STRUCTURAL TAC
WITHOUT COMMENTS

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850-487-1824

Total Mods for report: 182

TAC: Structural

Total Mods for **Structural** in **Approved as Modified: 3**

Total Mods for report: 182

Sub Code: Building

S7500

1

Date Submitted	11/28/2018	**Section**	1710	**Proponent**	Scott McAdam
Chapter	17	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Modified				
Commission Action	Pending Review				

Comments

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

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.

Text of Mod 7500-A1

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 1-1/2 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.

1st Comment Period History

7500-A1

Proponent Lynn 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 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.

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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.

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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.

S8099

Date Submitted	12/13/2018	**Section**	2214	**Proponent**	Bonnie Manley
Chapter	22	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Approved as Modified
Commission Action Pending Review

Comments

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

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.

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~~

~~b.~~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, Specification~~s~~ 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.

810.Steel Deck Institute, Inc., SDI.

a.Reserved.

b.Reserved.

c.Reserved.

d.Reserved.

e.Reserved.

f.Diaphragm Design Manual, SDI.

bg.SDI-C-2011 Standard for Composite Steel Floor Deck Slabs

ch.SDI-RD-2010 Standard for Steel Roof Deck

di.SDI-NC-2010Standard for Non-Composite Steel Floor Deck.

911.Steel Joist Institute, SJI.

a. 44th43rd 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

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~~12.Reserved.~~

~~a.Reserved.~~

~~b.Reserved.~~

~~13.Reserved.~~

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~~14~~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

Alternate Language

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.

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

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.

<u>b</u>~~g~~.SDI-C~~-2011~~ Standard for Composite Steel Floor Deck Slabs

<u>c</u>~~h~~.SDI-RD~~-2010~~ Standard for Steel Roof Deck

<u>d</u>~~i~~.SDI-NC~~-2010~~ Standard for Non-Composite Steel Floor Deck.

<u>9</u>~~11~~.Steel Joist Institute, SJI.

a. <u>44th</u>~~43rd~~ Edition Standard Specifications ~~and~~ Load <u>Tables</u> 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~~<u>90</u> 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

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~~12.Reserved.~~

~~a.Reserved.~~

~~b.Reserved.~~

~~13.Reserved.~~

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~~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

S8222

3

Date Submitted	12/14/2018	**Section**	609.7.2.1	**Proponent**	Lynn Miller
Chapter	6	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Modified
Commission Action Pending Review

Comments

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

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.

Text of Mod 8222 including A1

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)].

1st Comment Period History

8222-A1

Proponent Lynn 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 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 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)].

TAC: Structural

Total Mods for **Structural** in **Approved as Submitted: 156**

Total Mods for report: 182

Sub Code: Building

S7233

4

Date Submitted	11/12/2018	**Section**	202	**Proponent**	T Stafford
Chapter	2	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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 Approved as Submitted
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.

S7513

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

TAC Recommendation Approved as Submitted
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.

S7841

Date Submitted	12/10/2018	**Section**	202	**Proponent**	Paul Coats
Chapter	2	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Approved as Submitted				
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 w ording of this definition has often caused confusion among code users w hen 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 w ood 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 w ith 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://w w w .aw c.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	**Section**	202	**Proponent**	John Woestman
Chapter	2	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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.

S8264

Date Submitted 12/14/2018
Chapter 2
Section 202
Affects HVHZ No
Proponent Joseph Crum
Attachments No
TAC Recommendation Approved as Submitted
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	Approved as Submitted				
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	**Section**	423.1	**Proponent**	Ann Russo5
Chapter	4	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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.

Date Submitted	11/30/2018	Section	423.1.1	Proponent	Ann Russo5
Chapter	4	Affects HVHZ	No	Attachments	No
TAC Recommendation	Approved as Submitted				
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	Approved as Submitted				
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	Approved as Submitted				
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.

S7501

Date Submitted	11/28/2018	**Section**	721.1	**Proponent**	Paul Coats
Chapter	7	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Approved as Submitted
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 11/4"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 11/4" Type S drywallscrews spaced 12" o.c. and the face layeris fastened with 15/8" 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 11/2" 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 $9^{1}/_{2}$″ with a minimum flange depth of $1^{5}/_{16}$″ and a minimum flange cross-sectional area of 1.95 square inches; minimum web thickness of $^{3}/_{8}$″) @ 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 $1^{1}/_{4}$″ Type S drywall screws. Two layers of $^{1}/_{2}$″ 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 $1^{1}/_{4}$″ Type S drywall screws spaced 12″ o.c. and the face layer is fastened with $1^{5}/_{8}$″ 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 $1^{1}/_{2}$″ 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)

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 1/2" with a minimum flange depth of 1 5/16" and a minimum flange cross-sectional area of 1.95 square inches; minimum web thickness of 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 1/4" Type S drywall screws. Two layers of 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 1/4" Type S drywall screws spaced 12" o.c. and the face layer is fastened with 1 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 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)

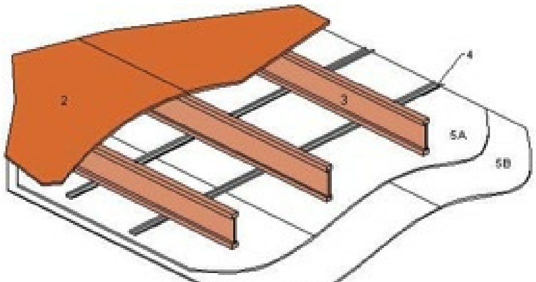
Reason: This proposal, in our opinion, is an editoral change as it simply is provided to correct what is currently specified in the 2015 IBC. The current text entry as published in the 2015 IBC is not correctly shown as the current code does not specify the resilient channel requirement as shown in the 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	Approved as Submitted				
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	Approved as Submitted				
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~~ <u>ANSI</u> A135.4.

[BS]1404.3.2 Hardboard siding.

Hardboard siding shall conform to the requirements of ~~AHA~~ <u>ANSI</u> 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 Approved as Submitted
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.

S7226

Date Submitted	11/12/2018	**Section**	1609	**Proponent**	T Stafford
Chapter	16	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation	Approved as Submitted
Commission Action	Pending Review

Comments

General Comments	**No**	**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

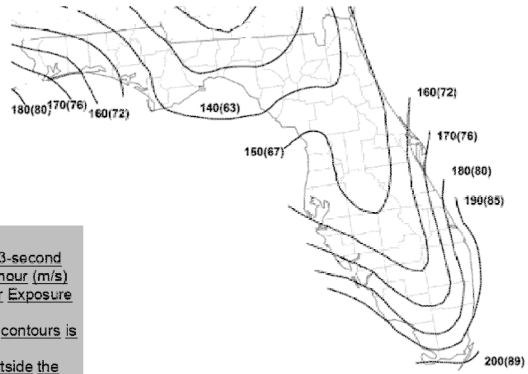
S7226-G1

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.

