontal. The braces shall be spaced not more than 4 feet (1219 mm) on center and the unbraced length of braces shall not exceed 8 feet (2438 mm).

R802.4.6 Collar ties. Where collar ties are used to connect opposing rafters, they shall be located in the upper third of the attic space and fastened in accordance with Table R602.3(1). Collar ties shall be not less than 1 inch by 4 inch (nominal), spaced not more than 4 feet on center. Ridge straps in accordance with Table R602.3(1) shall be permitted to replace collar ties.

R802.5 Ceiling joists. Ceiling joists shall be continuous across the structure or securely joined where they meet over interior partitions in accordance with Table R802.5.2.

R802.5.1 Allowable ceiling Ceiling joist spans size. Spans for ceiling Ceiling joists shall be sized based on the joist spans in accordance with Tables R802.4(1R802.5.1(1)

and R802.4(2R802.5.1(2). For other grades and species and for other loading conditions, refer to the AWC STJR..

ADD NEW SECTION:

R802.5.2 Ceiling joist and rafter connections. Ceiling Where ceilings joists and run parallel to rafters, they shall be nailed connected to each other in accordance with Table R802.5.1(9), and the rafter shall be nailed to rafters at the top wall plate in accordance with Table R602.3(1)R802.5.2.. Ceiling joists shall be continuous or securely joined in accordance with Table R802.5.1(9) where they meet over interior partitions and are nailed to adjacent rafters to provide a continuous tie across the building where such joists are parallel to the rafters. Where ceiling joists are not connected to the rafters at the top wall plate, joists connected higher in the attic shall be installed as rafter ties, or rafter ties they shall be installed to provide a continuous tie in the bottom third of the rafter height in accordance with Figure R802.4.5. and Table R802.5.2. Where the ceiling joists are installed above the bottom third of the rafter height, the ridge shall be designed as a beam.

Where ceiling joists do not run parallel to rafters, rafter ties shall be installed. Rafter ties shall be not less than 2 inches by 4 inches (51 mm by 102 mm) (nominal), installed in accordance with the connection requirements in Table R802.5.1(9), or connections of equivalent capacities shall be provided.
Where ceiling joists or rafter ties are not provided, the ridge formed by these rafters shall be supported by a wall or girder designed in accordance with accepted engineering practice.
Collar ties or ridge straps to resist wind uplift shall be connected into the upper third of the attic space top plates in accordance with Table R602.3(1).
Collar ties Each rafter shall be not less than 1 inch by 4 inches (25 mm by 102 mm) (nominal), spaced not more than 4 feet (1219 mm) on center tied across the structure with a rafter tie or a 2x4 kicker connected to the ceiling diaphragm with nails equivalent in capacity to TableR802.5.2.

R802.5.2.1 Ceiling joists lapped. Ends of ceiling joists shall be lapped not less than 3 inches (76 mm) or butted over bearing partitions or beams and toenailed to the bearing member. Where ceiling joists are used to provide resistance to rafter thrust, lapped joists shall be nailed together in accordance with Table R802.5.1(9) R802.5.2, and butted joists shall be tied together in a manner to resist such thrust. Joists that do not resist thrust shall be permitted to be nailed in accordance with Table R602.3(1).

R802.5.2.2 Rafter ties. Wood rafter ties shall be not less than 2 inches by 4 inches installed in accordance with Table R802.5.2 at each rafter. Other approved rafter tie methods shall be permitted.

R802.3.3R802.5.2.3 Blocking. Blocking shall be a minimum of utility grade lumber.

Related changes

Renumber the followingtables:

R802.4(1) as R802.5.1(1) - no change to table.
R802.4(2) as R802.5.1(2) - no change to table.
R802.5.1(1) as R802.4.1(1) - no change to table.
R802.5.1(2) as R802.4.1(2) - no change to table.
R802.5.1(3) as R802.4.1(3) - no change to table.
R802.5.1(4) as R802.4.1(4) - no change to table.
R802.5.1(5) as R802.4.1(5) - no change to table.
R802.5.1(6) as R802.4.1(6) - no change to table.
R802.5.1(7) as R802.4.1(7) - no change to table.
R802.5.1(8) as R802.4.1(8) - no change to table.
R802.5.1(9) as R802.5.2 - no change to table.

Renumber Figure R802.5.1 as R802.4.5
and delete all cross references to section numbers from the table. and delete "Note: Where ceiling joists..."

Renumber the cross reference in Table R602.3(1), item 4: Table R802.5.1(9) asR802.5.2

S7985

Date Submitted	12/13/2018	**Section**	804	**Proponent**	Ann Russo8
Chapter	8	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

RB321-16

Summary of Modification

The proposal is one in a series intended to update the content of the Cold-Formed Steel (CFS) light-framed construction provisions of the FBCR.

Rationale

The proposal is one in a series intended to update the content of the Cold-Formed Steel (CFS) light-framed construction provisions of the FBCR. The proposed revisions align the FBCR with the provisions of AISI S230-15, Standard for Cold- Formed Steel Framing - Prescriptive Method for One- and Two-Family Dwellings.
Also, the applicable design wind speed is changed to less than 140 mph ultimate. The framing tables are revised to reflect the wind load increase and to align with ASCE 7-10.Directional Method.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

The proposed changes to this section will not effect the enforcement of the code as it is only updating to current standards.

Impact to building and property owners relative to cost of compliance with code

The proposed changes to this section will not increase the cost of construction in general. While the overwhelming majority of the prescribed members have not changed or are reduced in size, there may be conditions for which the minimum member size will increase.

Impact to industry relative to the cost of compliance with code

The proposed changes to this section will not increase the cost of construction in general. While the overwhelming majority of the prescribed members have not changed or are reduced in size, there may be conditions for which the minimum member size will increase.

Impact to small business relative to the cost of compliance with code

The proposed changes to this section will not increase the cost of construction in general. While the overwhelming majority of the prescribed members have not changed or are reduced in size, there may be conditions for which the minimum member size will increase.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Updates the code with the current standards so will enhance the safety for the public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The proposed changes to this section updates to the most current standards so will strengthen the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The proposed changes to this section updates to the most current standards and does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The proposed changes to this section updates to the most current standards and does not degrade the effectiveness of the code.

Section: R804.1.1, R804.3.1.1, R804.3.2.1, R804.3.6, R804.3.7.1

Revise as follows:

R804.1.1 Applicability limits. The provisions of this section shall control the construction of cold-formed steel roof framing for buildings not greater than 60 feet (18 288 mm) perpendicular to the joist, rafter or truss span, not greater than 40 feet (12 192 mm) in width parallel to the joist span or truss, less than or equal to three stories above *grade* plane and with roof slopes not less than 3:12 (25-percent slope) or greater than 12:12 (100-percent slope). Cold-formed steel roof framing constructed in accordance with the provisions of this section shall be limited to sites where the ultimate design wind speed is less
than ~~139~~ 140 miles per hour (~~62~~63 m/s), Exposure Category B or C, and the ground snow load is less than or equal to 70 pounds per square foot (3350 Pa).

R804.3.1.1 Minimum ceiling joist size. Ceiling joist size and thickness shall be determined in accordance with the limits set forth in Tables R804.3.1.1(1) and R804.3.1.1(2). When determining the size of ceiling joists, the lateral support of the top flange shall be classified as unbraced, braced at midspan or braced at third points in accordance with Section ~~R804.3.1.4~~ R804.3.1.3. Where sheathing materialisattachedtothetopflangeofceilingjoistsorwherethebracingisspacedcloserthanthirdpoint of the joists, the "third point" values from Tables R804.3.1.1(1) and R804.3.1.1(2) shall beused.

Ceiling joists shall have a bearing support length of not less than 1 1/2 inches (38 mm) and shall be connected to roof rafters (heel joint) with No. 10 screws in accordance with Figure R804.3.1.1 and Table 804.3.1.1(3).

_Where continuous joists are framed across interior bearing supports, the interior bearing supports shall be located within 24 inches (610) mm) of midspan of the ceiling joist, and the individual spans shall not exceed the applicable spans in Tables R804.3.1.1(1) and R804.3.1.1(2).

Where the *attic* is to be used as an occupied space, the ceiling joists shall be designed in accordance with Section R505.

TABLE R804.3.1.1 (1)

CEILING JOIST SPANS 10 PSF LIVE LOAD (NO ATTIC STORAGE)[a, b, c]

MEMBER DESIGNATION	ALLOWABLE SPAN (feet - inches)					
	Lateral Support of Top (Compression) Flange					
	Unbraced		Midspan Bracing		Third-point Bracing	
	Ceiling Joist Spacing (inches)					
	16	24	16	24	16	24
350S162-33	~~9'-5?~~ 9'-6"	8'-6?	~~12'-2?~~ 11'-10"	~~10'-4?~~ 9'-10"	~~12'-2?~~ 11'-10"	~~10'-7?~~ 10'-4"
350S162-43	~~10'-3?~~ 10'-4"	~~9'-12?~~ 9'-3"	~~13'-2?~~ 12'-10"	~~11'-6?~~ 11'-3"	~~13'-2?~~ 12'-10"	~~11'-6?~~ 11'-3"
350S162-54	11'-1?	9'-11?	13'-9?	12'-0?	13'-9?	12'-0?
350S162-68	~~12'-1?~~ 12'-2"	~~10'-9?~~ 10'-10"	~~14'-8?~~ 14'-9"	12'-10?	~~14'-8?~~ 14'-9"	12'-10?
550S162-33	~~10'-7?~~ 10'-11"	~~9'-6?~~ 9'-10"	~~14'-10?~~ 15'-7"	~~12'-10?~~ 12'-0"	~~15'-11?~~ 16'-10"	~~13'-4?~~ 12'-0"
550S162-43	11'-8?	10'-6?	~~16'-4?~~ 16'-10"	~~14'-3?~~ 14'-10"	~~17'-10?~~ 18'-4"	~~15'-3?~~ 16'-0"
550S162-54	~~12'-6?~~ 12'-7"	~~11'-2?~~ 11'-3"	~~17'-7?~~ 18'-0"	~~15'-7?~~ 16'-2"	~~19'-5?~~ 19'-4"	~~16'-10?~~ 17'-2"
550S162-68	~~13'-6?~~ 13'-7"	12'-1?	~~19'-2?~~ 19'-3"	~~17'-0?~~ 17'-3"	~~21'-0?~~ 20'-6"	~~18'-4?~~ 18'-5"
800S162-33	—	—	—	—	—	—
800S162-43	~~13'-0?~~ 13'-1"	11'-9?	~~18'-10?~~ 18'-9"	~~17'-0?~~ 16'-9"	~~21'-6?~~ 21'-2"	~~19'-0?~~ 18'-7"
800S162-54	~~13'-10?~~ 13'-11"	~~12'-5?~~ 12'-6"	~~20'-0?~~ 20'-1"	~~18'-0?~~ 18'-1"	~~22'-9?~~ 21'-5"	~~20'-4?~~ 20'-5"
800S162-68	14'-11?	13'-4?	~~21'-3?~~ 21'-4"	~~19'-1?~~ 19'-2"	~~24'-1?~~ 22'-9"	~~21'-8?~~ 21'-9"
1000S162-43	—	—	—	—	—	—
1000S162-54	~~14'-9?~~ 14'-10"	~~13'-3?~~ 13'-4"	21'-4?	~~19'-3?~~ 19'-2"	~~24'-4?~~ 22'-8"	~~22'-0?~~ 21'-8"
1000S162-68	15'-10?	~~14'-2?~~ 14'-3"	~~22'-8?~~ 22'-9"	20'-5?	~~25'-9?~~ 24'-3"	~~23'-2?~~ 23'-3"
1200S162-43	—	—	—	—	—	—
1200S162-54	—	—	—	—	—	—
1200S162-68	16'-8?	14'-11?	23'-11?	~~21'-6?~~ 21'-7"	~~27'-2?~~ 25'-5"	~~24'-6?~~ 24'-5"

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 pound per square foot = 0.0479 kPa.

a. Deflection criterion: *L* /240 for totalloads.

b. Ceiling dead load = 5 psf.
c. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.
d. Listed allowable spans are not applicable for 350S162-33, 550S162-33, 550S162-43, and 800S162-43 continuous joist members.

TABLE R804.3.1.1 (2)
CEILING JOIST SPANS 20 PSF LIVE LOAD (LIMITED ATTIC STORAGE)[a, b, c]

MEMBER DESIGNATION	ALLOWABLE SPAN (feet - inches)					
	Lateral Support of Top (Compression) Flange					
	Unbraced		Midspan Bracing		Third-point Bracing	
	Ceiling Joist Spacing (inches)					
	16	24	16	24	16	24
350S162-33	~~8'-2?~~8'-0"	~~6'-10?~~6'-5"	~~9'-9?~~9'-2"	~~6'-10?~~7'-5"	9'-11?	~~6'-10?~~7'-5"
350S162-43	~~8'-10?~~8'-11"	~~7'-10?~~7'-8"	~~11'-0?~~10'-9"	~~9'-5?~~8'-9"	~~11'-0?~~10'-10"	~~9'-7?~~9'-6"
350S162-54	~~9'-6?~~9'-7"	~~8'-6?~~8'-7"	~~11'-9?~~11'-7"	~~10'-3?~~10'-2"	~~11'-9?~~11'-7"	~~10'-3?~~10'-2"
350S162-68	10'-4?	~~9'-2?~~9'-3"	~~12'-7?~~12'-5"	~~11'-0?~~10'-10"	~~12'-7?~~12'-5"	~~11'-0?~~10'-10"
550S162-33	~~9'-2?~~9'-5"	~~8'-3?~~6'-11"	~~12'-2?~~10'-5"	~~8'-5?~~6'-11"	~~12'-6?~~ 10'-5"	~~8'-5?~~6'-11"
550S162-43	~~10'-1?~~10'-2"	~~9'-1?~~9'-2"	~~13'-7?~~14'-2"	11'-8?	~~14'-5?~~15'-2"	~~12'-2?~~11'-8"
550S162-54	~~10'-9?~~10'-10"	~~9'-8?~~9'-9"	~~14'-10?~~15'-7"	~~12'-10?~~14'-0"	~~15'-11?~~16'-7"	~~13'-6?~~14'-5"
550S162-68	~~11'-7?~~11'-8"	~~10'-4?~~10'-5"	~~16'-4?~~16'-7"	~~14'-0?~~14'-10"	~~17'-5?~~17'-9"	~~14'-11?~~15'-6
800S162-33	—	—	—	—	—	—
800S162-43	11'-4?	~~10'-1?~~10'-2"	~~16'-5?~~16'-1"	~~13'-6?~~11'-0"	~~18'-1?~~16'-6"	~~13'-6?~~11'-0"
800S162-54	~~20'-0?~~12'-0"	~~10'-9?~~10'-10	17'-4?	~~15'-6?~~15'-7"	~~19'-6?~~18'-7"	~~27'-0?~~17'-7"
800S162-68	12'-10?	~~11'-6?~~11'-6"	~~18'-5?~~18'-6"	~~16'-6?~~16'-7"	~~20'-10?~~19'-11"	~~18'-3?~~18'-11"
1000S162-43	—	—	—	—	—	—

1000S162-54	12'-10?	~~11'-6?~~11'-7"	~~18'-7?~~18'-5"	~~16'-9?~~16'-6"	~~21'-2?~~19'-8"	~~15'-5?~~18'-8"

1000S162-68	13'-8?	12'-3?	19'-8?	~~17'-8?~~17'-9"	~~22'-4?~~21'-1"	20'-1?
1200S162-43	—	—	—	—	—	—
1200S162-54	—	—	—	—	—	—
1200S162-68	~~14'-4?~~14'-5"	12'-11?	20'-9?	~~18'-8?~~18'-7"	~~23'-7?~~22'-0"	~~21'-3?~~21'-0"

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 pound per square foot = 0.0479 kPa.

a. Deflection criterion: L/240 for total loads.

b. Ceiling deal load = 5 psf.

c. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.
d. Listed allowable spans are not applicable for 350S162-33, 350S162 - 43, 550S162 - 33, 550S162-43, and 800S162 - 43 continuous joist members.

S8092

Date Submitted	12/13/2018	**Section**	803.2.3	**Proponent**	Paul Coats
Chapter	8	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

8081, 8084

Summary of Modification

Limits wood structural panel roof sheathing cantilever to no more than 9 inches unless supported by gable overhand framing.

Rationale

This modification was approved by the ICC committee and membership and appears in the 2018 edition of the International Residential Code. A sentence is added to R803.2.3 to clarify the appropriate limit on the distance unsupported sheathing can cantilever past the gable end roof framing, for the design of roof sheathing and attachment that is consistent with other provisions for roof sheathing in the code. See the attached support files for additional information and how this is related to other modifications for roof sheathing attachment.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Unsupported roof sheathing cantilever span limits, there are no problematic issues with enforcement.

Impact to building and property owners relative to cost of compliance with code

No cost-related impact.

Impact to industry relative to the cost of compliance with code

No cost-related impact.

Impact to small business relative to the cost of compliance with code

No cost-related impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The limit will enhance wind resistant roof design.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

R803.2.3Installation.

Wood structural panel used as roof sheathing shall be installed with joints staggered in accordance with Section R803.2.3.1 for wood roof framing or with Table R804.3 for cold-formed steel roof framing. Wood structural panel roof sheathing shall not cantilever more than 9 inches beyond the gable end wall unless supported by gable overhand framing.

RB221-16

IRC: R602.3, R803.2.3.

Proponent : James Smith (jsmith@awc.org)

2015 International Residential Code

TABLE R602.3 (1)
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Roof			
1	Blocking between ceiling joists or rafters to top plate	4-8d box ($2^1/_2$ ″ × 0.113″) or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
2	Ceiling joists to top plate	4-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Sections R802.3.1, R802.3.2 and Table R802.5.1(9)]	4-10d box (3″ × 0.128″); or 3-16d common ($3^1/_2$ ″ × 0.162″); or 4-3″ × 0.131″ nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Sections R802.3.1 and R802.3.2 and Table R802.5.1(9)]	Table R802.5.1(9)	Face nail
5	Collar tie to rafter, face nail or $1^1/_4$ ″ × 20 ga. ridge strap to rafter	4-10d box (3″ × 0.128″); or 3-10d common (3″ × 0.148″); or 4-3″ × 0.131″ nails	Face nail each rafter

6	Rafter or roof truss to plate	3-16d box nails (3 1/2″ × 0.135″); or 3-10d common nails (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss[i]
7	Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2″ ridge beam	4-16d (3 1/2″ × 0.135″); or 3-10d common (3 1/2″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box 3 1/2″ × 0.135″); or 2-16d common (3 1/2″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
Wall			
8	Stud to stud (not at braced wall panels)	16d common (3 1/2″ × 0.162″)	24″ o.c. face nail
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	16″ o.c. face nail
9	Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d box (3 1/2″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
		16d common (3 1/2″ × 0.162″)	16″ o.c. face nail
10	Built-up header (2″ to 2″ header with 1/2″ spacer)	16d common (3 1/2″ × 0.162″)	16″ o.c. each edge face nail
		16d box (3 1/2″ × 0.135″)	12″ o.c. each edge face nail
11	Continuous header to stud	5-8d box (2 1/2″ × 0.113″); or 4-8d common (2 1/2″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toe nail
		16d common (3 1/2″ × 0.162″)	16″ o.c. face nail

12	Top plate to top plate	10d box (3″ × 0.128″); or 3″ × 0.131″ nails	12″ o.c. face nail
13	Double top plate splice for SDCs A-D2 with seismic braced wall line spacing	8-16d common ($3\frac{1}{2}$″ × 0.162″); or 12-16d box ($3\frac{1}{2}$″ × 0.135″); or 12-10d box (3″ × 0.128″); or 12-3″ × 0.131″ nails	Face nail on each side of end joint (minimum 24″ lap splice length each side of end joint)
	Double top plate splice SDCs D_0 , D_1 , or D_2 ; and braced wall line spacing ≥ 25′	12-16d ($3\frac{1}{2}$″ × 0.135″)	

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
14	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common ($3\frac{1}{2}$″ × 0.162″)	16″ o.c. face nail
		16d box ($3\frac{1}{2}$″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
15	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box ($3\frac{1}{2}$″ × 0.135″); or 2-16d common ($3\frac{1}{2}$″ × 0.162″); or 4-3″ × 0.131″ nails	3 each 16″ o.c. face nail 2 each 16″ o.c. face nail 4 each 16″ o.c. face nail
16	Top or bottom plate to stud	4-8d box ($2\frac{1}{2}$″ × 0.113″); or 3-16d box ($3\frac{1}{2}$″ × 0.135″); or 4-8d common ($2\frac{1}{2}$″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box ($3\frac{1}{2}$″ × 0.135″); or 2-16d common ($3\frac{1}{2}$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail

17	Top plates, laps at corners and intersections	3-10d box (3″ × 0.128″); or 2-16d common ($3^{1}/_{2}$″ × 0.162″); or 3-3″ × 0.131″ nails	Face nail
18	1″ brace to each stud and plate	3-8d box ($2^{1}/_{2}$″ × 0.113″); or 2-8d common ($2^{1}/_{2}$″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples $1^{3}/_{4}$″	Face nail
19	1″ × 6″ sheathing to each bearing	3-8d box ($2^{1}/_{2}$″ × 0.113″); or 2-8d common ($2^{1}/_{2}$″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1^{3}/_{4}$″ long	Face nail
20	1″ × 8″ and wider sheathing to each bearing	3-8d box ($2^{1}/_{2}$″ × 0.113″); or 3-8d common ($2^{1}/_{2}$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3 staples, 1″ crown, 16 ga., $1^{3}/_{4}$″ long Wider than 1″ × 8″ 4-8d box ($2^{1}/_{2}$″ × 0.113″); or 3-8d common ($2^{1}/_{2}$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 4 staples, 1″ crown, 16 ga., $1^{3}/_{4}$″ long	Face nail
Floor			
21	Joist to sill, top plate or girder	4-8d box ($2^{1}/_{2}$″ × 0.113″); or 3-8d common ($2^{1}/_{2}$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
		8d box ($2^{1}/_{2}$″ × 0.113″)	4″ o.c. toe nail

22	Rim joist, band joist or blocking to sill or top plate (roof applications also)	8d common ($2^1/_2$ ″ × 0.131″); or 10d box (3″ × 0.128″); or 3″ × 0.131″ nails	6″ o.c. toe nail
23	1″ × 6″ subfloor or less to each joist	3-8d box ($2^1/_2$ ″ × 0.113″); or 2-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	Face nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
		Floor	
24	2″subfloor to joist or girder	3-16d box ($3^1/_2$ ″× 0.135″); or 2-16d common ($3^1/_2$ ″× 0.162″)	Blind and face nail
25	2″planks (plank & beam—floor & roof)	3-16d box ($3^1/_2$ ″× 0.135″); or 2-16d common ($3^1/_2$ ″× 0.162″)	At each bearing, face nail
26	Band or rim joist to joist	3-16d common ($3^1/_2$ ″× 0.162″) 4-10 box (3″× 0.128″), or 4-3″× 0.131″nails; or	End nail

		4-3″× 14 ga. staples, 7 /16 ″crown					
27	Built-up girders and beams, 2-inch lumber layers	20d common (4″× 0.192″); or	Nail each layer as follows: 32″o.c. at top and bottom and staggered.				
		10d box (3″× 0.128″); or 3″× 0.131″nails	24″o.c. face nail at top and bottom staggered on opposite sides				
		And: 2-20d common (4″× 0.192″); or 3-10d box (3″× 0.128″); or 3-3″× 0.131″nails	Face nail at ends and at each splice				
28	Ledger strip supporting joists or rafters	4-16d box (3 1 /2 ″× 0.135″); or 3-16d common (3 1 /2 ″× 0.162″); or 4-10d box (3″× 0.128″); or 4-3″× 0.131″nails	At each joist or rafter, face nail	29	Bridging to joist	2-10d (3″× 0.128″)	Each end, toe nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING OF FASTENERS	
			Panel Edges (inches)[h]	Intermediate supports[c, e] (inches)
Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing [see Table R602.3(3) for wood structural panel *exterior* wall sheathing to wall framing]				

30	3/8"–1/2"	6d common (2"× 0.113") nail (subfloor, wall)[i] 8d common (2 1/2"× 0.131") nail (roof)	6	12[f]
31	19/32"–1"	8d common nail (2 1/2"× 0.131")	6	12[f]
32	11/8"–11/4"	10d common (3"× 0.148") nail; or 8d (21/2"× 0.131") deformed nail	6	12
Other wall sheathing[g]				
33	1/2"structural cellulosic fiberboard sheathing	1 1/2"galvanized roofing nail, 7/16" head diameter, or 1"crown staple 16 ga., 1 1/4" long	3	6
34	25/32"structural cellulosic fiberboard sheathing	1 3/4"galvanized roofing nail, 7/16"head diameter, or 1"crown staple 16 ga., 1 1/4" long	3	6
		1 1/2		

35	$^{1}/_{2}$ "gypsum sheathing[d]	"galvanized roofing nail; staple galvanized, $1^{1}/_{2}$ "long; $1^{1}/_{4}$ " screws, Type W or S	7	7
36	$^{5}/_{8}$ "gypsum sheathing[d]	$1^{3}/_{4}$ "galvanized roofing nail; staple galvanized, $1^{5}/_{8}$ " long; $1^{5}/_{8}$ " screws, Type W or S	7	7
Wood structural panels, combination subfloor underlayment to framing				
37	$^{3}/_{4}$ " and less	6d deformed (2"× 0.120") nail; or 8d common ($2^{1}/_{2}$ "× 0.131") nail	6	12
38	$^{7}/_{8}$ "– 1"	8d common ($2^{1}/_{2}$ "× 0.131") nail; or 8d deformed ($2^{1}/_{2}$ "× 0.120") nail	6	12
39	$1^{1}/_{8}$ "– $1^{1}/_{4}$ "	10d common (3"× 0.148") nail; or 8d deformed (2^{1}	6	12

		/2 "× 0.120") nail		

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.

a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.

b. Staples are 16 gage wire and have a minimum $^{7}/_{16}$ -inch on diameter crown width.

c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.

d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.

e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).

~~f. Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.~~

f. For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48" of roof end zones, eaves, and ridges, nails shall be spaced at 6 inches on center where the ultimate design wind speed is less than 130 mph and shall be spaced 4 inches on center where the ultimate design wind speed is 130 mph or greater but less than 140 mph.

g. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.

h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.

i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

R803.2.3 Installation. Wood structural panel used as roof sheathing shall be installed with joints staggered or not staggered in accordance with Table R602.3(1), APA E30 for wood roof framing or with Table R804.3 for cold-formed steel roof framing. Wood structural panel roof sheathing shall not cantlever more than 9 inches beyond the gable end wall unless supported by gable overhang framing.

Reason: Nailing requirements provided in the IRC Table 602.3(1) were reviewed using loads from ASCE 7-10 *Minimum Design Loads for Buildings and Other Structures.* Nailing requirements for common species of roof framing with specific gravities of 0.42 or greater (e.g. SPF, Hem-Fir) were analyzed and it was found that the nail spacing requirements in footnote "f" needed to be slightly modified to clarify that nail spacing for all sheathing to framing attached to intermediate supports within 48" of roof end zones, eaves, and ridges must be reduced, not just at the gable end roof framing. For ultimate wind speeds of 130 mph and greater, the threshold for reducing the nail spacing from 6" to 4" in the 48" end zone areas was slightly modified while clarifying that ultimate wind speeds of 140 mph or greater are is outside the scope of the IRC structural provisions. The language in footnote "f" was revised to clarify the intent of this footnote. A sentence was also added to R803.2.3 to clarify the appropriate limit on the distance unsupported sheathing can cantilever past the gable end roof framing. Tabulated calculation results based on ASCE 7-10 are provided below: (insert attachment here)

WFCM Table 3.10 (Exposure C) - Based on ASCE 7-10
Roof Sheathing Attachment Requirements for Wind Loads

700-yr. Wind Speed 3-second gust (mph)			110		115		120		130		140	
			Wood Structural Panel Sheathing									
			E	F	E	F	E	F	E	F	E	F
Sheathing Location[1]	Rafter/Truss Framing Specific Gravity, G	Rafter/Truss Spacing (in.)	Maximum Nail Spacing for 8d Common Nails or 10d Box Nails (inches, o.c.)[2]									
Interior Zone	0.42	12	6	12	6	12	6	12	6	12	6	12
		16	6	12	6	12	6	12	6	12	6	12
		19.2	6	12	6	12	6	12	6	12	6	12
		24	6	12	6	12	6	12	6	12	6	12
Perimeter Edge Zone	0.42	12	6	12	6	12	6	12	6	12	6	6
		16	6	12	6	6	6	6	6	6	6	6
		19.2	6	6	6	6	6	6	6	6	6	6
		24	6	6	6	6	6	6	6	4	6	4
Gable Endwall Rake or Rake Truss with up to 9" Rake Overhang	0.42	-	6		6		6		4		4	

E - Nail spacing at panel edges (in.)
F - Nail spacing at intermediate supports in the panel field (in.)

1 For roof sheathing within 4 feet of the perimeter edge of the roof, including 4 feet on each side of the roof peak, the 4 foot perimeter edge zone attachment requirements shall be used.
2 For wind speeds greater than 130 mph, blocking is required which transfers shear load to two additional joi

Cost Impact: Will not increase the cost of construction
The change to footnote "f" is a clarification of the current footnote "f" intent. The 9" limit on gable overhang is not really an increase in requirement, but a limitation to allow more efficient nailing patterns.

RB221-16 : TABLE R602.3-SMITH11542

Final Action: AM (Approved as Modified by the Committee)

RB221-16

Committee Action: **Approved as Modified**

Modification:

TABLE R602.3 (1)
FASTENING SCHEDULE

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.
a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.
b. Staples are 16 gage wire and have a minimum $^{7}/_{16}$ -inch on diameter crown width.
c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.
d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.
e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).
f. For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48" of roof ~~end zones, eaves,~~ edges and ridges, nails shall be spaced at 6 inches on center where the ultimate design wind speed is less than 130 mph and shall be spaced 4 inches on center where the ultimate design wind speed is 130 mph or greater but less than 140 mph.
g. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.

h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.
i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

R803.2.3 Installation. Wood structural panel used as roof sheathing shall be installed with joints staggered or not staggered in accordance with Table R602.3(1), APA E30 for wood roof framing or with Table R804.3 for cold-formed steel roof framing. Wood structural panel roof sheathing in accordance with Table R503.2.1.1(1) shall not cantilever more than 9 inches beyond the gable end wall unless supported by gable overhang framing.

Committee Reason:

The committee approved this change based on the proponents published reason statement. The proposal aligns the roof sheathing nail spacing with the ASCE 7-10 loading and provides an allowable cantilever for the sheathing past the gable end. The modifications deleted the terms end zones and eaves to avoid confusion with edges and added a reference to the sheathing installation table.

Assembly Action: **None**

RB222-16

IRC: R602.3, R803.2.3.

Proponent : James Smith (jsmith@awc.org)

2015 International Residential Code

TABLE R602.3 (1)
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
		Roof	
1	Blocking between ceiling joists or rafters to top plate	4-8d box ($2^1/_2$ ″ × 0.113″) or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
2	Ceiling joists to top plate	4-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Sections R802.3.1, R802.3.2 and Table R802.5.1(9)]	4-10d box (3″ × 0.128″); or 3-16d common ($3^1/_2$ ″ × 0.162″); or 4-3″ × 0.131″ nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Sections R802.3.1 and R802.3.2 and Table R802.5.1(9)]	Table R802.5.1(9)	Face nail
5	Collar tie to rafter, face nail or $1^1/_4$ ″ × 20 ga. ridge strap to rafter	4-10d box (3″ × 0.128″); or 3-10d common (3″ × 0.148″); or 4-3″ × 0.131″ nails	Face nail each rafter

6	Rafter or roof truss to plate	3-16d box nails (3 1/2 ″ × 0.135″); or 3-10d common nails (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss[i]
7	Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2″ ridge beam	4-16d (3 1/2 ″ × 0.135″); or 3-10d common (3 1/2 ″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box 3 1/2 ″ × 0.135″); or 2-16d common (3 1/2 ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
Wall			
8	Stud to stud (not at braced wall panels)	16d common (3 1/2 ″ × 0.162″)	24″ o.c. face nail
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	16″ o.c. face nail
9	Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d box (3 1/2 ″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
		16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail
10	Built-up header (2″ to 2″ header with 1/2 ″ spacer)	16d common (3 1/2 ″ × 0.162″)	16″ o.c. each edge face nail
		16d box (3 1/2 ″ × 0.135″)	12″ o.c. each edge face nail
11	Continuous header to stud	5-8d box (2 1/2 ″ × 0.113″); or 4-8d common (2 1/2 ″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toe nail
		16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
12	Top plate to top plate	10d box (3″ × 0.128″); or 3″ × 0.131″ nails	12″ o.c. face nail
13	Double top plate splice for SDCs A-D2 with seismic braced wall line spacing	8-16d common ($3^{1}/_{2}$ ″ × 0.162″); or 12-16d box ($3^{1}/_{2}$ ″ × 0.135″); or 12-10d box (3″ × 0.128″); or 12-3″ × 0.131″ nails	Face nail on each side of end joint (minimum 24″ lap splice length each side of end joint)
	Double top plate splice SDCs D_0 , D_1 , or D_2 ; and braced wall line spacing ≥ 25′	12-16d ($3^{1}/_{2}$ ″ × 0.135″)	
14	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common ($3^{1}/_{2}$ ″ × 0.162″)	16″ o.c. face nail
		16d box ($3^{1}/_{2}$ ″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
15	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box ($3^{1}/_{2}$ ″ × 0.135″); or 2-16d common ($3^{1}/_{2}$ ″ × 0.162″); or 4-3″ × 0.131″ nails	3 each 16″ o.c. face nail 2 each 16″ o.c. face nail 4 each 16″ o.c. face nail
16	Top or bottom plate to stud	4-8d box ($2^{1}/_{2}$ ″ × 0.113″); or 3-16d box ($3^{1}/_{2}$ ″ × 0.135″); or 4-8d common ($2^{1}/_{2}$ ″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box ($3^{1}/_{2}$ ″ × 0.135″); or 2-16d common ($3^{1}/_{2}$ ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail

17	Top plates, laps at corners and intersections	3-10d box (3″ × 0.128″); or 2-16d common ($3^1/_2$ ″ × 0.162″); or 3-3″ × 0.131″ nails	Face nail
18	1″ brace to each stud and plate	3-8d box ($2^1/_2$ ″ × 0.113″); or 2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples $1^3/_4$ ″	Face nail
19	1″ × 6″ sheathing to each bearing	3-8d box ($2^1/_2$ ″ × 0.113″); or 2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	Face nail
20	1″ × 8″ and wider sheathing to each bearing	3-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	Face nail
		Wider than 1″ × 8″ 4-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 4 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	
Floor			
21	Joist to sill, top plate or girder	4-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
		8d box ($2^1/_2$ ″ × 0.113″)	4″ o.c. toe nail

22	Rim joist, band joist or blocking to sill or top plate (roof applications also)	8d common ($2^1/_2$ " × 0.131"); or 10d box (3" × 0.128"); or 3" × 0.131" nails	6" o.c. toe nail
23	1" × 6" subfloor or less to each joist	3-8d box ($2^1/_2$ " × 0.113"); or 2-8d common ($2^1/_2$ " × 0.131"); or 3-10d box (3" × 0.128"); or 2 staples, 1" crown, 16 ga., $1^3/_4$ " long	Face nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Floor			
24	2"subfloor to joist or girder	3-16d box ($3^1/_2$ "× 0.135"); or 2-16d common ($3^1/_2$ "× 0.162")	Blind and face nail
25	2"planks (plank & beam—floor & roof)	3-16d box ($3^1/_2$ "× 0.135"); or 2-16d common ($3^1/_2$ "× 0.162")	At each bearing, face nail
26	Band or rim joist to joist	3-16d common ($3^1/_2$ "× 0.162") 4-10 box (3"× 0.128"), or 4-3"× 0.131"nails; or	End nail

		4-3″× 14 ga. staples, 7 /16 ″crown					
27	Built-up girders and beams, 2-inch lumber layers	20d common (4″× 0.192″); or	Nail each layer as follows: 32″o.c. at top and bottom and staggered.				
		10d box (3″× 0.128″); or 3″× 0.131″nails	24″o.c. face nail at top and bottom staggered on opposite sides				
		And: 2-20d common (4″× 0.192″); or 3-10d box (3″× 0.128″); or 3-3″× 0.131″nails	Face nail at ends and at each splice				
28	Ledger strip supporting joists or rafters	4-16d box (3 1 /2 ″× 0.135″); or 3-16d common (3 1 /2 ″× 0.162″); or 4-10d box (3″× 0.128″); or 4-3″× 0.131″nails	At each joist or rafter, face nail	29	Bridging to joist	2-10d (3″× 0.128″)	Each end, toe nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING OF FASTENERS	
			Panel Edges (inches)[h]	Intermediate supports[c, e] (inches)
Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing [see Table R602.3(3) for wood structural panel *exterior* wall sheathing to wall framing]				

30	3/8″– 1/2″	6d common (2″× 0.113″) nail (subfloor, wall)[i]8d common (2 1/2″× 0.131″) nail (roof)	6	~~12~~6[f]
31	19/32″– 1″	8d common nail (2 1/2″× 0.131″)	6	~~12~~6[f]
32	1 1/8″–1 1/4″	10d common (3″× 0.148″) nail; or 8d (2 1/2″× 0.131″) deformed nail	6	12
Other wall sheathing[g]				
33	1/2″structural cellulosic fiberboard sheathing	1 1/2″galvanized roofing nail, 7/16″ head diameter, or 1″crown staple 16 ga., 1 1/4″ long	3	6
34	25/32″structural cellulosic fiberboard sheathing	1 3/4″galvanized roofing nail, 7/16″head diameter, or 1″crown staple 16 ga., 1 1/4″ long	3	6
		1 1/2		

35	1/2" gypsum sheathing[d]	"galvanized roofing nail; staple galvanized, 1 1/2" long; 1 1/4" screws, Type W or S	7	7
36	5/8" gypsum sheathing[d]	1 3/4" galvanized roofing nail; staple galvanized, 1 5/8" long; 1 5/8" screws, Type W or S	7	7
Wood structural panels, combination subfloor underlayment to framing				
37	3/4" and less	6d deformed (2"× 0.120") nail; or 8d common (2 1/2"× 0.131") nail	6	12
38	7/8"– 1"	8d common (2 1/2"× 0.131") nail; or 8d deformed (2 1/2"× 0.120") nail	6	12
39	1 1/8"– 1 1/4"	10d common (3"× 0.148") nail; or 8d deformed (2 1	6	12

		/2 "× 0.120") nail		

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.

a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.

b. Staples are 16 gage wire and have a minimum $^{7}/_{16}$ -inch on diameter crown width.

c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.

d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.

e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).

~~f. Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.~~

f. For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48" of roof end zones, eaves, and ridges, nails shall be spaced at 4" on center where the ultimate design wind speed is 120 mph or greater but less than 140 mph.

g. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.

h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.

i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

Revise as follows:

R803.2.3 Installation. Wood structural panel used as roof sheathing shall be installed with joints staggered or not staggered in accordance with Table R602.3(1), APA E30 for wood roof framing or with Table R804.3 for cold-formed steel roof framing. Wood structural panel roof sheathing shall not cantilever more than 9 inches beyond the gable end wall unless supported by gable overhang framing.

Reason: The nailing requirements provided in IRC Table R602.3(1) were reviewed using loads from the New ASCE 7-16 *Minimum Design Loads for Buildings and Other Structures*. As shown in the table below, calculated wind loads on elements and fasteners with small tributary areas like roof sheathing nails have increased dramatically, almost doubling in the interior portions of the roof (Roof Zone 1).

Roof Zone	ASCE 7-10			ASCE 7-16			Increase (%)
	GC_p	Gc_{pi}	GC_p-Gc_{pi}	GC_p	Gc_{pi}	GC_p-Gc_{pi}	
1	-1.0	-0.18	-1.2	-2.0	-0.18	-2.2	85%
2	-1.8	-0.18	-2.0	-3.0	-0.18	-3.2	61%
2 overhang	-2.8	0.00	-2.8	-3.5	0.00	-3.5	25%
3	-3.0	-0.18	-3.2	-3.6	-0.18	-3.8	19%
3 overhang	-3.7	0.00	-3.7	-4.7	0.00	-4.7	27%

To determine the impact of the new ASCE 7-16 loading provisions, nailing requirements for common species of roof framing with specific gravities of 0.42 or greater (e.g. SPF, Hem-Fir) were analyzed using ASCE 7-16 and it was found that the nail spacing requirements in Table R602.3(1) needed to be significantly modified, especially in the

interior portion of the roof. As shown in the tabulated results below, nailing at intermediate supports in the interior portions of the roof (Roof Zone 1) need to be reduced from 12" o.c. to 6" o.c. However, changes to loads in the end zone portions of the roof were less significant and required far less adjustment. In fact, the 6" o.c. spacing is appropriate for all connection in the end zone portions, except where ultimate wind speeds equal or exceed 120 mph.

WFCM Table 3.10 (Exposure C) - Based on ASCE 7-16
Roof Sheathing Attachment Requirements for Wind Loads

700-yr. Wind Speed 3-second gust (mph)			110		115		120		130		140	
			Wood Structural Panel Sheathing									
			E	F	E	F	E	F	E	F	E	F
Sheathing Location[1]	Rafter/Truss Framing Specific Gravity, G	Rafter/Truss Spacing (in.)	Maximum Nail Spacing for 8d Common Nails or 10d Box Nails (inches, o.c.)[2]									
Interior Zone	0.42	12	6	12	6	12	6	12	6	12	6	12
		16	6	12	6	12	6	12	6	12	6	6
		19.2	6	12	6	12	6	12	6	6	6	6
		24	6	12	6	6	6	6	6	6	6	6
Perimeter Edge Zone	0.42	12	6	12	6	12	6	6	6	6	6	6
		16	6	6	6	6	6	6	6	6	6	6
		19.2	6	6	6	6	6	6	6	6	6	4
		24	6	6	6	6	6	4	6	4	6	4
Gable Endwall Rake or Rake Truss with up to 9" Rake Overhang	0.42	-	6		6		4		4		4	

E - Nail spacing at panel edges (in.)

F - Nail spacing at intermediate supports in the panel field (in.)

1 For roof sheathing within 4 feet of the perimeter edge of the roof, including 4 feet on each side of the roof peak, the 4 foot perimeter edge zone attachment requirements shall be used.

2 For wind speeds greater than 130 mph, blocking is required which transfers shear load to two additional joi

The language in footnote "f" needed to be slightly modified to clarify that nail spacing for all sheathing to framing attached to gable end roof framing and intermediate supports within 48" of roof end zones, eaves and ridges must be reduced from 6" to 4" where ultimate wind speeds exceed 120 mph. Language was also added to clarify that ultimate wind speeds of 140 mph or greater is outside the scope of the IRC structural provisions. A sentence was also added to R803.2.3 to clarify the appropriate limit on the distance unsupported sheathing can cantilever past the gable end roof framing.

Cost Impact: Will increase the cost of construction
Even though much of the proposal is a clarification that should make it easier to use and thereby reduce cost, the change in fastener spacings from 12" to 6" in rows 30 and 31 of the table will increase the number of nails and the time to install, which will increase cost. This increase in cost is the direct result of compliance with the increased wind uplift loads in ASCE 7-16.

RB222-16 : TABLE R602.3-SMITH11567

Final Action: D (Disapproved)

RB222-16

Committee Action: **Disapproved**

Committee Reason: Based on the proponets request for disapproval and the committees previous action on RB20-16.

Assembly Action: **None**

S8150

Date Submitted	12/14/2018	**Section**	802.2	**Proponent**	T Stafford
Chapter	8	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

This proposal is intended to clarify the limits for using the prescriptive (non-high) wind criteria that's been carried forward in the FBCR from the IRC.