Add new Figure 1609.3(3)



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.

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, V_{ULT}, 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.

$V_{asd} = V_{ult}$ v0.6 (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. V_{asd} = nominal design wind speed applicable to methods specified in Exceptions 1 through 5 of Section 1609.1.1.

c. V_{ult} = ultimate design wind speeds determined from Figure 1609.3(1), 1609.3(2), ~~or~~ 1609.3(3) or 1609.2(4).

http://www.floridabuilding.org/Upload/Modifications/Rendered/Mod_7226_TextOfModification_3.png

Date Submitted	11/23/2018	**Section**	1606	**Proponent**	Joseph Crum
Chapter	16	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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.Whereabuildingorstructureisoccupiedbytwoormoreoccupancies 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	Approved as Submitted				
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 Approved as Submitted
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

S7428

Date Submitted	11/25/2018	**Section**	1609.6	**Proponent**	T Stafford
Chapter	16	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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 Approved as Submitted
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	Approved as Submitted				
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.

Text of Modification Table reformatted for viewing online

1609.7Garage 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/m^2.

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.

1609.7Garage 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 S																
Width(ft)	Height(ft)	100 MPH		110 MPH		120 MPH		130 MPH		140 MPH		150 MPH		160 MPH		170 MPH		18
		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.
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.
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.
		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.
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.
78 MPH		85 MPH		93 MPH		101 MPH		108 MPH		116 MPH		124 MPH		132 MPH		139 MPH		14

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. 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. 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. 3.Plus and minus signs signify pressures acting toward and away from the building surfaces.
4. 4.Negative pressures assume door has 2 feet of width in building's end zone.
5. 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 Approved as Submitted
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	Approved as Submitted				
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)

S7409

28

Date Submitted 11/23/2018	**Section** 1802.1	**Proponent** Joseph Crum
Chapter 18	**Affects HVHZ** No	**Attachments** No

TAC Recommendation Approved as Submitted
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 Approved as Submitted
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 Approved as Submitted
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

Date Submitted	11/23/2018	**Section**	1810.3.3.1.6	**Proponent**	Joseph Crum
Chapter	18	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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	Approved as Submitted				
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).

S7415

Date Submitted	11/23/2018	**Section**	1810.3.5.2.2	**Proponent**	Joseph Crum
Chapter	18	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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	Approved as Submitted				
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.

S8156

Date Submitted	12/14/2018	**Section**	1810.3.5.2.3	**Proponent**	Dale Biggers
Chapter	18	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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~~ a nominal 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	Approved as Submitted				
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 Approved as Submitted
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 Approved as Submitted
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.

S7419

39

Date Submitted 11/24/2018	**Section** 2101.2	**Proponent** Joseph Crum
Chapter 21	**Affects HVHZ** No	**Attachments** No

TAC Recommendation Approved as Submitted
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 Approved as Submitted
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.~~

Date Submitted	12/15/2018	**Section**	2107.2	**Proponent**	Joseph Belcher for MAF
Chapter	21	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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~~ 6.1.6.1.1, lap splices. As an alternative to Section ~~8.1.6.7.1.1~~ 6.1.6.1.1, 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, length, but need not be greater than 72 db. 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~~ <u>6-1</u>~~), but shall not be less than 12 inches (305 mm) and need not be greater than 72~~ *~~db~~*~~.~~

2108.3 <u>Reserved.</u> ~~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 d_b.

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

S8372

Date Submitted	12/15/2018	**Section**	2103.1	**Proponent**	Joseph Belcher for MAF
Chapter	21	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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 Approved as Submitted
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).

S7421

Date Submitted	11/24/2018	**Section**	2208.2	**Proponent**	Joseph Crum
Chapter	22	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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 Approved as Submitted
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 Approved as Submitted
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~~.

S8102

Date Submitted	12/13/2018	Section	2221	Proponent	Bonnie Manley
Chapter	22	Affects HVHZ	Yes	Attachments	No

TAC Recommendation Approved as Submitted
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(911).

S8103

Date Submitted	12/13/2018	**Section**	2222	**Proponent**	Bonnie Manley
Chapter	22	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Approved as Submitted
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 Approved as Submitted
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.

S7422

Date Submitted	11/24/2018	**Section**	2303.2.4	**Proponent**	Joseph Crum
Chapter	23	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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).

S7626

Date Submitted	12/2/2018	**Section**	2304.8	**Proponent**	Ann Russo8
Chapter	23	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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
	15/32	24	20	25
covered in DOC PS 1 or DOC PS 2	1/2	24	25	30
	19/32	24	40[cb]	50[cb]
	5/8	24	45[cb]	55[cb]
	23/32 , 3/4	24	60[cb]	65[cb]

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]
Panel span rating roof/ floor span	Panel thickness (inches)	Maximum span (inches)		Load[ed] (psf)		Maximum span (inches)
		With edge support[fe]	Without edge support	Total load	Live load	
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]

	MINIMUM NET THICKNESS (inches) OF LUMBER PLACED			
	Perpendicular to supports		Diagonally to supports	
SPAN (inches)	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
Chapter 23
Section 2304.8
Affects HVHZ No
Proponent Ann Russo8
Attachments No
TAC Recommendation Approved as Submitted
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.

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 Approved as Submitted
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	Approved as Submitted				
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 by methods based on rational analysis performed in accordance with ASCE 7 ~~a registered professional engineer or registered architect proficient in structural design~~ to withstand the loads required in Chapter 16 (High-Velocity Hurricane Zones).

Date Submitted	12/10/2018	**Section**	2322.2.3	**Proponent**	Eduardo Fernandez
Chapter	23	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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	Approved as Submitted				
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	Approved as Submitted				
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 Approved as Submitted

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)

Date Submitted	12/10/2018	**Section**	2304.10.1	**Proponent**	Paul Coats
Chapter	23	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Approved as Submitted				
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.

Reviseasfollows:

TABLE2304.10.1
FASTENINGSCHEDULE

(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]		

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		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
	23/8" × 0.113" nail (roof)	4	8
	1 3/4" 16 gage staple, 7/16" crown (roof)	3	6
	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
32. 19/32"–3/4"	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

ForSI: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).

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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.

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 (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 (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,	

	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.

Final Action: AS (Approved as Submitted)

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 (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 (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 (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,	

	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 Approved as Submitted
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
7.Roof rafterstoridgevalley orhip rafters;orroof rafterto2-inchridgebeam	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
	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, 7/16?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

16. Stud totoporbottom plate	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
	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
	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
27. Built-upgirders andbeams,2?lumber layers	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)
	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
31. 3/8?–1/2?	13/4? 16gagestaple, 7/16? crown (roof)	3	6
	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
32. 19/32?–3/4?	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 (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 4-16d 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~~<u>common</u> or deformed (2 1/2″ × 0.~~113~~ <u>0.131</u>″) (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″) <u>(subfloor and wall)</u>	6	12
	<u>8d common or deformed (2 1/2″ × 0.131″) (roof)</u>	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 (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.