Rationale

This proposal is intended to clarify the applicability of the prescriptive criteria in the FBCR for wood, masonry, concrete and steel buildings. Since the first edition, the FBCR has limited the use of the prescriptive criteria that has been carried forward from the IRC. With the adoption of ASCE 7-10 in the 2010 FBCR, the prescriptive provisions have not been permitted to be used in any area of Florida. Recent editions of the FBCR have simply deleted this criteria. During the last cycle, language was added to specifically address the limits but was not as comprehensive as in previous editions. This proposal simply provides additional clarification.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with the code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to cost of compliance with the code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to cost of compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal clarifies requirements for wind design of buildings within the scope of the FBCR.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code by clarifying the wind design requirements of buildings within the scope of the FBCR.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

R802.2 Design and construction. Where the ultimate design wind speed, V_{ult}, equals or exceeds 115 mph, wood roof framing shall be in accordance with Section R301.2.1.1 or ANSI AWC NDS. Where ultimate design wind speed, V_{ult}, is less than 115 mphwood roof framing shall be in accordance with the provisions of this section.

R802.2.1 Framing details ~~Design and construction~~. The framing details required in Section R802 apply to roofs having a minimum slope of three units vertical in 12 units horizontal (25-percent slope) or greater. Roof-ceilings shall be designed and constructed in accordance with the provisions of this chapter and Figures R606.11(1), R606.11(2) and R606.11(3) or in accordance with AWC NDS. Components of roof-ceilings shall be fastened in accordance with Table R602.3(1).

Date Submitted	12/14/2018	**Section**	802.5.1	**Proponent**	Paul Coats
Chapter	8	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments	**No**	**Alternate Language**	**No**

Related Modifications

Summary of Modification

Removes a redundant footnote from Table R802.5.1(9) Rafter/Ceiling Joist Heel Joint Connections

Rationale

This modification was approved by the ICC committee and membership and appears in the 2018 edition of the International Residential Code. Footnote "f" is redundant to footnote "h" in purpose. Footnote "f" should have been removed at the time footnote "h" was added to better account for the effect of rafter ties located above the bottom of the attic space. The approach in footnote "h" allow s application for use on lower slope rafter systems, less penalty for smaller raised distances, and a more simple method to determine heel joint connection requirements. There is no change to footnote h.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Cleans up a connection table by removing a superfluous footnote.

Impact to building and property owners relative to cost of compliance with code

No cost-related impact.

Impact to industry relative to the cost of compliance with code

No cost-related impact.

Impact to small business relative to the cost of compliance with code

No cost-related impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Cleans up important connection table.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

TABLE R802.5.1(9)

RAFTER/CEILING JOIST HEEL JOINT CONNECTIONS[a, b, c, d, e, ~~f~~, h]

(no change to body of table, only delete footnote f in its entirety and renumber remaining footnotes)

1. ~~f.Where rafter ties are substituted for ceiling joists, the heel joint connection requirement shall be taken as the tabulated heel joint connection requirement for two-thirds of the actual rafter slope.~~

   ~~g.~~f. Applies to roof live load of 20 psf or less.

   ~~h.~~g. *(footnote h remains unchanged)*
2.

RB319-16

IRC: R802.5.1.

Proponent : Paul Coats, PE CBO, representing American Wood Council (pcoats@awc.org)

2015 International Residential Code

Revise as follows:

TABLE R802.5.1 (9)
RAFTER/CEILING JOIST HEEL JOINT CONNECTIONS[a, b, c, d, e, ~~f,~~ h]

RAFTER SLOPE	RAFTER SPACING (inches)	GROUND SNOW LOAD (psf)															
		20[g]				30				50				70			
		Roof span (feet)															
		12	20	28	36	12	20	28	36	12	20	28	36	12	20	28	36
		Required number of 16d common nails[a, b] per heel joint splices[c, d, ~~e, f~~]															
3:12	12	4	6	8	10	4	6	8	11	5	8	12	15	6	11	15	20
	16	5	8	10	13	5	8	11	14	6	11	15	20	8	14	20	26
	24	7	11	15	19	7	11	16	21	9	16	23	30	12	21	30	39
4:12	12	3	5	6	8	3	5	6	8	4	6	9	11	5	8	12	15
	16	4	6	8	10	4	6	8	11	5	8	12	15	6	11	15	20
	24	5	8	12	15	5	9	12	16	7	12	17	22	9	16	23	29
5:12	12	3	4	5	6	3	4	5	7	3	5	7	9	4	7	9	12
	16	3	5	6	8	3	5	7	9	4	7	9	12	5	9	12	16
	24	4	7	9	12	4	7	10	13	6	10	14	18	7	13	18	23
7:12	12	3	4	4	5	3	3	4	5	3	4	5	7	3	5	7	9
	16	3	4	5	6	3	4	5	6	3	5	7	9	4	6	9	11

	24	3	5	7	9	3	5	7	9	4	7	10	13	5	9	13	17
9:12	12	3	3	4	4	3	3	3	4	3	3	4	5	3	4	5	7
	16	3	4	4	5	3	3	4	5	3	4	5	7	3	5	7	9
	24	3	4	6	7	3	4	6	7	3	6	8	10	4	7	10	13
12:12	12	3	3	3	3	3	3	3	3	3	3	3	4	3	3	4	5
	16	3	3	4	4	3	3	3	4	3	3	4	5	3	4	5	7
	24	3	4	4	5	3	3	4	6	3	4	6	8	3	6	8	10

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. 40d box nails shall be permitted to be substituted for 16d common nails.

b. Nailing requirements shall be permitted to be reduced 25 percent if nails are clinched.

c. Heel joint connections are not required where the ridge is supported by a load-bearing wall, header or ridge beam.

d. Where intermediate support of the rafter is provided by vertical struts or purlins to a load-bearing wall, the tabulated heel joint connection requirements shall be permitted to be reduced proportionally to the reduction in span.

e. Equivalent nailing patterns are required for ceiling joist to ceiling joist lap splices.

~~f. Where rafter ties are substituted for ceiling joists, the heel joint connection requirement shall be taken as the tabulated heel joint connection requirement for two-thirds of the actual rafter slope.~~

g. Applies to roof live load of 20 psf or less.

h. Tabulated heel joint connection requirements assume that ceiling joists or rafter ties are located at the bottom of the attic space. Where ceiling joists or rafter ties are located higher in the attic, heel joint connection requirements shall be increased by the following factors:

H_C/H_R	**Heel Joint Connection Adjustment Factor**
1/3	1.5
1/4	1.33
1/5	1.25
1/6	1.2
1/10 or less	1.11

where:

H_C = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.

H_R = Height of roof ridge measured vertically above the top of the rafter support walls.

Reason: Footnote "f" is redundant to footnote "h" in purpose. Footnote "f" should have been removed at the time footnote "h" was added to better account for the effect of rafter ties located above the bottom of the attic space. The approach in footnote "h" allows application for use on lower slope rafter systems, less penalty for smaller raised distances, and a more simple method to determine heel joint connection requirements. There is no change to footnote h.

Cost Impact: Will not increase the cost of construction
This is an editorial change that removes an unneeded provision which is captured by another footnote, and

therefore represents no increase in cost of construction.

Final Action: AS (Approved as Submitted

S8329

Date Submitted	12/15/2018	**Section**	806.5	**Proponent**	Joseph Lstiburek
Chapter	8	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Need to provide a definition for Vapor Diffusion Port

Summary of Modification

Allows the sealing of soffit vents while allowing moisture to leave attics via upper vents that are vapor open but airtight. Solve attic duct condensation problems.

Rationale

Venting attics in hot humid climates with hot humid air results in condensation on ductwork located in attics. This modification allows moisture in attics to be removed by vapor diffusion rather than by air change eliminating condensation on attic ductwork.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Reduces condensation and mold problems in attics.

Impact to building and property owners relative to cost of compliance with code

Cost of construction is less as the amount of venting is reduced. Not installing soffit vents is less expensive than installing soffit vents.

Impact to industry relative to the cost of compliance with code

Cost of construction is less as the amount of venting is reduced. Not installing soffit vents is less expensive than installing soffit vents.

Impact to small business relative to the cost of compliance with code

Cost of construction is less as the amount of venting is reduced. Not installing soffit vents is less expensive than installing soffit vents.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Reduces condensation and mold problems in attics.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Reduces condensation and mold problems in attics.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Has no impact on existing materials, products, methods or systems.

Does not degrade the effectiveness of the code

Improves the effectiveness of the code by reducing attic condensation and mold problems.

R202
Add definition as follows:

VAPOR DIFFUSION PORT An assembly constructed or installed within a roof assembly at an opening in the roof deck to convey water vapor from an unvented attic to the outside atmosphere.

SECTION R806 ROOF VENTILATION

R806.5 Unvented attic and unvented enclosed rafter assemblies.
Unvented attics and unvented enclosed roof framing assemblies created by ceilings that are applied directly to the underside of the roof framing members and structural roof sheathing applied directly to the topof the roof framing members/rafters, shall be permitted where all the following conditions are met:
1. The unvented attic space is completely within the building thermal envelope.
2. No interior Class I vapor retarders are installed on the ceiling side (attic floor) of the unvented attic assembly or on the ceiling side of the unvented enclosed roof framing assembly.
3. Where wood shingles or shakes are used, a minimum **1/4**-inch (6.4 mm) vented airspace separates the shingles or shakes and the roofing underlayment above the structural sheathing.
4. In Climate Zones 5, 6, 7 and 8, any air-impermeable insulation shall be a Class II vapor retarder, or shall have a Class **11** vapor retarder coating or covering in direct contact with the underside of theinsulation.
5. Insulation shall be located in accordance with the following:
5.1. Item 5.1.1, 5.1.2, 5.1.3 or 5.1.4 shall be met, depending on the air permeability of the insulation directly under the structural roof sheathing. Where air-permeable insulation is located on top of the attic floor or on top of the attic ceiling Item 5.2 shall be met.
5.1.1. Where air-impermeable insulation is provided, it shall be applied in direct contact with the underside of the structural roof sheathing.
5.1.2. Where air-permeable insulation is provided inside the building thermal envelope, it shall be installed in accordance with Section 5.1.1. In addition to the air-permeable installed directly below the structural sheathing, rigid board or sheet insulation shall be installed directly above the structural roof sheathing in accordance with the R-values in Table R806.5 for condensation control.
5.1.3. Where both air-impermeable and air-permeable insulation are provided, the air-impermeable insulation shall be applied in direct contact with the underside of the structural roof sheathing in accordance with Item 5.1.1 and shall be in accordance with the R-values in Table R806.5 for condensation control. The air-permeable insulation shall be installed directly under the air impermeable insulation.
5.1.4. Alternatively, sufficient rigid board or sheet insulation shall be installed directly above the structural roof sheathing to maintain the monthly average temperature of the underside of the structural roof sheathing above 45°F (7°C). For calculation purposes, an interior air temperatureof68°F (20°C) is assumed and the exterior air temperature is assumed to be the monthly averageoutside air temperature of the three coldest months.

5.2. In Climate Zones 1, 2 and 3, air-permeable insulation installed in unvented attics on the top of the attic floor, or on top of the ceiling shall meet the following requirements:
5.2.1. An approved vapor diffusion port shall be installed not more than 12 inches (305 mm) from the highest point of the roof, measured vertically from the highest point of the roof to the lower edge of the port.
5.2.2. The port area shall be greater than or equal to 1:600 of the ceiling area. Where there are multiple ports in the attic, the sum of the port areas shall be greater than or equal to the area requirement.
5.2.3. The vapor-permeable membrane in the vapor diffusion port shall have a vapor permeance rating of greater than or equal to 20 perms when tested in accordance with Procedure A of ASTM E96.
5.2.4. The vapor diffusion port shall serve as an air barrier between the attic and the exterior of the building.
5.2.5. The vapor diffusion port shall protect the attic against the entrance of rain and snow.

5.3. Where preformed insulation board is used as the air-impermeable insulation layer, it shall be sealed at the perimeter of each individual sheet interior surface to form a continuous layer.

S8378

Date Submitted	12/15/2018	**Section**	806.5	**Proponent**	Craig Conner
Chapter	8	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** | **Alternate Language** **No**

Related Modifications

Chapter 2 definition

Summary of Modification

This adds expands unvented attic option and adds new materials.

Rationale

The proposed code change allows the use of lower cost alternatives. Specifically, the proposed code change allows the use of blown cellulose, fiberglass batts, and blown fiberglass to construct unvented attic assemblies. The approach is limited to Climate Zones 1, 2 and 3 based on research and historic experience over the past decade.

This same change was approved for the IRC last code cycle. This also allows insulation to be above the ceiling or on the attic floor. With air permeable insulation the insulation can be installed directly to the underside of the roof deck or at the floor or ceiling level of an attic assembly as moisture laden air is more buoyant than dry air and therefore the moisture will accumulate at the ridge and exit via the vapor diffusion.

The research work supporting this code change is an outgrowth of the original research work supporting unvented attic assemblies started in 1995 under the Department of Energy's Building America Program. The same technical team and the same technical rigor that supported the original code changes for unvented attics in the early 2000's are behind this proposed code change.
The technical rationale and research behind this code change can be found at Venting Vapor (http://buildingscience.com/documents/insights/bsi-088-venting-vapor?topic=doctypes/insights).
For a history of conditioned attics, see Cool Hand Luke Meets Attics (http://buildingscience.com/documents/insights/bsi-077-cool-hand-luke-meets-attics).
Here is the technical data (https://buildingscience.com/documents/building-america-reports/ba-1511-fieldtesting-unvented-roof-fibrous-insulation-tiles-and) and more technical data (http://buildingscience.com/documents/building-america-reports/ba-1409-field-testing-unvented-roofsasphalt-shingles-cold-and)
Links to two full research reports are at the bottom of the pages on the web site.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

none

Impact to building and property owners relative to cost of compliance with code

potentially lower cost because of additional options with less expensive materials

Impact to industry relative to the cost of compliance with code

potentially lower cost because of additional options with less expensive materials

Impact to small business relative to the cost of compliance with code

potentially lower cost because of additional options with less expensive materials

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

yes proven to mitigate moisture build up and rot in attic cavities

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Provides a potentially less expensive option and reduces moisture condensation and problems. Improves code because it uses a better method of controlling moisture buildup.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Allows construction with additional materials, instead of restricting practical application to one material.

Does not degrade the effectiveness of the code

Providing usable options improves the code.

Section 806.5

(806.5.1 no edit.)

~~5.2.Where preformed insulation board is used as the air-impermeable insulation layer, it shall be sealed at the perimeter of each individual sheet interior surface to form a continuous layer.~~

5.2. In climate zones 1, 2, and 3 air-permeable insulation installed in unvented attics shall meet the following requirements:

5.2.1. A vapor diffusion port shall be installed not more than 12 inches (305mm) from the highest point of the roof, measured vertically from the highest point of the roof to the lower edge of the port.

5.2.2. The port area shall be = 1:600 of the ceiling area. Where there are multiple ports in the attic, the sum of the port areas shall be greater than or equal to the area requirement.

5.2.3. The vapor permeable membrane in the vapor diffusion port shall have a vapor permeance rating of =20 perms when tested in accordance with Procedure A of ASTM E96.

5.2.4. The vapor diffusion port shall serve as an air barrier between the attic and the exterior of the building.

5.2.5. The vapor diffusion port shall protect the attic against the entrance of rain and snow.

5.2.6. Framing members and blocking shall not block the free flow of water vapor to the port. Not less than a 2-inch (50 mm) space shall be provided between any blocking and them roof sheathing. Air-permeable insulation shall be permitted within that space.

5.2.7. The roof slope shall be =3:12 (vertical/horizontal).

5.2.8. Where only air-permeable insulation is used, it shall be installed directly below the structural roof sheathing, on top the attic floor, or on top of the ceiling.

5.2.9. The air shall be supplied at a flow rate =50 CFM (23.6 L/s) per 1000 ft2of ceiling.

5.3. The air shall be supplied from ductwork providing supply air to the occupiable space when the conditioning system is operating. Alternatively, the air shall be supplied by a supply fan when the conditioning system is operating. Where preformed insulation board is used as the air-impermeable insulation layer, it shall be sealed at the perimeter of each individual sheet interior surface to form a continuous layer.

S8398

Date Submitted	12/15/2018	**Section**	806	**Proponent**	Michael Fischer
Chapter	8	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Editorial revisions to attic ventilation requirements.

Rationale

Align with FBC.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

0

Impact to building and property owners relative to cost of compliance with code

0

Impact to industry relative to the cost of compliance with code

0

Impact to small business relative to the cost of compliance with code

0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

yes

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Yes

Does not degrade the effectiveness of the code

Yes

R806.1 Ventilation required.

Enclosed attics and enclosed rafter spaces formed where ceilings are applied directly to the underside of roof rafters shall have cross ventilation for each separate space by ventilating openings protected against the entrance of rain or snow. Ventilation openings shall have a least dimension of 1/16 inch (1.6 mm) minimum and 1/4 inch (6.4 mm) maximum. Ventilation openings having a least dimension larger than 1/4 inch (6.4 mm) shall be provided with corrosion-resistant wire cloth screening, hardware cloth, perforated vinyl, or similar material with openings having a least dimension of 1/16 inch (1.6 mm) minimum and 1/4 inch (6.4 mm) maximum. Openings in roof framing members shall conform to the requirements of Section R802.7. Required ventilation openings shall open directly to the outside air and shall be protected to prevent the entry of birds, rodents, snakes and other similar creatures.

R806.2 Minimum vent area.

The minimum net free ventilating area shall be 1/150 of the area of the vented space.

Exception: The minimum net free ventilation area shall be 1/300 of the vented space provided~~ one or more of the following conditions are met:~~

~~1.In Climate Zones 6, 7 and 8, a Class I or II vapor retarder is installed on the warm-in-winter side of the ceiling.~~

~~2.~~Not less than 40 percent and not more than 50 percent of the required ventilating area is provided by ventilators located in the upper portion of the attic or rafter space. Upper ventilators shall be located not more than 3 feet (914 mm) below the ridge or highest point of the space, measured vertically, with the balance of the required ventilation provided by eave or cornice vents. Where the location of wall or roof framing members conflicts with the installation of upper ventilators, installation more than 3 feet (914 mm) below the ridge or highest point of the space shall be permitted.

R806.3 Vent and insulation clearance.

Where eave or cornice vents are installed, blocking, bridging and insulation shall not block the free flow of air. Not less than a 1-inch (25 mm) space shall be provided between the insulation and the roof sheathing and at the location of the vent.

FBC ARMA Code Proposals

Attic Ventilation

R806.1 Ventilation required.
Enclosed attics and enclosed rafter spaces formed where ceilings are applied directly to the underside of roof rafters shall have cross ventilation for each separate space by ventilating openings protected against the entrance of rain or snow. Ventilation openings shall have a least dimension of 1/16 inch (1.6 mm) minimum and 1/4 inch (6.4 mm) maximum. Ventilation openings having a least dimension larger than 1/4 inch (6.4 mm) shall be provided with corrosion-resistant wire cloth screening, hardware cloth, perforated vinyl, or similar material with openings having a least dimension of 1/16 inch (1.6 mm) minimum and 1/4 inch (6.4 mm) maximum. Openings in roof framing members shall conform to the requirements of Section R802.7. Required ventilation openings shall open directly to the outside air and shall be protected to prevent the entry of birds, rodents, snakes and other similar creatures.

R806.2 Minimum vent area.
The minimum net free ventilating area shall be 1/150 of the area of the vented space.
Exception: The minimum net free ventilation area shall be 1/300 of the vented space provided~~ one or more of the following conditions are met:~~
~~1.In Climate Zones 6, 7 and 8, a Class I or II vapor retarder is installed on the warm-in-winter side of the ceiling.~~
~~2.~~Not less than 40 percent and not more than 50 percent of the required ventilating area is provided by ventilators located in the upper portion of the attic or rafter space. Upper ventilators shall be located not more than 3 feet (914 mm) below the ridge or highest point of the space, measured vertically, with the balance of the required ventilation provided by eave or cornice vents. Where the location of wall or roof framing members conflicts with the installation of upper ventilators, installation more than 3 feet (914 mm) below the ridge or highest point of the space shall be permitted.

R806.3 Vent and insulation clearance.
Where eave or cornice vents are installed, blocking, bridging and insulation shall not block the free flow of air. Not less than a 1-inch (25 mm) space shall be provided between the insulation and the roof sheathing and at the location of the vent.

Reason: The proposal is intended to align the FBC-R attic ventilation requirements of R806.1 and R806.3 with the FBC Chapter 12, and acknowledge that Condition 1 addresses climate zones outside of the Florida Building Codes.

S7426

Date Submitted	11/25/2018	**Section**	905.17.1	**Proponent**	T Stafford
Chapter	9	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No | **Alternate Language** No

Related Modifications

Summary of Modification

Correlates the wind loading requirements in the code for rooftop PV with ASCE 7-16.

Rationale

This proposal correlates the wind loading requirements on roof mounted photovoltaic systems with the newly referenced ASCE 7-16. During Phase I of the 2020 update of the FBC, the Commission voted to update ASCE 7 from the 2010 edition to the 2016 edition (ASCE 7-16). ASCE 7-16 contains two new methods for wind loads on photovoltaic systems. One method is based on the component and cladding loads applicable to the roof. The other method is based on entirely different criteria and research. Therefore, for clarification, this proposal simply references ASCE 7 for wind loads on rooftop PV systems.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to industry relative to the cost of compliance with code

No impact to building and property owners relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to small business relative to the cost of compliance with code

No impact to building and property owners relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This code change correlates the code with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This code change improves the code by providing correlation with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This code change dos not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This code change does not degrade the effectiveness of the code.

R905.17.1 Wind resistance. Rooftop mounted photovoltaic systems shall be designed for wind loads <u>in accordance with ASCE 7</u> ~~for component and cladding in accordance with Chapter 16 of the *Florida Building Code, Building* using an effective wind area based on the dimensions of a single unit frame~~.

S7967

Date Submitted	12/14/2018	**Section**	905	**Proponent**	Andy Williams
Chapter	9	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

R301.2.1

Summary of Modification

Addition of Wind Resistance testing ASTM D3161 to measure metal roof shingle wind resistance performance

Rationale

This proposal recognizes wind resistance of metal roof shingles as a separate item, R905.4.4.1. These items are not the same as asphalt shingles, R905.2.4.1. Showing compliance with the FRC wind resistance requirements is necessary for proper evaluation. UL580, UL1897, and FM4474, currently recognized in the FBC for “Other roof systems,” including metal panel systems, are added as options for metal shingles. TAS 107, which directly states its appropriateness for metal shingles, is added with ASTM equivalent D3161. UL has provided metal shingle wind classifications for many years and currently has D3161-related listings in the Online Certifications Directory.

D3161, created for asphalt shingles, was expanded in 2013 to include other discontinuous, air permeable, steep slope roofing products. This includes metal shingles (specifically identified in Section 1.3). UL was a proponent of the D3161 scope change showing support of D3161 to demonstrate wind resistance.

This proposal removes problems for metal shingle use by clarifying options to show compliance with the wind resistance code requirements. Included are uplift resistance methods used in the FBC for many years (UL1897, UL580, FM4474), and accepted methods of fan-induced wind simulations (TAS 107, ASTM D3161) that are used for other discontinuous, air-permeable roof covers (asphalt shingles) and building integrated PV shingles. The fan-induced options provide alternatives for evaluation of air permeable metal shingles in a non-air-permeable manner via the uplift resistance methods, which unfairly represents the products.

Table R905.4.4.1 is added to establish recognition of metal shingles qualified via D3161. Classifications are equivalent to those for asphalt shingles (Table R905.2.6.1). Like asphalt, metal shingles qualified via D3161 must to bear a label and classification (Table R905.4.4.1).

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal should have no additional impact on enforcement of the code

Impact to building and property owners relative to cost of compliance with code

This proposal should have no additional cost impact for compliance with the code

Impact to industry relative to the cost of compliance with code

This proposal should have no additional cost impact for compliance with the code

Impact to small business relative to the cost of compliance with code

This proposal should have no additional cost impact for compliance with the code

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal should provide realistic performance information to better ensure safety through code compliance.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal provides more accurate performance information on this type of roofing system.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal provides more accurate performance information on this type of roofing system.

Does not degrade the effectiveness of the code

This proposal provides more accurate performance information on this type of roofing system.

Mod 7967

Add new text as follows

R905.4.4.1

R905.4.4.1 Wind Resistance of Metal roof shingles. Metal roof shingles applied to a solid or closely fitted deck shall be tested in accordance with ASTM D3161, FM 4474, UL 580, UL 1897 or TAS 107. Metal roof shingles tested in accordance with ASTM D3161 shall meet the classification requirements of Table R905.2.4.1 for the appropriate maximum basic wind speed and the metal shingle packaging shall bear a label to indicate compliance with ASTM D3161 and the required classification in Table R905.4.4.1.

Add new table as follows:

TABLE R905.4.4.1

CLASSIFICATION OF METAL ROOF SHINGLES TESTED IN ACCORDANCE WITH ASTM D3161

MAXIMUM BASIC WIND SPEED FROM FIGURE 1609A, B, C or ASCE-7	V_{asd}	ASTM D3161
110	85	D or F
116	90	D or F
129	100	D or F
142	110	F
155	120	F
168	130	F
181	140	F
194	150	F

Modify existing text as follows

R301.2.1 Wind design criteria.

Buildings and portions thereof shall be constructed in accordance with the wind provisions of this code using the ultimate design wind speed in Table R301.2(1) as determined from Figure R301.2(4). Where different construction methods and structural materials are used for various portions of a building, the applicable requirements of this section for each portion shall apply. Where not otherwise specified, the wind loads listed in Table R301.2(2) adjusted for height and exposure using Table R301.2(3) shall be used to determine design load performance requirements for wall coverings, curtain walls, roof coverings, exterior windows, skylights, and exterior doors (other than garage doors). Where loads for garage doors are not otherwise specified, the loads listed in Table R301.2(4) adjusted for height and exposure using Table R301.2(3) shall be used to determine design load performance requirements. Asphalt shingles shall be designed for wind speeds in accordance with Section R905.2.4. Metal roof shingles shall be designed for wind speeds in accordance with Section R905.4.4. A continuous load path shall be provided to transmit the applicable uplift forces from the roof assembly to the foundation.

S8077

Date Submitted	12/13/2018	**Section**	905.3	**Proponent**	T Stafford
Chapter	9	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Revises the roof tile section to clarify that wind loads on tile have to comply with ASCE 7-16.

Rationale

This proposal is primarily a correlation. During Phase I of the 2020 update of the FBC, the Commission voted to update ASCE 7 from the 2010 edition to the 2016 edition (ASCE 7-16). In ASCE 7-16, the component and cladding loads and roof zones for roofs with a MRH of 60 feet and less have changed. The code currently refers to the FRSA/TRI manual for tile. However Table 1A (uplift loads for underlayment and hip/ridge tiles) and Tables 2A and 2B (aerodynamic uplift moment) are still based on ASCE 7-10. This proposal simply clarifies that these loads have to be determined in accordance with ASCE 7-16. Clarifying language has also been added with regards to the manufacturer's product approval installation instructions.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners. While there may be cost impacts for certain buildings due to the adoption of ASCE 7-16, this code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to industry relative to the cost of compliance with code

No impact to industry. While there may be cost impacts for certain buildings due to the adoption of ASCE 7-16, this code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to small business relative to the cost of compliance with code

No impact to small business. While there may be cost impacts for certain buildings due to the adoption of ASCE 7-16, this code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This code change correlates the code with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This code change improves the code by providing correlation with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This code change dos not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This code change does not degrade the effectiveness of the code.

Revise as follows:

R905.3 Clay and concrete tile. The installation of clay and concrete tile shall ~~be in~~ comply ~~accordance~~ with the manufacturer's product approval installation instructions~~, or~~ in accordance with the recommendations of FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual*, Fifth Edition where the V_{asd} is determined in accordance with Section R301.2.1.3 or the recommendations of RAS 118, 119 or 120.

Revise as follows:

R905.3.2 Deck slope. Clay and concrete roof tile shall be installed on roof slopes in ~~accordance~~ compliance with the manufacturer's product approval installation instructions in accordance with therecommendations of FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual, Fifth Edition where the V_{asd} is determined in accordance with Section R301.2.1.3 or the recommendations of RAS 118, 119 or 120.

R905.3.3 Underlayment. Required underlayment shall comply with the underlayment manufacturer's product approval installation instructions in accordance with the FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual,* Fifth Edition, except as modified in Section R905.3.3.1, where the V_{asd} is determined in accordance with Section R301.2.1.3 or the recommendations of RAS 118, 119 or 120.

R905.3.3.1 FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual,* Fifth Edition. Delete Table 1A in the FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual*, Fifth Edition. Required design pressures for underlayments for tile systems shall be determined in accordance with ASCE 7.

~~**R905.3.3.1 Slope and underlayment requirements.**Refer to manufacturer's installation instructions, FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual,* Fifth Edition where the V_{asd} is determined in accordance with Section R301.2.1.3 or RAS 118, 119 or 120 for underlayment and slope requirements for specific roof tile systems.~~

Revise as follows:

~~Table~~ R905.3.7 Wind resistance of Clay and Concrete Tile ~~Attachment.~~ ~~Reserved.~~ Wind loads on clay and concrete tile roof coverings shall be determined in accordance with Section 1504.2 of the *Florida Building Code, Building.*

R905.3.7.1 Hip and ridge tiles. Hip and ridge tiles shall be installed in compliance ~~accordance~~ with the manufacturer's product approval installation instructions in accordance with the FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual*, Fifth Edition, except as modified in Section R905.3.7.1, where the V_{asd} is determined in accordance with Section R301.2.1.3 or the recommendations of RAS 118, 119 or 120.

R905.3.7.1.1 FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual,* Fifth Edition. Delete Tables 2A and 2B in the FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual*, Fifth Edition. Required design pressures for hip and ridge tiles shall be determined in accordance with ASCE 7.

Date Submitted	11/13/2018	**Section**	46	**Proponent**	T Stafford
Chapter	46	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Updates the vinyl siding specification to the 2017 edition.

Rationale

This proposal updates the specification standard for vinyl siding to ASTM D3679-17. One of the key changes in ASTM D3679-17 is an update to the pressure equalization factor (PEF). For determining the design wind pressure rating of vinyl siding, ASTM D 3679 permits test pressures to be adjusted to account for pressure equalization across the vinyl siding due to leakage paths (gaps). Pressure equalization refers to the reduction in net wind forces across cladding layers caused by external pressures being transferred to an interior air space. Previous editions have permitted the PEF to be taken as 0.36. ASTM D3679-17 increases the PEF to 0.5 based on new research.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

Will potentially increase the cost of vinyl siding in some areas of Florida. However, this is a standard update supported by industry.

Impact to industry relative to the cost of compliance with code

Will potentially increase the cost of vinyl siding in some areas of Florida. However, this is a standard update supported by industry.

Impact to small business relative to the cost of compliance with code

Will potentially increase the cost of vinyl siding in some areas of Florida. However, this is a standard update supported by industry.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal will be beneficial to the health, safety, and welfare of the general public by reducing the potential for wind damage to vinyl siding.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal strengthens the code by increasing the wind load resistance of vinyl siding based on new research.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

ASTM D3679—~~13~~17 Specification for Rigid Poly (Vinyl Chloride) (PVC) Siding R703.11

S7340

Date Submitted	11/20/2018	**Section**	46	**Proponent**	Jessica Ferris
Chapter	46	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

This modification updates the ANSI/WMA 100 standard reference and corrects the organization's acronym reference.

Rationale

The ANSI/WMA 100 was updated in 2018 and this updated reference should be reflected in the 7th edition of the Florida Residential Code to stay current. Also the association's acronym is WMA, not WDMA, and that needs to be corrected. In addition, the correct hyperlink to the WMA website is www.worldmillworkalliance.com.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification does not impact enforcement.

Impact to building and property owners relative to cost of compliance with code

This modification does not impact cost of compliance.

Impact to industry relative to the cost of compliance with code

This modification does not impact cost of compliance.

Impact to small business relative to the cost of compliance with code

This modification does not impact cost of compliance.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

See attached impact statement.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

See attached impact statement.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The WMA 100 standard is an optional testing and labeling wind load compliance method for side-hinged exterior doors and therefore does not discriminate against other testing and labeling methods referenced in Section 609.3 of the residential base code.

Does not degrade the effectiveness of the code

See attached impact statement.

WDMA

World Millwork Alliance10047 Robert Trent Jones Parkway New Port Richey, FL 34655-4649

Standard reference number	Title	Referenced in code section number
ANSI/WMA 100—20186	Standard Method of Determining Structural Performance Ratings of Side Hinged Exterior Door Systems and Procedures for Component Substitution	R609.3

Impact Statement Support file for Proposed Modification # 7340
2020 Triennial Original Modification 11/02/2018 - 12/15/2018
Code Version: 2020
Sub Code: Residential
Chapter & Topic: Chapter 46 – Reference Standards

Has a reasonable and substantial connection with the health, safety, and welfare of the general public:

The ANSI/WMA 100 is a structural performance standard for side-hinged doors that measures the wind load resistance of doors in accordance with established test methods. The structural integrity of a building's envelope is paramount to the health, safety, and welfare of the public; therefore, testing and labeling side-hinged doors to the WMA 100 standard provides the public with assurance that a side-hinged door has met specific structural performance requirements.

Strengthens or improves the code, and provides equivalent or better products, methods or systems of construction:

Section R609.3 of the 6th edition of the residential code (base code) refers to requirements for design wind load performance. The updated WMA 100 improves the code in that the standard not only determines design pressure ratings for side-hinged doors under wind loads as required by the code, but also provides procedures for door component substitution that other comparable standards do not provide.

Does not degrade the effectiveness of the code:

The WMA 100 standard does not degrade the effectiveness of the code. Rather, it enhances its effectiveness by providing side-hinged exterior door products with an alternative yet comparable testing and labeling path for complying to wind load requirements in the residential code which is more cost-effective for the door industry overall because it minimizes unnecessary and/or duplicative testing.

S7705

Date Submitted	12/5/2018	**Section**	102.4	**Proponent**	Dick Wilhelm
Chapter	46	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

This proposed modification updates AAMA, FMA and ASTM reference standards in Chapter 46, 6th Edition of the 2017 Florida Building Code (Residential). The modification also removes outdated reference standards.

Rationale

Updates reference standards pertaining to the manufacture, testing and quality assurance of fenestration products.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification does not impact the enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This modification does not impact the cost associated with the enforcement of the code.

Impact to industry relative to the cost of compliance with code

This modification does not impact the cost of enforcement of the code.

Impact to small business relative to the cost of compliance with code

This modification does not impact cost associated with compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Reference standards control the manufacture, testing and quality assurance of fenestration products sold throughout Florida.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Updating testing and performance standards provides the consumer with the latest innovation in technology

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code

AAMA

1402—09 Standard Specifications for Aluminum Siding, Soffit and Fascia

~~101/I.S.2—97 Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors~~

AAMA/NPEA/NSA 2100—12 Voluntary Specifications for Sunrooms

AAMA/WDMA/CSA101/I.S.2/A440—~~05 or~~ 08, ~~or~~ 11 or 17 North American Fenestration Standard/Specifications for Windows, Doors and Skylights

AAMA 450—10 Voluntary Performance Rating Method for Mulled Fenestration Assemblies

AAMA 506-11 Voluntary Specification for Impact and Cycle Testing of Fenestration Products.

711—~~07 or~~ 16 Voluntary Specification for Self-Adhering Flashing Used for Installation of Exterior Wall Fenestration Products

714—~~12 or~~ 15 Voluntary Specification for Liquid Applied Flashing Used to Create a Water-resistive Seal around Exterior Wall Openings in Buildings

FMA/AAMA 100—12 Standard Practice for the Installation of Windows with Flanges or Mounting

FMA/AAMA 200—12 Standard Practice for the Installation of Windows with Frontal Flanges

FMA/WDMA 250—10 Standard Practice for the Installation of Non-Frontal Flange Windows with Mounting Flanges for Surface Barrier Masonry for Extreme Wind/Water Conditions

FMA/AAMA/WDMA300—12 Standard Practice for the Installation of Exterior Doors in Wood Frame Construction for Extreme Wind/Water Exposure

FMA/AAMA/WDMA 400-13 Standard Practice for the Installation of Exterior Doors in Surface Barrier Masonry Construction for Extreme Wind/Weather Exposure

ASTM

E1300—04e01, 07e01, 09e ~~or~~ 12AE1 or -16 Practice for Determining Load Resistance of Glass in Buildings

E1886—~~02 or 05~~ or 12 or 2013a Test Method for Performance of Exterior Windows, Curtain Walls, Doors and Storm Shutters Impacted by Missiles and Exposed to Cyclic Pressure Differentials

E1996—~~05, 06, 09~~-17 or~~,~~2012a or 2014a Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes

F2090—~~13~~ 17Specification for Window Fall Prevention Devices—with Emergency Escape (Egress) Release Mechanisms

S7881

Date Submitted	12/11/2018	**Section**	4601	**Proponent**	Joseph Hetzel
Chapter	46	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Updating the ANSI/DASMA standards referenced by including additional equivalent versions.

Rationale

Same as Modification 7880.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact.

Impact to building and property owners relative to cost of compliance with code

No impact.

Impact to industry relative to the cost of compliance with code

No impact.

Impact to small business relative to the cost of compliance with code

No impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Upholds the health, safety and welfare of the general public by referencing additional equivalent standards.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens and improves the code by providing additional equivalent referenced standards versions.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The standards are all material/product/method/system neutral.

Does not degrade the effectiveness of the code

Referencing the additional equivalent standards upholds the effectiveness of the code.

108—05 - 	Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference -	R609.4 -
108—12 -	Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference -	R609.4 -
108—17 -	Standard Method for Testing Sectional Garage Doors, Rolling Doors, and Flexible Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference -	R609.4 -
115—05 -	Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure -	R301.2.1.2 -
115—12 -	Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure -	R301.2.1.2 -
115—17 -	Standard Method for Testing Sectional Doors, Rolling Doors, and Flexible Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure -	R301.2.1.2 -

ANSI/DASMA 108-2005

AMERICAN NATIONAL STANDARD

STANDARD METHOD FOR TESTING SECTIONAL GARAGE DOORS AND ROLLING DOORS: DETERMINATION OF STRUCTURAL PERFORMANCE UNDER UNIFORM STATIC AIR PRESSURE DIFFERENCE

ANSI/DASMA 108-2005

Door & Access Systems Manufacturers' Association, International

Sponsor:

DASMA
Door & Access Systems Manufacturers Association International

1300 Sumner Ave
Cleveland, Ohio 44115-2851

AMERICAN NATIONAL STANDARD

Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference

Sponsor

Door & Access Systems Manufacturers' Association, International

American National Standard

American National Standard implies a consensus of those substantially concerned with its scope and provisions. An American National Standard is intended as a guide to aid the manufacturer, the consumer, and the general public. The existence of an American National Standard does not in any respect preclude anyone, whether he has approved the standard or not, from manufacturing, marketing, purchasing or using products, processes, or procedures not conforming to the standard. American National Standards are subject to periodic review and users are cautioned to obtain the latest editions.

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URL: www.dasma.com

Suggestions for improvement of this standard will be welcome.
They should be sent to the Door & Access Systems Manufacturers' Association, International.

Printed in the United States of America

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Foreword (This foreword is included for information only and is not part of ANSI/DASMA 108-2005, *Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference.)*

This standard was developed concurrently by the Technical Committee of the DASMA Commercial & Residential Garage Door Division and by the DASMA Rolling Door Division. It incorporates years of experience in testing sectional garage doors and rolling doors commonly found in garage type structures. The committees and divisions believe the existence of the standard will provide a uniform basis of testing and rating the structural performance of such doors under uniform static air pressure difference.

The DASMA Rolling Door Division and the DASMA Commercial & Residential Garage Door Division concurrently approved revisions to the standard on April 21, 2006. DASMA employed the canvass method to demonstrate consensus and to gain approval as an American National Standard. The ANSI Board of Standards Review first granted approval of the document as an American National Standard on May 21, 2002, and granted approval of the most recent revisions to the standard on January 29, 2007.

DASMA recognizes the need to periodically review and update this standard. Suggestions for improvement should be forwarded to the Door & Access Systems Manufacturers' Association, International, 1300 Sumner Avenue, Cleveland, Ohio, 44115-2851.

ANSI/DASMA 108-2005
AMERICAN NATIONAL STANDARD

Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference

1.0 SCOPE

1.1 This test method describes the determination of the structural performance of garage door and rolling door assemblies under uniform static air pressure difference, using a test chamber.

1.2 This test method is intended only for evaluating the structural performance associated with the specified test specimen and not the structural performance of adjacent construction.

1.3 The proper use of this test method requires a knowledge of the principles of pressure and deflection measurement.

1.4 This test method describes the apparatus and the procedure to be used for applying uniformly distributed loads to a specimen.

1.5 This test method does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

1.6 This test method shall be considered equivalent to ASTM E 330-02, provided the pass/fail criteria contained in Section 11 of this standard is applied to testing in accordance with ASTM E 330-02.

1.7 For products intended for installation in the Florida High Velocity Hurricane Zone (Miami-Dade and Broward Counties), the testing procedure in Appendix A shall be used.

2. 0 DEFINITIONS

2.1 Design load: the specified difference in static air pressure (positive or negative) for which the specimen is to be tested, expressed in pounds per square foot (or pascals).

2.2 Full Operability: the ability for the door to be fully opened and closed.

2.3 Permanent deformation: the displacement or change in dimension of the specimen after the applied load has been removed and the specimen has relaxed for the specified period of time.

2.4 Preload: 50% of design load

2.5 Test load: the specified difference in static air pressure (positive or negative), equal to 1.5 times the design load, expressed in pounds per square foot (or pascals). (Note: Test load is equivalent to the proof load as defined by 330-02.)

2.6 Test specimen: the complete installed door assembly and mounting hardware as specified on the submitted drawing.

3.0 SUMMARY OF TEST METHOD

3.1 Seal the test specimen against one face as with a normal door assembly.

3.2 Supply air to or exhaust air from the chamber according to a specific test program, at the rate required to maintain the appropriate test pressure difference across the specimen.

3.3 Observe, measure, and record the deflections, deformations, and nature of any distresses or failures of the specimen.

4.0 APPARATUS

4.1 Test Chamber

4.1.1 A chamber shall be used which includes one open side against which the specimen is installed.

4.1.2 Provide a static pressure tap to measure the pressure difference across the test specimen. Locate the tap so that the reading is unaffected by the velocity of air supplied to or from the chamber or by any other air movements.

4.1.3 The air supply opening into the chamber shall be arranged so that the air does not impinge directly on the test specimen with any significant velocity.

4.1.4 A means shall be provided to facilitate test specimen adjustments and observations.

4.1.5 The test chamber and the specimen mounting frame shall not deflect under the test load in such a manner that the performance of the specimen will be affected.

4.2 Air System

4.2.1 A controllable blower, a compressed air supply, an exhaust system, or reversible controllable blower designed to provide the required maximum air pressure difference across the specimen.

4.2.2 The system shall provide an essentially constant air pressure difference for the required test period.

4.3 Pressure-Measuring Apparatus

4.3.1 The pressure-measuring apparatus shall be capable of measuring a test pressure difference within a tolerance of +/- 0.5% or +/- 0.1 inch of water column (+/- 25 Pa), whichever is greater.

4.4 Deflection-Measuring Apparatus

4.4.1 The deflection-measuring apparatus shall be capable of measuring deflections within a tolerance of +/- 1/16 inch (+/- 1.60 mm).

4.4.2 The maximum deflection, located where the door system experiences maximum deflection, shall be measured.

4.4.3 Additional locations for deflection measurements, if required, shall be stated by the specifier.

4.4.4 The deflection gages shall be installed so that the deflection of the test specimen can be measured without being influenced by possible movements of, or movements within, the specimen or member supports.

4.4.5 Deflection-measuring apparatus may also be used to measure permanent deformation.

4.5 Permanent Deformation-Measuring Apparatus

4.5.1 Permanent deformation can be determined by the use of a straight-edge type gage applied to specimen members after pre-loading and again after the test load has been removed.

5.0 HAZARDS

5.1 At the pressure used in this test method, hazardous conditions may result if failure occurs.

5.2 Take proper safety precautions to protect observers in the event that a failure occurs.

5.3 Do not permit personnel in pressure chambers during testing.

6.0 TEST SPECIMENS

6.1 The test specimen shall be as per the manufacturer's detailed drawings and/or written instructions. For sectional garage doors, the horizontal track and hanging brackets may be shortened to fit the test chamber.

6.2 The test specimen shall be anchored as supplied by the manufacturer for installation, or as set forth in a referenced specification, if applicable.

7.0 CALIBRATION

7.1 All pressure and deflection measuring devices shall be calibrated, not more than 6 months prior to testing, in accordance with the device manufacturer's specification.

7.2 All pressure and deflection measuring devices shall be capable of achieving the tolerances provided in Section 4.0.

7.3 Calibration of manometers and mechanical deflection measuring devices are normally not required, provided the instruments are used at a temperature near their design temperature.

8.0 REQUIRED INFORMATION

8.1 Documentation in the form of detailed drawings and/or written instructions indicating complete test specimen.

8.2 The number of incremental loads and the positive and negative test loads at these increments at which deflection measurements are required.

8.3 The duration of incremental and maximum loads.

8.4 The number and location of required deflection measurements.

9.0 PREPARATION FOR TEST

9.1 Remove from the test specimen any shipping or construction material that is not to be used.

9.2 Carefully review the manufacturer's installation instructions, noting any conditions that would alter a normal installation.

9.3 Fit the specimen against the chamber opening, as with a normally installed door assembly. The exterior side of the specimen shall face the higher pressure side for positive loads; the interior side shall face the higher pressure side for negative loads.

9.4 Support and secure the specimen, exactly as shown in the installation documentation.

9.5 Install the door system per the manufacturer's installation instructions; and the door either counterbalanced where no more than the larger of 5% of door weight or ten pounds (44.5 N) applied force is required to open the door manually from the fully closed position, or a simulated counterbalance condition (including locking mechanism) by shimming up the ends of the door.

9.6 If air flow through the test specimen is such that the specified pressure cannot be maintained, cover the entire specimen and mounting frame with a single thickness of polyethylene film no thicker than .002 inches (.050 mm). The technique of application is important to ensure that the maximum load is transferred to the specimen and that the membrane does not prevent movement or failure of the specimen. Apply the film loosely with extra folds of material at each corner and at all offsets and recesses. When the load is applied, there shall be no fillet caused by tightness of plastic film. On negative pressure tests, it is especially important that the film fully contact the door surface and not span between strut, stile or rail members. Tape may be used to protect the film from sharp edges, to attach the film, and to repair holes in the film. Tape shall not provide structural support.

10.0 TEST PROCEDURE

10.1 Check the specimen for proper adjustment, and that the specimen has been assembled in accordance with manufacturer's installation instructions.

10.2 Check that the specimen has been properly prepared for testing in accordance with documentation.

10.3 Install deflection-measuring devices at the predetermined locations, according to Section 4.4.

10.4 Apply pre-load (50% of design load) and hold for 10 seconds.

10.5 Release the pressure difference across the specimen.

10.6 Allow a recovery period for stabilization of the test specimen. The recovery period for stabilization shall not be less than 1 minute nor more than 5 minutes.

10.7 Record initial static pressure and deflection gage readings.

10.8 Begin applying load until the design load is reached. Measure maximum deflection at design load. The design load shall be held for 10 seconds.

10.9 Release the load and measure the permanent deformation, if desired, within 1 to 5 minutes.

10.10 The pressure shall then be reapplied until the test load is reached. The test load shall be held for 10 seconds.

10.11 Release the load.

10.12 If the specimen has sustained the predetermined design load and test load without failure, repeat 10.3 through 10.11 for the opposite loading direction.

11.0 PASS/FAIL CRITERIA

11.1 The door system shall sustain both the design load and the test load for the predetermined amount of time.

11.2 The door system shall remain in the opening throughout the duration of the test.

11.3 The door systems shall be evaluated for full operability at the conclusion of the test. The door shall pass only if the test engineer deems that the door system has full operability.

12.0 TEST REPORT

12.1 Identification of the test

specimen **12.1.1** Manufacturer

12.1.2 Location of manufacturer

12.1.3 Dimensions

12.1.4 Model Type

12.1.5 Material description

12.1.6 Test specimen selection procedure

12.2 Detailed drawings of the test specimen (separate drawings for each test specimen are not required if all test specimen differences are noted on the drawings)

12.2.1 Dimensioned section profiles

12.2.2 Door dimensions and arrangement

12.2.3 Opening framing

12.2.4 Installation and spacing of anchorage

12.2.5 Weather-stripping

12.2.6 Locking arrangement

12.2.7 Hardware

12.2.8 Glazing details

12.2.9 Any other pertinent construction details, including the operator and its attachment if included in the test specimen.

12.3 Type, quantity and location(s) of the locking and operating hardware

12.4 Glazing thickness and type, and method of glazing

12.5 Record ambient temperature

12.6 Tabulation of data:

12.6.1 Pre-load pressure and duration

12.6.2 Design pressure differences exerted on the specimen

12.6.3 Design pressure durations

12.6.4 Pertinent deflections at these design pressure differences

12.6.5 Test pressure differences exerted on specimen

12.6.6 Test pressure durations

12.6.7 Permanent deformations at locations specified for each specimen tested.

12.7 Pass/Fail criteria results

12.8 Visual observations of performance

12.9 State whether or not tape or film were used to seal against air leakage, and whether in the judgment of the test engineer, the tape or film influenced the results of the test.

12.10 Name of the individual that conducted the test

12.11 Name and address of the testing facility

12.12 Names of official observers

12.13 Other data, useful to the understanding of the test report, as determined by the laboratory or specifier, shall either be included within the report or appended to the report.

REFERENCED DOCUMENTS:

ASTM-E 330-02, Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

ANSI/DASMA 108 Test Report Form

Uniform Static Air Pressure Performance

Test Specimen Identification:

Manufacturer ____________________________ Manufacturer Location____________________________

Model Type/Number ________________ Dimensions____

Material Description ____

Test Specimen Selection Procedure____

Applicable Drawing No.'s ____

Operating Hardware (Type, Quantity, Location(s)):

____

____

Glazing Description:

Type: _____________ Thickness: _________________Method: ____________________

Ambient Temperature: __________

Performance:

	Positive Pressure	Negative Pressure
Pre-load Pressure		
Design Pressure		
Design Pressure Test Duration		
Maximum Deflection at Design Pressure		
Deflection after Release of Design Pressure		
Test Pressure		
Test Pressure Test Duration		

Pass/Fail Criteria:	Positive	Negative
Design Load Sustained? (Yes/No)	_______	_______
Test Load Sustained? (Yes/No)	_______	_______
Garage/Rolling Door remained in opening during duration of test? (Yes/No)	_______	_______
Garage/Rolling Door operable, after evaluation for full operability? (Yes/No)	_______	_______

Visual Observations of Performance:

____

____

____

Notes:

Testing Conducted by __________________________ **of**_________________________________

Signature of Tester ___________________________ **Date** __________________________________

Test Facility and Location ____

Official Observers ____

6

Appendix A

Testing Procedure for the Florida High Velocity Hurricane Zone

1. Scope

1.1 This Appendix covers procedures for conducting a uniform static air pressure test for garage doors and rolling doors as required in the Florida High Velocity Hurricane Zone per Section 1707.4.3 of the Florida Building Code, Building.

2. Referenced Documents

2.1 2004 Florida Building Code, Building

2.2 ASTM E 330-02

3. Terminology

3.1 *Definitions* – for definitions of terms used in this Appendix, refer to the Florida Building Code, Building

3.2 *Descriptions of Terms Specific to This Protocol*

3.2.1 ***Specimen*** – The entire assembled unit submitted for test, including anchorage devices and structure to which product is to be mounted.

3.2.2 ***Test Chamber*** – An airtight enclosure of sufficient depth to allow unobstructed deflection of the specimen during pressure loading, including ports for air supply and removal, and equipped with a device to measure test pressure differentials.

3.2.3 ***Maximum Deflection*** – The maximum displacement, measured to the nearest 1/8" (3 mm), attained from an original position while a maximum load is being applied.

3.2.4 ***Permanent Deformation*** – The permanent displacement, measured to the nearest 1/8" (3 mm), from an original position that remains after maximum test load has been removed.

3.2.5 ***Design Pressure (Design Wind Load)*** – The uniform static air pressure difference, inward or outward and expressed in pounds per square foot (Newtons per square meter), for which the specimen would be designed under service load conditions using Section 1619 of the Florida Building Code, Building.

3.2.6 ***Test Load*** – One and one-half (1.5) times the design pressure (positive or negative) as determine by Section 1714 of the Florida Building Code, Building, for which the specimen is to be tested, expressed in pounds per square foot (Newtons per square meter.)

3.2.7 ***Specimen Failure*** – A change in condition of the specimen indicative of deterioration under repeated load or incipient failure, such as cracking, fastener loosening, local yielding, or loss of adhesive bond.

4. Significance and Use

4.1 The test procedures outlined in this protocol provide a means of determining whether a garage door or rolling door provides sufficient resistance to wind forces as determine by Section 1619 of the Florida Building Code, Building.

5. Test Specimen and Procedures

5.1 ***Test specimen*** – All parts of the test specimen shall be full size, using the same materials, details, methods of construction and methods of attachment as proposed for actual use. The specimen shall consist of the entire assembled unit attached to a given type of structural framing of the building, and shall contain all devices used to resist wind forces.

A pressure treated nominal 2 x 4 - #3 Southern Pine wood buck shall be used for attachment of the specimen to the test frame/stand/chamber. Such wood buck shall become part of the approval.

5.1.1 Locking mechanisms shall be permanently mounted on the specimen. Such locking mechanism shall require no tools to be latched in the locked position. Devices such as pins shall be permanently secured to the specimen through the use of chains or wires which shall be of corrosion resistant material. This section shall not apply to specimens referenced in Section 2413 of the Florida Building Code, Building.

5.1.2 Products that are not categorized as means of egress/escape, and are provided with more than one single action locking mechanism, shall be provided with permanently posted instructions on latching for high wind pressures.

5.1.3 Doors shall be evaluated for operability after this test.

5.1.4 Specimen and fasteners, when used, shall not become disengaged during test procedure.

5.2 ***Procedure***

5.2.1 *Preparation* – Remove from the test specimen any sealing or construction material that is not normally used when installed in or on a building. Fit the specimen, with its structural framing, into or against the chamber opening. The outdoor side of the specimen shall face the higher pressure side for positive loads; the indoor side shall face the higher pressure side for negative loads. Support and secure the specimen by the same number and type of anchors to be approved for normal installation of the specimen in the building.

5.2.2 ***Single Action Locking/Closing Procedure***

5.2.2.1 All specimens which are required to comply with means of egress/escape, shall be tested for full static loads as required by Section 5.2.3 of this Appendix with only one single action locking mechanism. Additionally, doors that are not required to comply with means of egress/escape requirement shall be tested as described in Sections 5.2.2.2 and 5.2.2.3 of this Appendix.

5.2.2.2 Doors that are not required to comply with the means of egress/escape requirements, which are provided with more than one single action hardware and comply with the test described in this Appendix, shall also be successfully tested with a test load equal to a static air pressure based on wind velocity of 75 mph (33.6 m/s) using only one single action locking mechanism. Apply the corresponding positive test load and hold for 30 seconds. Release this test load across the specimen, and after a recovery period of not less than 1 minute nor more than 5 minutes, apply the corresponding reverse test load and hold for 30 seconds. Release the reverse test load and record observations. Such products shall have all additional locking mechanism permanently attached to the product by means of non-removable and non-corrosive devices, and shall comply with Section 5.1.1 of this Appendix.

5.2.3 ***Uniform Static Air Procedure***

5.2.3.1 Check specimen for adjustment and engage all locks.

5.2.3.2 Install all required measurement devices.

5.2.4 Apply one-half of the test load and hold for 30 seconds. Release the test load across the specimen, and after a recovery period of not less than 1 minute nor more than 5 minutes, apply one-half the reverse test load and hold for 30 seconds. Release reverse test load, and after a recovery period of not less than 1 minute nor more than 5 minutes, record all readings.

5.2.5 Apply full test load and hold for 30 seconds. Release the test load across the specimen, and after a recovery period of not less than 1 minute nor more than 5 minutes, apply full reverse test load and hold for 30 seconds. Release reverse test load, and after a recovery period of not less than 1 minute nor more than 5 minutes, record all readings.

5.3 Specimens successfully tested shall qualify assemblies with material thicker and of the same type and construction provided the anchorage of the product is proportionally changed according to the wind pressure test.

5.4 Specimens successfully tested shall qualify assemblies of a smaller size and of the same type and construction, provided the anchorage of the product remains unchanged.

6. Apparatus

6.1 The description of the apparatus is general in nature. Any equipment, properly certified, calibrated, and approved by the Authority Having Jurisdiction capable of performing this test within the allowable tolerance, shall be permitted.

6.2.1 ***Test Chamber*** – The test chamber, to which the specimen is mounted, shall be provided with pressure taps to measure the pressure difference across the test specimen and shall be so located that the reading is unaffected by the velocity of air supplied to or from the chamber. The specimen mounting frame shall not deflect under test load in such manner that the performance of the specimen will be affected.

6.2.2 ***Pressure-Measuring Apparatus*** – The pressure-measuring apparatus shall measure the test pressure difference within a tolerance of +/-2%

6.2.3 ***Deflection-Measuring System*** – The deflection-measuring system shall measure the deflection within a tolerance of 0.01” (0.25 mm).

6.2.4 ***Air System*** – A controllable blower, a compressed-air supply, an exhaust system, or reversible controllable blower designed to provide the required maximum air pressure difference across the specimen. The system shall provide an essentially constant air-pressure difference for the required test period.

6.3 ***Calibration of Equipment*** – The pressure-measuring apparatus and the deflection-measuring system shall be calibrated and certified by an independent qualified agency approved by the Authority Having Jurisdiction, at two-year intervals.

6.3.1 The calibration report shall include the date of the calibration, the name of the agency conducting the calibration, methods and equipment used in the calibration process, the equipment being calibrated, and any pertinent comments.

7. Hazards

7.1 Testing facilities shall take all necessary precautions to protect observers during the entire test procedure. All observers shall always be at a safe distance away from specimen and apparatus. Safety regulations shall be followed in order to avoid any injuries to any and all observers.

8. Testing Facilities

8.1 Any testing facility wishing to perform this test shall first obtain the approval of the Authority Having Jurisdiction. Such approval shall only be given to those facilities that show they are properly equipped to perform the complete test. Testing facilities shall request, in writing, approval of their facilities. Such request shall contain the ability of the facility to perform all aspects of the test, all equipment used in the performance of the test, name of the independent agency calibrating their equipment, location of facilities, personnel involved in the testing, a quality control program, a safety program and any other pertinent information which shall clearly indicate that such facility is in the business of performing independent testing. A representative of the Authority Having Jurisdiction shall visit the site, and shall reserve the right to order any changes necessary to accept the facility for testing.

8.2 Approval of facilities to perform the test described in this Appendix shall not constitute an approval of such facilities to perform other tests not specifically mentioned in this protocol.

8.3 The testing lab shall be TAS301 certified.

9. Format of Test

The manufacturer shall notify the Authority Having Jurisdiction at least seven (7) working days prior to the performing of the test. The Authority Having Jurisdiction reserves the right to observe the test. The Authority Having Jurisdiction must be notified of the place and time the test will take place. The test must be recorded on video and retained by the laboratory per TAS301.

10. **Test Reports** The following minimum information shall be included in the submitted report:

10.1 Date of the test and the report, and the report number.

10.2 Name and location of facilities performing the test.

10.3 Name and address of requester of the test.

10.4 Identification of the specimen (manufacturer, source of supply, dimension, model types, material, procedure of selection and any other pertinent information).

10.5 Detailed drawings of the specimen showing dimensioned section profiles, type of framing to which specimen was attached, panel arrangement, installation and spacing of anchorage, locking arrangement, sealant, hardware, product markings and their locations, and any other pertinent construction details. Any deviation from the drawings or any modifications made to the specimen to obtain the reported values shall be noted on the drawings and in the report.

10.6 Maximum deflection recorded, and mechanism used to make such determination.

10.7 Permanent deformation (a cross-sectional diagram shall be provided to show where it occurred).

10.8 Name, address, signature and seal of Florida professional engineer, witnessing the test and preparing the report. Engineer shall be part of the laboratory's permanent staff or under laboratory's contract.

10.9 A tabulation of pressure differences exerted across the specimen during the test and their duration.

10.10 Maximum positive and negative pressures used in the test.

10.11 A description of the condition of the test specimens after testing, including details of any damage and any other pertinent observations.

10.12 When the tests are made to check conformity of the specimen to a particular specification, an identification or description of that specification.

10.13 A statement that the tests were conducted in accordance with this test method.

10.14 A statement of whether or not, upon completion of all testing, the specimens meet the requirements of Section 1620 of the 2004 Florida Building Code, Building and this Appendix.

10.15 A statement as to whether or not tape or film, or both were used to seal against air leakage, and whether in the judgment of the test engineer, the tape or film influenced the results of the test.

10.16 Signatures of persons responsible for supervision of the tests, and a list of official observers.

10.17 All data not required herein, but useful to a better understanding of the test results, conclusions or recommendations, may be appended to the report.

11. Recording Deflections

Maximum Deflection

Permanent Deformation

100% recovery is required after half test load, and 80% minimum is required after full load (see Miami-Dade BCCO checklist 0220).

12. Additional Testing

12.1 After successfully completing all parts of the test described in the Appendix, the specimen shall be subjected to the forced entry test as required by the 2004 Florida Building Code, Building. Minimum gauge of materials shall be determined prior to testing per the 2004 Florida Building Code, Building.

12.2 If a product is subjected to weathering that can affect its integrity, the manufacturer shall contact the Authority Having Jurisdiction for additional testing requirements such as but not limited to moisture, U.V., accelerated aging, and other similar tests.

12.3 The Authority Having Jurisdiction shall reserve the right to require any additional testing necessary to assure full compliance with the intent of the 2004 Florida Building Code, Building.

13. Product Marking

13.1 All approved products shall be permanently labeled with the manufacturer's name, city, and state, and the following statement: "Product Control Approved."

13.2 Permanently labeled shall be a metallic label fixed permanently to the frame of the specimen by rivets or permanent adhesive.

13.3 Any instructions for operations shall be permanently mounted on the specimen in an area not subject to be painted or concealed.

DASMA – the Door & Access Systems Manufacturers Association, International – is North America's leading trade association of manufacturers of garage doors, rolling doors, garage door operators, vehicular gate operators, and access control products. With Association headquarters based in Cleveland, Ohio, our 90 member companies manufacture products sold in virtually every county in America, in every U.S. state, every Canadian province, and in more than 50 countries worldwide. DASMA members' products represent more than 95% of the U.S. market for our industry.

For more information about the Door & Access Systems Manufacturers Association, International, contact:

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Standard Method For Testing Sectional Garage Doors, Rolling Doors and Flexible Doors: Determination Of Structural Performance Under Uniform Static Air Pressure Difference

DASMA 108-2017

Door & Access Systems Manufacturers' Association, International

Sponsor:

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Standard Method for Testing Sectional Garage Doors, Rolling Doors and Flexible Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference

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Suggestions for improvement of this standard will be welcome.
They should be sent to the Door & Access Systems Manufacturers' Association, International.

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Foreword (This foreword is included for information only and is not part of DASMA 108-2015, *Standard Method for Testing Sectional Garage Doors, Rolling Doors and Flexible Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference.*)

This standard was developed concurrently by the DASMA Commercial & Residential Garage Door Division Technical Committee, the DASMA Rolling Door Division, and the DASMA High Performance Door Division. It incorporates years of experience in testing sectional garage doors and rolling doors commonly found in garage type structures. The committees and divisions believe the existence of the standard will provide a uniform basis of testing and rating the structural performance of such doors under uniform static air pressure difference.

The DASMA Commercial & Residential Garage Door Division, The DASMA Rolling Door Division, and the DASMA High Performance Door Division concurrently approved revisions to the standard on October 30, 2015. DASMA employed the canvass method to demonstrate consensus and to gain approval as an American National Standard. The ANSI Board of Standards Review first granted approval of the document as an American National Standard on May 21, 2002. The ANSI Board of Standards Review granted approval of the most recent revisions to the standard as an American National Standard on November 21, 2017.

DASMA recognizes the need to periodically review and update this standard. Suggestions for improvement should be forwarded to the Door & Access Systems Manufacturers' Association, International, 1300 Sumner Avenue, Cleveland, Ohio, 44115-2851.

DASMA – the Door & Access Systems Manufacturers Association, International – is North America's leading trade association of manufacturers of garage doors, rolling doors, garage door operators, vehicular gate operators, and access control products. With Association headquarters based in Cleveland, Ohio, our 90 member companies manufacture products sold in virtually every county in America, in every U.S. state, every Canadian province, and in more than 50 countries worldwide. DASMA members' products represent more than 95% of the U.S. market for our industry.

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ANSI/DASMA 108-2017

AMERICAN NATIONAL STANDARD

Standard Method for Testing Sectional Garage Doors, Rolling Doors and Flexible Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference

1.0 SCOPE

1.1 This test method describes the determination of the structural performance of garage door, rolling door and flexible door assemblies under uniform static air pressure difference, using a test chamber.

1.2 This test method is intended only for evaluating the structural performance associated with the specified test specimen and not the structural performance of adjacent construction.

1.3 The proper use of this test method requires a knowledge of the principles of pressure and deflection measurement.

1.4 This test method describes the apparatus and the procedure to be used for applying uniformly distributed loads to a specimen.

1.5 This test method does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

1.6 This test method shall be considered equivalent to ASTM E 330-02, provided

the pass/fail criteria contained in Section 11 of this standard is applied to testing in accordance with ASTM E 330-02.

1.7 For products intended for installation in the Florida High Velocity Hurricane Zone

(Miami-Dade and Broward Counties), the testing procedure in Appendix A shall be used.

2.0 DEFINITIONS

2.1 Design Load: The specified difference in static air pressure (positive or negative) for which the specimen is to be tested, expressed in pounds per square foot (or pascals).

2.2 Flexible Door: A door, excluding rolling sheet doors as defined in DASMA 207, in which a flexible fabric or other flexible sheet material forms the panel portion, even though it may have a rigid frame, rigid reinforcements, rigid support means for one or more edges thereof, or combinations of these features.

2.3 Full Operability: The ability for the door to be fully opened and closed.

2.4 Permanent Deformation: The displacement or change in dimension of the specimen after the applied load has been removed and the specimen has relaxed for the specified period of time.

2.5 Preload: 50% of design load.

2.6 Test Load: The specified difference in static air pressure (positive or negative), equal to 1.5 times the design load, expressed in pounds per square foot (or pascals). (Note: Test load is equivalent to the proof load as defined by 330-02.)

2.7 Test Specimen: The complete installed door assembly and mounting hardware as specified on the submitted drawing.

3.0 SUMMARY OF TEST METHOD

3.1 Seal the test specimen against one face as with a normal door assembly.

3.2 Supply air to or exhaust air from the chamber according to a specific test program, at the rate required to maintain the appropriate test pressure difference across the specimen.

3.3 Observe, measure, and record the deflections, deformations, and nature of any distresses or failures of the specimen.

4.0 APPARATUS

4.1 Test Chamber

4.1.1 A chamber shall be used which includes one open side against which the specimen is installed.

4.1.2 Provide a static pressure tap to measure the pressure difference across the test specimen. Locate the tap so that the reading is unaffected by the velocity of air supplied to or from the chamber or by any other air movements.

4.1.3 The air supply opening into the chamber shall be arranged so that the air does not impinge directly on the test specimen with any significant velocity.

4.1.4 A means shall be provided to facilitate test specimen adjustments and observations.

4.1.5 The test chamber and the specimen mounting frame shall not deflect under the test load in such a manner that the performance of the specimen will be affected.

4.2 Air System

4.2.1 A controllable blower, a compressed air supply, an exhaust system, or reversible controllable blower designed to provide the required maximum air pressure difference across the specimen.

4.2.2 The system shall provide an essentially constant air pressure difference for the required test period.

4.3 Pressure-Measuring Apparatus

4.3.1 The pressure-measuring apparatus shall be capable of measuring a test pressure difference within a tolerance of +/- 0.5% or +/- 0.1 inch of water column (+/- 25 Pa), whichever is greater.

4.4 Deflection-Measuring Apparatus

4.4.1 The deflection-measuring apparatus shall be capable of measuring deflections within a tolerance of +/- 1/16 inch (+/- 1.60 mm).

4.4.2 The maximum deflection, located where the door system experiences maximum deflection, shall be measured.

4.4.3 Additional locations for deflection measurements, if required, shall be stated by the specifier.

4.4.4 The deflection gages shall be installed so that the deflection of the test specimen can be measured without being influenced by possible movements of, or movements within, the specimen or member supports.

4.4.5 Deflection-measuring apparatus may also be used to measure permanent deformation.

4.5 Permanent Deformation-Measuring

Apparatus

4.5.1 Permanent deformation can be determined by the use of a straight-edge type gage applied to specimen members after pre-loading and again after the test load has been removed.

5.0 HAZARDS

5.1 At the pressure used in this test method, hazardous conditions may result if failure occurs.

5.2 Take proper safety precautions to protect observers in the event that a failure occurs.

5.3 Do not permit personnel in pressure chambers during testing.

6.0 TEST SPECIMENS

6.1 The test specimen shall be as per the manufacturer's detailed drawings and/or written instructions. Any horizontal track and hanging brackets may be shortened to fit the test chamber.

6.2 The test specimen shall be anchored as supplied by the manufacturer for installation, or as set forth in a referenced specification, if applicable.

7.0 CALIBRATION

7.1 All pressure and deflection measuring devices shall be calibrated, not more than 6 months prior to testing, in accordance with the device manufacturer's specification.

7.2 All pressure and deflection measuring devices shall be capable of achieving the tolerances provided in Section 4.0.

7.3 Calibration of manometers and mechanical deflection measuring devices are normally not required, provided the instruments are used at a temperature near their design temperature.

8.0 REQUIRED INFORMATION

8.1 Documentation in the form of detailed drawings and/or written instructions indicating complete test specimen.

8.2 The number of incremental loads and the positive and negative test loads at these increments at which deflection measurements are required.

8.3 The duration of incremental and maximum loads.

8.4 The number and location of required deflection measurements.

9.0 PREPARATION FOR TEST

9.1 Remove from the test specimen any shipping or construction material that is not to be used.

9.2 Carefully review the manufacturer's installation instructions, noting any conditions that would alter a normal installation.

9.3 Fit the specimen against the chamber opening, as with a normally installed door assembly. For flexible doors, the test report shall include a diagram indicating which side of the door received positive pressure and which side of the door received negative pressure.

9.4 Support and secure the specimen, exactly as shown in the installation documentation.

9.5 Install the door system per the manufacturer's installation instructions.

9.5.1 For garage doors and rolling doors, the door shall be counterbalanced where no more than the larger of 5% of door weight or ten pounds (44.5 N) applied force is required to open the door manually from the fully closed position, or a simulated counterbalance condition (including locking mechanism) shall be achieved by shimming up the ends of the door.

9.6 If air flow through the test specimen is such that the specified pressure cannot be maintained, cover the entire specimen and mounting frame with a single thickness of polyethylene film no thicker than .002 inches (.050 mm). The technique of application is important to ensure that the maximum load is transferred to the specimen and that the membrane does not prevent movement or failure of the specimen. Apply the film loosely with extra folds of material at each corner and at all offsets and recesses. When the load is applied, there shall be no fillet caused by tightness of plastic film. On negative pressure tests, it is especially important that the film fully contact the door surface and not span between door reinforcement or support members. Tape may be used to protect the film from sharp edges, to attach the film, and to repair holes in the film. Tape shall not provide structural support.

10.0 TEST PROCEDURE

10.1 Check the specimen for proper adjustment, and that the specimen has been assembled in accordance with manufacturer's installation instructions.

10.2 Check that the specimen has been properly prepared for testing in accordance with documentation.

10.3 Install deflection-measuring devices at the predetermined locations, according to Section 4.4.

10.4 Apply pre-load (50% of design load) and hold for 10 seconds.

10.5 Release the pressure difference across the specimen.

10.6 Allow a recovery period for stabilization of the test specimen. The recovery period for stabilization shall not be less than 1 minute nor more than 5 minutes.

10.7 Record initial static pressure and deflection gage readings.

10.8 Begin applying load until the design load is reached. Measure maximum deflection at design load. The design load shall be held for 10 seconds.

10.9 Release the load and measure the permanent deformation, if desired, within 1 to 5 minutes.

10.10 The pressure shall then be reapplied until the test load is reached. The test load shall be held for 10 seconds.

10.11 Release the load.

10.12 If the specimen has sustained the pre-determined design load and test load without failure, repeat 10.3 through 10.11 for the opposite loading direction.

11.0 PASS/FAIL CRITERIA

11.1 The door system shall sustain both the design load and the test load for the predetermined amount of time.

11.2 The door system shall remain in the opening throughout the duration of the test.

11.3 The door system shall be evaluated for full operability at the conclusion of the test. The door shall pass only if the test engineer deems that the door system has full operability.

12.0 TEST REPORT

12.1 Identification of the test specimen

12.1.1 Manufacturer

12.1.2 Location of manufacturer

12.1.3 Dimensions

12.1.4 Model Type

12.1.5 Material description

12.1.6 Test specimen selection procedure

12.2 Detailed drawings of the test specimen. For flexible doors, the test report shall include a diagram indicating which side of the door received positive pressure and which side of the door received negative pressure. (separate drawings for each test specimen are not required if all test specimen differences are noted on the drawings)

12.2.1 Dimensioned section profiles

12.2.2 Door dimensions and arrangement

12.2.3 Opening framing

12.2.4 Installation and spacing of Anchorage

12.2.5 Weather-stripping

12.2.6 Locking arrangement

12.2.7 Hardware

12.2.8 Glazing details

12.2.9 Any other pertinent construction details, including the operator and its attachment if included in the test specimen.

12.3 Type, quantity and location(s) of the locking and operating hardware.

12.4 Glazing thickness and type, and method of glazing.

12.5 Record ambient temperature

12.6 Tabulation of data:

12.6.1 Pre-load pressure and duration

12.6.2 Design pressure differences exerted on the specimen

12.6.3 Design pressure durations

12.6.4 Pertinent deflections at these design pressure differences

12.6.5 Test pressure differences exerted on specimen

12.6.6 Test pressure durations

12.6.7 Permanent deformations at locations specified for each specimen tested.

12.7 Pass/Fail criteria results

12.8 Visual observations of performance

12.9 State whether or not tape or film were used to seal against air leakage, and whether in the judgment of the test engineer, the tape or film influenced the results of the test.

12.10 Name of the individual that conducted the test

12.11 Name and address of the testing facility

12.12 Names of official observers

12.13 Other data, useful to the understanding of the test report, as determined by the laboratory or specifier, shall either be included within the report or appended to the report.

REFERENCED DOCUMENTS

1. ASTM-E 330-02, Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

2. DASMA 207, Standard for Rolling Sheet Doors

3. TAS 202-94. Uniform Static Air Pressure Testing, Miami-Dade County Building Code Compliance Office

DASMA 108 Test Report Form
Uniform Static Air Pressure Performance

Test Specimen Identification:
Manufacturer ___________________________Manufacturer Location______________________________
Model Type/Number ______________ Dimensions____
Material Description ____
Test Specimen Selection Procedure____
Applicable Drawing No.'s ____

Operating Hardware (Type, Quantity, Location(s)):

____

____

Glazing Description:
Type: ___________ Thickness: _______________Method: __________________

Ambient Temperature: ________

Performance:

	Positive Pressure	Negative Pressure
Pre-load Pressure		
Design Pressure		
Design Pressure Test Duration		
Maximum Deflection at Design Pressure		
Deflection after Release of Design Pressure		
Test Pressure		
Test Pressure Test Duration		

Pass/Fail Criteria: **Positive** **Negative**
Design Load Sustained? (Yes/No) _______ _____
Test Load Sustained? (Yes/No) _______ _____
Door remained in opening during duration of test? (Yes/No) _______ _____
Door operable, after evaluation for full operability? (Yes/No) _______ _____

Visual Observations of Performance:

____

____

____

Notes:

Testing Conducted by ________________________ **of** ____
Signature of Tester _________________________________ **Date** _________________________________
Test Facility and Location ____
Official Observers ____

Appendix A
Testing Procedure for the Florida High Velocity Hurricane Zone
(Uniform Static Air Pressure)

1. **Scope**

   1.1 This Appendix covers procedures for conducting a uniform static air pressure test for doors as required in the Florida High Velocity Hurricane Zone per Section 1710.5.2.1 of the Florida Building Code, Building.

   1.2 ASCE 7 Design Pressure are permitted to be multiplied by 0.6.

2. **Referenced Documents**

   2.1 2014 Florida Building Code, Building
   2.2 ASTM E 330-02
   2.3 ASCE 7-10
   2.4 TAS 301-94

3. **Terminology**

   3.1 *Definitions* – For definitions of terms used in this Appendix, refer to the Florida Building Code, Building.

   3.2 *Descriptions of Terms Specific to This Appendix.*

   3.2.1 ***Specimen*** **–** The entire assembled unit submitted for test, including anchorage devices and structure to which product is to be mounted.

   3.2.2 T***est Chamber*** **–** An airtight enclosure of sufficient depth to allow unobstructed deflection of the specimen during pressure loading, including ports for air supply and removal, and equipped with a device to measure test pressure differentials.

   3.2.3 ***Maximum Deflection*** **–** The maximum displacement measured to the nearest 1/8" (3 mm) attained from an original position while a maximum load is being applied.

   3.2.4 ***Permanent Deformation*** **–** The permanent displacement measured to the nearest 1/8" (3 mm) from an original position that remains after maximum test load has been removed.

   3.2.5 ***Design Pressure (Design Wind Load)*** **–** The uniform static air pressure difference, inward or outward and expressed in pounds per square foot (Newtons per square meter), for which the specimen would be designed under service load conditions using Section 1609 of the Florida Building Code, Building.

   3.2.6 ***Test Load*** **–** One and one-half (1.5) times the design pressure (positive or negative) as determine by Section 1609 of the Florida Building Code, Building, for which the specimen is to be tested, expressed in pounds per square foot (Newtons per square meter.)

3.2.7 ***Specimen Failure –*** A change in condition of the specimen indicative of deterioration under repeated load or incipient failure, such as cracking, fastener loosening, local yielding, or loss of adhesive bond.

4. **Significance and Use**

4.1 The test procedures outlined in this protocol provide a means of determining whether a door provides sufficient resistance to wind forces as determine by Section 1609 of the Florida Building Code, Building.

5. **Test Specimen and Procedures**

5.1 ***Test Specimen –*** All parts of the test specimen shall be full size, using the same materials, details, methods of construction and methods of attachment as proposed for actual use. The specimen shall consist of the entire assembled unit attached to a given type of structural framing of the building, and shall contain all devices used to resist wind forces.

5.1.1 Locking mechanisms shall be permanently mounted on the specimen. Such locking mechanism shall require no tools to be latched in the locked position. Devices such as pins shall be permanently secured to the specimen through the use of chains or wires which shall be of corrosion resistant material. This section shall not apply to specimens referenced in Section 2413 of the Florida Building Code, Building.

5.1.2 Products that are not categorized as means of egress/escape, and are provided with more than one single action locking mechanism, shall be provided with permanently posted instructions on latching for high wind pressures.

5.1.3. Doors shall be evaluated for operability after this test.

5.1.4. Specimen and fasteners, when used, shall not become disengaged during test procedure.

5.2 **Procedure**

5.2.1 ***Preparation*** – Remove from the test specimen any sealing or construction material that is not normally used when installed in or on a building. Fit the specimen, with its structural framing, into or against the chamber opening. For garage doors and rolling doors, the outdoor side of the specimen shall face the higher pressure side for positive loads; the indoor side shall face the higher pressure side for negative loads. For flexible doors, the test report shall include a diagram indicating which side of the door received positive pressure and which side of the door received negative pressure. Support and secure the specimen by the same number and type of anchors to be approved for normal installation of the specimen in the building.

5.2.2 ***Single Action Locking/Closing Procedure***

5.2.2.1 All specimens which are required to comply with means of egress/escape, shall be tested for full static loads as required by Section 5.2.3 of this Appendix with only one single action locking mechanism. Additionally, doors that are not required to comply with means of egress/escape requirement shall be tested as described in Sections 5.2.2.2 of this Appendix.

5.2.2.2 Doors that are not required to comply with the means of egress/escape requirements, which are provided with more than one single action hardware and comply with the test described in this Appendix, shall also be successfully tested with a test load equal to a static air pressure based on wind velocity of 97 mph (44 m/s) using only one single action locking mechanism. Test pressures are permitted to be multiplied by 0.6 as specified in Section 1.2. Apply the corresponding positive test load and hold for 30 seconds. Release this test load across the specimen and after a recovery period of not less than 1 minute nor more than 5 minutes, apply the corresponding reverse test load and hold for 30 seconds. Release the reverse test load and record observations. Such products shall have all additional locking mechanism permanently attached to the product by means of non-removable and non-corrosive devices, and shall comply with Section 5.1.1 of this Appendix.

5.2.3 **Uniform Static Air Procedure**

5.2.3.1 Check specimen for adjustment and engage all locks. 5.2.3.2 Install all required measurement devices.

5.2.3.2. Install all required measurement devices.

5.2.4 Apply one-half of the test load and hold for 30 seconds. Release the test load across the specimen, and after a recovery period of not less than 1 minute and not more than 5 minutes, apply one-half the reverse test load and hold for 30 seconds. Release reverse test load, and after a recovery period of not less than 1 minute and not more than 5 minutes, record all readings.

5.2.5 Apply full test load and hold for 30 seconds. Release the test load across the specimen, and after a recovery period of not less than 1 minute nor more than 5 minutes, apply full reverse test load and hold for 30 seconds. Release reverse test load, and after a recovery period of not less than 1 minute nor more than 5 minutes, record all readings.

5.2.7 Air Infiltration. Where required, air infiltration shall comply with either ASTM E283 or ANSI/DASMA 105.

5.3 Specimens successfully tested shall qualify assemblies with material thicker and of the same type and construction provided the anchorage of the product is proportionally changed according to the wind pressure test.

5.4 Specimens successfully tested shall qualify assemblies of a smaller size and of the same type and construction, provided the anchorage of the product remains unchanged.

6. Apparatus

6.1 The description of the apparatus is general in nature. Any equipment, properly certified, calibrated, and approved by the Authority Having Jurisdiction capable of performing this test within the allowable tolerance, shall be permitted.

6.2.1 ***Test Chamber –*** The test chamber, to which the specimen is mounted, shall be provided with pressure taps to measure the pressure difference across the test specimen and shall be so located that the reading is unaffected by the velocity of air supplied to or from the chamber. The specimen mounting frame shall not deflect under test load in such manner that the performance of the specimen will be affected.

6.2.2 ***Pressure-Measuring Apparatus –*** The pressure-measuring apparatus shall measure the test pressure difference within a tolerance of +/-2%

6.2.3 ***Deflection-Measuring System –*** The deflection-measuring system shall measure the deflection within a tolerance of 0.01" (0.25 mm).

6.2.4 ***Air System –*** A controllable blower, a compressed-air supply, an exhaust system, or reversible controllable blower designed to provide the required maximum air pressure difference across the specimen. The system shall provide an essentially constant air-pressure difference for the required test period.

6.3 ***Calibration of Equipment –*** The pressure-measuring apparatus and the deflection-measuring system shall be calibrated and certified by an independent qualified agency approved by the Authority Having Jurisdiction, at two-year intervals.

6.3.1 The calibration report shall include the date of the calibration, the name of the agency conducting the calibration, methods and equipment used in the calibration process, the equipment being calibrated, and any pertinent comments.

7. Hazards

7.1 Testing facilities shall take all necessary precautions to protect observers during the entire test procedure. All observers shall always be at a safe distance away from specimen and apparatus. Safety regulations shall be followed in order to avoid any injuries to any and all observers.

8. Testing Facilities - (For a more detailed description see TAS 301-94)

8.1 Any testing facility wishing to perform this test shall first obtain the approval of the

Authority Having Jurisdiction. Such approval shall only be given to those facilities that show they are properly equipped to perform the complete test. Testing facilities shall request, in writing, approval of their facilities. Such request shall contain the ability of the facility to perform all aspects of the test, all equipment used in the performance of the test, name of the independent agency calibrating their equipment, location of facilities, personnel involved in the testing, a quality control program, a safety program and any other pertinent information which shall clearly indicate that such facility is in the business of performing independent testing. A representative of the Authority Having Jurisdiction shall visit the site, and shall reserve the right to order any changes necessary to accept the facility for testing.

8.2 Approval of facilities to perform the test described in this Appendix shall not constitute an approval of such facilities to perform other tests not specifically mentioned in this protocol.

9. Format of Test

The manufacturer shall notify the Authority Having Jurisdiction at least seven (7) working days prior to the performing of the test. The Authority Having Jurisdiction reserves the right to observe the test. The Authority Having Jurisdiction must be notified of the place and time the test will take place. The test must be recorded on video and retained by the laboratory per TAS301.

10. Test Reports

The following minimum information shall be included in the submitted report:

10.1 Date of the test and the report, and the report number.

10.2 Name and location of facilities performing the test.

10.3 Name and address of requester of the test.

10.4 Identification of the specimen (manufacturer, source of supply, dimension, model types, material, procedure of selection and any other pertinent information).

10.5 Detailed drawings of the specimen showing dimensioned section profiles, type of framing to which specimen was attached, panel arrangement, installation and spacing of anchorage, locking arrangement, sealant, hardware, product markings and their locations, and any other pertinent construction details. Any deviation from the drawings or any modifications made to the specimen to obtain the reported values shall be noted on the drawings and in the report. For flexible doors, the test report shall include a diagram indicating which side of the door received positive pressure and which side of the door received negative pressure.

10.6 Maximum deflection recorded, and mechanism used to make such determination.

10.7 Permanent deformation (a cross-sectional diagram shall be provided to show where it occurred).

10.8 Name, address, signature and seal of Florida professional engineer, witnessing the test and preparing the report. Engineer shall be part of the laboratory's permanent staff or under laboratory's contract. (See TAS 301-94)

10.9 A tabulation of pressure differences exerted across the specimen during the test and their duration.

10.10 Maximum positive and negative pressures used in the test.

10.11 A description of the condition of the test specimens after testing, including details of any damage and any other pertinent observations.

10.12 When the tests are made to check conformity of the specimen to a particular specification, an identification or description of that specification.

10.13 A statement that the tests were conducted in accordance with this test method.

10.14 A statement of whether or not, upon completion of all testing, the specimens meet the requirements of Section 1620 of the 2004 Florida Building Code, Building and this Appendix.

10.15 A statement as to whether or not tape or film, or both were used to seal against air leakage, and whether in the judgment of the test engineer, the tape or film influenced the results of the test.

10.16 Signatures of persons responsible for supervision of the tests, and a list of official observers.

10.17 All data not required herein, but useful to a better understanding of the test results, conclusions or recommendations, may be appended to the report.

11. **Recording Deflections**

Maximum Deflection

Permanent Deformation

95% recovery is required after half test load, and 80% minimum is required after full load (see Miami-Dade County RER checklist 0220). An initial datum plane shall be established for this measurement, along with an initial measurement of deflection under a predetermined baseline pressure condition equal to 5% of the test load. Once the initial baseline deflection measurement is taken, it shall be replicated after the pressure test to measure the change in permanent set of the curtain. Operability of door before and after testing shall be reported.