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 Approved as Submitted
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 Approved as Submitted
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 Approved as Submitted
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**

S7951

Date Submitted	12/12/2018	**Section**	2306.1	**Proponent**	Borjen Yeh
Chapter	23	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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.)

S8186

Date Submitted	12/14/2018	Section	2303.1.9	Proponent	Joseph Crum
Chapter	23	Affects HVHZ	No	Attachments	No

TAC Recommendation Approved as Submitted
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 <u>permanent</u> wood foundation systems shall conform to Chapter 18.

Date Submitted	12/15/2018	**Section**	2304.12.2.2	**Proponent**	Randall Shackelford
Chapter	23	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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 Approved as Submitted
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 Approved as Submitted
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	Approved as Submitted				
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,~~ HHeat-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 SScreens ~~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 AAany 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.

S8035

Date Submitted	12/14/2018	**Section**	2509.2	**Proponent**	Manuel Hurtado
Chapter	25	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation	Approved as Submitted
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.

Date Submitted	12/15/2018	Section	2510.6	Proponent	John Woestman
Chapter	25	Affects HVHZ	No	Attachments	No

TAC Recommendation	Approved as Submitted
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 Approved as Submitted
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	**Section**	2603.12	**Proponent**	Bonnie Manley
Chapter	26	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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.

Mod 7604

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 sSteel framing(minimum	#8 screw into 33 milsteel or thicker	6	3	3	1.5	3	2	DR

penetration of steel thickness plus3 threads)		8	3	2	0.5	3	1.5	DR
		12	3	1.5	DR	3	0.75	DR
	#10 screw into 33 milsteel	6	4	3	2	4	3	0.5
		8	4	3	1	4	2	DR
		12	4	2	DR	3	1	DR
	#10 screw into 43 milsteel or thicker	6	4	4	3	4	4	2
		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 WEIGHTa

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[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 mil steel furring or minimum 1x wood furring[c]	33 mil cold-formed steel stud	#8 screw	Steel thickness plus 3 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 plus 3 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 plus 3 threads	12	3	1.5	DR	3	0.5	DR
				16	3	1	DR	2	DR	DR

				24	2	DR	DR	2	DR	DR
				12	4	3	1.5	4	3	DR
		#10 screw	Steel thickness plus3 threads	16	4	3	0.5	4	2	DR
				24	4	2	DR	4	0.5	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.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.

Date Submitted	12/15/2018	**Section**	2603.13	**Proponent**	John Woestman
Chapter	26	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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.

-

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.

-

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.

S7257

Date Submitted	11/13/2018	**Section**	35	**Proponent**	T Stafford
Chapter	35	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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—17~~13~~ Specification for Rigid Poly (Vinyl Chloride) (PVC) Siding 1404.9, 1405.14

S7704

Date Submitted	12/5/2018	**Section**	102.4	**Proponent**	Dick Wilhelm
Chapter	35	**Affects HVHZ**	Yes	**Attachments**	Yes
TAC Recommendation	Approved as Submitted				
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<u>,</u> ~~or~~ 11<u> or 17</u> 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

AAMA 506-11 Voluntary Specification for Impact and Cycle Testing of Fenestration Products.

711—~~07 or~~ 13 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

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ASTM

E1300—04e01, 07e01, 09e ~~or~~ 12AE1 or -16 Practice for Determining Load Resistance of Glass in Buildings

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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~~ 17Specification 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	Approved as Submitted				
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.

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—17

Standard Method for Testing Sectional Doors, Rolling Doors, and Flexible Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure

1609.1.2.3

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:

DASMA Door & Access Systems Manufacturers Association International

1300 Sumner Ave
Cleveland, Ohio 44115-2851

Standard Method for Testing Sectional Garage Doors, Rolling Doors and Flexible 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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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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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
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

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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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S8070

Date Submitted	12/13/2018	**Section**	35	**Proponent**	Bonnie Manley
Chapter	35	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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—1713, *Test Standard for Hold-Downs Attached to Cold-Formed Steel Structural Framing*, 2017

AISI S914—1715, *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	Approved as Submitted				
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 Approved as Submitted
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	**Section**	35	**Proponent**	Bonnie Manley
Chapter	35	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
Commission Action Pending Review

Comments

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

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

8107-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 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

AWS

B2.1—B2.1M—2018 ~~2014~~Specification for Welding Procedure and Performance Qualification

D1.1—D1.1M—2015~~2010~~Structural Welding Code—Steel

S8108

Date Submitted	12/13/2018	**Section**	35	**Proponent**	Bonnie Manley
Chapter	35	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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 Approved as Submitted
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 Approved as Submitted
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—1409 Specification for Structural Joints Using High Strength Bolts

S8114

Date Submitted	12/13/2018	**Section**	35	**Proponent**	Bonnie Manley
Chapter	35	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
Commission Action Pending Review

Comments

General Comments No **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	**Section**	35	**Proponent**	Bonnie Manley
Chapter	35	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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~~

S7483

87

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

TAC Recommendation Approved as Submitted
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~~ <u>the Florida Building Code Building</u> 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	Approved as Submitted
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~~ the Florida Building Code Building 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	Approved as Submitted				
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~~.

S8189

Date Submitted	12/14/2018	**Section**	301.1.4.2	**Proponent**	Ann Russo4
Chapter	3	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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.

S8054

Date Submitted	12/13/2018	**Section**	403.4.2	**Proponent**	Harold Barrineau
Chapter	4	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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	Approved as Submitted				
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.~~

S8178

Date Submitted	12/14/2018	**Section**	501	**Proponent**	Ann Russo4
Chapter	Appendix A	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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.

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~~

Sub Code: Residential

S7478

94

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

TAC Recommendation Approved as Submitted
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.

S7605

Date Submitted	11/30/2018	**Section**	202	**Proponent**	Ann Russo5
Chapter	2	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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.