12. **Additional Testing**

12.1 After successfully completing all parts of the test described in the Appendix, the specimen shall be subjected to the forced entry test by applying a 300 lb. (1335 N) load in the upward or opening direction at the door's mid-span, within 6 inches (152 mm) from the bottom. The load shall be held for 30 seconds. The minimum skin thickness for single skin garage doors shall be 24 gauge (.0209 inches) (0.531 mm), and 26 gauge (.0157 inches) (0.399 mm) for double skin (FBC Section 2222.4.3.)

12.2 If a product is subjected to weathering that can affect its integrity, the manufacturer shall contact the Authority Having Jurisdiction for additional testing requirements such as but not limited to moisture, U.V., accelerated aging, and other similar tests.

12.3 The Authority Having Jurisdiction shall reserve the right to require any additional testing necessary to assure full compliance with the intent of the 2014 Florida Building Code, Building.

13. **Product Marking**

13.1 All approved products shall be permanently labeled with the manufacturer's name, city, and state, and the following statement: "Product Control Approved."

13.2 Permanently labeled shall be a metallic label fixed permanently to the frame of the specimen by rivets or permanent adhesive.

13.3 Any instructions for operations shall be permanently mounted on the specimen in an area not subject to be painted or concealed.

Door & Access Systems Manufacturers Association International

DASMA – the Door & Access Systems Manufacturers Association, International – is North America's leading trade association of manufacturers of garage doors, rolling doors, garage door operators, vehicular gate operators, and access control products. With Association headquarters based in Cleveland, Ohio, our 90 member companies manufacture products sold in virtually every county in America, in every U.S. state, every Canadian province, and in more than 50 countries worldwide. DASMA members' products represent more than 95% of the U.S. market for our industry.

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ANSI/DASMA 115-2005

AMERICAN NATIONAL STANDARD

STANDARD METHOD FOR TESTING SECTIONAL GARAGE DOORS AND ROLLING DOORS: DETERMINATION OF STRUCTURAL PERFORMANCE UNDER MISSILE IMPACT AND CYCLIC WIND PRESSURE

ANSI/DASMA 115-2005

Door & Access Systems Manufacturers' Association, International

Sponsor:

DASMA
Door & Access Systems Manufacturers Association International

1300 Sumner Ave
Cleveland, Ohio 44115-2851

AMERICAN NATIONAL STANDARD

Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure

Sponsor

Door & Access Systems Manufacturers' Association, International

American National Standard

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Suggestions for improvement of this standard are welcome.
They should be sent to the Door & Access Systems Manufacturers' Association, International.

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Foreword (This foreword is included for information only and is not part of ANSI/DASMA 115, *Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure.*)

This standard was developed concurrently by the Technical Committees of the DASMA Commercial & Residential Garage Door Division and the DASMA Rolling Door Division. It incorporates years of experience in testing sectional garage doors and rolling doors commonly found in garage type structures. The committees and divisions believe the existence of the standard will provide a uniform basis of testing and rating the structural performance of such doors under missile impact and cyclic wind pressure.

The DASMA Rolling Door Division and the DASMA Commercial & Residential Garage Door Division concurrently approved revisions to the standard on April 21, 2006. DASMA employed the canvass method to demonstrate consensus and to gain approval as an American National Standard. The ANSI Board of Standards Review first granted approval of the document as an American National Standard on March 21, 2003, and granted approval of the most recent revisions to the standard on October 19, 2006.

DASMA recognizes the need to periodically review and update this standard. Suggestions for improvement should be forwarded to the Door & Access Systems Manufacturers' Association, International, 1300 Sumner Avenue, Cleveland, Ohio, 44115-2851.

ANSI/DASMA 115-2005

AMERICAN NATIONAL STANDARD

Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure

1.0 SCOPE

1.1 This test method determines the performance of sectional garage doors and rolling doors impacted by missiles and subsequently subjected to cyclic static pressure differentials.

1.2 The performance determined by this test method relates to the ability of the sectional garage door or rolling door to remain unbreached during a windstorm due to windborne debris.

1.3 Water exposure conditions shall not be a part of this standard.

1.4 The proper use of this test method requires a knowledge of the principles of pressure and deflection measurement.

1.5 This test method describes the apparatus and the procedure to be used for applying missile impact and cyclic static pressure loads to a specimen.

1.6 This test method does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

1.7 This test method incorporates applicable provisions from TAS 201, TAS 203, TDS 1-95, SSTD 12-97, ASTM E 1886-02, ASTM E 1996-03 and fatigue load testing referenced in the Florida Building Code, Building.

1.8 For products intended for installation in the Florida High Velocity Hurricane Zone (Miami-Dade and Broward Counties), the testing procedure in Appendix B and Appendix C shall be used.

2.0 DEFINITIONS

2.1 Air Pressure Cycle - beginning at zero air pressure differential, the application of positive (negative) pressure to achieve a specified air pressure differential and returning to zero pressure differential.

2.2 Air Pressure Differential - the specified differential in static air pressure across the specimen, creating a positive (negative) load, expressed in pounds per square foot (or pascals).

2.3 Basic Wind Speed - also known as design wind speed, the wind speed as determined by the specifying authority.

2.4 Design Pressure - also known as design load or design wind load, the specified difference in static air pressure (positive or negative) for which the specimen is to be tested, expressed in pounds per square foot (or pascals).

2.5 Full Operability – the ability for the door to be fully opened and closed.

2.6 Maximum Deflection – the maximum displacement of the specimen measured to the nearest 0.125 inch (3 mm) attained from the original position while the maximum test load is being applied.

2.7 Missile - the object that is propelled toward a test specimen.

2.8 Positive (Negative) Cyclic Test Load - the specified difference in static air pressure, creating an inward (outward) loading, for which the specimen is to be tested under repeated conditions, expressed in pounds per square foot (or pascals).

2.9 Recovery - The ratio of the differential measurement between the test specimen surface at rest (following cyclic test loading in one direction) and the maximum deflection measured (for such cyclic test loading), to the maximum deflection measured.

2.10 Section/Slat Joint - The section to section (slat to slat) interface defined by the longitudinal surfaces that move relative to each other as the door opens and closes.

2.11 Specifying Authority - the entity responsible for determining and furnishing information required to perform this test method.

2.12 Specimen Failure - deterioration under repeated load or incipient failure, as defined in the pass/fail criteria of this standard.

2.13 Test Chamber - an airtight enclosure of sufficient depth to allow unobstructed deflection of the specimen during pressure cycling, including ports for air supply and removal, and equipped with instruments to measure test pressure differentials.

2.14 Test Loading Program - the entire sequence of air pressure cycles to be applied to the test specimen.

2.15 Test Specimen - the complete installed door assembly and mounting hardware as specified on the submitted drawing.

2.16 Windborne Debris - objects carried by the wind in windstorms.

2.17 Windstorm - a weather event, such as a hurricane, with high sustained winds and turbulent gusts capable of generating windborne debris.

3.0 SUMMARY OF TEST METHODS

3.1 A test series shall consist of three identical test specimens.

3.2 Each test specimen shall be subjected to the large missile impact test and then to the cyclic pressure loading test.

3.3 A test specimen is considered to have passed the test if it satisfies the acceptance criteria of this standard.

4.0 TEST APARATUS

4.1 Test Chamber - See Section 2.12 for definition.

4.2 Air System - shall consist of a controllable blower, a compressed-air supply, an exhaust system, a reversible controllable blower, or other air-moving system capable of providing a variable pressure from zero to the required pressures, both positive and negative.

4.3 Large Missile - shall be a nominal 2x4 Southern Pine lumber, minimum Stud grade, with no knots within 12 inches (305 mm) of the impact end. The missile shall have a length of not less than 7 feet (2.13 m) and not more than 9 feet (2.75 m). The end of the missile subjected to impact shall be permitted to be rounded to no less than a 48 inch (1219 mm) diameter sphere, with sharp edges permitted to be rounded to no more than a 1/16 inch (2 mm) radius. The missile may be marked/ticked in dark ink at one inch (25 mm) intervals on center, and congruently numbered every three inches (76 mm). A sabot shall be attached to the trailing edge of the missile to facilitate launching. The weight of the sabot shall not exceed 0.5 lbs. (227 g). The combined weight of the timber and sabot, which constitutes the missile, shall be between 9 lbs. (4.08 kg) and 9.5 lbs. (4.31 kg). The missile shall be propelled through a cannon as described in section 4.4.

4.4 Large Missile Cannon - shall be capable of producing impact at the speed specified in Section 8.2. The missile cannon may use compressed air to propel the large missile, and if using compressed air shall consist of the following major components: a compressed air supply, a pressure release valve, a pressure gauge, a barrel and support frame, and a timing system for determining the missile speed. The barrel of the missile cannon shall consist of either a 4 inch (102 mm) inside diameter pipe or a nominal 2 inch (51 mm) by 4 inch (102 mm) rectangular tube, and shall be at least as long as the missile. The barrel of the large missile cannon shall be mounted on a support frame in a manner to facilitate aiming the large missile so that it impacts the test specimen at the desired location.

4.5 Timing System - shall be capable to measure speeds accurate to +/- 2%. One method shall be comprised of two, through-beam photoelectric sensors spaced at a known distance apart and used to start and stop an electronic clock, and shall be capable to measure speeds accurate to +/-2%. The speed of the missile shall be measured anywhere between the point where 100% of the missile is outside of the cannon, to the point where the missile is 1 ft. (300 mm) away from the test specimen. The missile speed shall not be measured while the missile is accelerating. The speed of the missile shall be determined by dividing the distance between the two through-beam photoelectric sensors by the total time interval counted by the electronic clock.

5.0 HAZARDS

5.1 If failure occurs during testing, hazardous conditions may result.

5.2 Take proper safety precautions to protect observers in the event that a failure occurs.

5.3 All observers shall be isolated from the path of the missile during the missile impact portion of the test.

5.4 Keep observers at a safe distance from the test specimen during the entire procedure.

6.0 TEST SPECIMENS

6.1 Three test specimens shall be supplied. Each test specimen shall be as per the manufacturer's detailed drawings and/or written instructions. For sectional garage doors, the horizontal track and hanging brackets may be shortened to fit the test chamber.

6.2 All parts of the test specimen, including glazing and structural framing, shall be full size.

6.3 The test specimen shall consist of the same materials, details, methods of construction and methods of attachment as proposed for actual use.

6.4 The specimen shall consist of the entire assembled unit attached to a given type of structural framing of the building, and shall contain all devices used to resist wind forces and windborne debris.

6.5 When testing sectional garage doors and rolling doors which include glazed products, the material used to make such glazed products windborne debris resistant (i.e. fillers, film and similar) shall be an integral part, factory applied, of such glazed products.

6.6 The door shall be either counterbalanced where no more than the larger of 5% of door weight or ten pounds applied force is required to open the door manually from the fully closed position, or a simulated counterbalance condition (including locking mechanism) shall be achieved by shimming up the bottom corners of the door.

7.0 CALIBRATION OF TIMING EQUIPMENT

7.1 The timing system shall be calibrated and certified by an independent approved qualified agency, at six-month intervals. See Appendix A for recommended methods.

7.2 The calibration report shall include the following:

7.2.1 The date of the calibration.

7.2.2 The name of the agency conducting the calibration.

7.2.3 The distance between the through-beam photoelectric sensors (if used).

7.2.4 The speed of the missile as measured by the timing system.

7.2.5 The speed of the missile as determined from the calibration system.

7.2.6 The percentage difference in speeds.

7.3 The system shall be determined to be accurate if the speed of the missile measured by the timing system and the speed measured by the calibration system agree within +/- 2%.

8.0 LARGE MISSILE IMPACT TEST

8.1 The test shall be conducted using a large missile cannon.

8.2 The large missile shall be as described in Section 4.3. The speed of the large missile shall be at least 50 ft/s (15.2 m/s). The speed of the large missile shall be measured as described in Section 4.5.

8.3 The large missile shall impact the surface of the test specimen "end on".

8.4 Impacts

8.4.1 For sectional garage doors, impacts shall be defined as follows:

- 8.4.1.1 Within a 5 inch (127 mm) radius circle having its center on a section joint at a hinge location nearest the midpoint of the test specimen.
- 8.4.1.2 Within a 5 inch (127 mm) radius circle having its center located in the thinnest section of the test specimen, equidistant between the lower two section joints and centered between vertical stiles.
- 8.4.1.3 Within a 5 inch (127 mm) radius circle having its center at a point 6 inches (152 mm) horizontally and vertically away from a bottom corner.

8.4.2 For rolling doors, impacts shall be defined as follows:

- 8.4.2.1 Within a 5 inch (127 mm) radius of the center of the door.
- 8.4.2.2 Within a 5 inch (127 mm) radius circle having its center at a point 6 inches (152 mm) horizontally and vertically away from a bottom corner.

8.5 Each specimen shall receive at least two (2) impacts from the large missile.

8.5.1 For sectional garage doors, the first specimen shall receive one impact complying with Section 8.4.1.1 and one impact complying with Section 8.4.1.3.

8.5.2 For sectional garage doors, the second specimen shall receive one impact complying with Section 8.4.1.2 and one impact complying with Section 8.4.1.3.

8.5.3 For sectional garage doors, the third specimen shall receive one impact complying with Section 8.4.1.1 and one impact complying with Section 8.4.1.2.

8.5.4 For rolling doors, each specimen shall receive impacts complying with Section 8.4.2.

8.6 For sectional garage doors and rolling doors that contain glazing, the glazing shall be impacted, in addition to the impact locations set forth in Section 8.5.

8.6.1 Glazing panels greater than or equal to 3 square feet (.28 sq m) in area shall receive two impacts. The first impact within a 5 inch (127 mm) radius circle having its center at a point 6 inches horizontally and vertically away from a corner of the glazing. The second impact within a 5 inch (127 mm) radius circle having its center at the midpoint of the glazing panel.

8.6.2 Glazing panels less than 3 square feet (.28 sq m) in area shall receive one impact located within a 5 inch (127 mm) radius circle having its center at the midpoint of the glazing panel.

8.6.3 For sectional garage doors and rolling doors that contain multiple panels of glazing, the innermost panel shall be impacted.

8.6.4 For sectional garage doors and rolling doors that contain different glazing thicknesses and/or glazing types, each different glazing thickness and glazing type shall be impacted.

9.0 TEST PROCEDURES - LARGE MISSILE IMPACT

9.1 Preparation

9.1.1 Remove from the test specimen any sealing or construction material that is not intended to be used when the unit is installed in or on a building. Support and secure the test specimen into the mounting frame in a vertical position using the same number and type of anchors normally used for product installation as defined by the manufacturer or as required for a specific project. If this is impractical, install the test specimen with the same number of equivalent fasteners located in the same manner as the intended installation. The test specimen shall not be removed from the mounting frame at any time during the test sequence. The test shall be recorded using video equipment.

9.1.2 Secure the test specimen mounting frame such that the large missile will impact the exterior side of the test specimen as installed.

9.1.3 Locate the end of the propulsion device from which the large missile will exit at a minimum distance from the specimen equal to 9 feet (2.74 m) plus the length of the large missile.

9.1.4 Weigh each large missile within four hours prior to each impact.

9.1.5 Align the large missile propulsion device such that the large missile will impact the test specimen at the specified location.

9.2 Large Missile Impact.

9.2.1 Propel the large missile at the specified impact speed and location.

9.2.2 Examine damage in light of the pass/fail criteria found in Section 9.3.

9.2.3 Repeat steps 9.2.1 through 9.2.2 at all additional impact locations specified for the test specimen.

9.3 Pass/Fail Criteria.

9.3.1 The test specimen shall be subjected to evaluation for operability, and shall be acceptable by the following:

9.3.1.1 The door system shall remain in the opening throughout the duration of the test.

9.3.1.2 The door shall be evaluated for full operability at the conclusion of the test. The door shall pass only if the test engineer deems that the door system has full operability.

9.3.2 Latches, locks and fasteners shall not become disengaged during the testing.

9.3.3 Excluding section/slat joints, no crack shall form longer than 5 inches (127 mm) and wider than 1/16 inch (1.6 mm) through which air can pass.

9.3.4 No opening shall form through which a 3 inch (76 mm) diameter sphere can pass.

9.3.5 All three test specimens shall be required to pass this testing.

9.4 Post Impact Test Procedure.

9.4.1 If the test specimen passes the acceptance criteria of the large missile impact test, it shall then be subjected to the cyclic pressure loading test specified in Section 10.

10.0 CYCLIC WIND PRESSURE LOADING TEST

10.1 General.

10.1.1 This test shall apply to sectional garage doors and rolling doors that have passed the acceptance criteria of the large missile impact test.

10.1.2 The test specimens tested for impact shall be used for the cyclic pressure loading test.

10.1.3 If air leakage through the test specimen is excessive, tape may be used to cover any joints through which air leakage is occurring.

10.1.4 Cracks due to impact testing shall not be restrained with tape.

10.1.5 Tape shall not be used when there is a probability that it may significantly restrict differential movement between adjoining members.

10.1.6 Both sides of the entire test specimen and mounting panel shall be permitted to be covered with a single thickness of polyethylene film no thicker than 2 mils (.050 mm), in order that the full load is transferred to the test specimen and that the membrane does not prevent movement or failure of the specimen. The film shall be applied loosely with extra folds of material at each corner and at all offsets and recesses. When the load is applied, there shall be no fillet caused by tightness of the plastic film.

10.2 Loading Sequence Alternatives.

10.2.1 Loading Sequence 1 shall be as follows:

#1: Range of Test: 0 to +0.5p Cycles: 600
#2: Range of Test: 0 to +0.6p Cycles: 70
#3: Range of Test: 0 to +1.3p Cycles: 1
#4: Range of Test: 0 to -0.5p Cycles: 600
#5: Range of Test: 0 to -0.6p Cycles: 70
#6: Range of Test: 0 to -1.3p Cycles: 1

10.2.2 Loading Sequence 2 shall be as follows:

#1: Range of Test: +0.2p to +0.5p Cycles: 3500
#2: Range of Test: 0 to +0.6p Cycles: 300
#3: Range of Test: +0.5p to +0.8p Cycles: 600
#4: Range of Test: +0.3p to +1.0p Cycles: 100
#5: Range of Test: -0.3p to -1.0p Cycles: 50
#6: Range of Test: -0.5p to -0.8p Cycles: 1050
#7: Range of Test: 0 to -0.6p Cycles: 50
#8: Range of Test: -0.2p to -0.5p Cycles: 3350

10.2.3 The parameter “p” shall be defined as sectional garage door or rolling door design wind load pressure, based on where the assembly will be used.

10.3Test Procedure.

10.3.1 For non-glazed sectional garage doors and non-glazed rolling doors, cyclic static pressure differential loading shall be applied in accordance with either Loading Sequence 1 or Loading Sequence 2 as described in Section 10.2.

10.3.2 For glazed sectional garage doors and glazed rolling doors, cyclic static pressure differential loading shall be applied in accordance with either Loading Sequence 1 or Loading Sequence 2 as described in Section 10.2.

10.3.3 Each cycle shall have duration not to exceed 20 seconds, where the cycles shall be applied as rapidly as possible and shall be performed in a continuous manner.

10.3.4 Interruptions for equipment maintenance and repair shall be permitted.

10.3.5 The test specimen shall not contact any portion of the test chamber at any time during the application of the cyclic static pressure differential loading.

10.3.6 Successful testing of a door assembly containing glazing shall qualify a door assembly of the same type that does not contain glazing.

10.4Pass/Fail Criteria.

10.4.1 The test specimen shall be subjected to evaluation for operability, and shall be acceptable by the following:

10.4.1.1 The door system shall remain in the opening throughout the duration of the test.

10.4.1.2 The door system shall be evaluated for full operability at the conclusion of the test. The door shall pass only if the test engineer deems that the door system has full operability.

10.4.2 Latches, locks and fasteners shall not become disengaged during the testing.

10.4.3 Excluding section/slat joints, no crack shall form longer than 5 inches (127 mm) and wider than 1/16 inch (1.6 mm) through which air can pass.

10.4.4 No opening shall form through which a 3 inch (76 mm) diameter sphere can pass.

10.4.5 All three test specimens shall be required to pass this testing.

11.0**TEST REPORTS**

11.1Date of the test.

11.2Date of the report.

11.3 A description of the test specimens, prior to impact and cyclic pressure loading, including all parts and components of a particular system of construction together with manufacturer's model number, if appropriate, or any other identification.

11.4 Detailed drawings of the test specimens, showing dimensioned section profiles, door dimensions and arrangement, framing location, weatherstripping, locking arrangements, hardware, sealants, glazing details, test specimen sealing methods, and any other pertinent construction details.

11.5 Proper identification of each test specimen, particularly with respect to distinguishing features or differing adjustments. A separate drawing for each test specimen shall not be required where all differences between them are noted on the drawings provided.

11.6Design pressure used as the basis for testing.

11.7Information on the large missile Appendix used:

11.7.1 Description of the missile, including dimensions and weight.

11.7.2 Missile speed measured.

11.7.3 Whether or not certification of the calibration equipment was required.

11.7.4 Missile orientation at impact.

11.7.5 Description of the location of each impact.

11.8Information on the cyclic loading Appendix used:

11.8.1 The positive and negative cyclic test load sequence.

11.8.2 The number of cycles applied for each sequence.

11.8.3 The minimum and maximum duration for each cycle.

11.9A description of the condition of the test specimens after testing, including details of any damage and any other pertinent observations.

11.10 When the tests are made to check conformity of the specimen to a particular specification, an identification or description of that specification.

11.11 A statement that the tests were conducted in accordance with the test method.

11.12 A statement of whether or not, upon completion of all testing, the test specimens meet the pass/fail criteria of this standard for both missile impact and cyclic loading.

11.13 A statement as to whether or not tape or film, or both, were used to seal against air leakage, and whether in the judgment of the test engineer, the tape or film influenced the results of the test. The name and author of the report.

11.14 The names and addresses of both the testing agency that conducted the tests and the requester of the tests.

11.15 Signatures of persons responsible for supervision of the tests and a list of official observers.

11.16 Any additional data or information considered to be useful to a better understanding of the test results, conclusions, or recommendations. This additional data/ information shall be appended to the report.

REFERENCED DOCUMENTS:

1. Protocol TAS 201, Impact Test Procedures, Miami-Dade County Building Code Compliance Office
2. Protocol TAS 203, Criteria For Testing Products Subject To Cyclic Wind Pressure Loading, Miami-Dade County Building Code Compliance Office
3. Standard TDI 1-95, Test For Impact and Cyclic Wind Pressure Resistance of Impact Protective Systems and Exterior Opening Systems, Texas Department of Insurance
4. Test Standard for Determining Impact Resistance From Windborne Debris, SSTD 12-97, Southern Building Code Congress International
5. ASTM E 1886-02, Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Storm Shutters Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
6. ASTM E 1996-04, Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Storm Shutters Impacted by Windborne Debris in Hurricanes
7. Fatigue Loading Testing, Section 1625.4, 2004 Florida Building Code, Building

ANSI/DASMA 115 Test Report Form
Missile Impact and Cyclic Loading

Date of Test ______________ Date of Report __________________

Test Specimen Identification:
Manufacturer
____
Manufacturer Location ____
Model Type/Number ______________ Dimensions ____________________________________
Material Description ____
Test Specimen Selection Procedure ____
____
____
Applicable Drawing No.'s ____
____

Operating Hardware (Type, Quantity, Location(s)):
____
____
____

Glazing Description: ____

Ambient Temperature: __________

Design pressure used as the basis for testing: __________

Large Missile Information:

Missile Dimensions ______________ Missile Weight _________
Missile speed measured _____________
Certification of the calibration equipment required? Yes No
Missile orientation at impact _______________

Impact #1 Location ____
Maximum Crack Length __________ Maximum Crack Width __________
Maximum Diameter Sphere Penetrating the Impact Location __________
Impact #2 Location ____
Maximum Crack Length __________ Maximum Crack Width __________
Maximum Diameter Sphere Penetrating the Impact Location __________
Impact #3 Location ____
Maximum Crack Length __________ Maximum Crack Width __________
Maximum Diameter Sphere Penetrating the Impact Location __________
Glazing Impact Location (if applicable) _________________________________
Maximum Diameter Sphere Penetrating the Impact Location __________
Test Result: Pass Fail

Notes:
____
____
____

ANSI/DASMA 115 Test Report Form
Missile Impact and Cyclic Loading

Cyclic Loading Information:

# Applied Pressure	# Cycles	Min. Duration (sec)	Max. Duration (sec)

Maximum Diameter Sphere Penetrating the Test Specimen _______________
Maximum Length of Crack Formed in Test Specimen ______ Crack Width ______

Test Result: Pass Fail

Notes:
____
____
____
____

Garage/Rolling Door Operable, after Evaluation for Full Operability? (Yes/No) ______

Certification: The signature of the tester attests that the testing was conducted in accordance with the referenced standard.

Testing Conducted by
____**of**______________________________

Signature of Tester _______________________________________ **Date** _____________________________

Test Facility and Location ____

Official Observers

____
____

Appendix A

The following appendix is informative only and is not a normative part of ANSI/DASMA 115.

Recommended Methods of Calibrating Timing Equipment

A.1 Photographically, using a stroboscope.

A.2 Photographically, using a high speed camera with a frame rate exceeding 500 frames per second.

A.3 Photographically, using a high speed video camera with a frame rate exceeding 500 frames per second.

A.4 Any other certified timing system calibration device with an accuracy of +/- 1%.

Appendix B

Impact Testing Procedure for the Florida High Velocity Hurricane Zone

1. Scope

1.1 This Appendix covers procedures for conducting the impact test of sectional garage doors and rolling doors as required by Section 1626 of the Florida Building Code, Building.

2. Referenced Documents

2.1 2004 Florida Building Code, Building

3. Terminology

3.1 *Definitions* – For definitions of terms used in this Appendix, refer to Sections 1625, 1626 and/or Chapter 2 of the Florida Building Code, Building.

3.2 *Description of Terms Specific to This Appendix*

3.2.1 *Specimen* – The entire assembled unit submitted for test, including but not limited to anchorage devices and structure to which product is to be mounted.

3.2.2 *Test Chamber* – An airtight enclosure of sufficient depth to allow unobstructed deflection of the specimen during pressure cycling, including ports for air supply and removal, and equipped with instruments to measure test pressure differentials.

3.2.3 *Maximum Deflection* – The maximum displacement of the specimen, measured to the nearest 1/8" (3 mm), attained from the original position while the maximum test load is being applied.

3.2.4 *Permanent Deformation* – The permanent displacement of the specimen, measured to the nearest 1/8 inch (3 mm), from the original position to final position that remains after maximum test load has been removed.

3.2.5 *Test Load* – As determined by Sections 1606, 1625 and 1626 of the Florida Building Code, Building.

3.2.6 *Specimen Failure* – A change in condition of the specimen indicative of deterioration under repeated load or incipient failure, such as cracking, fastener loosening, local yielding, or loss of adhesive bond.

4. Significance and Use

4.1 The test procedures outlined in this Appendix provide a means of determining whether a sectional garage door or rolling door provides sufficient resistance to windborne debris, as stated in Section 1626 of the Florida Building Code, Building.

5. Test Specimen

5.1 *Test specimen* – All parts of the test specimen shall be full size, using the same materials, details, methods of construction and methods of attachment as proposed for actual use. The specimen shall consist of the entire assembled unit attached to a given type of structural framing of the building, and shall contain all devices used to resist wind forces and windborne debris. When testing glazed products, the material used to make such glazed product windborne debris resistant (i.e. fillers, film and similar), shall be an integral part, factory applied, of such glazed product.

A pressure treated nominal 2 x 4 - #3 Southern Pine wood buck shall be used for attachment of the specimen to the test frame/stand/chamber. Such wood buck shall become part of the approval.

5.1.1 Locking mechanisms shall be permanently mounted on the specimen. Such locking mechanism shall require no tools to be latched in the locked position. Devices such as pins shall be permanently secured to the specimen through the use of chains or wires that shall be of corrosion resistant material. This section shall not apply to specimens referenced in Section 2413 of the Florida Building Code, Building.

5.1.2 Products that are not categorized as means of egress/escape, and are provided with more than one single action locking mechanism, shall be provided with permanently posted instructions on latching for high wind pressures.

5.1.3 Specimen and fasteners, when used, shall not become disengaged during test procedure.

6. Apparatus

6.1 The description of the apparatus is general in nature. Any equipment, properly certified, calibrated, and approved by the Authority Having Jurisdiction capable of performing this test within the allowable tolerance, shall be permitted.

6.2 *Major Components*

6.2.1 *Cyclic Wind Pressure Loading* – Number of cycles and amount of pressure shall be as indicated in Section 1625.4, Table 1625 and Table 1626 of the Florida Building Code, Building. Design wind pressure shall be determined by using Section 1609 of the Florida Building Code, Building.

6.2.1.1 *Test Chamber* – The test chamber, to which the specimen is mounted, shall be provided with pressure taps to measure the pressure difference across the test specimen and shall be so located that the reading is unaffected by the velocity of air supplied to or from the chamber. The specimen mounting frame shall not deflect under test load in such manner that the performance of the specimen will be affected.

6.2.1.2 *Air System* – A controllable blower, a compressed-air supply, an exhaust system, or reversible controllable blower designed to provide the required maximum air pressure difference across the specimen. The system shall provide an essentially constant air-pressure difference for the required test period.

6.3 *Missile Impact*

6.3.1 *Timing System* – The timing system, which is comprised of two, through-beam photoelectric sensors spaced at a known distance apart and used to start and stop an electronic clock, shall be capable to measure speeds accurate to +/- 2%. The speed of the missile shall be measured anywhere between the point where 90% of the missile is outside of the cannon, to the point where the missile is 1 ft. (305 mm) away from the test specimen. The missile speed shall not be measured while the missile is accelerating. The through-beam photoelectric sensors shall be of the same model.

The electronic clock shall be activated when the reference point of the missile passes through the timing system. The electronic clock shall have an operating frequency of no less than 10 kHz with a response time not to exceed 0.15 milliseconds. The speed of the missile shall be determined by dividing the distance between the two through-beam photoelectric sensors by the total time interval counted by the electronic clock.

6.3.1.1 *Calibration of Timing Equipment* – The timing system shall be calibrated and certified by an independent qualified agency approved by the Authority Having Jurisdiction, at six-month intervals using one of the following methods:

1. Photographically, using a stroboscope,
2. Photographically, using a high speed camera with a frame rate exceeding 500 frames per second,
3. Photographically, using a high speed video camera with a frame rate exceeding 500 frames per second, or
4. Any other certified timing system calibration device used by an independent certified agency approved by this office.

The calibration report shall include the date of the calibration, the name of the agency conducting the calibration, the distance between the through-beam photoelectric sensors (if used), the speed of the missile as determined from the calibration system, and the percentage difference in speeds. The system shall be determined to be accurate if the speed of the missile measured by the timing system and the speed measured by the calibration system agree within 2%.

6.3.2.1 *Large Missile* – The large missile shall be a solid S4S nominal 2x4 #2 surface dry Southern Pine. The weight of the missile shall be as specified in Section 1626.2.3 of the Florida Building Code, Building and shall have a length of not less than 7 feet (2.14 m) and not more than 9 feet (2.75 m). The missile shall be marked/ticked in dark ink at one-inch intervals on center, and congruently numbered every three inches. A sabot shall be attached to the trailing edge of the missile to facilitate launching. The weight of the sabot shall not exceed 1/2 lb (.228 kg). The combined weight of the timber and sabot, which constitutes the missile, shall be between 9 lb. (4.1 kg) and 9.5 lb (4.23 kg). The missile shall be propelled through a cannon as described in section 6.3.3 of this Appendix.

6.3.2.2 When testing any specimen with more than one component, in addition to complying with the impacts required by Section 1626.2 of the Florida Building Code, Building, the framing member connecting these components shall be impacted at one-half the span of such member with the large missile at a speed indicated in Section 1626.2.4 of the Florida Building Code, Building.

6.3.2.3 Any specimen that passes the large missile impact test shall not be tested for the small missile impact test if the specimen has no opening through which a 3/16 inch (5 mm) sphere can pass.

6.3.3 *Large Missile Cannon* – The large missile cannon shall be compressed air to propel the large missile. The cannon shall be capable of producing impact at the speed specified in Section 1626.2.4 of the Florida Building Code, Building. The missile cannon shall consist of four major components: a compressed air supply, a pressure release valve, a pressure gauge, a barrel and support frame, and a timing system for determining the missile speed. The barrel of the missile cannon shall consist of a 4-inch (102 mm) inside diameter pipe and shall be at least as long as the missile. The barrel of the large missile cannon shall be mounted on a support frame in a manner to facilitate aiming the missile so that it impacts the specimen at the desired location. The distance from the end of the cannon to the specimen shall be 9 feet (2.75 m) plus the length of the missile.

6.3.4 *Small Missile* –The missiles shall be propelled by the cannon as described in Section 6.3.5 of this Appendix. The small missile shall be launched in such a manner that each specimen shall be impacted simultaneously over an area not to exceed two square feet per impact as described in Section 1626.3.5 of the Florida Building Code, Building.

6.3.5 *Small Missile Cannon* – A compressed air cannon shall be used that is capable of propelling missiles of the size and speed defined in Section 1626.3.3 and 1626.3.4 of the Florida Building Code, Building. The cannon assembly shall be comprised of a compressed air supply and gauge, a remote firing device and valve, a barrel, and a timing system. The small missile cannon shall be mounted to prevent movement of the cannon so that it can propel missiles to impact the test specimen at points defined in Section 1626.3.5 of the Florida Building Code, Building. The timing system shall be positioned to measure missile speed within 5 feet (1.53 m) of the impact point on the test specimen.

7. Hazards

7.1 Testing facilities shall take all necessary precautions to protect observers during the entire test procedure. All observers shall be at a safe distance away from specimen and apparatus. Safety regulations shall be followed in order to avoid any injuries to any and all observers.

8. Testing Facilities

8.1 Any testing facility wishing to perform this test shall first obtain the approval of the Authority Having Jurisdiction. Such approval shall only be given to those facilities that show they are properly equipped to perform the complete test, including the cyclic loading and the small and large missile impact test. Testing facilities shall request, in writing, approval of their facilities. Such request shall contain the ability of the facility to perform all aspects of the test, all equipment used in the performance of the test, name of independent agency calibrating their equipment, location of facilities, personnel involved in the testing, a quality control program, a safety program and any other pertinent information which shall clearly indicate that such facility is in the business of performing independent testing. A representative of the Authority Having Jurisdiction shall visit the site, and shall reserve the right to order any changes necessary to accept the facility for testing.

8.2 Approval of facilities to perform the test described in this Appendix does not constitute an approval of such facilities to perform other tests not specifically mentioned in this Appendix.

8.3 The testing lab shall be TAS301 certified.

9. Format of Test

The manufacturer shall notify the Authority Having Jurisdiction seven (7) working days prior to the performing of the test. The Authority Having Jurisdiction reserves the right to observe the test. The Authority Having Jurisdiction must be notified of the place and time the test will take place. The test must be recorded on video and retained by the laboratory per TAS301.

10. Test Reports

The following minimum information shall be included in the submitted report:

10.1 Date of the test and the report, and report number.

10.2 Name, location, and certification number of facilities performing the test.

10.3 Name and address of requester of the test.

10.4 Identification of the specimen (manufacturer, source of supply, dimension, model types, material, procedure of selection and any other pertinent information).

10.5 Detailed drawings of the specimen showing dimensioned section profiles, type of framing to which specimen was attached, panel arrangement, installation and spacing of anchorage, locking arrangement, sealants, hardware, product markings and their location, and any other pertinent construction details. Any deviation from the drawings or any modifications made to the specimen to obtain the reported values shall be noted on the drawings and in the report.

10.6 Maximum deflection recorded and mechanism used to make such determination.

10.7 Permanent deformation (a cross-sectional diagram shall be provided to show where it occurred).

10.8 Name, address, signature and seal of Florida professional engineer, witnessing the test and preparing the report. Engineer shall be part of the laboratory's permanent staff or under laboratory's contract.

10.9 The results for all three specimens shall be reported, each specimen being properly identified, particularly with respect to distinguishing features or differing adjustments. A separate drawing for each specimen shall not be required if all differences between them are noted on the drawings provided.

10.10 Location of impacts on each test specimen.

10.11 The large and small missile velocities.

10.12 The weight of the missiles.

10.13 Maximum positive and negative pressures used in the cyclic wind pressure loading.

10.14 A description of the condition of the test specimens after testing, including details of any damage and any other pertinent observations.

10.15 When the tests are made to check conformity of the specimen to a particular specification, an identification or description of that specification.

10.16 A statement that the tests were conducted in accordance with this test method.

10.17 A statement of whether or not, upon completion of all testing, the specimens meet the requirements of Section 1626 of the Florida Building Code, Building.

10.18 A statement as to whether or not tape or film, or both were used to seal against air leakage, and whether in the judgment of the test engineer, the tape or film influenced the results of the test.

10.19 Signatures of persons responsible for supervision of the tests, and a list of official observers.

10.20 All data not required herein, but useful to a better understanding of the test results, conclusions or recommendations, may be appended to the report.

11. Recording Deflections

Maximum Deflection

Permanent Deformation

12. Additional Testing

12.1 Following successful completion of this test, all specimens shall then be successfully tested as per Appendix C of this standard.

12.2 If a product is subjected to weathering that can affect its integrity, the manufacturer shall contact the Authority Having Jurisdiction for additional testing requirements such as but not limited to moisture, U.V., accelerated aging, and other similar tests.

12.3 The Authority Having Jurisdiction shall reserve the right to require any additional testing necessary to assure full compliance with the intent of the Florida Building Code, Building.

12.4 Products tested in accordance with this Appendix shall be required to be successfully tested under Appendix A of ANSI/DASMA 108 prior to conducting tests under this Appendix.

13. Product Marketing

13.1 Any and all approved products shall be permanently labeled with the manufacturer's name, city, and state, and the following statement: "Product Control Approved."

13.2 Permanently labeled shall be a metallic label fixed permanently to the frame of the specimen by rivets or permanent adhesive.

13.3 Any instructions for operations shall be permanently mounted on the specimen in an area not subject to be painted or concealed.

Appendix C

Cyclic Wind Pressure Testing Procedure for the Florida High Velocity Hurricane Zone

1. Scope

1.1 This Appendix covers procedures for conducting the cyclic wind pressure loading test required by the Florida Building Code, Building and Appendix B of this standard.

2. Referenced Documents

2.1 2004 Florida Building Code, Building.

3. Terminology

3.1 *Definitions* – For definitions of terms used in this Appendix, refer to the Florida Building Code, Building.

3.2 *Description of Terms Specific to This Appendix*

3.3 *Specimen* – The entire assembled unit submitted for test, including anchorage devices and structure to which product is to be mounted.

3.4 *Positive (negative) Cyclic Load* – The specified differential in static air pressure, creating an inward (outward) loading, for which the specimen is to be tested under repeated conditions, expressed in pounds per square foot.

3.5 *One cycle* – Beginning at the specified static air pressure, the application of positive cyclic test load, and returning to the specified static air pressure, followed by the application of negative cyclic test load.

3.6 *Design Pressure (Design Wind Load)* – The uniform static air pressure difference, inward or outward and expressed in pounds per square foot (Newtons per square meter), for which the specimen would be designed under service load conditions using Section 1606 of the Florida Building Code, Building.

3.7 *Test Chamber* – An airtight enclosure of sufficient depth to allow unobstructed deflection of the specimen during pressure cycling, including ports for air supply and removal, and equipped with a device to measure test pressure differentials.

3.8 *Maximum Deflection* – The maximum displacement, measured to the nearest 1/8 inch (3 mm), attained from an original position while the maximum load is being applied.

3.9 *Permanent Deformation* – The permanent displacement, measured to the nearest 1/8 inch (3 mm), from an original position that remains after the applied test load has been removed.

3.10 *Specimen Failure* – A change in condition of the specimen indicative of deterioration under repeated load or incipient failure, such as cracking, fastener loosening, local yielding, or loss of adhesive bond.

4. Significance and Use

4.1 This test method is a standard procedure for determining compliance with Section 1625, Table 1625.4 and Table 1626 of the Florida Building Code, Building. This test method shall be intended to be used for installations of sectional garage doors and rolling doors. This test method shall consist of supplying air to and exhausting air from the chamber in accordance with a specific test loading program at the rate required to maintain the test pressure differential across the specimen, and observing, measuring, and recording the deflection, deformations, and nature of any distress or failures of the specimen.

5. Test Specimen

5.1 *Test specimen* – All parts of the test specimen shall be full size, using the same materials, details, methods of construction and methods of attachment as proposed for actual use. The specimen shall consist of the entire assembled unit attached to a given type of structural framing of the building, and shall contain all devices used to resist wind forces and windborne debris. When testing glazed products, the material used to make such glazed product windborne debris resistant (i.e. fillers, film and similar) shall be an integral part, factory applied, of such glazed product.

A pressure treated nominal 2 x 4 - #3 Southern Pine wood buck shall be used for attachment of the specimen to the test frame/stand/chamber. Such wood buck shall become part of the approval.

5.1.1 Locking mechanisms shall be permanently mounted on the specimen. Such locking mechanism shall require no tools to be latched in the locked position. Devices such as pins shall be permanently secured to the specimen through the use of chains or wires which shall be of corrosion resistant material. This section shall not apply to shutters.

5.1.2 Products that are not categorized as means of egress/escape, and are provided with more than one single action locking mechanism, shall be provided with permanently posted instructions on latching for high wind pressures.

5.1.3 Specimen and fasteners, when used, shall not become disengaged during test procedure.

5.2 If the impact test is to be performed on the test specimen, such test shall be conducted prior to performing the test described in this Appendix.

5.3 All locking mechanisms shall be in place when performing this test.

5.4 Doors shall be evaluated for operability after this test.

6. Procedure

6.1 *Preparation* – Remove from the test specimen any sealing or construction material that is not normally used when installed in or on a building. Fit the specimen with its structural framing into or against the chamber opening. The outdoor side of the specimen shall face the higher pressure side for positive loads; the indoor side shall face the higher pressure side for negative loads. Support and secure the specimen by the same number and type of anchors to be approved for normal installation of the specimen in the building.

6.2 Support and secure the test specimen by the same number and type of anchors normally used in installing the unit in the building.

6.3 Load the specimen using the cycles specified in Table 1625.4 and/or Table 1626 of the Florida Building Code, Building, whichever of these apply.

6.4 In the case of Table 1625.4 of the Florida Building Code, Building, Section 6.3 of this Appendix shall be repeated for negative pressures.

6.5 Assemblies shall be tested with no resultant failure or distress, and shall have a recovery of at least 90% over maximum deflection.

7. Apparatus

7.1 The description of the apparatus is general in nature. Any equipment, properly certified, calibrated, and approved by the Authority Having Jurisdiction capable of performing this test within the allowable tolerance shall be permitted.

7.2 *Major Components*

7.2.1 *Test Chamber* – The test chamber, to which the specimen is mounted, shall be provided with pressure tabs to measure the pressure difference across the test specimen and shall be so located that the reading is unaffected by the velocity of air supplied to or from the chamber. The specimen mounting frame shall not deflect under test load in such manner that the performance of the specimen will be affected.

7.2.2 *Pressure-Measuring Apparatus* – The pressure-measuring apparatus shall measure the test pressure difference within a tolerance of +/-2%

7.2.3 *Deflection-Measuring System* – The deflection-measuring system shall measure the deflection within a tolerance of 0.01 inch (0.25 mm).

7.2.4 *Air System* – A controllable blower, a compressed-air supply, an exhaust system, or reversible controllable blower designed to provide the required maximum air pressure difference across the specimen. The system shall provide an essentially cyclic static air-pressure difference for the required test period.