S7262

Date Submitted	11/14/2018	**Section**	301.2	**Proponent**	T Stafford
Chapter	3	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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]

Roof	Zone	Effective Wind Area (ft²)	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
			Ultimate Design Wind Speed, V_{ult} (mph)															
Gable Roof 0 to 7 degrees	$1,1^{e}$	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
	$1,1^{e}$	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
	$1,1^{e}$	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
	$1,1^{e}$	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	45.3
	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	-35.0
	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	-76.5
	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	68.9
	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	-54.8
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	-46.8
	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	41.5
	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:

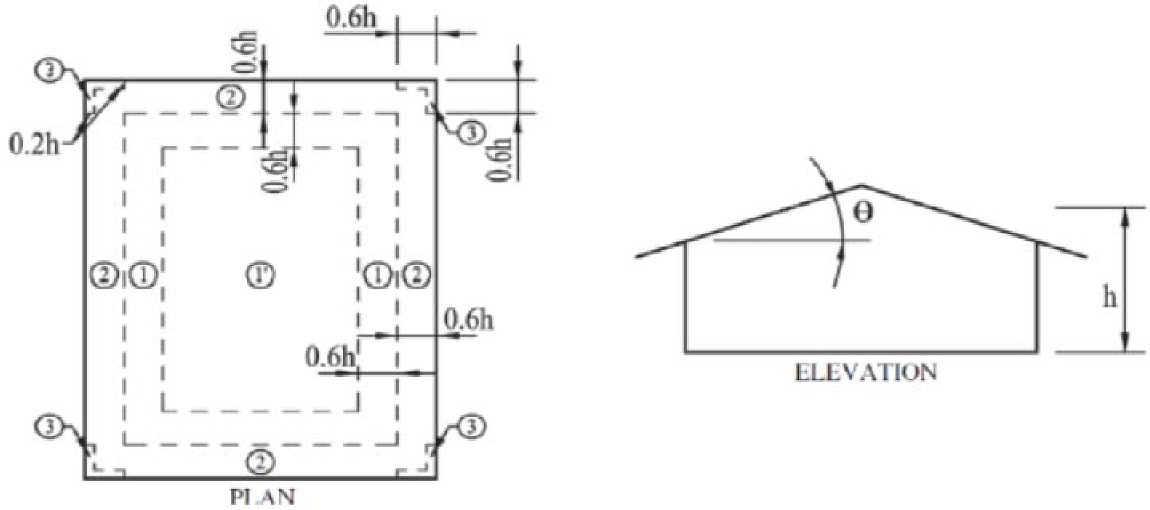
(figure not shown for brevity)

~~For SI: 1 foot = 304.8 mm, 1 degree = 0.0175 rad.~~
~~**Note:** a = 4 feet in all cases.~~

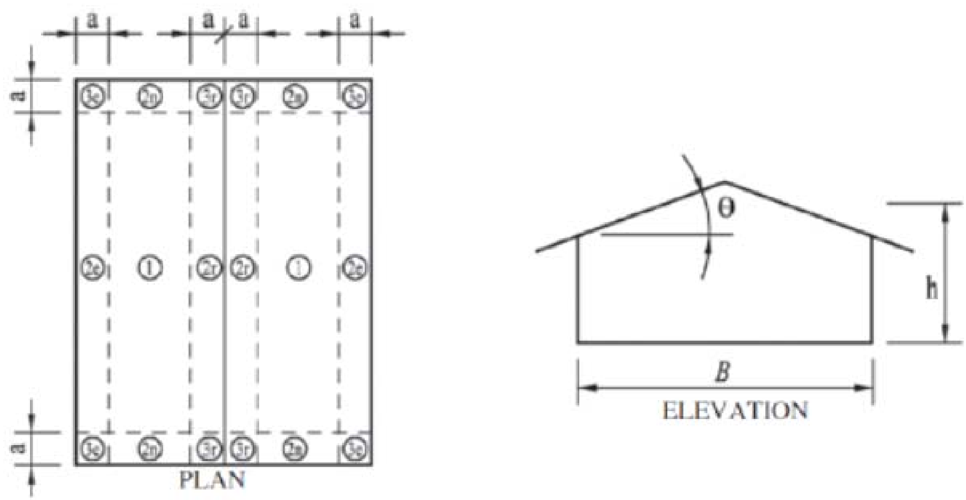
~~**FIGURE R301.2(7)**~~

~~**COMPONENT AND CLADDING PRESSURE ZONES**~~

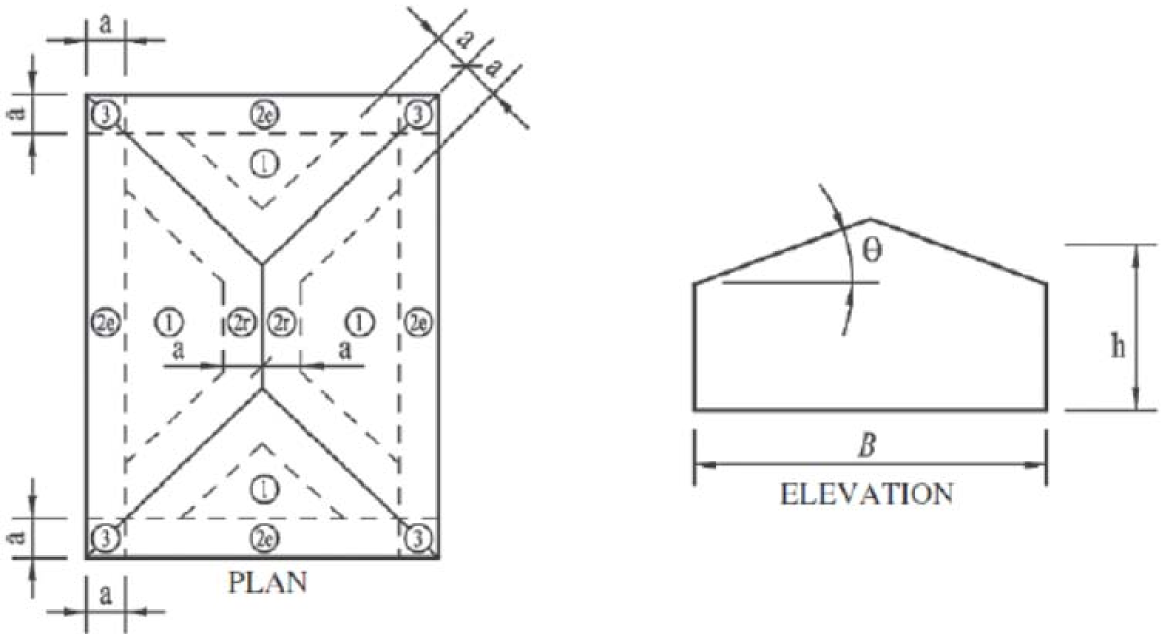
Add new Figure R301.2(7) as follows:



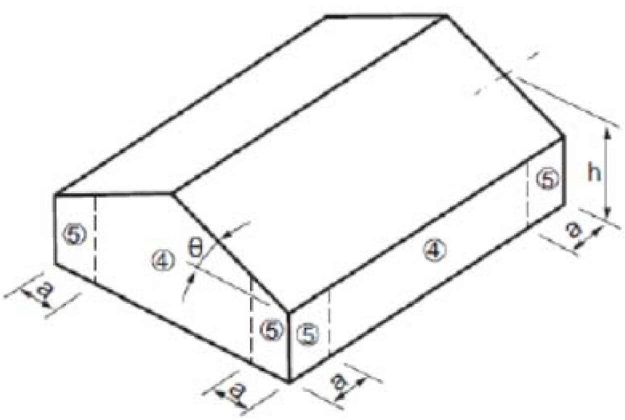
Gable and Flat Roofs θ ≤ 7°



Gable Roofs 7° < θ ≤ 45°



Hip Roofs 7° < θ ≤ 45°



Walls

<u>For SI: 1 foot = 304.8 mm, 1 degree = 0.0175 rad.</u>
<u>**Note:** a = 4 feet in all cases.</u>

<u>FIGURE R301.2(7)</u>
<u>COMPONENT AND CLADDING PRESSURE ZONES</u>

S7616

Date Submitted	11/30/2018	**Section**	301	**Proponent**	Joseph Hetzel
Chapter	3	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation	Approved as Submitted
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.