7.3 *Calibration of Equipment* – The pressure-measuring apparatus and the deflection-measuring system shall be calibrated and certified by an independent qualified agency approved by the Authority Having Jurisdiction, at two-year intervals.

7.3.1 The calibration report shall include the date of the calibration, the name of the agency conducting the calibration, methods and equipment used in the calibration process, the equipment being calibrated and any pertinent comments.

8. Hazards

8.1 Testing facilities shall take all necessary precautions to protect the observers during the entire test procedure. All observers shall always be at a safe distance away from specimen and apparatus. Safety regulations shall be followed in order to avoid any injuries to any and all observers.

9. Testing Facilities

9.1 Any testing facility wishing to perform testing on such products shall first obtain the approval of the Authority Having Jurisdiction. Such approval shall only be given to those facilities that show they are properly equipped to perform the complete test. Testing facilities shall request, in writing, approval of their facilities. Such request shall contain the ability of the facility to perform all aspects of the test, all equipment used in the performance of the test, name of independent agency calibrating their equipment, location of facilities, personnel involved in the testing, a quality control program, a safety program and any other pertinent information which shall clearly indicated that such facility is in the business of performing independent testing. A representative of the Authority Having Jurisdiction shall visit the site, and shall reserve the right to order any changes necessary to accept the facility for testing.

9.2 Approval of facilities to perform the test described in this Appendix shall not constitute an approval of such facilities to perform other tests not specifically mentioned in this Appendix.

9.3 The testing lab shall be TAS301 certified.

10. Format of Test

The manufacturer shall notify the Authority Having Jurisdiction seven (7) working days prior to the performing of the test. The Authority Having Jurisdiction reserves the right to observe the test. The Authority Having Jurisdiction must be notified of the place and time the test will take place. The test must be recorded on video and retained by the laboratory per TAS301.

11. Test Reports

The following minimum information shall be included in the submitted report:

11.1 Date of the test and the report, and report number.

11.2 Name and location of facilities performing the test.

11.3 Name and address of requester of the test.

11.4 Identification of the specimen (manufacturer, source of supply, dimension, model types, material, procedure of selection and any other pertinent information).

11.5 Detailed drawings of the specimen showing dimensioned section profiles, type of framing to which specimen was attached, panel arrangement, installation and spacing of anchorage, locking arrangement, sealant, hardware, product markings and their location, and any other pertinent construction details. Any deviation from the drawings or any modifications made to the specimen to obtain the reported values shall be noted on the drawings and in the report.

11.6 Maximum deflection recorded, and mechanism used to make such determination.

11.7 Permanent deformation (a cross-sectional diagram shall be provided to show where it occurred).

11.8 Name, address, signature and seal of Florida professional engineer, witnessing the test and preparing the report. Engineer shall be part of the laboratory's permanent staff or under laboratory's contract.

11.9 A tabulation of pressure differences exerted across the specimen during the test and their duration.

11.10 Maximum positive and negative pressures used in the test.

11.11 A description of the condition of the test specimens after testing, including details of any damage and any other pertinent observations.

11.12 When the tests are made to check conformity of the specimen to a particular specification, an identification or description of that specification.

11.13 A statement that the tests were conducted in accordance with this test method.

11.14 A statement of whether or not, upon completion of all testing, the specimens meet the requirements of Section 1609 of the Florida Building Code, Building and this Appendix.

11.15 A statement as to whether or not tape or film or both were used to seal against air leakage, and whether in the judgment of the test engineer, the tape of film influenced the results of the test.

11.16 Signatures of persons responsible for supervision of the tests and a list of official observers.

11.17 All data not required herein, but useful to a better understanding of the test results, conclusions or recommendations, may be appended to the report.

12. Recording Deflections

Maximum Deflection

Permanent Deformation

13. Additional Testing

13.1 Prior to conducting the test described in this Appendix, all specimens shall have successfully completed the test specified in Appendix B.

13.2 If a product is subjected to weathering that can affect its integrity, the manufacturer shall contact the Authority Having Jurisdiction for additional testing requirements such as but not limited to moisture, U.V., accelerated aging, and other similar tests.

13.3 The Authority Having Jurisdiction shall reserve the right to require any additional testing necessary to assure full compliance with the intent of the Florida Building Code, Building.

13.4 Products tested in accordance with this Appendix shall be required to be successfully tested under Appendix A of ANSI/DASMA 108 prior to conducting tests under this Appendix.

14. Product Marking

14.1 Any and all approved products shall be permanently labeled with the manufacturer's name, city, and state, and the following statement: "Product Control Approved."

14.2 Permanent label shall be a metallic label fixed permanently to the frame of the specimen by rivets or permanent adhesive.

14.3 Any instructions for operations shall be permanently mounted on the specimen in an area not subject to be painted or concealed.

DASMA – the Door & Access Systems Manufacturers Association, International – is North America's leading trade association of manufacturers of garage doors, rolling doors, garage door operators, vehicular gate operators, and access control products. With Association headquarters based in Cleveland, Ohio, our 90 member companies manufacture products sold in virtually every county in America, in every U.S. state, every Canadian province, and in more than 50 countries worldwide. DASMA members' products represent more than 95% of the U.S. market for our industry.

For more information about the Door & Access Systems Manufacturers Association, International, contact:

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STANDARD METHOD FOR TESTING SECTIONAL DOORS, ROLLING DOORS, AND FLEXIBLE DOORS: DETERMINATION OF STRUCTURAL PERFORMANCE UNDER MISSILE IMPACT AND CYCLIC WIND PRESSURE

DASMA 115-2017

Door & Access Systems Manufacturers' Association, International

Sponsor:

DASMA
Door & Access Systems Manufacturers Association International

1300 Sumner Ave
Cleveland, Ohio 44115-2851

Standard Method for Testing Sectional Doors, Rolling Doors, and Flexible Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure

Sponsor

Door & Access Systems Manufacturers' Association, International

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Suggestions for improvement of this standard are welcome.
They should be sent to the Door & Access Systems Manufacturers' Association, International.

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Foreword (This foreword is included for information only and is not part of DASMA 115, *Standard Method for Testing Sectional Doors, Rolling Doors, and Flexible Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure.*)

This standard was developed by the DASMA Rolling Door Division, the DASMA High Performance Door Division, and the Technical Committee of the DASMA Commercial & Residential Garage Door Division. It incorporates years of experience in testing sectional doors commonly found in garages. The committee and division believe the existence of the standard will provide a uniform basis of testing and rating the structural performance of such doors under missile impact and cyclic wind pressure.

The DASMA Commercial & Residential Garage Door Division originally approved the standard as a DASMA standard on July 7, 1999. DASMA employed the canvass method to demonstrate consensus and to gain approval as an American National Standard. The ANSI Board of Standards Review granted approval as an American National Standard on March 21, 2005. The document was reviewed and revised to expand the scope to include rolling doors and flexible doors in 2010. The revised standard was finalized by the DASMA Commercial & Residential Garage Door, DASMA Rolling Door, and DASMA High Performance Door Divisions in 2012 and the ANSI Board of Standards Review granted recognition of the revised standard as an American National Standard on November 18, 2014. The Divisions approved revisions on October 30, 2015. The ANSI Board of Standards Review reaffirmed approval as an American National Standard on November 21, 2017.

DASMA recognizes the need to periodically review and update this standard. Suggestions for improvement should be forwarded to the Door & Access Systems Manufacturers' Association, International, 1300 Sumner Avenue, Cleveland, Ohio, 44115-2851.

DASMA 115-2017

Standard Method for Testing Sectional Doors, Rolling Doors, and Flexible Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure

1.0 SCOPE

1.1 This test method determines the structural performance of sectional doors, rolling doors, and flexible door assemblies impacted by missiles and subsequently subjected to cyclic static pressure differentials.

1.2 The performance determined by this test method relates to the ability of the sectional door or rolling door to remain unbreached during a windstorm due to windborne debris.

1.3 Water exposure conditions shall not be a part of this standard.

1.4 The proper use of this test method requires a knowledge of the principles of pressure and deflection measurement.

1.5 This test method describes the apparatus and the procedure to be used for applying missile impact and cyclic static pressure loads to a specimen.

1.6 This test method does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

1.7 This test method incorporates applicable provisions from TAS 201, TAS 203, TDS 1-95, SSTD 12-97, ASTM E 1886-02, ASTM E 1996-03 and fatigue load testing referenced in the Florida Building Code, Building.

1.8 For products intended for installation in the Florida High Velocity Hurricane Zone (Miami-Dade and Broward Counties), the testing procedure in Appendix B and Appendix C shall be used.

2.0 DEFINITIONS

2.1 Air Pressure Cycle - beginning at zero air pressure differential, the application of positive (negative) pressure to achieve a specified air pressure differential and returning to zero pressure differential.

2.2 Air Pressure Differential - the specified differential in static air pressure across the specimen, creating a positive (negative) load, expressed in pounds per square foot (or pascals).

2.3 Basic Wind Speed - also known as design wind speed, the wind speed as determined by the specifying authority.

2.4 Design Pressure - also known as design load or design wind load, the specified difference in static air pressure (positive or negative) for which the specimen is to be tested, expressed in pounds per square foot (or pascals).

2.5 Flexible Door: A door, excluding rolling sheet doors as defined in DASMA 207, in which a flexible fabric or other flexible sheet material forms the panel portion, even though it may have a rigid frame, rigid reinforcements, rigid support means for one or more edges thereof, or combinations of these features.

2.6 Full Operability – the ability for the door to be fully opened and closed.

2.7 Maximum Deflection – the maximum displacement of the specimen measured to the nearest 0.125 inch (3 mm) attained from the original position while the maximum test load is being applied.

2.8 Missile - the object that is propelled toward a test specimen.

2.9 Positive (Negative) Cyclic Test Load - the specified difference in static air pressure, creating an inward (outward) loading, for which the specimen is to be tested under repeated conditions, expressed in pounds per square foot (or pascals).

2.10 Recovery - The ratio of the differential measurement between the test specimen surface at rest (following cyclic test loading in one direction) and the maximum deflection measured (for such cyclic test loading), to the maximum deflection measured.

2.11 Rolling Door - A vertically operating, coiling door typically used in commercial or industrial applications.

2.12 Sectional Door - A door made of two or more horizontal sections hinged together so as to provide a door capable of closing the entire opening and which is by means of tracks and track rollers.

2.13 Section/Slat Joint - The section to section (slat to slat) interface defined by the longitudinal surfaces that move relative to each other as the door opens and closes.

2.14 Specifying Authority - the entity responsible for determining and furnishing information required to perform this test method.

2.15 Specimen Failure - deterioration under repeated load or incipient failure, as defined in the pass/fail criteria of this standard.

2.16 Test Chamber - an airtight enclosure of sufficient depth to allow unobstructed deflection of the specimen during pressure cycling, including ports for air supply and removal, and equipped with instruments to measure test pressure differentials.

2.17 Test Loading Program - the entire sequence of air pressure cycles to be applied to the test specimen.

2.18 Test Specimen - the complete installed door assembly and mounting hardware as specified on the submitted drawing.

2.19 Windborne Debris - objects carried by the wind in windstorms.

2.20 Windstorm - a weather event, such as a hurricane, with high sustained winds and turbulent gusts capable of generating windborne debris.

3.0 SUMMARY OF TEST METHODS

3.1 A test series shall consist of three identical test specimens.

3.2 Each test specimen shall be subjected to the large missile impact test and then to the cyclic pressure loading test.

3.3 A test specimen is considered to have passed the test if it satisfies the acceptance criteria of this standard.

4.0 TEST APPARATUS

4.1 Test Chamber - See Section 2.12 for definition.

4.2 Air System - shall consist of a controllable blower, a compressed-air supply, an exhaust system, a reversible controllable blower, or other air-moving system capable of providing a variable pressure from zero to the required pressures, both positive and negative.

4.3 Large Missile - shall be a nominal 2x4 Southern Pine lumber, minimum Stud grade, with no knots within 12 inches (305 mm) of the impact end. The missile shall have a length of not less than 7 feet (2.13 m) and not more than 9 feet (2.75 m). The end of the missile subjected to impact shall be permitted to be rounded to no less than a 48 inch (1219 mm) diameter sphere, with sharp edges permitted to be rounded to no more than a 1/16 inch (2 mm) radius. The missile may be marked/ticked in dark ink at one inch (25 mm) intervals on center, and congruently numbered every three inches (76 mm). A sabot shall be attached to the trailing edge of the missile to facilitate launching. The weight of the sabot shall not exceed 0.5 lbs. (227 g). The combined weight of the timber and sabot, which constitutes the missile, shall be between 9 lbs. (4.08 kg) and 9.5 lbs. (4.31 kg). The missile shall be propelled through a cannon as described in section 4.4.

4.4 Large Missile Cannon - shall be capable of producing impact at the speed specified in Section 8.2. The missile cannon may use compressed air to propel the large missile, and if using compressed air shall consist of the following major components: a compressed air supply, a pressure release valve, a pressure gauge, a barrel and support frame, and a timing system for determining the missile speed. The barrel of the missile cannon shall consist of either a 4 inch (102 mm) inside diameter pipe or a nominal 2 inch (51 mm) by 4 inch (102 mm) rectangular tube, and shall be at least as long as the missile. The barrel of the large missile cannon shall be mounted on a support frame in a manner to facilitate aiming the large missile so that it impacts the test specimen at the desired location.

4.5 Timing System - shall be capable to measure speeds accurate to +/- 2%. One method shall be comprised of two, through-beam photoelectric sensors spaced at a known distance apart and used to start and stop an electronic clock, and shall be capable to measure speeds accurate to +/- 2%. The speed of the missile shall be measured anywhere between the point where 100% of the missile is outside of the cannon, to the point where the missile is 1 ft. (300 mm) away from the test specimen. The missile speed shall not be measured while the missile is accelerating. The speed of the missile shall be determined by dividing the distance between the two through-beam photoelectric sensors by the total time interval counted by the electronic clock.

5.0 HAZARDS

5.1 If failure occurs during testing, hazardous conditions may result.

5.2 Take proper safety precautions to protect observers in the event that a failure occurs.

5.3 All observers shall be isolated from the path of the missile during the missile impact portion of the test.

5.4 Keep observers at a safe distance from the test specimen during the entire procedure.

6.0 TEST SPECIMENS

6.1 Three test specimens shall be supplied. Each test specimen shall be as per the manufacturer's detailed drawings and/or written instructions. Any horizontal track and hanging brackets may be shortened to fit the test chamber.

6.2 All parts of the test specimen, including glazing and structural framing, shall be full size.

6.3 The test specimen shall consist of the same materials, details, methods of construction and methods of attachment as proposed for actual use.

6.4 The specimen shall consist of the entire assembled unit attached to a given type of structural framing of the building, and shall contain all devices used to resist wind forces and windborne debris.

6.5 When testing doors which include glazed products, the material used to make such glazed products windborne debris resistant (i.e. fillers, film and similar) shall be an integral part, factory applied, of such glazed products.

6.6 Install the door system per the manufacturer's installation instructions.

6.7 For doors that contain vents with a gross opening area of 60 square inches or greater, vents shall be tested as a factory applied, integral part of doors.

6.7.1 For sectional doors and rolling doors, the door shall be counterbalanced where no more than the larger of 5% of door weight or ten pounds applied force is required to open the door manually from the fully closed position, or a simulated counterbalance condition (including locking mechanism) shall be achieved by shimming up the bottom corners of the door.

7.0 CALIBRATION OF TIMING EQUIPMENT

7.1 The timing system shall be calibrated and certified by an independent approved qualified agency, at twelve-month intervals. See Appendix A for recommended methods.

7.2 The calibration report shall include the following:

7.2.1 The date of the calibration.

7.2.2 The name of the agency conducting the calibration.

7.2.3 The distance between the through-beam photoelectric sensors (if used).

7.2.4 The speed of the missile as measured by the timing system.

7.2.5 The speed of the missile as determined from the calibration system.

7.2.6 The percentage difference in speeds.

7.3 The system shall be determined to be accurate if the speed of the missile measured by the timing system and the speed measured by the calibration system agree within +/- 2%.

8.0 LARGE MISSILE IMPACT TEST

8.1 The test shall be conducted using a large missile cannon.

8.2 The large missile shall be as described in Section 4.3. The speed of the large missile shall be at least 50 ft/s (15.2 m/s). The speed of the large missile shall be measured as described in Section 4.5.

8.3 The large missile shall impact the surface of the test specimen "end on".

8.4 Impacts

8.4.1 For sectional doors, impacts shall be defined as follows:

8.4.1.1 Within a 5 inch (127 mm) radius circle having its center on a section joint at a hinge location nearest the midpoint of the test specimen.
8.4.1.2 Within a 5 inch (127 mm) radius circle having its center located in the thinnest section of the test specimen, equidistant between the lower two section joints and centered between vertical stiles.
8.4.1.3 Within a 5 inch (127 mm) radius circle having its center at a point 6 inches (152 mm) horizontally and vertically away from a bottom corner.

8.4.2 For rolling doors impacts shall be defined as follows:
8.4.2.1 Within a 5 inch (127 mm) radius of the center of the door.
8.4.2.2 Within a 5 inch (127 mm) radius circle having its center at a point 6 inches (152 mm) horizontally and vertically away from a bottom corner.

8.4.3 For flexible doors, impacts shall be defined as follows:
8.4.3.1 Within a 5 inch (127 mm) radius of the center of the largest unsupported area of the door.
8.4.3.2 Within a 5 inch (127 mm) radius circle having its center at the location of the weakest panel reinforcing member.
8.4.3.3 Within a 5 inch (127 mm) radius circle having its center at a point either 6 inches (152 mm) horizontally and vertically away from a bottom corner or 6 inches (152 mm) above a bottom reinforcing member if present.

8.5 Each specimen shall receive at least two (2) impacts from the large missile.

8.5.1 For sectional doors, the first specimen shall receive one impact complying with Section 8.4.1.1 and one impact complying with Section 8.4.1.3.

8.5.2 For sectional doors, the second specimen shall receive one impact complying with Section 8.4.1.2 and one impact complying with Section 8.4.1.3.

8.5.3 For sectional doors, the third specimen shall receive one impact complying with Section 8.4.1.1 and one impact complying with Section 8.4.1.2.

8.5.4 For rolling doors, each specimen shall receive impacts complying with Section 8.4.2.

8.5.5 For flexible doors, the first specimen shall receive one impact complying with Section 8.4.3.1 and one impact complying with Section 8.4.3.3.

8.5.6 For flexible doors, the second specimen shall receive one impact complying with Section 8.4.3.2 and one impact complying with Section 8.4.3.3.

8.5.7 For flexible doors, the third specimen shall receive one impact complying with Section 8.4.3.1 and one impact complying with Section 8.4.3.2.

8.6 For doors that contain glazing, the glazing shall be impacted, in addition to the impact locations set forth in Section 8.5.

8.6.1 Glazing panels greater than or equal to 3 square feet (.28 sq m) in area shall receive two impacts. The first impact within a 5 inch (127 mm) radius circle having its center at a point 6 inches horizontally and vertically away from a corner of the glazing. The second impact within a 5 inch (127 mm) radius circle having its center at the midpoint of the glazing panel.

8.6.2 Glazing panels less than 3 square feet (.28 sq m) in area shall receive one impact located within a 5 inch (127 mm) radius circle having its center at the midpoint of the glazing panel.

8.6.3 For doors that contain multiple panels of glazing, the innermost panel shall be impacted.

8.6.4 For doors that contain different glazing thicknesses and/or glazing types, each different glazing thickness and glazing type shall be impacted.

8.7 For doors that contain vents with a gross opening area of 60 square inches or greater, vents shall be impacted in addition to the impact locations set forth in Section 8.5.

8.7.1 The vent impact shall be within a 5 inch (127 mm) radius of the center of the vent.

8.7.2 For doors that contain multiple vents, the innermost vent shall be impacted.

9.0 TEST PROCEDURES - LARGE MISSILE IMPACT

9.1 Preparation

9.1.1 Remove from the test specimen any sealing or construction material that is not intended to be used when the unit is installed in or on a building. Support and secure the test specimen into the mounting frame in a vertical position using the same number and type of anchors normally used for product installation as defined by the manufacturer or as required for a specific project. If this is impractical, install the test specimen with the same number of equivalent fasteners located in the same manner as the intended installation. The test specimen shall not be removed from the mounting frame at any time during the test sequence. The test shall be recorded using video equipment.

9.1.2 Secure the test specimen mounting frame such that the large missile will impact the exterior side of the test specimen as installed.

9.1.3 Locate the end of the propulsion device from which the large missile will exit at a minimum distance from the specimen equal to 9 feet (2.74 m) plus the length of the large missile.

9.1.4 Weigh each large missile within four hours prior to each impact.

9.1.5 Align the large missile propulsion device such that the large missile will impact the test specimen at the specified location.

9.2 Large Missile Impact.

9.2.1 Propel the large missile at the specified impact speed and location.

9.2.2 Examine damage in light of the pass/fail criteria found in Section 9.3.

9.2.3 Repeat steps 9.2.1 through 9.2.2 at all additional impact locations specified for the test specimen.

9.3 Pass/Fail Criteria.

9.3.1 The test specimen shall be subjected to evaluation for operability, and shall be acceptable by the following:

9.3.1.1 The door system shall remain in the opening throughout the duration of the test.

9.3.1.2 The door shall be evaluated for full operability at the conclusion of the test. The door shall pass only if the test engineer deems that the door system has full operability.

9.3.2 Latches, locks and fasteners and vents shall not become disengaged during the testing.

9.3.3 Excluding section/slat joints, vents or fabric jamb engagement, no crack or tear shall form longer than 5 inches (127 mm) and wider than 1/16 inch (1.6 mm) through which air can pass.

9.3.4 For sectional doors and rolling door elements excluding vents, no opening shall form through which a 3 inch (76 mm) diameter sphere can pass.

9.3.5 For flexible doors, no opening shall form creating a perimeter greater than 15 9/16 inches (395 mm).

9.3.6 All three test specimens shall be required to pass this testing.

9.4 Post Impact Test Procedure.

9.4.1 If the test specimen passes the acceptance criteria of the large missile impact test, it shall then be subjected to the cyclic pressure loading test specified in Section 10.

10.0 CYCLIC WIND PRESSURE LOADING TEST

10.1 General.

10.1.1 This test shall apply to doors that have passed the acceptance criteria of the large missile impact test.

10.1.2 The test specimens tested for impact shall be used for the cyclic pressure loading test.

10.1.3 If air leakage through the test specimen is excessive, tape may be used to cover any joints through which air leakage is occurring.

10.1.4 Cracks due to impact testing shall not be restrained with tape.

10.1.5 Tape shall not be used when there is a probability that it may significantly restrict differential movement between adjoining members.

10.1.6 Both sides of the entire test specimen and mounting panel shall be permitted to be covered with a single thickness of polyethylene film no thicker than 2 mils (.050 mm), in order that the full load is transferred to the test specimen and that the membrane does not prevent movement or failure of the specimen. The film shall be applied loosely with extra folds of material at each corner and at all offsets and recesses. When the load is applied, there shall be no fillet caused by tightness of the plastic film.

10.2 Loading Sequence Alternatives.

10.2.1 Loading Sequence 1 shall be as follows:

#1:	Range of Test: 0 to +0.5p	Cycles: 600
#2:	Range of Test: 0 to +0.6p	Cycles: 70
#3:	Range of Test: 0 to +1.3p	Cycles: 1
#4:	Range of Test: 0 to -0.5p	Cycles: 600
#5:	Range of Test: 0 to -0.6p	Cycles: 70
#6:	Range of Test: 0 to -1.3p	Cycles: 1

10.2.2 Loading Sequence 2 shall be as follows:

#1:	Range of Test: +0.2p to +0.5p	Cycles: 3500
#2:	Range of Test: 0 to +0.6p	Cycles: 300
#3:	Range of Test: +0.5p to +0.8p	Cycles: 600
#4:	Range of Test: +0.3p to +1.0p	Cycles: 100

#5: Range of Test: -0.3p to -1.0p Cycles: 50
#6: Range of Test: -0.5p to -0.8p Cycles: 1050
#7: Range of Test: 0 to -0.6p Cycles: 50
#8: Range of Test: -0.2p to -0.5p Cycles: 3350

10.2.3 The parameter "p" shall be defined as door design wind load pressure, based on where the assembly will be used.

10.3 Test Procedure.

10.3.1 For non-glazed doors, cyclic static pressure differential loading shall be applied in accordance with either Loading Sequence 1 or Loading Sequence 2 as described in Section 10.2.

10.3.2 For glazed doors, cyclic static pressure differential loading shall be applied in accordance with either Loading Sequence 1 or Loading Sequence 2 as described in Section 10.2.

10.3.3 Each cycle shall have duration not to exceed 20 seconds, where the cycles shall be applied as rapidly as possible and shall be performed in a continuous manner.

10.3.4 Interruptions for equipment maintenance and repair shall be permitted.

10.3.5 The test specimen shall not contact any portion of the test chamber at any time during the application of the cyclic static pressure differential loading.

10.3.6 Successful testing of a door assembly containing glazing shall qualify a door assembly of the same type that does not contain glazing.

10.4 Post-Test Pass/Fail Criteria.

10.4.1 The test specimen shall be subjected to evaluation for operability, and shall be acceptable by the following:

10.4.1.1 The door system shall remain in the opening throughout the duration of the test.

10.4.1.2 The door system shall be evaluated for full operability at the conclusion of the test. The door shall pass only if the test engineer deems that the door system has full operability.

10.4.2 Latches, locks and fasteners and vents shall not become disengaged during the testing.

10.4.3 Excluding section/slat joints, vents or fabric jamb engagement, no crack or tear shall form longer than 5 inches (127 mm) and wider than 1/16 inch (1.6 mm) through which air can pass.

10.4.4 For sectional doors and rolling door elements excluding vents, no opening shall form through which a 3 inch (76 mm) diameter sphere can pass.

10.4.5 For flexible doors, no opening shall form creating a perimeter greater than 15 9/16 inches (395 mm).

10.4.6 All three test specimens shall be required to pass this testing.

11.0 TEST REPORTS

11.1 Date of the test.

11.2 Date of the report.

11.3 A description of the test specimens, prior to impact and cyclic pressure loading, including all parts and components of a particular system of construction together with manufacturer's model number, if appropriate, or any other identification.

11.4 Detailed drawings of the test specimens, showing dimensioned section profiles, door dimensions and arrangement, framing location, weatherstripping, locking arrangements, hardware, sealants, glazing details, test specimen sealing methods, and any other pertinent construction details.

11.5 Proper identification of each test specimen, particularly with respect to distinguishing features or differing adjustments. A separate drawing for each test specimen shall not be required where all differences between them are noted on the drawings provided.

11.6 Design pressure used as the basis for testing.

11.7 Information on the large missile Appendix used:

11.7.1 Description of the missile, including dimensions and weight.

11.7.2 Missile speed measured.

11.7.3 Whether or not certification of the calibration equipment was required.

11.7.4 Missile orientation at impact.

11.7.5 Description of the location of each impact.

11.8 Information on the cyclic loading Appendix used:

11.8.1 The positive and negative cyclic test load sequence.

11.8.2 The number of cycles applied for each sequence.

11.8.3 The minimum and maximum duration for each cycle.

11.9 A description of the condition of the test specimens after testing, including details of any damage and any other pertinent observations.

11.10 When the tests are made to check conformity of the specimen to a particular specification, an identification or description of that specification.

11.11 A statement that the tests were conducted in accordance with the test method.

11.12 A statement of whether or not, upon completion of all testing, the test specimens meet the pass/fail criteria of this standard for both missile impact and cyclic loading.

11.13 A statement as to whether or not tape or film, or both, were used to seal against air leakage, and whether in the judgment of the test engineer, the tape or film influenced the results of the test. The name and author of the report.

11.14 The names and addresses of both the testing agency that conducted the tests and the requester of the tests.

11.15 Signatures of persons responsible for supervision of the tests and a list of official observers.

11.16 Any additional data or information considered to be useful to a better understanding of the test results, conclusions, or recommendations. This additional data/ information shall be appended to the report.

REFERENCED DOCUMENTS:

1. Protocol TAS 201-94, Impact Test Procedures, Miami-Dade County Building Code Compliance Office
2. Protocol TAS 203-94, Criteria For Testing Products Subject To Cyclic Wind Pressure Loading, Miami-Dade County Building Code Compliance Office
3. Standard TDI 1-95, Test For Impact and Cyclic Wind Pressure Resistance of Impact Protective Systems and Exterior Opening Systems, Texas Department of Insurance
4. Test Standard for Determining Impact Resistance From Windborne Debris, SSTD 12-97, Southern Building Code Congress International
5. ASTM E 1886-05, Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Storm Shutters Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
6. ASTM E 1996-05, Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Storm Shutters Impacted by Windborne Debris in Hurricanes
7. Fatigue Loading Testing, Section 1625.4, 2004 Florida Building Code, Building
8. ANSI/DASMA 207, Standard for Rolling Sheet Doors

DASMA 115 Test Report Form

Missile Impact and Cyclic Loading

Date of Test _____________ Date of Report _________________

Test Specimen Identification:
Manufacturer ____
Manufacturer Location ____
Model Type/Number _____________ Dimensions ___________________________________
Material Description ____
Test Specimen Selection Procedure ____
____
____
Applicable Drawing No.'s ____
____
____

Operating Hardware (Type, Quantity, Location(s)):
____
____
____

Glazing Description: ____

Ambient Temperature: _________

Design pressure used as the basis for testing: _________

Large Missile Information:

Missile Dimensions _____________ Missile Weight ________
Missile speed measured ____________
Certification of the calibration equipment required? Yes No
Missile orientation at impact ______________

Impact #1 Location ____
Maximum Crack Length _________ Maximum Crack Width _________
Maximum Diameter Sphere Penetrating the Impact Location _________
Impact #2 Location ____
Maximum Crack Length _________ Maximum Crack Width _________
Maximum Diameter Sphere Penetrating the Impact Location _________
Impact #3 Location ____
Maximum Crack Length _________ Maximum Crack Width _________
Maximum Diameter Sphere Penetrating the Impact Location _________
Glazing Impact Location (if applicable) _____________________________________
Maximum Diameter Sphere Penetrating the Impact Location _________
Test Result: Pass Fail

Notes:
____
____
____
____

DASMA 115 Test Report Form

Missile Impact and Cyclic Loading

Cyclic Loading Information:

Applied Pressure # Cycles Min. Duration (sec) Max. Duration (sec)

____
____
____
____
____
____
____
____

Maximum Diameter Sphere Penetrating the Test Specimen _____________
Maximum Length of Crack Formed in Test Specimen ______ Crack Width ______

Test Result: Pass Fail

Notes:

____
____
____
____

Door Operable, after Evaluation for Full Operability? (Yes/No) ______

Certification: The signature of the tester attests that the testing was conducted in accordance with the referenced standard.

Testing Conducted by _________________________________**of**_________________________

Signature of Tester ________________________________ **Date** _________________________

Test Facility and Location ____

Official Observers

____

The following appendices are informative only and are not a normative part of DASMA 115.

Appendix A

Recommended Methods of Calibrating Timing Equipment

A.1 Photographically, using a stroboscope.

A.2 Photographically, using a high speed camera with a frame rate exceeding 500 frames per second.

A.3 Photographically, using a high speed video camera with a frame rate exceeding 500 frames per second.

A.4 Any other certified timing system calibration device with an accuracy of +/- 1%.

Appendix B

Impact Testing Procedure for the Florida High Velocity Hurricane Zone

1. Scope

1.1 This Appendix covers procedures for conducting the impact test of doors as required by Section 1626 of the Florida Building Code, Building.

2. Referenced Documents

2.1 2014 Florida Building Code, Building

3. Terminology

3.1 *Definitions* – For definitions of terms used in this Appendix, refer to Sections 1625, 1626 and/or Chapter 2 of the Florida Building Code, Building.

3.2 *Description of Terms Specific to This Appendix*

3.2.1 *Specimen* – The entire assembled unit submitted for test, including but not limited to anchorage devices and structure to which product is to be mounted.

3.2.2 *Test Chamber* – An airtight enclosure of sufficient depth to allow unobstructed deflection of the specimen during pressure cycling, including ports for air supply and removal, and equipped with instruments to measure test pressure differentials.

3.2.3 *Maximum Deflection* – The maximum displacement of the specimen, measured to the nearest 1/8" (3 mm), attained from the original position while the maximum test load is being applied.

3.2.4 *Permanent Deformation* – The permanent displacement of the specimen, measured to the nearest 1/8 inch (3 mm), from the original position to final position that remains after maximum test load has been removed.

3.2.5 *Test Load* – As determined by Sections 1609, 1625 and 1626 of the Florida Building Code, Building.

3.2.6 *Specimen Failure* – A change in condition of the specimen indicative of deterioration under repeated load or incipient failure, such as cracking, fastener loosening, local yielding, or loss of adhesive bond.

4. Significance and Use

4.1 The test procedures outlined in this Appendix provide a means of determining whether a door provides sufficient resistance to windborne debris, as stated in Section 1626 of the Florida Building Code, Building.

5. Test Specimen

5.1 *Test specimen* – All parts of the test specimen shall be full size, using the same materials, details, methods of construction and methods of attachment as proposed for actual use. The specimen shall consist of the entire assembled unit attached to a given type of structural framing of the building, and shall contain all devices used to resist wind forces and windborne debris. When testing glazed products, the material used to make such glazed product windborne debris resistant (i.e. fillers, film and similar), shall be an integral part, factory applied, of such glazed product.

5.1.1 Locking mechanisms shall be permanently mounted on the specimen. Such locking mechanism shall require no tools to be latched in the locked position. Devices such as pins shall be permanently secured to the specimen through the use of chains or wires that shall be of corrosion resistant material. This section shall not apply to specimens referenced in Section 2413 of the Florida Building Code, Building.

5.1.2 Products that are not categorized as means of egress/escape, and are provided with more than one single action locking mechanism, shall be provided with permanently posted instructions on latching for high wind pressures.

5.1.3 Specimen and fasteners, when used, shall not become disengaged during test procedure.

5.1.4 Specimen with vent(s) with gross opening areas less than 60 square inches each in the bottom section only shall not be required to have the vent(s) missile impact tested.

6. Apparatus

6.1 The description of the apparatus is general in nature. Any equipment, properly certified, calibrated, and approved by the Authority Having Jurisdiction capable of performing this test within the allowable tolerance, shall be permitted.

6.2 *Major Components*

6.2.1 *Cyclic Wind Pressure Loading* – Number of cycles and amount of pressure shall be as indicated in Section 1625.4, Table 1625 and Table 1626 of the Florida Building Code, Building. Design wind pressure shall be determined by using Section 1609 of the Florida Building Code, Building.

6.2.1.1 *Test Chamber* – The test chamber, to which the specimen is mounted, shall be provided with pressure taps to measure the pressure difference across the test specimen and shall be so located that the reading is unaffected by the velocity of air supplied to or from the chamber. The specimen mounting frame shall not deflect under test load in such manner that the performance of the specimen will be affected.

6.2.1.2 *Air System* – A controllable blower, a compressed-air supply, an exhaust system, or reversible controllable blower designed to provide the required maximum air pressure difference across the specimen. The system shall provide an essentially constant air-pressure difference for the required test period.

6.2.1.3 Test Temperature – The test shall be conducted at a test temperature range of 59 to 95°F (15 to 35°C).

6.3 *Missile Impact*

6.3.1 *Timing System* – The timing system, which is comprised of two, through-beam photoelectric sensors spaced at a known distance apart and used to start and stop an electronic clock, shall be capable to measure speeds accurate to +/- 2%. The speed of the missile shall be measured anywhere between the point where 90% of the missile is outside of the cannon, to the point where the missile is 1 ft. (305 mm) away from the test specimen. The missile speed shall not be measured while the missile is accelerating. The through-beam photoelectric sensors shall be of the same model.

The electronic clock shall be activated when the reference point of the missile passes through the timing system. The electronic clock shall have an operating frequency of no less than 10 kHz with a response time not to exceed 0.15 milliseconds. The speed of the missile shall be determined by dividing the distance between the two through-beam photoelectric sensors by the total time interval counted by the electronic clock.

6.3.1.1 *Calibration of Timing Equipment* – The timing system shall be calibrated by an independently calibrated speed measuring system and certified by an independent qualified agency approved by the Authority Having Jurisdiction, at six-month intervals using one of the following methods:

1. Photographically, using a stroboscope,
2. Photographically, using a high speed camera with a frame rate exceeding 500 frames per second,
3. Photographically, using a high speed video camera with a frame rate exceeding 500 frames per second, or
4. Any other certified timing system calibration device used by an independent certified agency approved by this office.

The calibration report shall include the date of the calibration, the name of the agency conducting the calibration, the distance between the through-beam photoelectric sensors (if used), the speed of the missile as determined from the calibration system, and the percentage difference in speeds. The system shall be determined to be accurate if the speed of the missile measured by the timing system and the speed measured by the calibration system agree within 2%.

6.3.2.1 *Large Missile* – The large missile shall be a solid S4S nominal 2x4 #2 surface dry Southern Pine. The weight of the missile shall be as specified in Section 1626.2.3 of the Florida Building Code, Building and shall have a length of not less than 7 feet (2.14 m) and not more than 9 feet (2.75 m). The missile shall be marked/ticked in dark ink at one-inch intervals on center, and congruently numbered every three inches. A sabot shall be attached to the trailing edge of the missile to facilitate launching. The weight of the sabot shall not exceed 1/2 lb (.228 kg). The combined weight of the timber and sabot, which constitutes the missile, shall be between 9 lb. (4.1 kg) and 9.5 lb (4.23 kg). The missile shall be propelled through a cannon as described in section 6.3.3 of this Appendix.

6.3.2.2 When testing any specimen with more than one component, in addition to complying with the impacts required by Section 1626.2 of the Florida Building Code, Building, the framing member connecting these components shall be impacted at one-half the span of such member with the large missile at a speed indicated in Section 1626.2.4 of the Florida Building Code, Building.

6.3.2.3 Any specimen that passes the large missile impact test shall not be tested for the small missile impact test if the specimen has no opening through which a 3/16 inch (5 mm) sphere can pass.

6.3.3 *Large Missile Cannon* – The large missile cannon shall be compressed air to propel the large missile. The cannon shall be capable of producing impact at the speed specified in Section 1626.2.4 of the Florida Building Code, Building. The missile cannon shall consist of four major components: a compressed air supply, a pressure release valve, a pressure gauge, a barrel and support frame, and a timing system for determining the missile speed. The barrel of the missile cannon shall consist of a 4-inch (102 mm) inside diameter pipe and shall be at least as long as the missile. The barrel of the large missile cannon shall be mounted on a support frame in a manner to facilitate aiming the missile so that it impacts the specimen at the desired location. The distance from the end of the cannon to the specimen shall be 9 feet (2.75 m) plus the length of the missile.

6.3.4 *Small Missile* –The missiles shall be propelled by the cannon as described in Section 6.3.5 of this Appendix. The small missile shall be launched in such a manner that each specimen shall be impacted simultaneously over an area not to exceed two square feet per impact as described in Section 1626.3.5 of the Florida Building Code, Building.

6.3.5 *Small Missile Cannon* – A compressed air cannon shall be used that is capable of propelling missiles of the size and speed defined in Section 1626.3.3 and 1626.3.4 of the Florida Building Code, Building. The cannon assembly shall be comprised of a compressed air supply and gauge, a remote firing device and valve, a barrel, and a timing system. The small missile cannon shall be mounted to prevent movement of the cannon so that it can propel missiles to impact the test specimen at points defined in Section 1626.3.5 of the Florida Building Code, Building. The timing system shall be positioned to measure missile speed within 5 feet (1.53 m) of the impact point on the test specimen.

7. Hazards

7.1 Testing facilities shall take all necessary precautions to protect observers during the entire test procedure. All observers shall be at a safe distance away from specimen and apparatus. Safety regulations shall be followed in order to avoid any injuries to any and all observers.

8. Testing Facilities (For a more detailed description see TAS 301-94)

8.1 Any testing facility wishing to perform this test shall first obtain the approval of the Authority Having Jurisdiction. Such approval shall only be given to those facilities that show they are properly equipped to perform the complete test, including the cyclic loading and the small and large missile impact test. Testing facilities shall request, in writing, approval of their facilities. Such request shall contain the ability of the facility to perform all aspects of the test, all equipment used in the performance of the test, name of independent agency calibrating their equipment, location of facilities, personnel involved in the testing, a quality control program, a safety program and any other pertinent information which shall clearly indicate that such facility is in the business of performing independent testing. A representative of the Authority Having Jurisdiction shall visit the site, and shall reserve the right to order any changes necessary to accept the facility for testing.

8.2 Approval of facilities to perform the test described in this Appendix does not constitute an approval of such facilities to perform other tests not specifically mentioned in this Appendix.

9. Format of Test

The manufacturer shall notify the Authority Having Jurisdiction seven (7) working days prior to the performing of the test. The Authority Having Jurisdiction reserves the right to observe the test. The Authority Having Jurisdiction must be notified of the place and time the test will take place. The test must be recorded on video and retained by the laboratory per TAS301.

10. Test Reports

The following minimum information shall be included in the submitted report:

10.1 Date of the test and the report, and report number.

10.2 Name, location, and certification number of facilities performing the test.

10.3 Name and address of requester of the test.

10.4 Identification of the specimen (manufacturer, source of supply, dimension, model types, material, procedure of selection and any other pertinent information).

10.5 Detailed drawings of the specimen showing dimensioned section profiles, type of framing to which specimen was attached, panel arrangement, installation and spacing of anchorage, locking arrangement, sealants, hardware, product markings and their location, and any other pertinent construction details. Any deviation from the drawings or any modifications made to the specimen to obtain the reported values shall be noted on the drawings and in the report.

10.6 Maximum deflection recorded and mechanism used to make such determination.

10.7 Permanent deformation (a cross-sectional diagram shall be provided to show where it occurred).

10.8 Name, address, signature and seal of Florida professional engineer, witnessing the test and preparing the report. Engineer shall be part of the laboratory's permanent staff or under laboratory's contract. (See TAS 301-94)

10.9 The results for all three specimens shall be reported, each specimen being properly identified, particularly with respect to distinguishing features or differing adjustments. A separate drawing for each specimen shall not be required if all differences between them are noted on the drawings provided.

10.10 Location of impacts on each test specimen.

10.11 The large and small missile velocities.

10.12 The weight of the missiles.

10.13 Maximum positive and negative pressures used in the cyclic wind pressure loading.

10.14 A description of the condition of the test specimens after testing, including details of any damage and any other pertinent observations.

10.15 When the tests are made to check conformity of the specimen to a particular specification, an identification or description of that specification.

10.16 A statement that the tests were conducted in accordance with this test method.

10.17 A statement of whether or not, upon completion of all testing, the specimens meet the requirements of Section 1626 of the Florida Building Code, Building.

10.18 A statement as to whether or not tape or film, or both were used to seal against air leakage, and whether in the judgment of the test engineer, the tape or film influenced the results of the test.

10.19 Signatures of persons responsible for supervision of the tests, and a list of official observers.

10.20 All data not required herein, but useful to a better understanding of the test results, conclusions or recommendations, may be appended to the report.

11. Recording Deflections

Maximum Deflection

Permanent Deformation

12. Additional Testing

12.1 Following successful completion of this test, all specimens shall then be successfully tested as per Appendix C of this standard.

12.2 If a product is subjected to weathering that can affect its integrity, the manufacturer shall contact the Authority Having Jurisdiction for additional testing requirements such as but not limited to moisture, U.V., accelerated aging, and other similar tests.

12.3 The Authority Having Jurisdiction shall reserve the right to require any additional testing necessary to assure full compliance with the intent of the Florida Building Code, Building.

12.4 Products tested in accordance with this Appendix shall be required to be successfully tested under Appendix A of ANSI/DASMA 108 prior to conducting tests under this Appendix.

13. Product Marketing

13.1 Any and all approved products shall be permanently labeled with the manufacturer's name, city, and state, and the following statement: "Product Control Approved."