Text of Modification

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/m^2.

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.

S7629

Date Submitted	12/2/2018	**Section**	317.3	**Proponent**	Ann Russo8
Chapter	3	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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.

S7737

Date Submitted	12/6/2018	**Section**	317.1	**Proponent**	Scott McAdam
Chapter	3	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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	**Section**	308.6	**Proponent**	Roger LeBrun
Chapter	3	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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).

S7653

Date Submitted	12/3/2018	**Section**	403.4	**Proponent**	Ann Russo8
Chapter	4	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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.

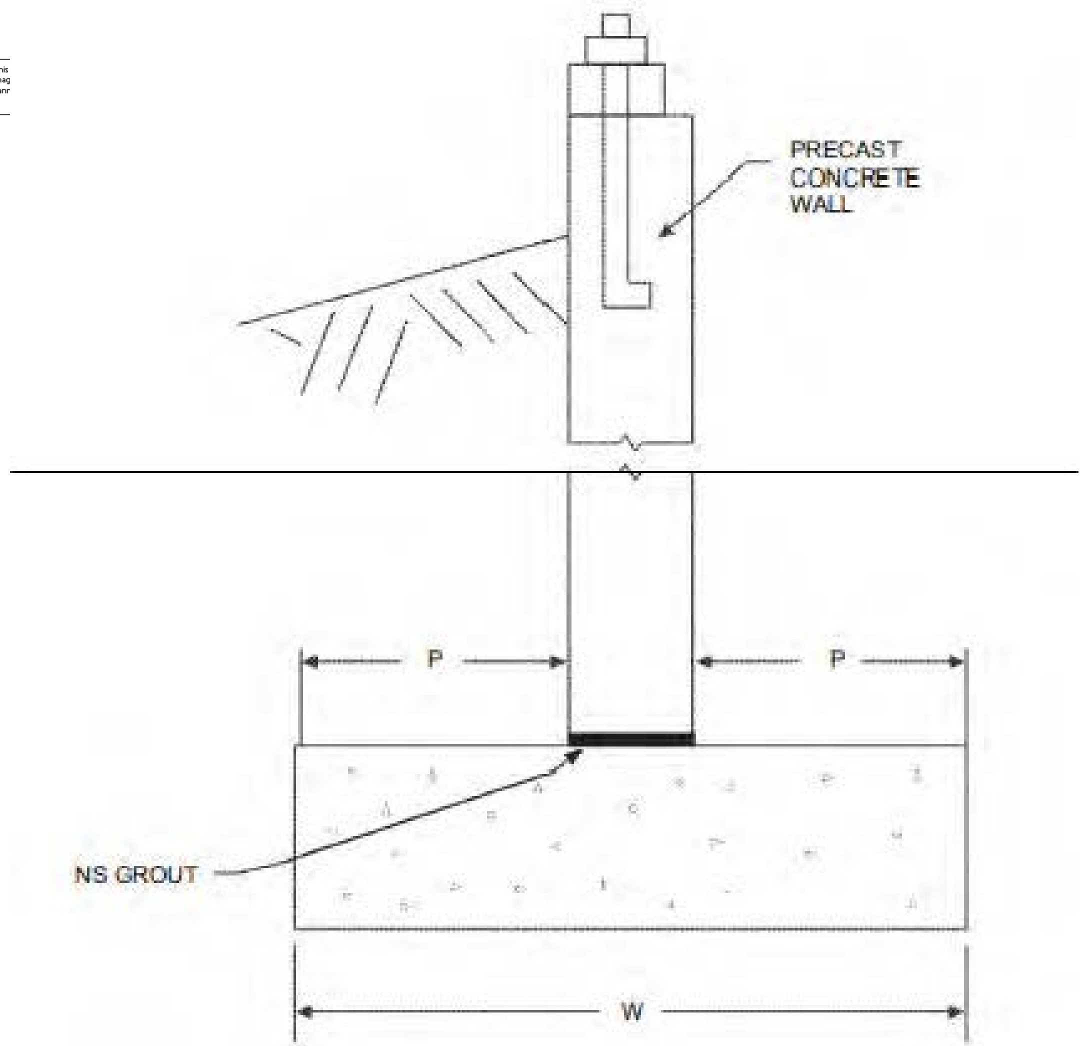
Does not degrade the effectiveness of the code

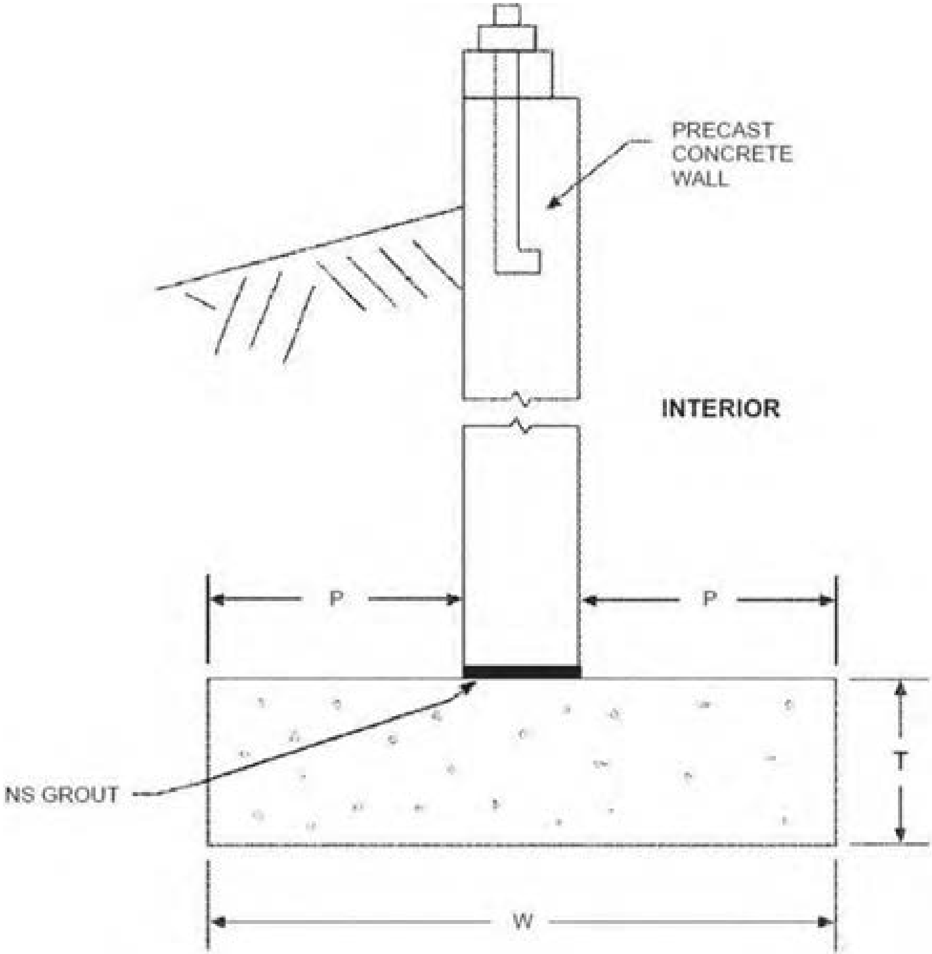
Simply adds T dimension for footer thickness with no additional effect on the code. Does not degrade the effectiveness of the code.