13.2 Permanently labeled shall be a metallic label fixed permanently to the frame of the specimen by rivets or permanent adhesive.

13.3 Any instructions for operations shall be permanently mounted on the specimen in an area not subject to be painted or concealed.

Appendix C
Cyclic Wind Pressure Testing Procedure for the Florida High Velocity Hurricane Zone

1. Scope

1.1 This Appendix covers procedures for conducting the cyclic wind pressure loading test required by the Florida Building Code, Building and Appendix B of this standard.

2. Referenced Documents

2.1 2014 Florida Building Code, Building.

3. Terminology

3.1 *Definitions* – For definitions of terms used in this Appendix, refer to the Florida Building Code, Building.

3.2 *Description of Terms Specific to This Appendix*

3.3 *Specimen* – The entire assembled unit submitted for test, including anchorage devices and structure to which product is to be mounted.

3.4 *Positive (negative) Cyclic Load* – The specified differential in static air pressure, creating an inward (outward) loading, for which the specimen is to be tested under repeated conditions, expressed in pounds per square foot.

3.5 *One cycle* – Beginning at the specified static air pressure, the application of positive cyclic test load, and returning to the specified static air pressure, followed by the application of negative cyclic test load.

3.6 *Design Pressure (Design Wind Load)* – The uniform static air pressure difference, inward or outward and expressed in pounds per square foot (Newtons per square meter), for which the specimen would be designed under service load conditions using Section 1609 of the Florida Building Code, Building.

3.7 *Test Chamber* – An airtight enclosure of sufficient depth to allow unobstructed deflection of the specimen during pressure cycling, including ports for air supply and removal, and equipped with a device to measure test pressure differentials.

3.8 *Maximum Deflection* – The maximum displacement, measured to the nearest 1/8 inch (3 mm), attained from an original position while the maximum load is being applied.

3.9 *Permanent Deformation* – The permanent displacement, measured to the nearest 1/8 inch (3 mm), from an original position that remains after the applied test load has been removed.

3.10 *Specimen Failure* – A change in condition of the specimen indicative of deterioration under repeated load or incipient failure, such as cracking, fastener loosening, local yielding, or loss of adhesive bond.

4. Significance and Use

4.1 This test method is a standard procedure for determining compliance with Section 1625, Table 1625.4 and Table 1626 of the Florida Building Code, Building. This test method shall be intended to be used for installations of sectional doors, rolling doors and flexible doors. This test method shall consist of supplying air to and exhausting air from the chamber in accordance with a specific test loading program at the rate required to maintain the test pressure differential across the specimen, and observing, measuring, and recording the deflection, deformations, and nature of any distress or failures of the specimen.

5. Test Specimen

5.1 *Test specimen* – All parts of the test specimen shall be full size, using the same materials, details, methods of construction and methods of attachment as proposed for actual use. The specimen shall consist of the entire assembled unit attached to a given type of structural framing of the building, and shall contain all devices used to resist wind forces and windborne debris. When testing glazed products, the material used to make such glazed product windborne debris resistant (i.e. fillers, film and similar) shall be an integral part, factory applied, of such glazed product.

5.1.1 Locking mechanisms shall be permanently mounted on the specimen. Such locking mechanism shall require no tools to be latched in the locked position. Devices such as pins shall be permanently secured to the specimen through the use of chains or wires which shall be of corrosion resistant material.

5.1.2 Products that are not categorized as means of egress/escape, and are provided with more than one single action locking mechanism, shall be provided with permanently posted instructions on latching for high wind pressures.

5.1.3 Specimen and fasteners, when used, shall not become disengaged during test procedure.

5.2 If the impact test is to be performed on the test specimen, such test shall be conducted prior to performing the test described in this Appendix.

5.3 All locking mechanisms shall be in place when performing this test.

5.4 Doors shall be evaluated for operability after this test.

6. Procedure

6.1 *Preparation* – Remove from the test specimen any sealing or construction material that is not normally used when installed in or on a building. Fit the specimen with its structural framing into or against the chamber opening. The outdoor side of the specimen shall face the higher pressure side for positive loads; the indoor side shall face the higher pressure side for negative loads. Support and secure the specimen by the same number and type of anchors to be approved for normal installation of the specimen in the building.

6.2 Support and secure the test specimen by the same number and type of anchors normally used in installing the unit in the building.

6.3 Load the specimen using the cycles specified in Table 1625.4 and/or Table 1626 of the Florida Building Code, Building, whichever of these apply.

6.4 In the case of Table 1625.4 of the Florida Building Code, Building, Section 6.3 of this Appendix shall be repeated for negative pressures.

6.5 Assemblies shall be tested with no resultant failure or distress, and shall have a recovery of at least 90% over maximum deflection.

6.6 Test Temperature. The test shall be conducted at a test temperature range of 59 to 95°F (15 to 35°C).

7. Apparatus

7.1 The description of the apparatus is general in nature. Any equipment, properly certified, calibrated, and approved by the Authority Having Jurisdiction capable of performing this test within the allowable tolerance shall be permitted.

7.2 *Major Components*

7.2.1 *Test Chamber* – The test chamber, to which the specimen is mounted, shall be provided with pressure tabs to measure the pressure difference across the test specimen and shall be so located that the reading is unaffected by the velocity of air supplied to or from the chamber. The specimen mounting frame shall not deflect under test load in such manner that the performance of the specimen will be affected.

7.2.2 *Pressure-Measuring Apparatus* – The pressure-measuring apparatus shall measure the test pressure difference within a tolerance of +/-2%

7.2.3 *Deflection-Measuring System* – The deflection-measuring system shall measure the deflection within a tolerance of 0.01 inch (0.25 mm).

7.2.4 *Air System* – A controllable blower, a compressed-air supply, an exhaust system, or reversible controllable blower designed to provide the required maximum air pressure difference across the specimen. The system shall provide an essentially cyclic static air-pressure difference for the required test period.

7.3 *Calibration of Equipment* – The pressure-measuring apparatus and the deflection-measuring system shall be calibrated by an independently calibrated speed measuring system and certified by an independent qualified agency approved by the Authority Having Jurisdiction, at two-year intervals.

7.3.1 The calibration report shall include the date of the calibration, the name of the agency conducting the calibration, methods and equipment used in the calibration process, the equipment being calibrated and any pertinent comments.

8. Hazards

8.1 Testing facilities shall take all necessary precautions to protect the observers during the entire test procedure. All observers shall always be at a safe distance away from specimen and apparatus. Safety regulations shall be followed in order to avoid any injuries to any and all observers.

9. Testing Facilities (For a more detailed description see TAS 301-94)

9.1 Any testing facility wishing to perform testing on such products shall first obtain the approval of the Authority Having Jurisdiction. Such approval shall only be given to those facilities that show they are properly equipped to perform the complete test. Testing facilities shall request, in writing, approval of their facilities. Such request shall contain the ability of the facility to perform all aspects of the test, all equipment used in the performance of the test, name of independent agency calibrating their equipment, location of facilities, personnel involved in the testing, a quality control program, a safety program and any other pertinent information which shall clearly indicated that such facility is in the business of performing independent testing. A representative of the Authority Having Jurisdiction shall visit the site, and shall reserve the right to order any changes necessary to accept the facility for testing.

9.2 Approval of facilities to perform the test described in this Appendix shall not constitute an approval of such facilities to perform other tests not specifically mentioned in this Appendix.

10. Format of Test

The manufacturer shall notify the Authority Having Jurisdiction seven (7) working days prior to the performing of the test. The Authority Having Jurisdiction reserves the right to observe the test. The Authority Having Jurisdiction must be notified of the place and time the test will take place. The test must be recorded on video and retained by the laboratory per TAS301.

11. Test Reports

The following minimum information shall be included in the submitted report:

11.1 Date of the test and the report, and report number.

11.2 Name and location of facilities performing the test.

11.3 Name and address of requester of the test.

11.4 Identification of the specimen (manufacturer, source of supply, dimension, model types, material, procedure of selection and any other pertinent information).

11.5 Detailed drawings of the specimen showing dimensioned section profiles, type of framing to which specimen was attached, panel arrangement, installation and spacing of anchorage, locking arrangement, sealant, hardware, product markings and their location, and any other pertinent construction details. Any deviation from the drawings or any modifications made to the specimen to obtain the reported values shall be noted on the drawings and in the report.

11.6 Maximum deflection recorded, and mechanism used to make such determination.

11.7 Permanent deformation (a cross-sectional diagram shall be provided to show where it occurred).

11.8 Name, address, signature and seal of Florida professional engineer, witnessing the test and preparing the report. Engineer shall be part of the laboratory's permanent staff or under laboratory's contract. (See TAS 301-94)

11.9 A tabulation of pressure differences exerted across the specimen during the test and their duration.

11.10 Maximum positive and negative pressures used in the test.

11.11 A description of the condition of the test specimens after testing, including details of any damage and any other pertinent observations.

11.12 When the tests are made to check conformity of the specimen to a particular specification, an identification or description of that specification.

11.13 A statement that the tests were conducted in accordance with this test method.

11.14 A statement of whether or not, upon completion of all testing, the specimens meet the requirements of Section 1609 of the Florida Building Code, Building and this Appendix.

11.15 A statement as to whether or not tape or film or both were used to seal against air leakage, and whether in the judgment of the test engineer, the tape of film influenced the results of the test.

11.16 Signatures of persons responsible for supervision of the tests and a list of official observers.

11.17 All data not required herein, but useful to a better understanding of the test results, conclusions or recommendations, may be appended to the report.

12. Recording Deflections

Maximum Deflection

Permanent Deformation

13. Additional Testing

13.1 Prior to conducting the test described in this Appendix, all specimens shall have successfully completed the test specified in Appendix B.

13.2 If a product is subjected to weathering that can affect its integrity, the manufacturer shall contact the Authority Having Jurisdiction for additional testing requirements such as but not limited to moisture, U.V., accelerated aging, and other similar tests.

13.3 The Authority Having Jurisdiction shall reserve the right to require any additional testing necessary to assure full compliance with the intent of the Florida Building Code, Building.

13.4 Products tested in accordance with this Appendix shall be required to be successfully tested under Appendix A of ANSI/DASMA 108 prior to conducting tests under this Appendix.

14. Product Marking

14.1 Any and all approved products shall be permanently labeled with the manufacturer's name, city, and state, and the following statement: "Product Control Approved."

14.2 Permanent label shall be a metallic label fixed permanently to the frame of the specimen by rivets or permanent adhesive.

14.3 Any instructions for operations shall be permanently mounted on the specimen in an area not subject to be painted or concealed.

Appendix D
Windborne Debris Protection for Doors Installed in Essential Facilities

1. Scope

D1.1 This Appendix covers procedures for conducting testing in accordance with this standard, for doors to be installed in essential facilities.

2. Referenced Documents

D2.1 ASTM E1886
D2.2 ASTM E1996
D2.3 ASCE 7
D2.4 International Building Code (IBC)
D2.5 International Residential Code (IRC)

3. Terminology

3.1 **Essential facility.** A building or structure including, but not limited to: hospitals; other health care facilities having emergency treatment facilities; jails and detention facilities; fire, rescue and police stations; emergency vehicle garages; designated emergency shelters; communications centers and other facilities required for emergency response; power generating stations; other public utility facilities required in an emergency; and buildings and other structures having critical national defense functions.

3.2 **Wind Zone.** An area defined by maximum and minimum wind speed boundaries, established by the local authority having jurisdiction, and may be based on a specific version of ASCE 7, the IBC, or the IRC.

4. Applicable Missile Type and Speed

4.1 The large missile shall be as described in Section 4.3 of this standard.

4.2 For Wind Zones 1 and 2, the speed of the large missile shall be at least 50 ft/sec (15.25 m/s). For Wind Zones 3 and 4, the speed of the large missile shall be at least 80 ft/sec (24.38 m/s).

4.3 The speed of the large missile shall be measured as described in Section 4.5 of this standard.

DASMA
Door & Access Systems
Manufacturers Association
International

DASMA – the Door & Access Systems Manufacturers Association, International – is North America's leading trade association of manufacturers of garage doors, rolling doors, garage door operators, vehicular gate operators, and access control products. With Association headquarters based in Cleveland, Ohio, our 90 member companies manufacture products sold in virtually every county in America, in every U.S. state, every Canadian province, and in more than 50 countries worldwide. DASMA members' products represent more than 95% of the U.S. market for our industry.

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S7947

Date Submitted	12/12/2018	**Section**	46	**Proponent**	Borjen Yeh
Chapter	46	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

Summary of Modification

Update referenced standards published by APA.

Rationale

The referenced standards have been updated by APA and available for free download at the APA web site (www.apawood.org).

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to cost of compliance with code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal updated the referenced standards published by APA.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

APA APA - The Engineered Wood Association 7011 South 19th Street, Tacoma, WA 98466

Standard reference number	Title	Referenced in code section number
ANSI/ A190.1—1712	Structural Glued-laminated Timber	R502.1.3, R602.1.3, R802.1.2
ANSI/APA PRP 210—201408	Standard for Performance-rated Engineered Wood Siding	R604.1, Table R703.3(1), R703.3.3
ANSI/APA PRG 320—20182012	Standard for Performance-rated Cross Laminated Timber	R502.1.6, R602.1.6, R802.1.6
ANSI/APA PRR 410—20162011	Standard for Performance-rated Engineered Wood Rim Boards	R502.1.7, R602.1.7, R802.1.7
APA E30—1611	Engineered Wood Construction Guide	Table R503.2.1.1(1), R503.2.2, R803.2.2, R803.2.3

S7991

Date Submitted	12/12/2018	**Section**	46	**Proponent**	Bonnie Manley
Chapter	46	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **Yes** **Alternate Language** **No**

Related Modifications

7856, 7857, 7858, 7989

Summary of Modification

This proposal is one in a series adopting the latest generation of AISI standards for cold-formed steel.

Rationale

This proposal is one in a series adopting the latest generation of AISI standards for cold-formed steel. This particular proposal focuses on Chapter 46 by updating references to the AISI suite of standards, including the addition of one new cold-formed steel standard -- AISI S240 – now referenced in Chapter 7. All AISI standards are published and available for a free download at: www.aisistandards.org.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

1st Comment Period History

S7991-G1

Proponent	Jaime Gascon	**Submitted**	1/22/2019	**Attachments**	No

Comment:

This standards update does impact the HVHZ. Needs correlation as to the sections in the code that reference the new standard added; ANSI S240-15.

AISI S100-16—12 *North American Specification for the Design of Cold-formed Steel Structural Members*, 20162012

AISI S200—12 North American Standard for Cold-formed Steel Framing—General Provisions 2012

AISI S220-15—11 *North American Standard for Cold-formed Steel Framing—Nonstructural Members*, 20152011

AISI S230-15—07/S3-12 (2012) *Standard for Cold-formed Steel Framing—Prescriptive Method for One- and Two-family Dwellings*, 20152007 with Supplement 3, dated 2012 (Reaffirmed 2012)

AISI S240—15, *North American Standard for Cold-Formed Steel Structural Framing*, 2015

S7996

Date Submitted	12/12/2018	**Section**	46	**Proponent**	Bonnie Manley
Chapter	46	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

Summary of Modification

This proposal updates the AISI S230 reference to the 2018 edition.

Rationale

The 2018 editions of the IBC and IRC reference the 2015 edition of AISI S230. The 2015 edition of AISI S230 is based upon ASCE 7-10. With the Florida code cycle happening in 2019, there is an opportunity to adopt the 2018 edition of AISI S230, which is based upon ASCE 7-16. If ASCE 7-16 is chosen as a basis for both the Florida Building Code and Florida Residential Code, it would be appropriate to adopt this latest edition of AISI S230 for coordination.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

AISI S230--18~~—07/S3-12 (2012)~~ *Standard for Cold-formed Steel Framing—Prescriptive Method for One- and Two-family Dwellings*, 2018~~2007 with Supplement 3, dated 2012 (Reaffirmed 2012)~~

Date Submitted	12/15/2018	**Section** 46		**Proponent**	Joseph Belcher for AAF
Chapter	46	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **Yes** **Alternate Language** **Yes**

Related Modifications

N/A

Summary of Modification

Updates the AAF Guide to Aluminum Construction in High Wind Areas.

Rationale

The AAF is working with Dr. Timothy Reinhold, P.E. to get the AAF Guide updated to comply with ASCE 7-16. The design pressure for screen enclosures of Table 2002.4 are not affected because they are based on wind tunnel testing and the analysis of the wind tunnel data. There will be increases on solid roofs and we are working on completing those updates. Unfortunately, Hurricane Michael took some time and delayed the work. I am going to forward a copy of the AAF to the Structural TAC members and the staff and will provide the updated information during the Public Comment period.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact on cost of enforcement of code as the AAF Guide has been adopted for a number of years.

Impact to building and property owners relative to cost of compliance with code

No impact on cost of code compliance for property owners as the AAF Guide has been adopted for a number of years.

Impact to industry relative to the cost of compliance with code

No impact on cost of code compliance to industry as the AAF Guide has been adopted for a number of years. There will be an increase in uplift loads in the 15% range on solid roofs but that is due to changes in ASCE 7-16; not the AAF Guide.

Impact to small business relative to the cost of compliance with code

No cost impact relative to compliance with the code. No impact on cost of code compliance to small business as the AAF Guide has been adopted for a number of years. There will be an increase in uplift loads in the 15% range on solid roofs but that is due to changes in ASCE 7-16; not the AAF Guide.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The proposal is connected with the welfare and safety of the public because it updates a construction document to meet the latest design pressures due to the effects of wind.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The proposal improves the code because it is updating a prescriptive document to meet the latest design pressures due to the effects of wind.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The change does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The proposed change does not degrade the effectiveness of the code.

Alternate Language

1st Comment Period History

8395-A2

Proponent Joseph Belcher for AAF **Submitted** 2/17/2019 **Attachments** Yes

Rationale

The updated version of the Guide to Aluminum Construction in High Wind Areas was provided to staff and the Structural TAC members. Approval of the updated standard will make the code compliant with ASCE 7-16 if adopted with no changes to the roofing provisions.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact.

Impact to building and property owners relative to cost of compliance with code

There will be an increase in projects with solid roof surfaces.

Impact to industry relative to the cost of compliance with code

There will be an increase in projects with solid roof surfaces.

Impact to Small Business relative to the cost of compliance with code

No cost impact relative to compliance with the code. No impact on cost of code compliance to small business as the AAF Guide has been adopted for a number of years. There will be an increase in uplift loads in the 15% range on solid roofs but that is due to changes in ASCE 7-16; not the AAF Guide.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Brings the referenced prescriptive document into compliance with ASCE 7-16.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Brings the referenced prescriptive document into compliance with ASCE 7-16.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the code.

Alternate Language

1st Comment Period History

8395-A1

Proponent Joseph Belcher for AAF **Submitted** 2/17/2019 **Attachments** Yes

Rationale

The modifications update the Guide to Aluminum Construction in High Wind Areas to bring it into compliance with ASCE 7-16.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact.

Impact to building and property owners relative to cost of compliance with code

There will be an increase to projects with solid roof surfaces but the changes are necessary to meet the updated national wind design standards.

Impact to industry relative to the cost of compliance with code

There will be an increase to projects with solid roof surfaces but the changes are necessary to meet the updated national wind design standards.

Impact to Small Business relative to the cost of compliance with code

No cost impact relative to compliance with the code. No impact on cost of code compliance to small business as the AAF Guide has been adopted for a number of years. There will be an increase in uplift loads in the 15% range on solid roofs but that is due to changes in ASCE 7-16; not the AAF Guide.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Brings the adopted prescriptive document into compliance with the adopted wind design standard.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Brings the adopted prescriptive document into compliance with the adopted wind design standard.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the code.

1st Comment Period History

S8395-G1

Proponent	Joseph Belcher for AA	**Submitted**	2/17/2019	**Attachments**	Yes

Comment:

During our initial assessment, we did not believe Tables 202.4 and 2002.4A would need to be modified because the values were based on testing. However, we have engaged Dr. Timothy Reinhold and now recognized the need to modify the portion of the tables related to solid surfaces to comply with ASCE 7-16. If ASCE 7-16 is modified with no changes to the roofing provisions, the unmodified Tables 202.4 and 2002.4A contained in the FBC would not be in compliance with ASCE 7-16. Adoption of the attached tables will be an enhancement of the code by bringing it into compliance with the updated wind design standard.

Chapter 46 AAF

AAF	Aluminum Association of Florida 3203 Lawton Road #110 Orlando, FL 32803	
Standard Reference Number	Title	Referenced in code section number
AAF- ~~14~~ 20	Guide to Aluminum Construction in High Wind Areas (~~2014~~) (2020).	R301.2.1.1.1

A modified version of the Guide to Aluminum Construction in High Wind Areas was submitted to the Structural TAC and to staff. The modified version updates the year of the Guide, updates the edition of ASCE 7, and updates tables related to solid roof surfaces.

S8395 -A2 Text Modification

A modified version of the Guide to Aluminum Construction in High Wind Areas was submitted to the Structural TAC and to staff. The modified version updates the year of the Guide, updates the edition of ASCE 7, and updates tables related to solid roof surfaces.

Table 2002.4

DESIGN WIND PRESSURES SCREENED ENCLOSURES [a, b, f, g, h]
(STRENGTH DESIGN OR LRFD ONLY)

	ULTIMATE DESIGN WIND SPEED V_{ult} (mph)																				
	110			120			130			140			150			160			170		
Surface	Design Pressures by Exposure Category (psf)																				
	B	C	D	B	C	D	B	C	D	B	C	D	B	C	D	B	C	D	B	C	D
Horizontal Pressures on Windward Surfaces [d]	17	24	28	20	28	33	23	32	38	27	38	44	31	43	51	36	49	58	40	56	66
Horizontal Pressures on Leeward Surfaces [d]	13	18	21	15	22	26	20	26	31	21	29	34	22	34	40	25	39	46	29	44	52
Vertical Pressures on Screen Surfaces [c]	4	7	8	6	8	9	6	9	11	8	11	12	9	12	14	10	14	16	11	15	18
Vertical Pressures on Solid Surfaces [e]	~~14~~ 17	~~19~~ 24	~~23~~ 29	~~17~~ 21	~~23~~ 29	~~27~~ 34	~~20~~ 24	~~27~~ 34	~~32~~ 40	~~23~~ 28	~~32~~ 39	~~37~~ 46	~~25~~ 32	~~36~~ 45	~~42~~ 53	~~29~~ 36	~~41~~ 51	~~48~~ 60	~~33~~ 41	~~46~~ 58	~~54~~ 68

For SI: 1 pound per square foot = 9.479 kN/m2.

NOTES:

a. Pressures apply to enclosures with a mean enclosure roof height of 30 feet (10 m). For other heights, multiply the pressures in this table by the factors in Table 2002.4A.

b. Apply horizontal pressures to the area of the enclosure projected on a vertical plane normal to the assumed wind direction, simultaneously inward on the windward side and outward on the leeward side.

c. Apply vertical pressures upward and downward to the area of the enclosure projected on a horizontal plane.

d. Apply horizontal pressures simultaneously with vertical pressures.

e. Table pressures are MWFRS Loads. The design of solid roof panels and their attachments shall be based on component and cladding loads for enclosed, ~~or~~ partially enclosed structures, or attached canopies as appropriate.

f. Table pressures apply to 20 × 20 × 0.013" mesh screen. For 18 ×14 × 0.013" mesh screen, pressures on screen surfaces may be multiplied by 0.88. For screen densities greater than 20 × 20 × 0.013", use pressures for enclosed buildings.

g. Table pressures may be interpolated using ASCE 7 methodology.

h. For allowable stress design (ASD) pressures shall be permitted to be multiplied by 0.6.

TABLE 2002.4A
HEIGHT ADJUSTMENT FACTORS

MEAN ROOF HEIGHT	EXPOSURE		
	B	C	D
0-15	~~1~~ <u>0.81</u>	0.86	0.89
20	~~1~~ <u>0.89</u>	0.92	0.93
25	~~1~~ <u>0.94</u>	0.96	0.97
30	1	1	1
35	1.05	1.03	1.03
40	1.09	1.06	1.05
45	1.12	1.09	1.07
50	1.16	1.11	1.09
55	1.19	1.14	1.11
60	1.22	1.16	1.13

S7167

308

Date Submitted	11/2/2018	**Section**	1	**Proponent**	Michael Goolsby
Chapter	RAS 117	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Establish consistency with ASCE 7-16.

Rationale

RAS 117 revisions are required to ensure guidance and examples for establishing enhanced fastener density in elevated roof pressure zones that are consistent with ASCE 7-16.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None. Continues to provide examples and guidance to perform calculations for enhanced fastening in elevated pressure zones for single ply roof systems; thereby, simplifying verification of code compliance.

Impact to building and property owners relative to cost of compliance with code

Reduces cost by providing examples and guidance in establishing enhanced fastening compliance for single ply roof systems, making unnecessary the additional expense of site specific engineering.

Impact to industry relative to the cost of compliance with code

Reduces cost by providing examples and guidance in establishing enhanced fastening compliance for single ply roof systems, making unnecessary the additional expense of site specific engineering.

Impact to small business relative to the cost of compliance with code

Reduces cost by providing examples and guidance in establishing enhanced fastening compliance for single ply roof systems, making unnecessary the additional expense of site specific engineering.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Continues to provide examples and guidance to perform calculations for enhanced fastening in elevated pressure zones for single ply roof systems; thereby, simplifying verification of code compliance and increasing life safety relating to wind load requirements.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This revision provides examples and guidance to perform calculations for enhanced fastening in elevated pressure zones for single ply roof systems, making unnecessary additional site specific engineering for low-rise buildings.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This revision only establishes examples and guidance for establishing enhanced fastening and in no way restricts roof systems, components or materials.

Does not degrade the effectiveness of the code

This revision enhances the code by providing an alternative to site specific engineering for low-rise and low-slope buildings.

Mod 7167

RAS-117

ROOFING APPLICATION STANDARD (RAS) No.117-20
STANDARD REQUIREMENTS FOR BONDING OR MECHANICAL ATTACHMENT OF INSULATION PANELS AND MECHANICAL ATTACHMENT OF ANCHOR AND/OR BASE SHEETS TO SUBSTRATES

1. Scope

1.1 The standards set forth herein provide a means of determining proper attachment of anchor and/or base sheets and insulation panels.

1.2 All testing shall be conducted by an approved testing agency. This roofing application standard has been developed to provide a responsive method of complying with the requirements of Chapters 15 & 16 (High-Velocity Hurricane Zones) of the *Florida Building Code, Building*. Compliance with the requirements, procedures and examplesspecified herein, when using the Tables contained in RAS 128, do not require additional signed and sealed engineering design calculations. All other calculations must be prepared, signed and sealed by a ~~A~~ Professional Engineer, or Registered Architect~~, shall sign and seal all calculations~~.

8. Perimeter, and Corner Roof Areas

8.1 The roofing assembly Product Approval shall list the maximum design pressure for the accepted assembly. Such pressure shall be applicable to Zone 1' or Zone 1, as applicable and ~~the field of the roof area (1)~~ as defined in ASCE 7. Should the roof assembly Product Approval allow extrapolation to Zone 1, Zone 2 or Zone 3 , as applicable and ~~perimeter and corners areas (2 and 3)~~ as defined in ASCE 7, the following shall apply.

- The maximum extrapolation shall not be greater than ~~280~~ 300 percent except as noted in Section 9.2.
- The minimum fastener separation shall not be less than 4 in. o.c.
- If Zone 1, Zone 2 or Zone 3, as applicable shall ~~the perimeter and/or corner areas of the roof~~ have calculated design pressures which are less than or equal to the maximum design pressures noted in the roof assembly Product Approval, then specified anchor/base sheet or insulation attachment shall also apply in these areas.
- If the minimum design pressure exceeds the roof assembly maximum design pressure such roofing system may be granted a one-time approval by the authority having jurisdiction, provided the applicant demonstrates, by testing and/or rational analysis that such roofing system complies with the provision of the Florida Building Code.

9. Insulation Attachment — New Construction/Reroof Application

9.1 Example of Data Extrapolation:
9.1.1 Given:
~~A building having a roof mean height less than 60 feet where the design pressures are as follows:~~

Zone 1': *-37.0 psf*
Zone 1 ***~~Field Area:~~*** *~~- 43.0~~ -64.0 psf*
Zone 2 ***~~Perimeter Area~~****: ~~- 56.0~~ -84.0 psf*
Zone 3 ***~~Corner Areas~~****: ~~- 90.0~~ -115.0 psf*

Consider a Roof Assembly Product Approval, which includes a system having an accepted maximum design pressure of -45 pound per square foot (2155 Pa). The Product Approval specifies 4-ft by 4-ft insulation panels attached with four fasteners per panel.

9.1.2 Determine the required number of fasteners per insulation panel to meet the design pressures in the elevated pressure zones.

General Equation:

$$\left(\frac{\text{known \# of fasteners}}{\text{max. design pressure}}\right) = \left(\frac{\text{unknown \# of fasteners}}{\text{elevated design pressure}}\right)$$

Zone 1:

$$\left(\frac{4\ \text{fasteners}}{45\ \text{psf}}\right) = \left(\frac{\text{X fasteners}}{64\ \text{psf}}\right) = 5.7\ \text{fasteners}$$

All fractions shall be rounded up to the next whole number. Therefore, the Zone 1 insulation panels shall be fastened with six fasteners per 4-ft by 4-ft panel. Fastener locations shall be in compliance with Figure 3, herein.

~~Perimeter Area~~ Zone 2:

$$\left(\frac{4\ \text{fasteners}}{45\ \text{psf}}\right) = \left(\frac{\text{X fasteners}}{\not{56}\ 84\ \text{psf}}\right) = 7.5\ \not{4.9}\ \text{fasteners}$$

All fractions shall be rounded up to the next whole number. Therefore, the Zone 2 ~~perimeter~~ insulation panels shall be fastened with eight ~~five~~ fasteners per 4-ft by 4-ft panel. Fastener locations shall be in compliance with Figure 3, herein.

~~Corner Areas~~ Zone 3:

$$\left(\frac{4\ \text{fasteners}}{45\ \text{psf}}\right) = \left(\frac{\text{X fasteners}}{115\ \not{90}\ \text{psf}}\right) = \not{8}\ 10.2\ \text{fasteners}$$

Therefore, Zone 3 ~~corner~~ panels shall be attached with ~~eight~~ eleven fasteners per 4-ft by 4-ft panel. Fastener locations shall be in compliance with Figure 3, herein.

9.2 If the data extrapolation results in a number of fasteners for an elevated pressure zone which exceeds ~~280~~ 300 percent of that for the field area, additional testing, as determined by the building official, may be required to confirm the performance of the Roof System Assembly.

9.3 If an insulation panel overlaps into an elevated pressure zone ~~(i.e. field area insulation panel overlapping into the perimeter or corner area of the roof, or a perimeter area insulation panel overlapping into the corner area of the roof)~~, the more stringent fastener density shall apply to the entire overlapping panel.

9.4 For multilayer insulation systems, the fastener density specified for the top panel shall be used. If the top layer is bonded in hot asphalt, the fastener density of the base insulation layer shall be used.

9.5 Alternatively, the base sheet of an approved roof assembly may be mechanically attached with insulation fasteners and plates through the insulation panels to the structural deck to increase the uplift performance of the roof assembly. Base sheet fastener spacing shall be as listed in roof assembly Product Approval, or may be determined in compliance with Section 10, herein.

~~9.6 For buildings of mean roof height greater than 60 feet the example above shall also apply.~~

10.4 **Example of Data Extrapolation:**

10.4.1 Given: A building having a concrete deck and a roof mean height less than 60 feet where the design pressures are as follows:

Zone 1':	*-37.0 psf*
~~Field Area~~ Zone 1:	*- 64.0 psf ~~-43.0 psf~~*
~~Perimeter Area~~ Zone2:	*- 84.0 psf ~~-56.0 psf~~*
~~Corner Area~~ Zone 3:	*- 115.0 psf ~~-90.0 psf~~*

Consider a roof assembly Product Approval, which includes a system having a maximum design pressure of -45 psf (2155 Pa). The Product Approval specifies an anchor/base sheet, having a width of 36 in. attached with approved fasteners and bearing plates at a spacing of 12 in. o.c. at a 4 in. side lap and two rows staggered in the center of the sheet, 24 in. o.c.

10.4.4 Determine anchor/base sheet fastener spacing (FS) to meet the design pressures in the elevated pressure zones of the roof.

10.4.5 **General Equation:**

$$FS = \frac{f_y \times 144}{P \times RS}$$

FS = fastener spacing (in.);
f_y = fastener value (lbf):
P = design pressure (psf): and
RS = row spacing (in.).

Note: As noted in the above equation, the row spacing is not needed to determine the fastener spacing. The row spacing is merely the net width of the sheet divided by the number of rows. For this case, the net width i 32 in. and there are three fastener rows (i.e. one side lap row and two center rows). This leads to a row spacing of 10.7 in. For Zone 3 a row spacing of 8 in. is necessary.

Zone 1:

$$FS = \frac{(60.0\ lbf) \times \left(\frac{144\ \text{in.}^2}{\text{Ft.}^2}\right)}{(64.0\ psf) \times (10.7\ inches)} = 12.6\ inches$$

All fractions shall be rounded down to the next whole number. Therefore, Zone 1 anchor/base sheet attachment could be with three rows spaced 10.7 in. apart, with fasteners spaced at 12 in. o.c. Generally, side lap fastener spacing should not exceed 12 in. o.c.

~~Perimeter Area~~ Zone 2:

$$FS = \frac{(60.0\ lbf) \times \left(\frac{144\ in.^2}{ft.^2}\right)}{(84.0\ \cancel{56.0}\ psf) \times (10.7\ inches)} = \cancel{14.4}\ 9.6\ inches$$

All fractions shall be rounded down to the next whole number. Therefore, a fastener spacing of 9 in. o.c. at a 4 in. side lap ~~perimeter area anchor/base sheet attachment could be with~~ and three rows spaced 10.7 in. apart, 9 ~~14~~ in. o.c. would be an acceptable Zone 2 anchor sheet fastener spacing. Generally, side lap fastener spacing should not exceed 12 in. o.c.

~~Corner Areas~~**Zone 3:**

$$FS = \frac{(60.0\ lbf) \times \left(\frac{144\ in.^2}{ft.^2}\right)}{(\cancel{90.0}\ 115.0\ psf) \times (\cancel{10.7}\ 8\ inches)} = 9.04\ inches$$

Therefore, a fastener spacing of 9 in. o.c. at a 4 in. side lap and two four rows ~~staggered in the center of the sheet~~ spaced~~,~~ 8 ~~9~~ in. apart, 9 in. o.c. would be an acceptable Zone 3 ~~corner area~~ anchor sheet fastener spacing.

11.2 Example of Data Extrapolation:

11.2.1 Given: ~~A building having a roof mean height less than 60 feet where the design pressures are as follows:~~

Zone 1’ ~~Field Area:~~	*~~- 43.0~~ -37.0 psf*
Zone 1:	-64.0 psf
Zone 2 ~~Perimeter Area:~~	*~~- 56.~~0 -84.0 psf*
Zone 3 ~~Corner Areas~~:	*~~90.0~~ -115.0 psf*

Consider an architectural appearance application in which an ASTM D226, Type II base sheet, having a width of 36 in., is to be mechanically attached with a 3-in. side lap, to nominal 1-in. wood plank (13/16-in. tongue and groove) using #8 wood screws and 15/8-inch diameter tin caps. One ply of approved mineral surfaced roll roofing is to be applied over the mechanically attached base sheet in a full mopping of hot asphalt.

11.2.3 Determine a base sheet fastener spacing (FS) to meet the design pressures in each pressure zone of the roof.

General Equation:

$$FS = \frac{(\text{design value}) \times 144}{P \times RS}$$

Note: The side lap, for this case is specified at 3 in. Therefore, the row spacing (RS) in the above noted equation shall be 11 inch for Zone 1’ and Zone 1 [i.e., sheet width (36 inch) minus side lap width (3 inch) divided by the number of fastener rows (3)]. The row spacing (RS) for Zone 2 and Zone 3 shall be 8.25 inches [i.e., sheet width (36 inch) minus side lap width (3 inch) divided by the number of fastener rows (4)].

Zone 1’ ~~Field Area~~:

$$FS = \frac{(38.2\ lbf) \times \left(\frac{144\ in.^2}{ft.^2}\right)}{(40.0\ 37.0\ psf) \times (11\ inches)} = 132.5\ inches$$

All fractions shall be rounded down to the next whole number. Therefore, a fastener spacing of ~~12~~ 13 in. o.c. at a 3-in. side lap and two rows staggered in the center of the sheet, ~~12~~ 13 in. o.c. would be an acceptable Zone 1’ ~~field area~~ base sheet fastener spacing.

Zone 1 ~~Perimeter Area~~:

$$FS = \frac{(38.2\ lbf) \times \left(\frac{144\ in.^2}{ft.^2}\right)}{(4764.0\ psf) \times (11\ inches)} = 10.7\ 7.8\ inches$$

All fractions shall be rounded down to the next whole number. Therefore, a fastener spacing of ~~10~~ 7 in. o.c. at a 3-in. side lap and two rows staggered in the center of the sheet, ~~10~~ 7 in. o.c. would be an acceptable Zone 1 ~~perimeter area~~ base sheet fastener spacing.

Zone 2 ~~***Corner Areas***~~***:***

$$FS = \frac{(38.2\ lbf) \times \left(\frac{144\ in.^2}{ft.^2}\right)}{(\cancel{55}84.0\ psf) \times (\cancel{11}8.25\ inches)} = \cancel{9.1}7.9\ inches$$

For Zone 2, an additional fourth row has been added. All fractions shall be rounded down to the next whole number. Therefore, a fastener spacing of ~~9~~ 7 in. o.c. at a 3-in. side lap and ~~two~~ three rows staggered in the center of the sheet, ~~9~~ 7 in. o.c. would be an acceptable Zone 2 ~~perimeter area~~ base sheet fastener spacing.

Zone 3:

$$FS = \frac{(38.2\ lbf) \times \left(\frac{144\ in.^2}{Ft.^2}\right)}{(115.0\ psf) \times (8.25\ inches)} = 5.8\ inches$$

For Zone 3, an additional fourth row has been added. All fractions shall be rounded down to the next whole number. Therefore, a fastener spacing of 5 in. o.c. at a 3-in. side lap and three rows staggered in the center of the sheet, 5 in. o.c. would be an acceptable Zone 3 base sheet fastener spacing.

S8298

Date Submitted	12/15/2018	**Section**	3	**Proponent**	Chadwick Collins
Chapter	RAS 117	**Affects HVHZ**	Yes	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No **Alternate Language** No

Related Modifications

Summary of Modification

Update to reflect the tested roof systems within the installed roof system.

Rationale

The Asphalt Roofing Manufacturers Association staff and volunteers and the Miami-Dade roofing product staff team worked together over the past year to perform a thorough review of the HVHZ requirements for asphalt roofing, and underlayment materials, as well as related RAS and TAS protocols. Many of these requirements have not been updated in decades; this review is an attempt to correlate the FBC with other changes that have occurred within the FBC, at ASCE, and with other standards developers including ASTM International. ARMA has submitted a series of code modifications that reflect that effort.

These proposed modifications include:

- Removal of references to withdrawn standards.
- Removal of references to legacy documents, including ICBO acceptance criteria.
- Updates to referenced standards, including name changes.
- Updates to performance criteria to reflect changes in referenced standards.
- Modifications to certain initial and aged performance values for test requirements to more accurately reflect the intent of the code.
- Removal of redundant or unnecessary requirements.
- Editorial changes and grammatical corrections.

ARMA would like to thank the staff at Miami-Dade for their efforts in working through this very tedious process.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Ensures that the roof systems being installed align more with the systems listed in approvals in regard to using tapered insulation.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code to align installed systems more with the listed systems in approvals in regard to tapered insulation

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

All insulation would have to meet the proposed language

Does not degrade the effectiveness of the code

The code is more effective in the alignment of the installed system with listed approved systems in regard to tapered insulation.

See attached file.

RAS 117 Section 3.10

Tapered insulation may be substituted for any flat stock type listed in the Roof System Assembly Product Approval. The fastening requirements shall remain the same and have a minimum thickness as specified in the Roof System Assembly Product Approval. ~~Polyisocyanurate tapered insulation systems shall have a minimum aver- age thickness per panel of 1 in.~~

S7156

Date Submitted	11/2/2018	**Section**	1	**Proponent**	Michael Goolsby
Chapter	RAS 117	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Establish consistency with ASCE 7-16.

Rationale

RAS 127 revisions necessary to reflect ASCE 7-16 wind load requirements for low-rise, steep-slope roof systems. Providing worse case design tables for exposure category “C” and “D” buildings.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None. Continues to provide prescriptive wind load tables.

Impact to building and property owners relative to cost of compliance with code

Reduces cost by providing a prescriptive means of wind load compliance, making unnecessary the additional expense of site specific engineering.

Impact to industry relative to the cost of compliance with code

Reduces cost by providing a prescriptive means of wind load compliance, making unnecessary the additional expense of site specific engineering.

Impact to small business relative to the cost of compliance with code

Reduces cost by providing a prescriptive means of wind load compliance, making unnecessary the additional expense of site specific engineering.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This revision provides prescriptive wind load tables making unnecessary additional site specific engineering for low-rise buildings; thereby, increasing life safety by ensuring wind load compliance. meet

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This revision provides prescriptive wind load tables making unnecessary additional site specific engineering for low-rise buildings; thereby, increasing life safety by ensuring wind load compliance. meet

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This revision only establishes wind load requirement and in no way restricts roof systems, components or materials.

Does not degrade the effectiveness of the code

This revision enhances the code by providing an alternative to site specific engineering for low-rise and low-slope buildings.

ROOFING APPLICATION STANDARD (RAS) No. 127
PROCEDURE FOR DETERMINING THE MOMENT OF RESISTANCE AND MINIMUM CHARACTERISTIC RESISTANCE LOAD TO INSTALL A TILE SYSTEM ON A BUILDING OF A SPECIFIED ROOF SLOPE AND HEIGHT USING ALLOWABLE STRESS DESIGN (ASD) IN ACCORDANCE WITH ASCE 7

1. Scope

This standard covers the procedure for determining the Moment of Resistance (Mr) and Minimum Characteristic Resistance Load (*F'*) to install a tile system on buildings of a specified roof slope and height. Compliance with the requirements and procedures herein specified, where the design wind uplift pressures (P_{asd}) have been determined based on Tables 1-3, ~~or~~ Tables ~~2~~ 4-6, Tables 7-9 or Tables10-12 of this standard, as applicable, do not require additional signed and sealed engineering design calculation. All other calculations must be prepared, signed and sealed by a professional engineer or registered architect. Tables 1-3 ~~is~~ are applicable to a wind speed of 175 mph, risk category II buildings with gable roofs with overhangs, and exposure category C. Tables ~~2~~ 4-6 ~~is~~ are applicable to a wind speed of 175 mph, risk category II buildings with gable roofs with overhangs, and exposure category D. Tables 7-9 are applicable to a wind speed of 175 mph, for risk category II buildings with hip roofs and overhangs, and exposure category C. Tables 10-12 are applicable to a wind speed of 175 mph, for risk category II buildings with hip roofs and overhangs, and exposure category D.

For steep slope roof systems other than tile, Tables 1-3, Tables 4-6, Tables 7-9 or Tables10-12 of this standard, as applicable, do not require additional signed and sealed engineering design calculation when determining the use of a specific product approval. All other calculations must be prepared, signed and sealed by a professional engineer or registered architect.

All calculations must be submitted to the building official at time of permitting.

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2. How to determine the Moment Resistance (Mr) (Moment Based Systems)

2.1 Determine the minimum design wind pressures for ~~the field, perimeter and corner areas (P_{asd} 1, P P_{asd} 2 and P_{asd} 3, respectively)~~ each roof pressure zone using the values given in Tables 1-3, or Tables ~~2~~ 4-6, Tables 7-9 or Tables10-12, as applicable, or those obtained by engineering analysis prepared, signed and sealed by a professional engineer or registered architect based on ASCE 7.

2.2 Locate the aerodynamic multiplier (?) in tile Product Approval.

2.3 Determine the restoring moment due to gravity (Mg) per Product Approval.

2.4 Determine the attachment resistance (Mf) per Product Approval.

2.5 Determine the Moment of Resistance (Mr) per following formula:
Mr = (P_{asd} ?) - Mg

2.6 Compare the values for Mr, with the values for Mf, noted in the Product Approval. If the Mf values are greater than or equal to the Mr values, for each area of the roof ~~[i.e., field Pasd(1), perimeter Pasd(2) and corner Pasd(3) areas]~~, then the tile attachment method is acceptable.

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3. How to determine the Minimum Characteristic Resistance Load (*F'*) (Uplift Based System)

3.1 Determine the minimum design pressures for ~~the field, perimeter and corner areas [Pasd(1), Pasd(2) and Pasd(3), respectively]~~ each roof pressure zone using the values given in Table 1 or Table 2, as applicable, or those obtained by engineering analysis prepared, signed and sealed by a professional engineer or registered architect based on the criteria set forth in ASCE 7.

3.2 Determine the angle (?) of roof slope, from Tables 1-3, ~~or~~ Tables ~~2~~ 4-6, Tables 7-9 or Tables10-12, as applicable.

3.3 Determine the length (l), width (w) and average tile weight (W) of tile, per Product Approval.

3.4 Determine the required uplift resistance (Fr) per following formula:
Fr = [(P_{asd} x l x w) - W] x cos ?

3.5 Compare the values for Fr with the values for *F'* noted in the Product Approval. If the *F'* values are greater than or equal to the Fr values, for each area of ~~roof [i.e., field Pasd(1) perimeter (Pasd(2) and corner Pasd(3) areas]~~, then the tile attachment method is acceptable.

~~TABLE 1 — RISK CATEGORY II EXPOSURE CATEGORY "C"1~~
~~MINIMUM DESIGN WIND UPLIFT PRESSURES IN PSF FOR FIELD [Pasd(1)], PERIMETER [Pasd(2)] AND CORNER [Pasd(3)] AREAS OF ROOFS FOR EXPOSURE C BUILDINGS WITH A ROOF MEAN HEIGHT AS SPECIFIED3~~

ROOF SLOPE	> 2:12 to £ 6:12			> 6:12 to £12:12	
Roof mean height	Pasd(1)	Pasd(2)	Pasd(3)2	Pasd(1)	Pasd(1) Pasd(2) & Pasd(3)
£ 20'	-39.1	-68.1	-100.7	-42.8	-50.0
> 20' to = 25'	-40.9	-71.3	-105.4	-44.8	-52.3
> 25' to = 30'	-42.4	-73.9	-109.3	-46.4	-54.3
> 30' to = 35'	-43.9	-76.6	-113.2	-48.1	-56.2
> 35' to = 40'	-45.1	-78.7	-116.3	-49.4	-57.8

~~1 Calculated in accordance with ASCE.~~
~~2 For Hip Roofs with slope ??5.5:12, Pasd(3) shall be treated as Pasd(2).~~
~~3 Pasd = 0.6Pult~~
-
-
-

~~TABLE 2 — RISK CATEGORY II EXPOSURE CATEGORY "D"1~~
~~MINIMUM DESIGN WIND UPLIFT PRESSURES IN PSF FOR FIELD [Pasd(1)], PERIMETER [Pasd(2)] AND CORNER [Pasd(3)] AREAS OF ROOFS FOR EXPOSURE D BUILDINGS WITH A ROOF MEAN HEIGHT AS SPECIFIED3~~

ROOF SLOPE	> 2:12 to £ 6:12			> 6:12 to £12:12	
Roof mean height	Pasd(1)	Pasd(2)	Pasd(3)2	Pasd(1)	Pasd(1) Pasd(2) & Pasd(3)
£ 20'	-47.0	-81.9	-121.0	-51.4	-60.1
> 20' to = 25'	-48.8	-85.0	-125.7	-53.4	-62.4
> 25' to = 30'	-50.3	-87.7	-129.6	-55.0	-64.4
> 30' to = 35'	-51.5	-89.9	-132.7	-56.4	-65.9
> 35' to = 40'	-52.7	-91.9	-135.8	--57.7	-67.9

~~1 Calculated in accordance with ASCE 7.~~
~~2 For Hip Roofs with slope ≤ 5.5:12, P_{asd}(3) shall be treated as P_{asd}(2).~~
~~3 P_{asd} = 0.6P_{ult}~~
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TABLE 1 — Gable Roofs MINIMUM ASD DESIGN WIND UPLIFT PRESSURES IN PSF FOR ROOF SLOPE - =2:12 to =4:12 RISK CATEGORY II EXPOSURE CATEGORY "C" (Overhang)				
Roof Mean Height	Roof Pressure Zones			
	1 and 2e	2n and 2r	3e	3r
=15'	-91	-125	-145	-166
>15 to =20'	-97	-133	-154	-176
>20' to =25'	-101	-139	-162	-184
>25' to =30'	-105	-145	-168	-192
>30 to =35'	-109	-149	-174	-198
>35 to =40'	-112	-154	-179	-204
>40' to =45'	-115	-157	-183	-209
>45' to =50'	-117	-161	-187	-213
>50' to =55'	-120	-164	-191	-218
>55' to =60'	-122	-167	-194	-222

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TABLE 2 — Gable Roofs

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MINIMUM ASD DESIGN WIND UPLIFT PRESSURES IN PSF
FOR ROOF SLOPE - >4:12 to =6:12
RISK CATEGORY II EXPOSURE CATEGORY "C"

(Overhang)

Roof Mean Height	Roof Pressure Zones			
	1 and 2e	2n and 2r	3e	3r
=15'	-74	-108	-128	-166
>15 to =20'	-79	-115	-136	-176
>20' to =25'	-82	-120	-143	-184
>25' to =30'	-86	-125	-148	-192
>30 to =35'	-88	-129	-153	-198
>35 to =40'	-91	-133	-158	-204
>40' to =45'	-93	-136	-161	-209
>45' to =50'	-95	-139	-165	-213
>50' to =55'	-97	-142	-169	-218
>55' to =60'	-99	-145	-172	-222

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-
-

TABLE 3 — Gable Roofs

MINIMUM ASD DESIGN WIND UPLIFT PRESSURES IN PSF
FOR ROOF SLOPE - >6:12 to =12:12

RISK CATEGORY II EXPOSURE CATEGORY "C" (Overhang)			
Roof Mean Height	Roof Pressure Zones		
	1, 2e and 2r	2n and 3r	3e
=15'	-94	-101	-142
>15 to =20'	-100	-107	-151
>20' to =25'	-105	-113	-158
>25' to =30'	-109	-117	-164
>30 to =35'	-113	-121	-170
>35 to =40'	-116	-124	-174
>40' to =45'	-119	-127	-179
>45' to =50'	-122	-130	-183
>50' to =55'	-124	-133	-186
>55' to =60'	-126	-135	-190

TABLE 4 — Gable Roofs

MINIMUM ASD DESIGN WIND UPLIFT PRESSURES IN PSF
FOR ROOF SLOPE - =2:12 to =4:12
RISK CATEGORY II EXPOSURE CATEGORY"D"

(Overhang)

Roof Mean Height	Roof Pressure Zones			
	1 and 2e	2n and 2r	3e	3r
=15’	-110	-152	-176	-201
>15 to =20’	-116	-159	-185	-211
>20’ to =25’	-121	-166	-193	-220
>25’ to =30’	-125	-171	-199	-227
>30 to =35’	-128	-176	-204	-233
>35 to =40’	-131	-180	-209	-238
>40’ to =45’	-134	-183	-213	-243
>45’ to =50’	-136	-187	-217	-248
>50’ to =55’	-138	-190	-221	-252
>55’ to =60’	-140	-193	-224	-256

TABLE 5 — Gable Roofs

MINIMUM ASD DESIGN WIND UPLIFT PRESSURES IN PSF
FOR ROOF SLOPE - >4:122 to =6:12
RISK CATEGORY II EXPOSURE CATEGORY“D”

(Overhang)

	Roof Pressure Zones

Roof Mean Height	1 and 2e	2n and 2r	3e	3r
=15’	-90	-131	-156	-201
>15 to <20’	-94	-138	-164	-211
>20’ to =25’	-98	-143	-170	-220
>25’ to =30’	-101	-148	-176	-227
>30 to =35’	-104	-151	-180	-233
>35 to =40’	-107	-155	-185	-238
>40’ to =45’	-109	-159	-188	-243
>45’ to =50’	-111	-161	-192	-248
>50’ to =55’	-113	-164	-195	-252
>55’ to =60’	-114	-167	-198	-256

TABLE 6 — Gable Roofs

MINIMUM ASD DESIGN WIND UPLIFT PRESSURES IN PSF
FOR ROOF SLOPE - >6:122 to =12:12
RISK CATEGORY II EXPOSURE CATEGORY“D”

(Overhang)

	Roof Pressure Zones

Roof Mean Height	1, 2e and 2r	2n and 3r	3e
=15’	-115	-123	-172
>15 to =20’	-120	-129	-181
>20’ to =25’	-125	-134	-188
>25’ to =30’	-129	-138	-194
>30 to =35’	-133	-142	-200
>35 to =40’	-136	-146	-204
>40’ to =45’	-139	-149	-208
>45’ to =50’	-141	-151	-212
>50’ to =55’	-143	-154	-216
>55’ to =60’	-146	-156	-219

TABLE 7 — Hip Roofs MINIMUM ASD DESIGN WIND UPLIFT PRESSURES IN PSF FOR ROOF SLOPE - =2:12 to =4:12 RISK CATEGORY II EXPOSURE CATEGORY “C” (Overhang)	
	Roof Pressure Zones

Roof Mean Height	1	2r	2e	3
=15’	-84	-105	-111	-132
>15 to =20’	-89	-111	-118	-140
>20’ to =25’	-94	-116	-124	-147
>25’ to =30’	-97	-121	-129	-152
>30 to =35’	-101	-125	-133	-157
>35 to =40’	-103	-129	-137	-162
>40’ to =45’	-106	-132	-140	-166
>45’ to =50’	-108	-135	-143	-170
>50’ to =55’	-111	-137	-146	-173
>55’ to =60’	-113	-140	-149	-176

TABLE 8 — Hip Roofs

MINIMUM ASD DESIGN WIND UPLIFT PRESSURES IN PSF
FOR ROOF SLOPE - >4:12 to =6:12
RISK CATEGORY II EXPOSURE CATEGORY “C”

(Overhang)

	Roof Pressure Zones

Roof Mean Height	1	2r and 2e	3
=15'	-71	-91	-111
>15 to =20'	-75	-97	-118
>20' to =25'	-79	-101	-124
>25' to =30'	-82	-105	-129
>30 to =35'	-84	-109	-133
>35 to =40'	-87	-112	-137
>40' to =45'	-89	-114	-140
>45' to =50'	-91	-117	-143
>50' to =55'	-93	-120	-146
>55' to =60'	-94	-122	-149

TABLE 9 — Hip Roofs

MINIMUM ASD DESIGN WIND UPLIFT PRESSURES IN PSF
FOR ROOF SLOPE - >6:12 to =12:12
RISK CATEGORY II EXPOSURE CATEGORY "C"

(Overhang)

	Roof Pressure Zones

Roof Mean Height	1	2r	2e	3
=15’	-84	-125	-128	-155
>15 to =20’	-89	-133	-136	-165
>20’ to =25’	-94	-139	-143	-173
>25’ to =30’	-97	-145	-148	-180
>30 to =35’	-101	-149	-153	-186
>35 to =40’	-103	-154	-158	-191
>40’ to =45’	-106	-157	-162	-196
>45’ to =50’	-108	-161	-165	-200
>50’ to =55’	-111	-164	-169	-204
>55’ to =60’	-113	-167	-172	-208

TABLE 10 — Hip Roofs

MINIMUM ASD DESIGN WIND UPLIFT PRESSURES IN PSF
FOR ROOF SLOPE - =2:12 to =4:12
RISK CATEGORY II EXPOSURE CATEGORY“D”[1, 2]

(Overhang)

	Roof Pressure Zones

Roof Mean Height	1	2r	2e	3
=15'	-102	-127	-135	-160
>15 to =20'	-107	-133	-142	-168
>20' to =25'	-112	-139	-148	-175
>25' to =30'	-115	-143	-152	-180
>30 to =35'	-118	-147	-157	-185
>35 to =40'	-121	-151	-160	-190
>40' to =45'	-124	-154	-164	-193
>45' to =50'	-126	-156	-167	-197
>50' to =55'	-128	-159	-169	-200
>55' to =60'	-130	-161	-172	-203

TABLE 11 — Hip Roofs

MINIMUM ASD DESIGN WIND UPLIFT PRESSURES IN PSF
FOR ROOF SLOPE - >4:122 to =6:12
RISK CATEGORY II EXPOSURE CATEGORY"D"[1, 2]

(Overhang)

	Roof Pressure Zones

Roof Mean Height	1	2e and 2r	3
=15’	-85.2	-110	-135
>15 to =20’	-90	-116	-142
>20’ to =25’	-94	-121	-148
>25’ to =30’	-97	-125	-152
>30 to =35’	-99	-128	-157
>35 to =40’	-102	-131	-160
>40’ to =45’	-104	-134	-164
>45’ to =50’	-106	-136	-167
>50’ to =55’	-107	-138	-169
>55’ to =60’	-109	-140	-172

TABLE 12 — Hip Roofs

MINIMUM ASD DESIGN WIND UPLIFT PRESSURES IN PSF
FOR ROOF SLOPE - >6:122 to =12:12
RISK CATEGORY II EXPOSURE CATEGORY“D”’[1, 2]

(Overhang)

	Roof Pressure Zones

Roof Mean Height	1	2e	2r	3
=15’	-102	-156	-152	-189
>15 to =20’	-107	-164	-159	-198
>20’ to =25’	-112	-170	-166	-206
>25’ to =30’	-115	-176	-171	-213
>30 to =35’	-118	-180	-176	-219
>35 to =40’	-121	-185	-180	-224
>40’ to =45’	-124	-188	-183	-228
>45’ to =50’	-126	-192	-187	-233
>50’ to =55’	-128	-195	-190	-236
>55’ to =60’	-130	-198	-193	-240

TABLE 13
WHERE TO OBTAIN INFORMATION

Description	Symbol	Where to find
Roof Zone Design Pressure	Pasd~~(1) or Pasd(2) or Pasd(3)~~	Tables 1-3, ~~or~~ Tables ~~2~~ 4-6, Tables 7-9 or Tables10-12, as applicable, or by an engineer analysis prepared, signed and sealed by a professional engineer based on ASCE 7
Mean Roof Height	H	Job Site
Roof Slope	?	Job Site

Aerodynamic Multiplier	?	Product Approval
Restoring Moment due to Gravity	Mg	Product Approval
Attachment Resistance	Mf	Product Approval
Required Moment Resistance	Mr	Calculated
Minimum Characteristic Resistance Load	F'	Product Approval
Required Uplift Resistance	Fr	Calculated
Average Tile Weight	W	Product Approval
Tile Dimensions	l = length w = width	Product Approval

~~All calculations must be submitted to the building official at the time of permitting.~~

S7157

Date Submitted	11/2/2018	**Section**	1	**Proponent**	Michael Goolsby
Chapter	RAS 117	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

Summary of Modification

Establish consistency with ASCE 7-16.

Rationale

RAS 128 revisions necessary to reflect ASCE 7-16 wind load requirements for low-rise low-slope roof systems. Providing worse case design tables for exposure category “C” and “D” buildings.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None. Continues to provide prescriptive wind load tables.

Impact to building and property owners relative to cost of compliance with code

Reduces cost by providing a prescriptive means of wind load compliance, making unnecessary the additional expense of site specific engineering.

Impact to industry relative to the cost of compliance with code

Reduces cost by providing a prescriptive means of wind load compliance, making unnecessary the additional expense of site specific engineering.

Impact to small business relative to the cost of compliance with code

Reduces cost by providing a prescriptive means of wind load compliance, making unnecessary the additional expense of site specific engineering

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This revision provides prescriptive wind load tables making unnecessary additional site specific engineering for low-rise buildings; thereby, increasing life safety by ensuring wind load compliance.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This revision provides prescriptive wind load tables making unnecessary additional site specific engineering for low-rise buildings.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This revision only establishes wind load requirement and in no way restricts roof systems, components or materials.

Does not degrade the effectiveness of the code

This revision enhances the code by providing an alternative to site specific engineering for low-rise and low-slope buildings.

ROOFING APPLICATION STANDARD (RAS) No. 128 STANDARD PROCEDURE FOR DETERMINING APPLICABLE WIND ALLOWABLE STRESS DESIGN PRESSURES FOR LOW SLOPE ROOF IN ACCORDANCE WITH ASCE 7

1. Scope

1.1 This roofing application standard has been developed to provide a responsive method of complying with the requirements of Chapters 15 & 16 (High-Velocity Hurricane Zones) of the *Florida Building Code, Building*. Compliancewith the requirements and proceduresherein specified, where the pressures (P_{asd}) have been determined based on Table 1, ~~or Table~~ 2, 3 or 4, of this standard, as applicable, do not require additional signed and sealed engineering design calculations. All other calculations must be prepared, signed and sealed by a professional engineer or registered architect.

2. Definitions

2.1 For definitions of terms used in this application standard, refer to ASTM D1079 and the *Florida Building Code, Building.*

3. Applicability

3.1 This application standard applies to buildings meeting all of the following:

a. located in ~~e~~Exposure Category C ~~and~~ or D ~~category buildings~~, with and without overhangs; and

b. ~~building~~ eave heights of less than or equal to ~~40~~ 60 feet; and

c. roof incline (~~pitch~~ slope) ~~is not greater than~~ =1.5~~1/2~~ in.:12 in., and

d. risk category II ~~buildings~~ only.

3.2 Using Table 1, ~~or~~ 2, 3 or 4 below, as applicable, determine the minimum design pressure for each respective roof area, which corresponds to the applicable roof height range.

3.3 Referencing the selected Roof Assembly Product Approval, check that the listed maximum allowable components and cladding design pressure for the ~~particular~~ approved system meets or exceeds those listed in Table 1, ~~or Table~~ 2, 3 or 4 ~~above~~ below, as applicable.

~~TABLE 1 — RISK CATEGORY II EXPOSURE CATEGORY "C"[1, 2] MINIMUM DESIGN WIND UPLIFT PRESSURES, IN PSF FOR FIELD [Pasd(1)], PERIMETER [Pasd(2)]AND CORNER [Pasd(3)] AREAS OF ROOFS FOR EXPOSURE "C" BUILDINGS~~ -			
~~Roof mean height (below)~~ -	~~Pasd(1) (Field)~~	~~Pasd(2) (Perimeter)~~	~~Pasd(3) (Corners)~~ -
~~20~~	~~-42.8~~	~~-71.7~~	~~-108.0~~
~~25~~	~~-44.8~~	~~-75.1~~	~~-113.0~~
~~30~~	~~-46.4~~	~~-77.8~~	~~-117.2~~
~~35~~	~~-48.1~~	~~-80.6~~	~~-121.3~~
~~40~~	~~-49.4~~	~~-82.9~~	~~-124.7~~

~~1 Calculated in accordance with ASCE 7.~~
~~2 Pasd = 0.6Pult~~

~~TABLE 2 — RISK CATEGORY II EXPOSURE CATEGORY "D"[1, 2] MINIMUM DESIGN WIND UPLIFT PRESSURES, IN PSF FOR FIELD [Pasd(1)],~~

~~PERIMETER [Pasd(2)] AND CORNER [Pasd(3)] AREAS OF ROOFS FOR EXPOSURE "D" BUILDINGS~~			
~~Roof mean height (below)~~ -	~~Pasd(1) (Field)~~	~~Pasd(2) (Perimeter)~~	~~Pasd(3) (Corners)~~ -
~~20~~	~~-51.4~~	~~-86.2~~	~~-129.7~~
~~25~~	~~-53.4~~	~~-89.5~~	~~-134.7~~
~~30~~	~~--55.0~~	~~-92.3~~	~~-138.9~~
~~35~~	~~-56.4~~	~~-94.5~~	~~-142.3~~
~~40~~	~~-57.7~~	~~-96.8~~	~~-145.6~~

~~1 Calculated in accordance with ASCE 7.~~
~~2 Pasd = 0.6Pult~~

TABLE 1 —MINIMUM ASD DESIGN WIND UPLIFT PRESSURES, IN PSF FOR ROOF SLOPE - =1½ :12 RISK CATEGORY II EXPOSURE CATEGORY "C" - (Overhang) -			
- - - - - Eave Height -	- Roof Pressure Zones -		
	- - 1' and 1	- - 2	- - 3
- =15' -	- -64	- -84	- -115
- >15 to =20' -	- -68	- -89	- -122
- >20' to =25' -	- -71	- -94	- -128
- >25' to =30' -	- -74	- -97	- -133
- >30' to =35' -	- -76	- -101	- -137
- >35' to =40'	- -78	- -104	- -141
- >40' to =45'	- -80 -	- -106	- -145

>45' to =50'	-82	-109	-148
>50' to =55'	-84	-111	-151
>55' to =60'	-85	-113	-154

TABLE 2 - MINIMUM ASD DESIGN WIND UPLIFT PRESSURES, IN PSF FOR ROOF SLOPE - =1½ :12 RISK CATEGORY II EXPOSURE CATEGORY"D" (Overhang)			
Eave Height	Roof Pressure Zones		
	1' and 1	2	3
=15'	-77	-102	-139
>15 to =20'	-81	-107	-146
>20' to =25'	-85	-112	-152
>25' to =30'	-87	-115	-157
>30 to =35'	-90	-118	-161
>35 to =40'	-92	-121	-165
>40' to =45'	-94	-124	-169
>45' to =50'	-96	-126	-172
>50' to =55'	-97	-128	-175

>55' to =60'	-99	-130	-177

TABLE 3 —MINIMUM ASD DESIGN WIND UPLIFT PRESSURES, IN PSF FOR ROOF SLOPE - =1½ :12
RISK CATEGORY II EXPOSURE CATEGORY "C"

(Roof)

Eave Height	Roof Pressure Zones			
	1'	1	2	3
=15'	-37	-64	-84	-115
>15 to =20'	-39	-68	-89	-122
>20' to =25'	-41	-71	-94	-128
>25' to =30'	-42	-74	-97	-133
>30 to =35'	-44	-76	-101	-137
>35 to =40'	-45	-78	-103	-141
>40' to =45'	-46	-80	-106	-145
>45' to =50'	-47	-82	-109	-148
>50' to =55'	-48	-84	-111	-151
>55' to =60'	-49	-85	-113	-154

TABLE 4 —MINIMUM ASD DESIGN WIND UPLIFT PRESSURES, IN PSF FOR ROOF SLOPE - =1½ :12 RISK CATEGORY II EXPOSURE CATEGORY "D" (Roof)				
Eave Height	Roof Pressure Zones			
	1'	1	2	3
=15'	-45	-77	-102	-139
>15 to =20'	-47	-81	-107	-146
>20' to =25'	-49	-85	-112	-152
>25' to =30'	-50	-87	-115	-157
>30 to =35'	-52	-90	-118	-161
>35 to =40'	-53	-92	-121	-165
>40' to =45'	-54	-94	-124	-169
>45' to =50'	-55	-96	-126	-172
>50' to =55'	-56	-97	-128	-175
>55' to =60'	-57	-99	-130	-177

S7164

Date Submitted	11/2/2018	**Section**	4	**Proponent**	Michael Goolsby
Chapter	RAS 137	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No

Alternate Language No

Related Modifications

Summary of Modification

Establish consistency with ASCE 7-16.

Rationale

RAS 137 revisions necessary to reflect ASCE 7-16 wind load requirements for low-rise, steep-slope roof systems. Providing example calculations for enhanced fastening in elevated pressure zones on roofs.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None. Continues to provide examples and guidance to perform calculations for enhanced fastening in elevated pressure zones for single ply roof systems; thereby, simplifying verification of code compliance.

Impact to building and property owners relative to cost of compliance with code

Reduces cost by providing examples and guidance in establishing enhanced fastening compliance for single ply roof systems, making unnecessary the additional expense of site specific engineering.

Impact to industry relative to the cost of compliance with code

Reduces cost by providing examples and guidance in establishing enhanced fastening compliance for single ply roof systems, making unnecessary the additional expense of site specific engineering.

Impact to small business relative to the cost of compliance with code

Reduces cost by providing examples and guidance in establishing enhanced fastening compliance for single ply roof systems, making unnecessary the additional expense of site specific engineering.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Continues to provide examples and guidance to perform calculations for enhanced fastening in elevated pressure zones for single ply roof systems; thereby, simplifying verification of code compliance and increasing life safety relating to wind load requirements.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This revision provides examples and guidance to perform calculations for enhanced fastening in elevated pressure zones for single ply roof systems, making unnecessary additional site specific engineering for low-rise buildings.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This revision only establishes examples and guidance for establishing enhanced fastening and in no way restricts roof systems, components or materials.

Does not degrade the effectiveness of the code

This revision enhances the code by providing an alternative to site specific engineering for low-rise and low-slope buildings.

4.2 The roofing assembly Product Approval shall list the maximum design pressure for the accepted assembly. Such pressure shall be applicable to the field of the roof area (1) as defined in ASCE 7. Should the roof assembly Product Approval allow extrapolation to perimeter and corners areas [(2) and (3)] as defined in ASCE 7, the following shall apply:

- The maximum extrapolation shall not be greater than ~~280~~ <u>300</u> percent.
- The minimum fastener separation shall not be less than 6 inches o.c. Should determined fastener density require closer fastener spacing, then the membrane width shall be reduced, (e.g., half sheets).
- If the perimeter and/or corner areas of the roof have calculated design pressures which are less than or equal to the maximum design pressures noted in the roof assembly Product Approval, then specified membrane attachment shall also apply in these areas.

5. Single-Ply Membrane Attachment

5.1 Should the roof assembly Product Approval allow extrapolation to <u>Zone 1, Zone 2 and Zone 3</u> ~~perimeter and corners areas [(2) and (3)]~~ as defined in ASCE 7, the following shall apply:

5.1.1 Single-ply membrane attachment for elevated pressure zones may be determined through extrapolation of the data for field area attachment.

5.1.1.1 Alternatively, the mechanically attached, single-ply roof assembly may be tested for dynamic uplift pressure resistance, in compliance with Appendix B of TAS 114 resulting in a “fastener assembly design value.” This “Fastener Assembly Design Value” will be listed in the single-ply roof assembly Product Approval for use in determining fastener spacing.

6. Example of Data Extrapolation

Notes: The following data extrapolation example results in a “Fastener Value” which is based on the maximum design pressure from a particular roof assembly Product Approval. The maximum design pressures are the result of laboratory uplift testing of the assembly after a 2:1 margin of safety is applied. Therefore, the “Fastener Value” determined herein inherently has a 2:1 margin of safety applied.

6.1 Known:

~~Consider a building having an uninsulated concrete deck and a roof mean height less than 60 feet where the~~ <u>The</u> design pressures are as follows:

<u>***Zone 1’:*** *-37.0 psf*</u>
<u>***Zone 1***</u> ~~***Field Area:***~~ ~~*– 43.0*~~ <u>*-64.0*</u> *psf*
<u>***Zone 2***</u> ~~***Perimeter Area***~~*:* ~~*– 56.0*~~ <u>*-84.0*</u> *psf*
<u>***Zone 3***</u> ~~***Corner Areas***~~*:* ~~*– 90.0*~~ *-*<u>*115.0*</u> *psf*

Consider a roof assembly Product Approval which includes a system having a maximum design pressure of -45 psf. The Product Approval specifies a single-ply membrane mechanically attached 18 in. o.c. through 4.5 in. wide fastening tabs spaced 18 in. o.c. on the underside of the membrane.

6.1.1 Determine the number of square feet per fastener (x):

The following equation may be utilized to determine the number of square feet per fastener (x) if this number is unknown.

$$X = \frac{(\text{row spacing x fastener spacing})}{144}$$

For this case, this results in 2.25 ft^2 per fastener, as shown below.

$$X = \frac{(18 \text{ in x } 18 \text{ in})}{144} = 2.25 \ ft^2$$

6.1.2 Determine the "Fastener Value."

General Equation:

fv = (max.*design pressure) x* [*square feet per fastener (X)*]

For this case, this results in a fastener value of 101.25 lbf, as shown below.

$$\left(\frac{45 \ lbf}{ft.^2} \right) \text{X} \left(\frac{2.25 \ ft.^2}{\text{fastener}} \right) = 101.25 \ lbf$$

6.1.3 Determine a fastener spacing (FS) to meet the design pressures in the elevated pressure zones of the roof.

General Equation:

$$FS = \frac{f_y \times 144}{P \times RS}$$

where:

FS = fastener spacing (in);
fv = fastener value (lbf);
P = design pressure (psf); and,
RS = row spacing (in.)

~~Perimeter Area~~ Zone 1:

$$FS = \frac{(101.25 \ lbf) \text{ x } \left(\frac{144 \ in.^2}{ft.^2} \right)}{(\sout{56.0} \ 64.0 \ psf) \text{ x } (18 \ inches)} = \sout{44.5} \ 12.7 \ inches$$

All fractions shall be rounded down to the next whole number. Therefore, a fastener spacing of ~~14~~ 12 in. o.c. through 4.5 in. wide fastening tabs spaced 18 in. o.c. on the underside of the membrane would be acceptable for the perimeter area.

Corner Areas Zone 2:

$$FS = \frac{(101.25\ \mathit{lbf}) \times \left(\frac{144\ \mathit{in.}^2}{\mathit{ft.}^2}\right)}{(\cancel{90.0}\ 84.0\ \mathit{psf}) \times (18\ \mathit{inches})} = \cancel{9}\ 9.6\ \mathit{inches}$$

Therefore, a fastener spacing of 9 in. o.c. through 4.5 in. wide fastening tabs spaced 18 in. o.c. on the underside of the membrane would be acceptable for the corner areas.

Zone 3:

$$FS = \frac{(101.25\ \mathit{lbf}) \times \left(\frac{144\ \mathit{in.}^2}{\mathit{ft.}^2}\right)}{(115.0\ \mathit{psf}) \times (18\ \mathit{inches})} = 7.0\ \mathit{inches}$$

Therefore, a fastener spacing of 7 in. o.c. through 4.5 in. wide fastening tabs spaced 18 in. o.c. on the underside of the membrane would be acceptable for the corner areas.

S8284

Date Submitted	12/15/2018	**Section**	1	**Proponent**	Chadwick Collins
Chapter	TAS 107	**Affects HVHZ**	Yes	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

RAS TAS

Summary of Modification

HVHZ roofing updates

Rationale

The Asphalt Roofing Manufacturers Association staff and volunteers and the Miami-Dade roofing product staff team worked together over the past year to perform a thorough review of the HVHZ requirements for asphalt roofing, and underlayment materials, as well as related RAS and TAS protocols. Many of these requirements have not been updated in decades; this review is an attempt to correlate the FBC with other changes that have occurred within the FBC, at ASCE, and with other standards developers including ASTM International. ARMA has submitted a series of code modifications that reflect that effort.

These proposed modifications include:

- Removal of references to withdrawn standards.
- Removal of references to legacy documents, including ICBO acceptance criteria.
- Updates to referenced standards, including name changes.
- Updates to performance criteria to reflect changes in referenced standards.
- Modifications to certain initial and aged performance values for test requirements to more accurately reflect the intent of the code.
- Removal of redundant or unnecessary requirements.
- Editorial changes and grammatical corrections.

ARMA would like to thank the staff at Miami-Dade for their efforts in working through this very tedious process.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

Reduced product approval expense

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Updates important roofing requirements for HVHZ use.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Removes outdated references.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not require use of any specific type of product.

Does not degrade the effectiveness of the code

Ensures that the code is up to date with available research and referenced standards.

See attached file.

TESTING APPLICATION STANDARD (TAS) No. 107-~~95~~20

TEST PROCEDURE FOR WIND RESISTANCE TESTING OF NON-RIGID, DISCONTINUOUS ROOF SYSTEM ASSEMBLIES (Modified from ASTM D3161)

1. Scope

1.1 This test method covers the determination of the resistance to wind blow-up ~~or blow-off~~ of asphalt shingles, metal shingles or other non-rigid, discontinuous Roof System Assemblies when installed in compliance with the manufacturer's current, published installation instructions.

2. Referenced Documents

2.1 *ASTM Standards*

D3161 Standard Test Method for Wind Resistance of Asphalt Shingles

E380 Excerpts from the Standard Practice for Use of the International System of Units (SI) (the Modernized Metric System)

2.2 *The Florida Building Code, Building*.

3. Terminology & Units

3.1 Definitions- For definitions of terms used in this specification, refer to ASTM D3161; and/or Chapters 2 and 15 (High-Velocity Hurricane Zones) of the *Florida Building Code, Building*. Definitions from the *Florida Building Code, Building* shall take precedence.

3.2 Units - For conversion of U.S. customary units to SI units, refer to ASTM E380.

4. Types of Roof System Assemblies

4.1 Asphalt shingles are of two types:

4.1.1 *Type I* - Shingles with a factory-applied adhesive (self-sealing shingles).

4.1.2 *Type II* - Shingles of the lock-type, with mechanically interlocking tabs or ears.

4.2 Metal shingles or other non-rigid, discontinuous Roof System Assemblies shall be tested under this Protocol at the direction of the Authority Having Jurisdiction.

5. Significance and Use

5.1 Asphalt shingles, metal shingles or other non-rigid, discontinuous Roof System Assemblies that have demonstrated wind resistance by this test have also performed well in use. Local wind conditions may differ from the test conditions both in intensity and duration, and should be taken into consideration. This method is suitable for use in specifications and regulatory statutes. This method, assisted by experience and engineering judgment, will also prove useful for development work.

6. Test Limitations and Precautions

6.1 This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

7. Apparatus

7.1 Test Machine

7.1.1 The "test machine" shall be capable of delivering a horizontal stream of air through a rectangular opening, 36 in. (914 mm) wide and 12 in. (305 mm) high, at a velocity of 110 mph (177 km/h) ± 5% as measured at the orifice.

7.1.2 The "test machine" shall be equipped with an adjustable stand on which a test panel is placed. The stand shall be adjustable to setting the test panel at any desired slope, at any horizontal distance from the lower edge of the duct opening, and at various angles incident to the wind direction.

7.2 Clock

7.3 Mechanical Circulation Conditioning Cell or Room

7.3.1 A mechanical circulation conditioning cell or room with a forced air circulation shall be utilized for self-sealing shingle conditioning. The cell or room shall be capable of receiving a minimum 50 in. (1.27 m) wide by 66 in. (1.68 m) long test panel at a slope of 2 in:12 in. and of maintaining a uniform temperature of 135 to 140°F (57 to 60°C).

8. Test Specimen

8.1 Deck

8.1.1 The wood test deck shall consist of APA 32/16 span rated sheathing of $^{15}/_{32}$ in. thickness and not less than 50 in. by 66 in. (1.27 m by 1.68 m) in dimension. The wood test deck shall be of such rigidity that it will not twist or distort with normal handling, or vibrate from the wind velocity during the test.

8.2 Underlayment

8.2.1 Underlayment shall be either two layers of *approved* ~~15 lb~~ ASTM D226, Type I or one layer of *approved* ASTM D226, Type II asphalt saturated felt underlayment mechanically attached to the wood test deck, with 12 ga. roofing nails and 1 5/8 in. tin caps, in a 12 in. grid patter staggered in two rows in the field and 6 in. o.c. attachment at any laps.

8.3 Self-Sealing Asphalt Shingles

8.3.1 Apply self-sealing asphalt shingles with multiple tabs to duplicate test decks, parallel to the short dimension of the test deck, in compliance with the manufacturer's instructions. Apply products with single tabs to duplicate test decks, parallel to the short dimension of the test deck, in such a manner that there is at least one full shingle in each course.

8.3.2 Secure the exposed portion of any partial product tab or shingle with face nailing or stapling such that the partial product tabs or partial shingles will remain in place for the entire duration of the test.

8.3.~~2~~3 Asphalt shingles shall be attached using 12 ga. roofing nails, properly positioned in compliance with the manufacturer's instructions, to fasten each shingle. No cement, other than the factory-applied adhesive, shall be used to fasten down the tabs. Do not apply pressure to the shingle tabs either during or after application.

8.4 Lock-Type Asphalt Shingles

8.4.1 Apply lock-type asphalt shingles to not less than four test decks, parallel to the short dimension of the panel, in compliance with the manufacturer's instructions. Se- cure the shingles at the outer edge of the test panel by exposed nailing to simulate anchoring at the rake edges of a roof deck.

8.5 Metal Shingles or Other

8.5.1 Apply metal shingles or other non-rigid, discontinuous components to duplicate test decks, parallel to the short dimension of the test deck, in compliance with the manufacturer's instructions.

8.6 Control the temperature at 80 ± 15°F (27 ± 8°C) and maintain the slope of the panel at 2 in:12 in. (17% slope) during shingle application.

9. Conditioning

9.1 Maintain the test specimens at a slope of 2 in:12 in. and at a temperature of 80 ± 15°F (27 + 8°C) until the commencement of heat conditioning.

9.2 Place the test specimens in the conditioning cell or room at a slope of 2 in:12 in. and maintain at a temperature of 135 to 140°F (57 to 60°C) for a continuous 16 hour period.

9.3 After completion of the conditioning period, allow the test specimens to come to room temperature [80 ± 15°F (27 ±8°C)] while at a slope of 2 in:12 in

9.4 Exercise care to avoid pressure on shingle tabs by any twisting or distortion of the test specimens during handling.

10. Procedure

10.1 Location of the Test Panel

10.1.1 Install the test specimen on the test carriage and adjust it in relation to the duct such that the exposed edge of the target course is on the same level as the lower edge of the duct orifice at a horizontal distance of 7 in. ± $^{1}/_{16}$ in. (178 ± 1 mm). The target course shall be the third course up from the bot- tom of the test specimen. The test incline shall be 2:12 in. for self-sealing shingles, and at the lowest incline recommended by the manufacturer for lock-type asphalt and metal shingles and other non-rigid, discontinuoussystems.

10.1.2 Since the design of lock-type shingle may make it difficult to determine the most critical angle of wind direction, conduct the test at a minimum of three different angles: 1) head-on; 2) with the bottom of the target course parallel to and 7 in. (178 mm) away from the machine orifice; and, 3) with the test specimen rotated 30 and 60 degrees from the head-on position, with the bottom corner of the third-course tab nearest to the duct being 7 in. (178 mm) away from and in the same horizontal plane as the bottom of the machine orifice. Test another panel at the position judged to be most critical on the basis of the first three tests.

10.2 Performing the Test

10.2.1 Maintain the ambient temperature at 75 ± 5°F (24 + 3°C) during the wind tests.

10.2.2 As soon as the test specimen is set in position, start the fan, adjust to produce a velocity of 110 mph (177 km/hr) ± 5% at the orifice, and maintain continuously for 2 hours, or until such lesser time as a failure occurs.

10.2.3 ~~During the test, an observer shall note any lifting of shingle tabs or non-rigid components and shall record any damage to a full shingle or non-rigid component or the disengaging of a locking ear or tab, or a shingle tab, including any failure of adhesive. The time at which any of these "failures" occurs should be noted.~~

Any steep slope roofing product assembly that fails to restrain full product tabs shall be considered as having failed this test.

10.2.4 If failure occurs during the test as defined in Section 10.2.3, stop the air flow and record the exposure time. ~~The end point for failure shall be taken as the time at which the sealing feature fails to restrain one or more full shingles or full shingle tabs, or a locking ear or tab of a lock shingle tears loose or disengages from its locking position or a non-rigid component is damaged so as to affect the performance of the system. In addition, no free portion of a shingle or non-rigid component shall lift so as to stand upright or bend back on itself during the test.~~

11. Certification

11.1 A test report will be provided to the Authority Having Jurisdiction confirming successful compliance with the test provisions of this Protocol. Completion of this test Protocol is one in a series of Testing Application Standards required by the Florida Building Code, Building for Product Approval of non-rigid, discontinuous Roof System Assemblies.

S7300

Date Submitted	11/16/2018	**Section**	4	**Proponent**	Jorge Acebo
Chapter	TAS 110	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

Summary of Modification

Modifies Table 4 in Section 4 to include updated requirement for TPO membranes.

Rationale

Updates requirement for TPO membranes to coincide with current requirements with other certification bodies.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Correlates updates for HVHZ requirements to improve building performance.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Removes outdated requirements.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Incorporates latest versions of referenced standards and removes obstacles to product approval.

Does not degrade the effectiveness of the code

Improves code effectiveness by specifying testing requirement specified and used by other certification bodies.

TAS 110 Section 4

Modify Table 4

PRODUCT STANDARD	TEST
Membrane Products	
Polyvinyl Chloride Sheet Roofing - PVC (Spec.)	D4434
Vulcanized Rubber Sheet Roofing - EPDM (Spec.)	D4637
Poly-isobutylene Sheet Roofing - PIB (Spec.)	D5019
Polyethylene Chlorinated Polyethylene Sheet Roofing - CMS (Spec.)	D5019
Hypalon Sheet Roofing	D5019
Unreinforced Thermoplastic Olefin Elastomer Sheet Roofing - TPO	TAS 131
Keytone Ethylene Ester Sheet Roofing - KEE (Spec.)	D6754
Thermoplastic Olefin Elastomer Sheet Roofing – TPO (Internally Reinforced only)	
Standard Specification	D6878
Static Puncture Resistance Report Results Only	D5602
Dynamic Puncture Resistance Report Results Only	D5635
Breaking Strength (after accelerated weathering) Report Results Only	D751
Elongation at Reinforcement Break (after accelerated weathering) Report Results Only	D751
All Single-Ply Membranes	TAS 117(B)
Other Components	
Sealants	TAS 132
Insulation	See Section 7 of this Protocol
Fasteners, Stress Plates, etc.	See Section 12 of this Protocol

Date Submitted	11/16/2018	**Section**	8	**Proponent**	Jorge Acebo
Chapter	TAS 110	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No **Alternate Language** No

Related Modifications

Summary of Modification

Modifies Table 8 in Section 8 to include requirements for Gypsum and Cementitious insulation boards and Lightweight Insulating Concrete.

Rationale

Updates requirement for Gypsum and Cementitious insulation boards and Lightweight Insulating Concrete to coincide with current requirements with other certification bodies.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Correlates updates for HVHZ requirements to improve building performance.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Removes outdated requirements.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Incorporates latest versions of referenced standards and removes obstacles to product approval.

Does not degrade the effectiveness of the code

Improves code effectiveness by specifying testing requirement specified and used by other certification bodies.