Revise as follows:

FIGURE R403.4 (2)

BASEMENT OR CRAWL SPACE WITH PRECAST FOUNDATION WALL ON SPREAD FOOTING




PRECAST
CONCRETE
WALL
INTERIOR
P
P
T
NS GROUT
W

S7654

Date Submitted	12/3/2018	**Section**	405.1	**Proponent**	Ann Russo8
Chapter	4	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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.

S7856

Date Submitted	12/12/2018	**Section**	505	**Proponent**	Bonnie Manley
Chapter	5	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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	Approved as Submitted				
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.

S7418

Date Submitted	11/24/2018	**Section**	606.2.3	**Proponent**	Joseph Crum
Chapter	6	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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 Approved as Submitted
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	Approved as Submitted				
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	
			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	All methods

			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	
	Number of braced wall lines (per plan direction)[c]		3	1.30	
			4	1.45	
4		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.

S7780

Date Submitted	12/8/2018	Section	602.1	Proponent	Borjen Yeh
Chapter	6	Affects HVHZ	No	Attachments	No

TAC Recommendation Approved as Submitted
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.

S7781

Date Submitted	12/9/2018	**Section** 610		**Proponent**	Borjen Yeh
Chapter	6	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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.

Text of 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 square foot (3.35 kPa), and the seismic design category is A, B or C.

R610.3 Materials.

SIPs shall comply with the ~~following criteria~~ requirements of ANSI/APA PRS 610.1:

~~**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.~~

R610.3.41 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 in accordance with ANSI/APA PRS 610.1.

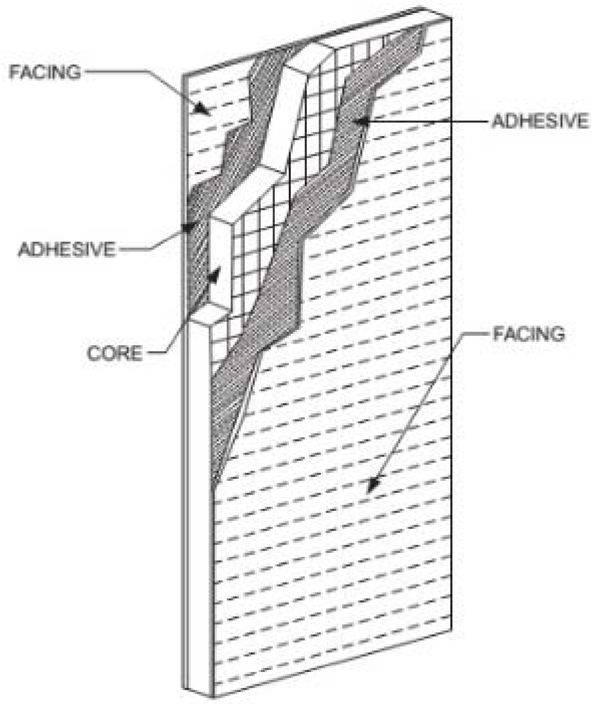


FIGURE R610.4

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.

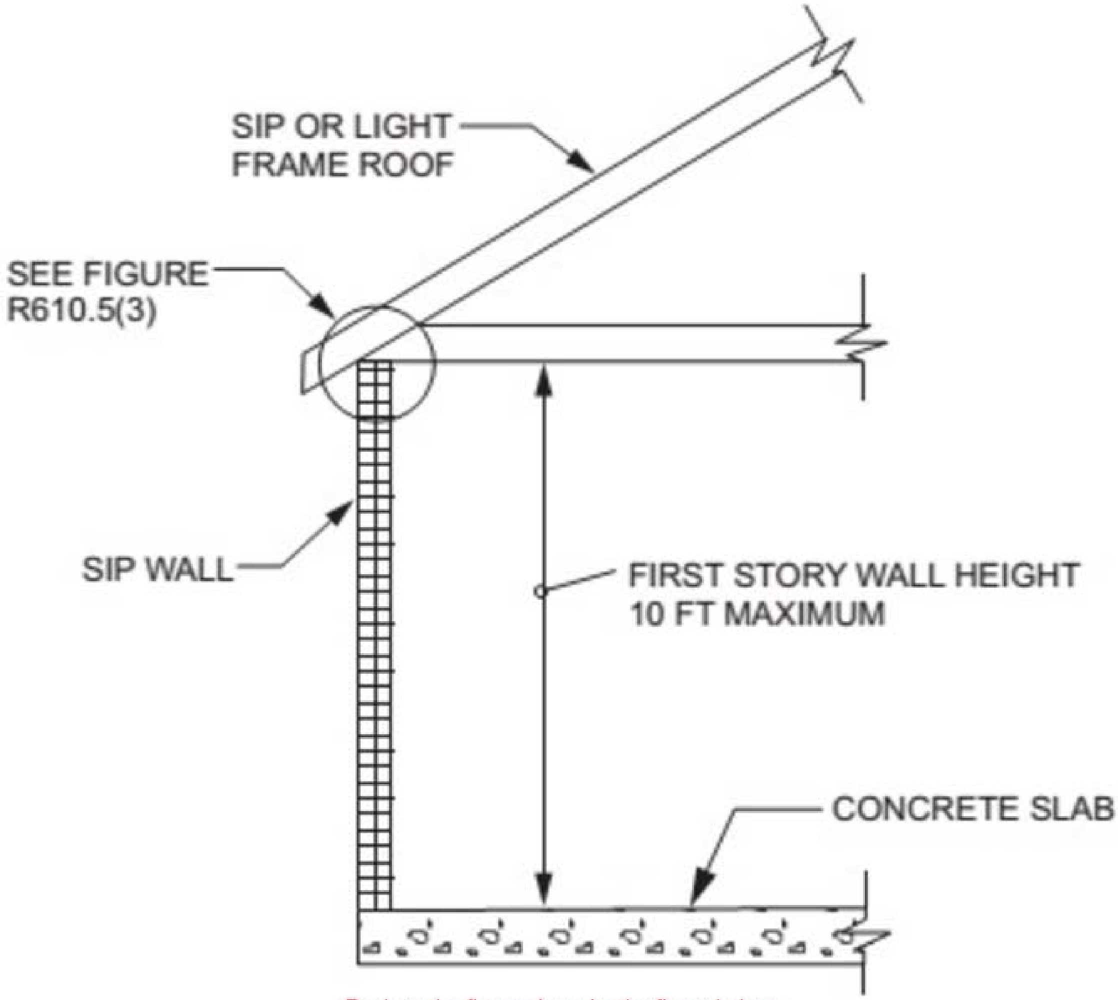
Maximum second-floor dead load from walls: 10 psf.