TAS 110 Section 8

Modify Table 8

Physical Property	Test Standard	Requirement
Expanded Polystyrene (EPS)		
Standard Specification	C578	Minimum Type IX
Flame Spread	E84	max. < 75
Extruded Polystyrene (XPS)		
Standard Specification	C578	Minimum Type IV
Flame Spread	E84	max. < 75
Fiberglass/Mineral Wool Fiber		
Standard Specification	C726	Type I or Type II
Wood Fiberboard		
Standard Specification	C208	Grade 1 or 2
Compressive Strength	C165	nominal 30 psi
Perlite		
Standard Specification	C728	Type I or Type II
Compressive Strength	C165 Procedure "A"	min. 35 psi
Water Vapor Permeability	C355	max. 25 perm-inch
Dimensional Stability	D2126	max. 2%
Flame Spread	E84	max. < 75
Polyisocyanurate		
Standard Specification	C1289	
Density	D1622	nominal 2 pcf
Compressive Strength	D1621	min. 18 psi
Water Absorption	C209	max. 1.0%
Water Vapor Permeance	E96	max. 1.0 perm
Dimensional		

Stability (7 Days)	D2116	max. 2%
Flame Spread	E84	max. < 75
Spread of Flame (with Roof Cover)	E108	min. Class 'B'
Gypsum		
Standard Specification	C1177	Type X
Cementitious		
Standard Specification	C1325	Type A or Type B
Lightweight Insulating Concrete		
Standard Specification	C869	Cellular
Standard Specification	C332	Aggregate

S8299

Date Submitted	12/15/2018	**Section**	1	**Proponent**	Chadwick Collins
Chapter	TAS 110	**Affects HVHZ**	Yes	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

HVHZ roofing updates

Rationale

The Asphalt Roofing Manufacturers Association staff and volunteers and the Miami-Dade roofing product staff team worked together over the past year to perform a thorough review of the HVHZ requirements for asphalt roofing, and underlayment materials, as well as related RAS and TAS protocols. Many of these requirements have not been updated in decades; this review is an attempt to correlate the FBC with other changes that have occurred within the FBC, at ASCE, and with other standards developers including ASTM International. ARMA has submitted a series of code modifications that reflect that effort.

These proposed modifications include:

- Removal of references to withdrawn standards.
- Removal of references to legacy documents, including ICBO acceptance criteria.
- Updates to referenced standards, including name changes.
- Updates to performance criteria to reflect changes in referenced standards.
- Modifications to certain initial and aged performance values for test requirements to more accurately reflect the intent of the code.
- Removal of redundant or unnecessary requirements.
- Editorial changes and grammatical corrections.

ARMA would like to thank the staff at Miami-Dade for their efforts in working through this very tedious process.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Updates roofing requirements and removes outdated references.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Removes outdated references

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not require use of any specific product

Does not degrade the effectiveness of the code

Ensures that the code is up to date with available research and referenced standards

See attached file.

TAS 110 Section 1

Add Section 1.2

Manufacturing location of tested products shall be verified by the testing laboratory and be included in the report.

TAS 110 Section 4

Modify Table 4

PRODUCT	TEST STANDARD
Membrane Products	
Polyvinyl Chloride Sheet Roofing - PVC (Spec.)	D4434
Vulcanized Rubber Sheet Roofing - EPDM (Spec.)	D4637
Poly-isobutylene Sheet Roofing - PIB (Spec.)	D5019
Polyethylene Chlorinated Polyethylene Sheet Roofing - CMS (Spec.)	D5019
Hypalon Sheet Roofing	D5019
Unreinforced Thermoplastic Olefin Elastomer Sheet Roofing - TPO	TAS 131
Keytone Ethylene Ester Sheet Roofing - KEE (Spec.)	D6754
Thermoplastic Olefin Elastomer Sheet Roofing – TPO (Internally Reinforced only)	
Standard Specification	D6878
Static Puncture Resistance Report Results Only	D5602
Dynamic Puncture Resistance Report Results Only	D5635
Breaking Strength (after accelerated weathering) Report Results Only	D751
Elongation at Reinforcement Break (after accelerated weathering) Report Results Only	D751
All Single-Ply Membranes	TAS 117(B)
Other Components	
Sealants	TAS 132
Insulation	See Section 7 of this Protocol
Fasteners, Stress Plates, etc.	See Section 12 of this Protocol

TAS 110 Section 8

Modify Table 8

Physical Property	Test Standard	Requirement
Expanded Polystyrene (EPS)		
Standard Specification	C578	Minimum Type IX

Flame Spread	E84	max. < 75
Extruded Polystyrene (XPS)		
Standard Specification	C578	Minimum Type IV
Flame Spread	E84	max. < 75
Fiberglass/Mineral Wool Fiber		
Standard Specification	C726	Type I or Type II
Wood Fiberboard		
Standard Specification	C208	Grade 1 or 2
Compressive Strength	C165	nominal 30 psi
Perlite		
Standard Specification	C728	Type I or Type II
Compressive Strength	C165 Procedure "A"	min. 35 psi
Water Vapor Permeability	C355	max. 25 perm-inch
Dimensional Stability	D2126	max. 2%
Flame Spread	E84	max. < 75
Polyisocyanurate		
Standard Specification	C1289	
Density	D1622	nominal 2 pcf
Compressive Strength	D1621	min. 18 psi
Water Absorption	C209	max. 1.0%
Water Vapor Permeance	E96	max. 1.0 perm
Dimensional Stability (7 Days)	D2116	max. 2%
Flame Spread	E84	max. < 75
Spread of Flame (with Roof Cover)	E108	min. Class 'B'
Gypsum		
Standard Specification	C1177	Type X
Cementitious		
Standard Specification	C1325	Type A or Type B
Lightweight Insulating Concrete		
Standard Specification	C869	Cellular
Standard Specification	C332	Aggregate

TAS 110 Section 9

Modify Table 9 footnote only

TABLE 9

Product	Test	Test Standard
Fiber Cement Roof Assembly	Wind Driven Rain Resistance	TAS 100

Fiber Cement Roofing Products	Physical Properties	TAS 135
Mechanical Attached Fiber Cement Tile or Shake Roof Assemblies (Uplift Based System)	Static Uplift Resistance	TAS 102(A) (See TAS 135 for details)
Mechanically Attached, Clipped Fiber Cement Tile or Shake Roof Assemblies (Uplift Based System)	Static Uplift Resistance	TAS 102(A) (See TAS 135 for details)
Fiber Cement Panel Roof Assemblies	Uplift Pressure Resistance	E 330 (See TAS 135 for details)
Underlayment		
Self-Adhered Underlayments	Physical Properties	TAS 103
Nail-On Underlayments	Physical Properties	TAS 104
Asphalt Based Underlayments	Physical Properties	See Section 2 of this Protocol
Attachment Components		
Nails, Screws, Clips, etc.	Corrosion Resistance	Appendix E of TAS 114

All Underlayments (with the exception of TAS 103 or TAS 104 underlayments) with exposure limitation in excess of 30 days must submit enhanced Accelerated Weathering testing in conjunction with applicable Physical Properties testing. Exposure limitations up to a maximum of 180 days will be established through ASTM D4798 ~~as outlined in ASTM D5147~~ for 1000 hours (cycle A-1); pass/fail established by physical properties testing of the weathered samples. Physical property testing where specimen size will not fit into the accelerated weathering device may be omitted.

TAS 110 Section 10

Modify Table 10 footnote only

TABLE 10

Product	Test	Test Standard
Non-Rigid, Discontinuous Roof Assembly	Wind Driven Rain Resistance	TAS 100
Non-Rigid, Discontinuous Roof Assembly	Wind Resistance	TAS 107
Non-Rigid, Discontinuous Roof Assembly	Fire Resistance min. Class 'B'	E 108 min. Class 'B'
Granule Surfaced, Glass Felt Asphalt Shingles	Physical Properties	D3462
Granule Surfaced, Class 'A' Asphalt Shingles Fiberglass Reinforced	Physical Properties	D3018 TAS 135
Composite Shingles Fiber Cement Shingles	Physical Properties	TAS 135
Metal Shingles	Salt Spray and Accelerated Weathering	B117 and G23
Underlayment		
Self-Adhered Underlayments	Physical Properties	TAS 103 or ASTM D1970
Nail-On Underlayments	Physical Properties	TAS 104
Asphalt Based Underlayments	Physical Properties	See Section 2 of this Protocol
Attachment Components		
Nails, Screws, Clips, etc	Corrosion Resistance	Appendix E of TAS 114

All Underlayments <u>(with the exception of TAS 103 or TAS 104 underlayments)</u> with exposure limitation in excess of 30 days must submit enhanced Accelerated Weathering testing in conjunction with applicable Physical Properties testing. Exposure limitations up to a maximum of 180 days will be established through ASTM D4798 ~~as outlined in ASTM D5147~~ for 1000 hours (cycle A<u>-1</u>); pass/fail established by physical properties testing of the weathered samples. Physical property testing where specimen size will not fit into the accelerated weathering device may be omitted.

TAS 110 Section 11

Modify Table 11(A) and 11(B) footnote 3 only

TABLE 11(A)

Product	Test	Test Standard
Mechanically Attached Rigid, Discontinuous Roof Assembly	Wind Driven Resistance	TAS 100
Mechanically Attached Rigid, Discontinuous Roof Assembly	Static Uplift Resistance	TAS 102
Mechanically Attached Clipped, Rigid, Discontinuous Roof Assembly	Static Uplift Resistance	TAS 102(A)
Mortar or Adhesive Set Tile Roof Assembly	Static Uplift Resistance	TAS 101
Rigid, Discontinuous Roof Assembly	Wind Tunnel Performance	TAS 108
Rigid, Discontinuous Roof Assembly	Air Permeability	TAS 116
Concrete Roof Tile	Physical Properties	TAS 112
Clay Roof Tile	Physical Properties	C 1167
Fiberglass Reinforced Composite Tile	Physical Properties	TAS 135
Underlayment		
Self-Adhered Underlayments	Physical Properties	TAS 103
Nail-On Underlayments	Physical Properties	TAS 104
Asphalt Based Underlayments	Physical Properties	See Section 2 of this Protocol
Attachment Components		
Nails, Screws, Clips, etc.	Corrosion Resistance	Appendix E of TAS 114
Mortar (for use in mortar set tile Roof System Assemblies)	Physical Properties	TAS 123
Adhesive (for use as a repair or supplemental attachment component)	Physical Properties	TAS 123(A)

TABLE 11(B)

Product	Test	Test Standard
Slate	Physical Properties	C406
Underlayment		
Self-Adhered Underlayments	Physical Properties	TAS 103 or ASTM D1970
Nail-On Underlayments	Physical Properties	TAS 104
Asphalt Based Underlayments	Physical Properties	See Section 2 of this Protocol
Attachment Components		
Nails, Screws, Clips, etc.	Corrosion Resistance	Appendix E of TAS 114

Notes:

1. Wind tunnel testing of rigid, discontinuous roof assemblies is op- tional and is only applicable to systems having rigid components which meet the size constraints set forth in TAS 108.
2. Air permeability testing of rigid, discontinuous roof assemblies is only applicable to those systems which are to be tested in compliance with TAS 108 and is not required for those systems generally consid- ered to be air permeable. This is a test to confirm the roof assembly would apply to wind tunnel testing.
3. All Underlayments (with the exception of TAS 103 or TAS 104 underlayments) with exposure limitation in excess of 30 days must submit enhanced Accelerated Weathering testing in conjunction with applicable Physical Properties testing. Exposure limitations up to a maximum of 180 days will be established through ASTM D4798 as outlined in ASTM D5147 for 1000 hours (cycle A-1); pass /fail established by physical properties testing of the weathered samples. Physical property testing where specimen size will not fit into the accelerated weathering device may be omitted.

TAS 110 Section 17

Modify Table 17 and footnote

TABLE 17

Product	Test	Test Standard
Non-Rigid, Discontinuous Roof Assembly	Wind Driven Rain Resistance	TAS 100
Plastic Tile/Shake/Slate Systems	Uplift Performance	TAS 125
Plastic Tile/Shake/Slate	Outdoor Exposure Xenon Arc	G26 (6500 watts) Test Method 1 or G155 (4500 hours)
	Tensile Test	D638 (+/- 10% allowable difference between exposed and non-exposed samples)
	Flexural Test	C158 (+/- 10% allowable difference between exposed and non-exposed samples)
Plastic Tile/Shake/Slate	Self Ignition	D1929 (greater than 650ºF)
Plastic Tile/Shake/Slate	Smoke Density Rating	E84 (rating less than 450) or D2843 (rating less than 75)
Plastic Tile/Shake/Slate	Rate of Burning	D635 (Class ~~C1~~ CC-1 or ~~C2~~ CC-2)
Underlayment		
Self-Adhered Underlayments	Physical Properties	TAS 103 or ASTM D1970
Nail-On Underlayments	Physical Properties	TAS 104
Asphalt Based Underlayments	Physical Properties	See Section 2 of this Protocol
Attachment Components		
Nails, Screws, Clips, etc.	Corrosion Resistance	Appendix E of TAS 114

All Underlayments (with the exception of TAS 103 or TAS 104 underlayments) with exposure limitation in excess of 30 days must submit enhanced Accelerated Weathering testing in conjunction with applicable Physical Properties testing. Exposure limitations up to a maximum of 180 days will be established through ASTM D4798 ~~as outlined in ASTM D5147~~ for 1000 hours (cycle A-1); pass /fail established by physical properties testing of the weathered samples. Physical property testing where specimen size will not fit into the accelerated weathering device may be omitted.

TAS 110 Section 18
ADD ALL ASTMs Specified in TAS 110

S7307

Date Submitted	11/16/2018	**Section**	1	**Proponent**	Jorge Acebo
Chapter	1	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Modifies the standard because the TPO TAS 131 testing requirements are being incorporated into TAS 110 as a submitted code mod.

Rationale

Modifies the existing testing protocol to be for unreinforced TPO membranes only. The Reinforced TPO membrane requirements are included in a proposed code mod for TAS 110 Section 4.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Correlates updates for HVHZ requirements to improve building performance.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Removes outdated requirements.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Incorporates latest versions of referenced standards and removes obstacles to product approval.

Does not degrade the effectiveness of the code

Improves code effectiveness by specifying testing requirement specified and used by other certification bodies.

TESTING APPLICATION STANDARD (TAS)131-95
STANDARD REQUIREMENTS FOR UNREINFORCED THERMOPLASTIC OLEFIN
ELASTOMER BASED SHEET USED IN SINGLE-PLY ROOF ~~MEMBRANE~~SYSTEMS

1. Scope:

1.1 This Protocol covers unreinforced ~~and reinforced~~ thermoplastic olefin elastomer sheet made from blends of polypropylene and ethylene-propylene rubber (TPO), intended for use as a roof membrane exposed to the weather.

1.2 The test and property limits are used to characterize the membrane and are minimum values. In-place roof system design criteria, such as fire resistance, field seaming strength, material compatibility, and up-lift resistance, in situ shrinkage, among others, are factors which must be considered but are beyond the scope of this specification.

1.3 The following precautionary caveat pertains to the test methods portion only, Section 8, of this specification: This Standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1.4 All testing shall be conducted by an approved testing agency, and all test reports shall be signed by an authorized signer of the testing/listing agency. Manufacturing location of tested products shall be verified by the testing laboratory and be included in the report.

2. Referenced Documents:

2.1 ASTM Standards

D412 Test Method for Rubber Properties in Tension

D471 Test Method for Rubber Property - Effect of Liquids

D573 Test method for Rubber-Deterioration in an Air Oven

D624 Test Method for Rubber Property - Tear Resistance

D751 Method of Testing Coated Fabrics

D816 Methods of Testing Rubber Cements

D1149 Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber (Flat Specimens)

D1204 Test Method for Linear Dimensional Changes of Non-rigid Thermoplastic Sheeting or Film at Elevated Temperature

~~D1822 Tensile Impact Testing~~

D2137 Test Method for Rubber Property - Brittleness Point of Flexible Polymers and Coated Fabrics

E 96 Water Vapor Permeability, Method BW

E380 Excerpts from Use of the International System of Units (SI) (The Modernized Metric System)

~~G 154 Standard Practice for Operating Fluorescent Light Apparatus for UV-Condensation (QUV) Exposure of Nonmetallic Material~~

G 155 Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials

2.2 The Florida Building Code, Building
2.3 Application Standards
TAS 114 Test Procedures for Roof System Assemblies in the High Velocity Hurricane Zone Jurisdiction

3. Terminology & Units:
3.1 Definitions - For definitions of terms used in this Protocol, refer to Chapter 2 and Section 1513 of the Florida Building Code, Building and/or the RCI Glossary of Terms. Definitions from the Florida Building Code, Building shall take precedence.
3.2 Units - For conversion of U.S. customary units to SI units, refer to ASTM E380.

4. Limitations and Precautions:
4.1 This Protocol may involve hazardous materials, operations and equipment. This Protocol does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

5. Classification:
5.1 Types are used to identify the principal polymer component of the sheet.
5.1.1 Ethylene-Propylene based elastomer (TPO)
~~5.2 Grades indicate the mass percentage of the polymer (TPO) in relation to the total sheet:~~
~~5.2.1 Grade 1 - Greater than 95%.~~
~~5.2.2 Grade 2 - 50 to 95%.~~
~~5.3 Class describes sheet construction.~~
~~5.3.1 Class U - Unreinforced.~~
~~5.3.2 Class SR - Reinforced, internally or externally.~~

6. Materials and Manufacture:
6.1 The sheet shall be formulated from the appropriate polymers and other compounding ingredients. The principal polymer used in the sheet shall be one of those listed in Section 5.1.1 ~~in accordance with the percentages listed in Sections 5.2.1 and 5.2.2.~~
6.2 The sheet shall be capable of being bonded to itself for making watertight field splices and repairs, and the supplier or fabricator shall recommend suitable bonding methods and materials.

7. Physical Properties:
7.1 The test shall conform to the physical requirements prescribed in Table 1 of this Protocol.

8. Dimensions and Permissible Variations:
8.1 The width and length of the sheet shall be as published and tested for physical property values. The sheet width shall be as tested for system performance in compliance with TAS 114.
8.1.1 The width and length tolerance shall be + 3%, - 0%.
8.2 The published sheet thickness tolerance shall be +15%, -10% of the specified thickness, but in no case shall the thickness be less than the minimum listed Table 1 of this Protocol.

Remove this table and footnotes

TABLE 1

PHYSICAL REQUIREMENTS FOR TPO ELASTOMER SHEETS

Physical Property	**Grade 1 or 2 Class SR**	**Grade 1 or 2 Class U Unreinforced**
Thickness (over scrim) in. (mm)	min. 0.015 (0.385)	NA
Thickness (overall) in. (mm)	min. 0.039 (1.0)	min. 0.039 (1.0)
Tensile Strength psi (MPa)	NA	min. 1740 (12.0)
Breaking Strength lbf (kN)	min. 225 (1.0)	NA
Elongation (ultimate) %	NA	min. 500
Elongation (at break) %	min. 151	NA
Tensile set %	NA	max. 10
Tear Resistance lbf/in (kN/m)		min. 340 (60)
Tearing Strength lbf (N)	min. 55 (245)	NA
Brittleness Point °F(°C)	max. -49 (-45)	max. -30 (-34)
Ozone Resistance no cracks	pass	pass
After Heat Aging (A.H.A.)		
Tensile Strength-A.H.A. psi (MPa)	NA	min. 1740 (120)
Breaking Strength-A.H.A. lbf (kN)	min. 225 (1.0)	NA
Elongation (ultimate)-A.H.A. %	NA	min. 500
Elongation (at break)-A.H.A. %	min. 151	NA
Tear Resistance -A.H.A. lbf/in. (kN/m)	NA	min. 340 (60)
Linear Dimensional Change - A.H.A % Weight Change -A.H.A %	max. ± 2	max. ± 2 max. ± 2
Water Absorption mass %	max. ± 42	max. ± 2
Factory Seam Strength lbf/in. (kN/m)	min. 51 (9) or Sheet Failure	min. 51 (9) or Sheet Failure
Weather Resistance no cracks or crazing	pass	pass
After Accelerated Weathering A.A.W.		
Tensile Strength-A.A.W. psi	report	min. 1450 (10.0)

~~(MPa)~~		
~~Elongation (ultimate)-A.A.W. %~~	~~report~~	~~min. 200 %~~
~~PRFSE-A.A.W. %~~	~~report~~	~~30.00~~
~~Static Puncture Resistance~~	~~report~~	~~report~~
~~Dynamic Puncture Resistance~~	~~report~~	~~report~~
~~Tensile Impact ft•lb/in2 (kJ/m2)~~	-	~~min. 21 (44)~~

~~1 For reinforcing fabric only.~~
~~2 Test performed on coating elastomer only.~~

Add this table

TABLE 1

PHYSICAL REQUIREMENTS FOR UNREINFORCED TPO ELASTOMER SHEETS

Physical Property	Requirement
Thickness (overall) in. (mm)	min. 0.039 (1.0)
Tensile Strength psi (MPa)	min. 1740 (12.0)
Elongation (ultimate) %	min. 500
Tear Resistance lbf/in (kN/m)	min. 340 (60)
Brittleness Point °F(°C)	max. -30 (-34)
Ozone Resistance no cracks	pass
After Heat Aging-(A.H.A.)	
Tensile Strength-A.H.A. psi (MPa)	min. 1740 (120)
Elongation (ultimate)-A.H.A. %	min. 500
Tear Resistance -A.H.A. lbf/in. (kN/m)	min. 340 (60)
Linear Dimensional Change - A.H.A %	max. ± 2
Weight Change -A.H.A %	max. ± 2
Water Absorption mass %	max. ± 2
Factory Seam Strength lbf/in. (kN/m)	min. 51 (9) or Sheet Failure
Weather Resistance no cracks or crazing	pass
After Accelerated Weathering-A.A.W.	
Tensile Strength-A.A.W. psi (MPa)	min. 1450 (10.0)
Elongation (ultimate)-A.A.W. %	min. 200 %
PRFSE-A.A.W. %	30.00
Static Puncture Resistance	report
Dynamic Puncture Resistance	report

9. Workmanship, Finish, and Appearance:

9.1 The sheet, including factory seams, if present, shall be water tight and free of pinholes, particles of foreign matter, undisbursed raw material, or other manufacturing defects that might affect serviceability. Excessive irregularities on the sheet surface shall not be acceptable (or portion thereof), then its rejection should be negotiated between supplier and buyer.

9.2 Edges of the sheets shall be straight and flat so that they may be seamed to one another without fishmouthing.

10. Test Methods: **(Needs to be Re-numbered)**

~~10.1 Thickness (over scrim) - Appendix A of this Protocol.~~

~~10.2 Dimensions - Test Method D 751~~

~~10.2.1 Testing shall be conducted after permitting the sheet to relax at 73°F (23°C) for 1 hour.~~

10.~~3~~1 Thickness (overall) - Test Methods D 412 for Class U Sheet and D 751 for Class SR Sheet.

10.~~4~~2 Tensile Strength - Test Method D 412, Die C for Class U Sheet.

~~10.5 Breaking Strength - Test Method D 751, Grab Method for Class SR Sheet.~~

10.~~6~~3 Elongation (ultimate) - Test Method D 412, Die C for Class U Sheet.

~~10.7 Elongation (at break) - Test Method D 751, Grab method for Class SR Sheet.~~

~~10.8 Tensile Set - Test Method D 412, Method A, Die C, 50% elongation for Class U Sheet.~~

10.~~9~~4 Tear Resistance - Test Method D 624, Die C for Class U Sheet.

~~10.10 Tearing Strength - Test Method D 751, Procedure B for Class SR Sheet.~~

10.~~11~~5 Brittleness Point - Test Method D 746 or D 2137.

10.~~12~~6 Ozone Resistance - Test Method D 1149.

10.~~12~~6.1 Inspect at 7x magnification on specimens exposed to 1 x 10-5 psi (100 MPa) ozone in air at 100°F (38°C). For Class U Sheet, wrap around 3" (76.2 mm) mandrel for 166 hour exposure. For Class SR Sheets, use Procedure B.

10.~~13~~7 Heat Aging - Test Method D 573.

10.~~13~~7.1 Age sheet specimens at 240°F (115°C) for 670 hours.

10.~~14~~8 Linear Dimensional Change - Test Method D 471.

10.~~14~~8.1 Conduct test at 158°F (70°C) for 166 hours.

10.~~15~~9 Water Absorption - Test Method D 471.

10.~~15~~9.1 Conduct test at 158°F (70°C) for 166 hours.

10.1~~6~~0 Factory Seam Strength - Test Method D 816, Method B.

10.1~~6~~0.1 Modify procedure by cutting a 1 in. (25.4 mm) wide by 12 in. (304.8 mm) long sample across the lap seam. Place in jaws approximately 2 in. (50.8 mm) from edges of the overlap area and test at 2 in. per minute (50.8 mm/min.) claim for rehearing.

10.1~~7~~1 Weather Resistance - Practice G 155

10.1~~7~~1.1 Xenon-Arc shall be operated to the following conditions:

Filter Type: borosilicate inner and outer
Exposure: 0.35 W/m2 at 340 nm
Cycle: 690 min light, 30 min. light and water spray Black Panel
Temperature: 80 ± 3°C
Relative Humidity: 50 ± 5%
Spray Water: deionized
Specimen Rotation: every 250 hours
Exposure Time: 4000 hours

10.171.2 Specimens for exposure shall be mounted under no strain. The recommended specimen size is 2.75 in. x 8.0 in. (70 mm x 203 mm). After exposure, remove the specimens and inspect immediately. Strain Class U specimens 10% and visually inspect for cracks and crazing under 7x magnification.

~~10.18 Weather Resistance - Practice G 154~~

~~10.18.1 Operate to the following conditions:~~

~~Lamp Type: Fluorescent UVB - 313 (UVB-B)~~

~~Test Cycle: 20 hours UV @ 80°C 4 hours condensate @50°C~~

~~Exposure: 2000 hours~~

~~10.19 Tensile Impact - ASTM D1822 for Class U Sheet.~~

11. Inspection and Special Testing:

11.1 The manufacturer shall inspect and test his production to assure compliance of the product with this Protocol.

11.2 If the results of any tests do not conform to the requirements of this specification, retesting to determine conformity shall be performed as required by the Authority Having Jurisdiction.

12. Rejection and Resubmittal:

12.1 Failure to conform to any one of the requirements prescribed in this specification shall constitute grounds for suspension of a current Product Approval.

13. Product Marking:

13.1 The sheet shall be identified on the labeling in compliance with Section 1517 of the Florida Building Code, Building.

14. Certification:

14.1 Upon request of the Authority Having Jurisdiction, a manufacturer may be required to certify that the material was manufactured and tested in accordance with this Protocol. Additional testing for confirmation may be required by an approved testing agency.

15. Packaging and Package Marking:

15.1 The material shall be rolled on a substantial core and packaged in a standard commercial manner.

15.2 Shipping containers shall be marked with the name of the material, the stock and lot number.

~~TESTING APPLICATION STANDARD (TAS) 131-95~~

~~Appendix A~~

~~TEST PROCEDURE FOR THICKNESS MEASUREMENT OF~~
~~COATING OVER CLASS SR OLEFIN ELASTOMER BASED SHEET ROOFING~~

~~1. Scope:~~

~~1.1 The procedure outlined in this Protocol Appendix provides a method for measuring the thickness of the coating over fiber backing or reinforcing fabric.~~

~~2. Measurement Method:~~

~~2.1 Principal~~

~~2.1.1 The thickness of coating material over fiber, fabric, or scrim can be observed with a standard microscope. Measurement is made with a calibrated eyepiece.~~

~~2.2 Apparatus~~

~~2.2.1 Microscope, 60x with reticule.~~

~~2.2.2 Light Source - If light source on the microscope is not adequate, a small high-intensity lamp may also be used.~~

~~2.2.3 Stage Micrometer, 0.001 in. (0.0254 mm) divisions.~~

~~2.3 Calibration Procedure~~

~~2.3.1 Place a standard reflectance stage micrometer in place of the specimen.~~
~~2.3.2 Position the reticle eyepiece and the micrometer such that the scales are superimposed. Focus the reticle by turning the eyepiece. Focus the specimen and reticle by turning the vertical adjustment knob.~~
~~2.3.3 Locate a point at which both scales line up. Count the number of micrometer divisions away. Measure to the nearest 0.0005 in. or 0.5 mil (0.0125 mm). The calibration may be optimized by increasing the number of divisions measured.~~
~~2.3.4 Repeat the calibration three times and average the results. A calibration example is given below.~~
~~2.3.5 Calibration Example~~
~~2.3.5.1 If four reticle divisions (RD) are found equal to 4.5 micrometer divisions (MD), then 1 RD = 0.001125 in. or 1.125 mils (28.6 mm) or the calibration factor.~~
~~2.4 Specimen Analysis:~~
~~2.4.1 Carefully center a sharp single edge razor or equivalent over the fiber intersections along the x-x axis.~~
~~2.4.2 Make a clean bias cut completely through the sheet.~~
~~2.4.3 Remove the razor-cut section and mount in common putty with the cut surface facing upward.~~
~~2.4.4 Observe the cut surface with the eyepiece reticle. Measure the thickness of the coating on either side of the thread intersection by counting the number of reticle divisions (to the nearest one-half division).~~
~~2.4.5 Sample three areas of the coatings and average the results.~~

~~3. Calculation and Report:~~
~~3.1 Multiply the number or reticle divisions representing the thickness of the coating by calibration factor. Report the average results from the areas of the coating to the nearest 0.005” or 0.5 mils (12.7 mm).~~

~~4. Precision:~~
~~4.1 Precision - Measurements are accurate to ± -0.005 in. or 5.0 mils (12.7 mm) when the thickness is about 0.020 in. or 20 mils (0.5 mm).~~

S8285

Date Submitted	12/15/2018	**Section**	1	**Proponent**	Chadwick Collins
Chapter	TAS 131	**Affects HVHZ**	Yes	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No **Alternate Language** No

Related Modifications

RAS TAS

Summary of Modification

HVHZ roofing updates

Rationale

The Asphalt Roofing Manufacturers Association staff and volunteers and the Miami-Dade roofing product staff team worked together over the past year to perform a thorough review of the HVHZ requirements for asphalt roofing, and underlayment materials, as well as related RAS and TAS protocols. Many of these requirements have not been updated in decades; this review is an attempt to correlate the FBC with other changes that have occurred within the FBC, at ASCE, and with other standards developers including ASTM International. ARMA has submitted a series of code modifications that reflect that effort.

These proposed modifications include:

- Removal of references to withdrawn standards.
- Removal of references to legacy documents, including ICBO acceptance criteria.
- Updates to referenced standards, including name changes.
- Updates to performance criteria to reflect changes in referenced standards.
- Modifications to certain initial and aged performance values for test requirements to more accurately reflect the intent of the code.
- Removal of redundant or unnecessary requirements.
- Editorial changes and grammatical corrections.

ARMA would like to thank the staff at Miami-Dade for their efforts in working through this very tedious process.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

Reduced product approval expense.

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Updates important roofing requirements for HVHZ use.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Removes outdated references.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not require use of any specific type of product.

Does not degrade the effectiveness of the code

Ensures that the code is up to date with available research and referenced standards.

See attached file.

TESTING APPLICATION STANDARD (TAS)131-95
STANDARD REQUIREMENTS FOR UNREINFORCED THERMOPLASTIC OLEFIN
ELASTOMER BASED SHEET USED IN SINGLE-PLY ROOF ~~MEMBRANE~~ SYSTEMS

1. Scope:

1.1 This Protocol covers unreinforced ~~and reinforced~~ thermoplastic olefin elastomer sheet made from blends of polypropylene and ethylene-propylene rubber (TPO), intended for use as a roof membrane exposed to the weather.

1.2 The test and property limits are used to characterize the membrane and are minimum values. In-place roof system design criteria, such as fire resistance, field seaming strength, material compatibility, and up-lift resistance, in situ shrinkage, among others, are factors which must be considered but are beyond the scope of this specification.

1.3 The following precautionary caveat pertains to the test methods portion only, Section 8, of this specification: This Standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1.4 All testing shall be conducted by an approved testing agency, and all test reports shall be signed by an authorized signer of the testing/listing agency. Manufacturing location of tested products shall be verified by the testing laboratory and be included in the report.

2. Referenced Documents:

2.1 ASTM Standards

D412 Test Method for Rubber Properties in Tension

D471 Test Method for Rubber Property - Effect of Liquids

D573 Test method for Rubber-Deterioration in an Air Oven

D624 Test Method for Rubber Property - Tear Resistance

D751 Method of Testing Coated Fabrics

D816 Methods of Testing Rubber Cements

D1149 Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber (Flat Specimens)

D1204 Test Method for Linear Dimensional Changes of Non-rigid Thermoplastic Sheeting or Film at Elevated Temperature

D1822 Tensile Impact Testing

D2137 Test Method for Rubber Property - Brittleness Point of Flexible Polymers and Coated Fabrics

E 96 Water Vapor Permeability, Method BW

E380 Excerpts from Use of the International System of Units (SI) (The Modernized Metric System)

G 154 Standard Practice for Operating Fluorescent Light Apparatus for UV-Condensation (QUV) Exposure of Nonmetallic Material

G 155 Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials

2.2 The Florida Building Code, Building
2.3 Application Standards
TAS 114 Test Procedures for Roof System Assemblies in the High Velocity Hurricane Zone Jurisdiction

3. Terminology & Units:
3.1 Definitions - For definitions of terms used in this Protocol, refer to Chapter 2 and Section 1513 of the Florida Building Code, Building and/or the RCI Glossary of Terms. Definitions from the Florida Building Code, Building shall take precedence.
3.2 Units - For conversion of U.S. customary units to SI units, refer to ASTM E380.

4. Limitations and Precautions:
4.1 This Protocol may involve hazardous materials, operations and equipment. This Protocol does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

5. Classification:
5.1 Types are used to identify the principal polymer component of the sheet.
5.1.1 Ethylene-Propylene based elastomer (TPO)
~~5.2 Grades indicate the mass percentage of the polymer (TPO) in relation to the total sheet:~~
~~5.2.1 Grade 1 - Greater than 95%.~~
~~5.2.2 Grade 2 - 50 to 95%.~~
~~5.3 Class describes sheet construction.~~
~~5.3.1 Class U - Unreinforced.~~
~~5.3.2 Class SR - Reinforced, internally or externally.~~

6. Materials and Manufacture:
6.1 The sheet shall be formulated from the appropriate polymers and other compounding ingredients. The principal polymer used in the sheet shall be one of those listed in Section 5.1.1 ~~in accordance with the percentages listed in Sections 5.2.1 and 5.2.2.~~
6.2 The sheet shall be capable of being bonded to itself for making watertight field splices and repairs, and the supplier or fabricator shall recommend suitable bonding methods and materials.

7. Physical Properties:
7.1 The test shall conform to the physical requirements prescribed in Table 1 of this Protocol.

8. Dimensions and Permissible Variations:
8.1 The width and length of the sheet shall be as published and tested for physical property values. The sheet width shall be as tested for system performance in compliance with TAS 114.
8.1.1 The width and length tolerance shall be + 3%, - 0%.
8.2 The published sheet thickness tolerance shall be +15%, -10% of the specified thickness, but in no case shall the thickness be less than the minimum listed Table 1 of this Protocol.

Remove this table and footnotes

TABLE 1

PHYSICAL REQUIREMENTS FOR TPO ELASTOMER SHEETS

Physical Property	Grade 1 or 2 Class SR	Grade 1 or 2 Class U Unreinforced
Thickness (over scrim) in. (mm)	min. 0.015 (0.385)	NA
Thickness (overall) in. (mm)	min. 0.039 (1.0)	min. 0.039 (1.0)
Tensile Strength psi (MPa)	NA	min. 1740 (12.0)
Breaking Strength lbf (kN)	min. 225 (1.0)	NA
Elongation (ultimate) %	NA	min. 500
Elongation (at break) %	min. 15[1]	NA
Tensile set %	NA	max. 10
Tear Resistance lbf/in (kN/m)		min. 340 (60)
Tearing Strength lbf (N)	min. 55 (245)	NA
Brittleness Point °F(°C)	max. -49 (-45)	max. -30 (-34)
Ozone Resistance no cracks	pass	pass
After Heat Aging (A.H.A.)		
Tensile Strength A.H.A. psi (MPa)	NA	min. 1740 (120)
Breaking Strength A.H.A. lbf (kN)	min. 225 (1.0)	NA
Elongation (ultimate) A.H.A. %	NA	min. 500
Elongation (at break) A.H.A. %	min. 15[1]	NA
Tear Resistance A.H.A. lbf/in. (kN/m)	NA	min. 340 (60)
Linear Dimensional Change A.H.A %	max. ± 2	max. ± 2
Weight Change A.H.A %		max. ± 2
Water Absorption mass %	max. ± 4[2]	max. ± 2
Factory Seam Strength lbf/in. (kN/m)	min. 51 (9) or Sheet Failure	min. 51 (9) or Sheet Failure
Weather Resistance no cracks or crazing	pass	pass
After Accelerated Weathering A.A.W.		
Tensile Strength A.A.W. psi (MPa)	report	min. 1450 (10.0)
Elongation (ultimate) A.A.W. %	report	min. 200 %
PRFSE A.A.W. %	report	30.00
Static Puncture Resistance	report	report
Dynamic Puncture Resistance	report	report
Tensile Impact ft•lb/in^2 (kJ/m^2)		min. 21 (44)

[1] For reinforcing fabric only.

[2] Test performed on coating elastomer only.

Add this table

TABLE 1

PHYSICAL REQUIREMENTS FOR UNREINFORCED TPO ELASTOMER SHEETS

Physical Property	Requirement
Thickness (overall) in. (mm)	min. 0.039 (1.0)
Tensile Strength psi (MPa)	min. 1740 (12.0)
Elongation (ultimate) %	min. 500
Tensile set %	max. 10
Tear Resistance lbf/in (kN/m)	min. 340 (60)
Brittleness Point °F(°C)	max. -30 (-34)
Ozone Resistance no cracks	pass
After Heat Aging-(A.H.A.)	
Tensile Strength-A.H.A. psi (MPa)	min. 1740 (120)
Elongation (ultimate)-A.H.A. %	min. 500
Tear Resistance -A.H.A. lbf/in. (kN/m)	min. 340 (60)
Linear Dimensional Change -A.H.A % Weight Change -A.H.A %	max. ± 2 max. ± 2
Water Absorption mass %	max. ± 2
Factory Seam Strength lbf/in. (kN/m)	min. 51 (9) or Sheet Failure
Weather Resistance no cracks or crazing	pass
After Accelerated Weathering-A.A.W.	
Tensile Strength-A.A.W. psi (MPa)	min. 1450 (10.0)
Elongation (ultimate)-A.A.W. %	min. 200 %
PRFSE-A.A.W. %	30.00
Static Puncture Resistance	report
Dynamic Puncture Resistance	report
Tensile Impact ft•lb/in^2 (kJ/m^2)	min. 21 (44)

9. Workmanship, Finish, and Appearance:

9.1 The sheet, including factory seams, if present, shall be water tight and free of pinholes, particles of foreign matter, undisbursed raw material, or other manufacturing defects that might affect serviceability. Excessive irregularities on the sheet surface shall not be acceptable (or portion thereof), then its rejection should be negotiated between supplier and buyer.

9.2 Edges of the sheets shall be straight and flat so that they may be seamed to one another without fishmouthing.

10. Test Methods: **(Need to be Re-numbered)**

~~10.1 Thickness (over scrim) - Appendix A of this Protocol.~~

~~10.2 Dimensions - Test Method D 751~~

~~10.2.1 Testing shall be conducted after permitting the sheet to relax at 73°F (23°C) for 1 hour.~~

10.~~3~~1 Thickness (overall) - Test Methods D 412 for Class U Sheet and D 751 for Class SR Sheet.

10.~~4~~2 Tensile Strength - Test Method D 412, Die C for Class U Sheet.

~~10.5 Breaking Strength - Test Method D 751, Grab Method for Class SR Sheet.~~

10.~~6~~3 Elongation (ultimate) - Test Method D 412, Die C for Class U Sheet.

~~10.7 Elongation (at break) - Test Method D 751, Grab method for Class SR Sheet.~~

10.~~8~~4 Tensile Set - Test Method D 412, Method A, Die C, 50% elongation for Class U Sheet.

10.~~9~~5 Tear Resistance - Test Method D 624, Die C for Class U Sheet.

~~10.10 Tearing Strength - Test Method D 751, Procedure B for Class SR Sheet.~~

10.~~11~~6 Brittleness Point - Test Method D 746 or D 2137.

10.~~12~~7 Ozone Resistance - Test Method D 1149.

10.~~12~~7.1 Inspect at 7x magnification on specimens exposed to 1 x 10-5 psi (100 MPa) ozone in air at 100°F (38°C). For Class U Sheet, wrap around 3" (76.2 mm) mandrel for 166 hour exposure. For Class SR Sheets, use Procedure B.

10.~~13~~8 Heat Aging - Test Method D 573.

10.~~13~~8.1 Age sheet specimens at 240°F (115°C) for 670 hours.

10.~~14~~9 Linear Dimensional Change - Test Method D 471.

10.~~14~~9.1 Conduct test at 158°F (70°C) for 166 hours.

10.~~15~~10 Water Absorption - Test Method D 471.

10.~~15~~10.1 Conduct test at 158°F (70°C) for 166 hours.

10.1~~6~~1 Factory Seam Strength - Test Method D 816, Method B.

10.1~~6~~1.1 Modify procedure by cutting a 1 in. (25.4 mm) wide by 12 in. (304.8 mm) long sample across the lap seam. Place in jaws approximately 2 in. (50.8 mm) from edges of the overlap area and test at 2 in. per minute (50.8 mm/min.) claim for rehearing.

10.1~~7~~2 Weather Resistance - Practice G 155

10.1~~7~~2.1 Xenon-Arc shall be operated to the following conditions:
Filter Type: borosilicate inner and outer
Exposure: 0.35 W/m2 at 340 nm
Cycle: 690 min light, 30 min. light and water spray Black Panel
Temperature: 80 ± 3°C
Relative Humidity: 50 ± 5%
Spray Water: deionized
Specimen Rotation: every 250 hours
Exposure Time: 4000 hours

10.172.2 Specimens for exposure shall be mounted under no strain. The recommended specimen size is 2.75 in. x 8.0 in. (70 mm x 203 mm). After exposure, remove the specimens and inspect immediately. Strain Class U specimens 10% and visually inspect for cracks and crazing under 7x magnification.

~~10.18 Weather Resistance - Practice G 154~~

~~10.18.1 Operate to the following conditions:~~
~~Lamp Type: Fluorescent UVB - 313 (UVB-B)~~
~~Test Cycle: 20 hours UV @ 80°C 4 hours condensate @50°C~~
~~Exposure: 2000 hours~~

10.193 Tensile Impact - ASTM D1822 for Class U Sheet.

11. Inspection and Special Testing:

11.1 The manufacturer shall inspect and test his production to assure compliance of the product with this Protocol.

11.2 If the results of any tests do not conform to the requirements of this specification, retesting to determine conformity shall be performed as required by the Authority Having Jurisdiction.

12. Rejection and Resubmittal:

12.1 Failure to conform to any one of the requirements prescribed in this specification shall constitute grounds for suspension of a current Product Approval.

13. Product Marking:

13.1 The sheet shall be identified on the labeling in compliance with Section 1517 of the Florida Building Code, Building.

14. Certification:

14.1 Upon request of the Authority Having Jurisdiction, a manufacturer may be required to certify that the material was manufactured and tested in accordance with this Protocol. Additional testing for confirmation may be required by an approved testing agency.

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15.2 Shipping containers shall be marked with the name of the material, the stock and lot number.

S8286

Date Submitted	12/15/2018	**Section**	1	**Proponent**	Chadwick Collins
Chapter	TAS 131	**Affects HVHZ**	Yes	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

RAS TAS

Summary of Modification

HVHZ roofing updates

Rationale

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Does not require use of any specific type of product.

Does not degrade the effectiveness of the code

Ensures that the code is up to date with available research and referenced standards.

See attached file.

TESTING APPLICATION STANDARD (TAS) 131-95
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COATING OVER CLASS SR OLEFIN ELASTOMER BASED SHEET ROOFING

1. Scope:

1.1 The procedure outlined in this Protocol Appendix provides a method for measuring the thickness of the coating over fiber backing or reinforcing fabric.

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2.2 Apparatus

2.2.1 Microscope, 60x with reticule.

2.2.2 Light Source - If light source on the microscope is not adequate, a small high-intensity lamp may also be used.

2.2.3 Stage Micrometer, 0.001 in. (0.0254 mm) divisions.

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2.3.5.1 If four reticle divisions (RD) are found equal to 4.5 micrometer divisions (MD), then 1 RD = 0.001125 in. or 1.125 mils (28.6 mm) or the calibration factor.

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