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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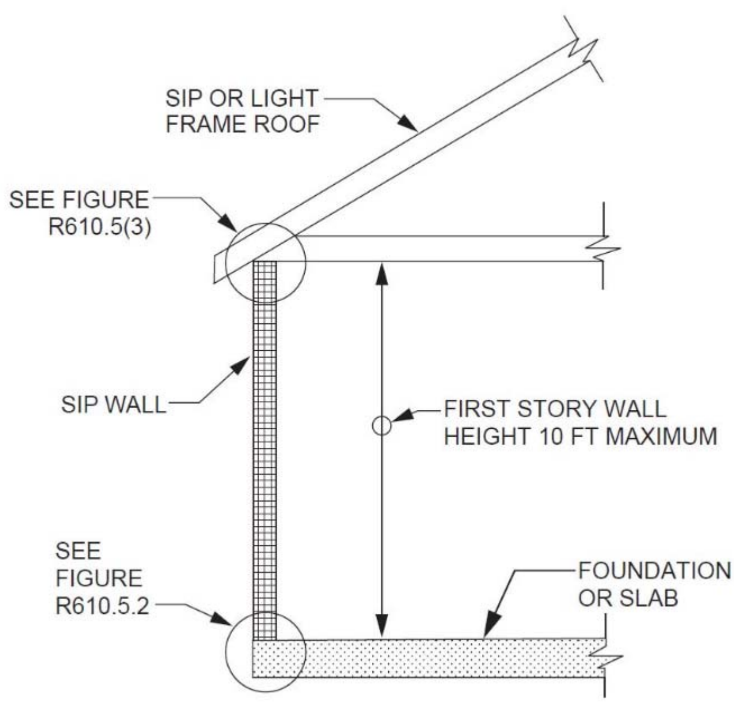
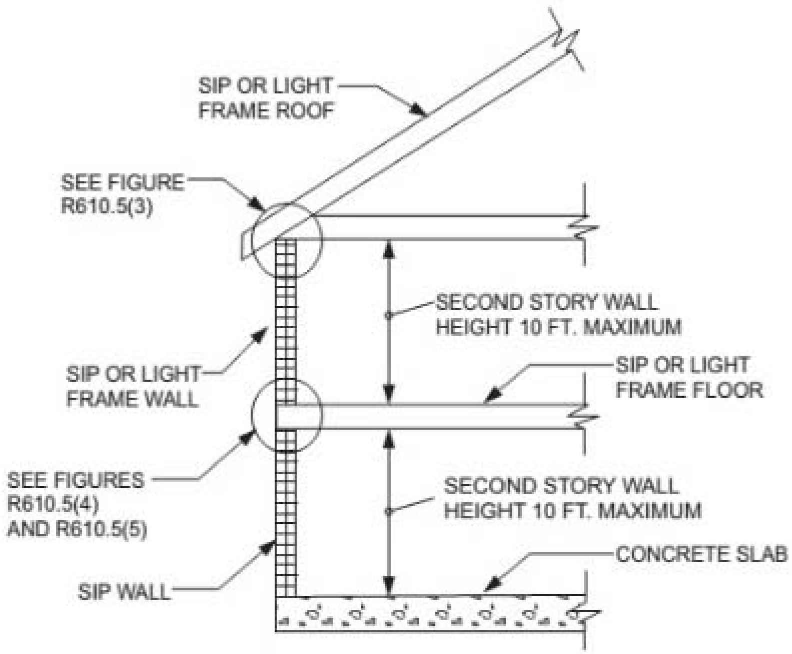


For SI: 1 foot = 304.8 mm.

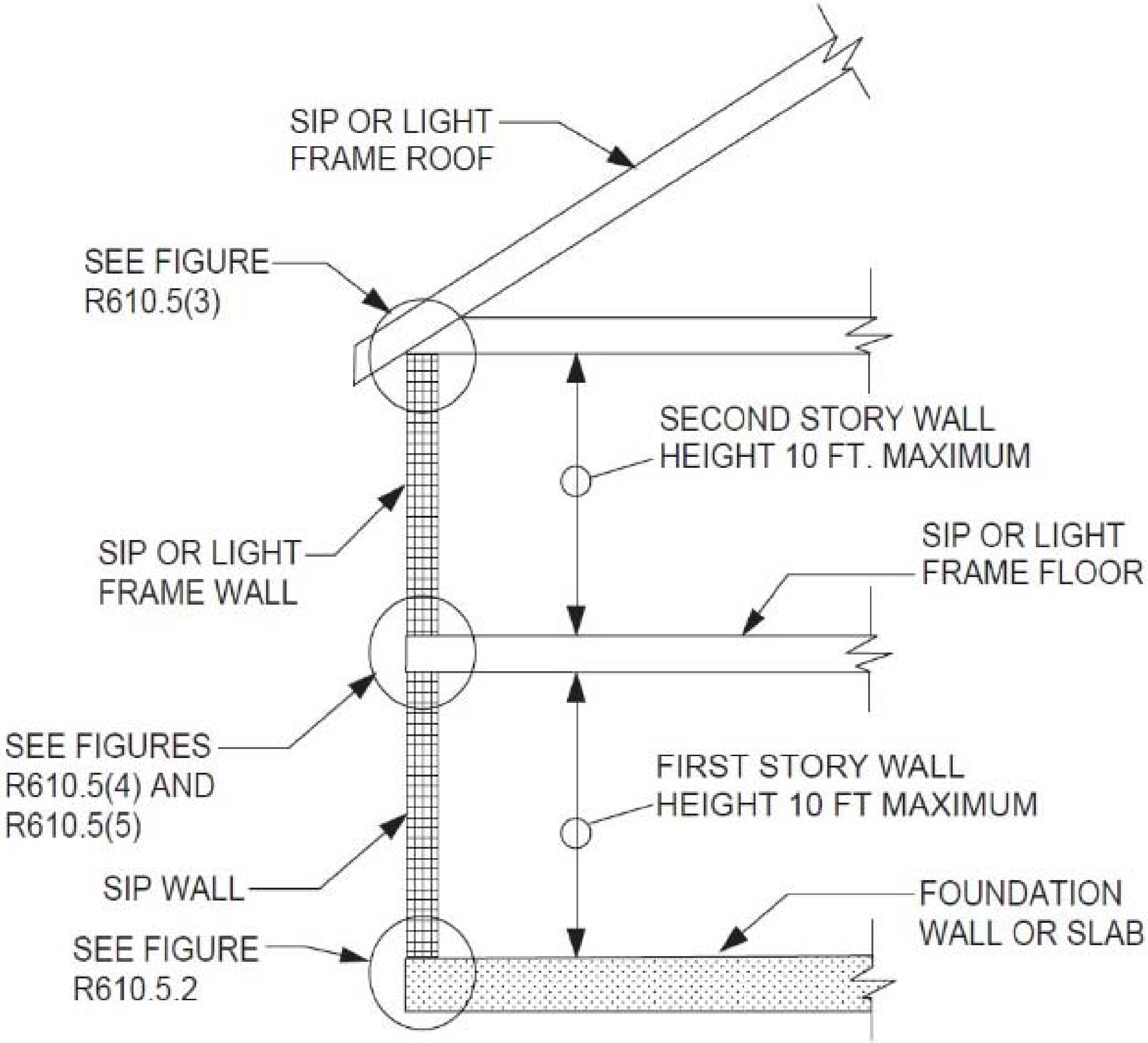
Note: Figures illustrate SIP-specific attachment requirements. Other connections shall be made in accordance with Tables R602.3(1) and (2), as appropriate.

FIGURE R610.5(1)

MAXIMUM ALLOWABLE HEIGHT OF SIP WALLS



Replace the figure above by the figure below

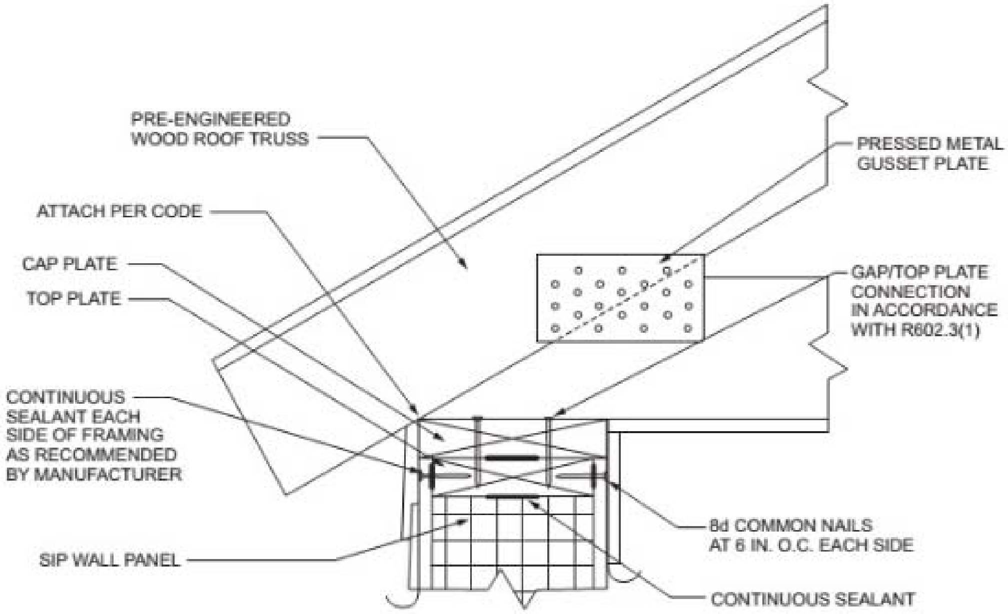


For SI: 1 inch = 25.4 mm.

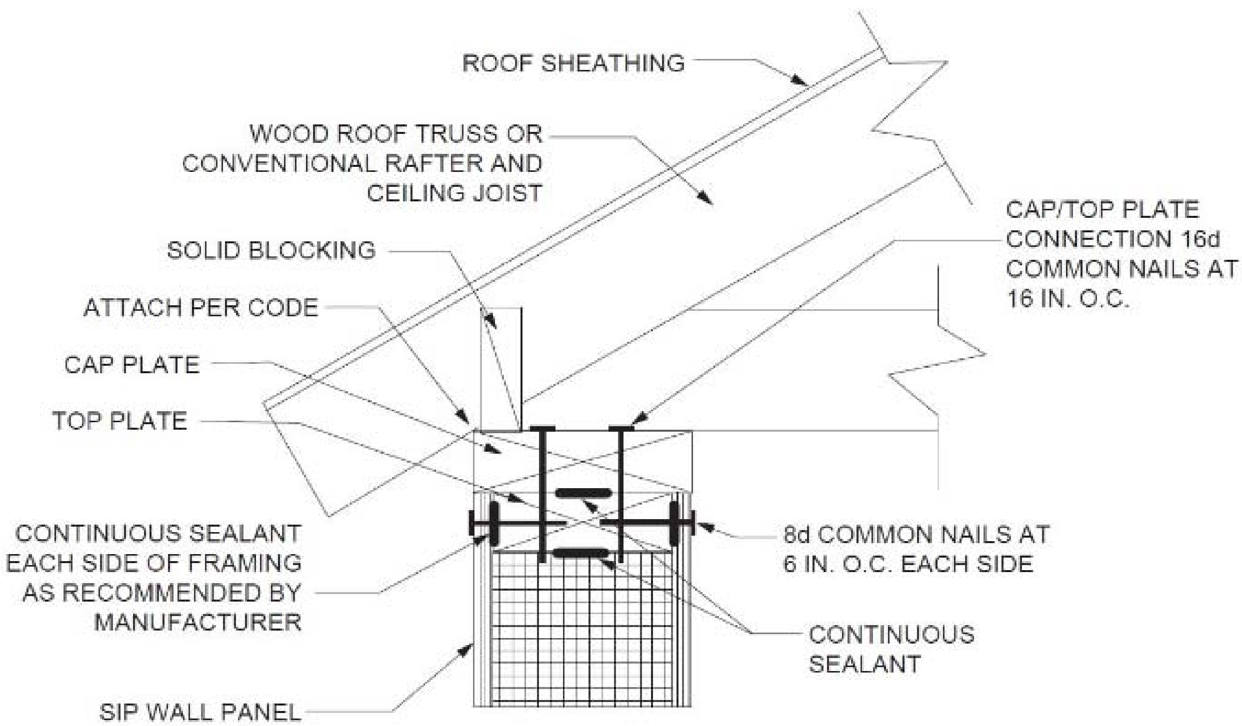
Note: Figures illustrate SIP-specific attachment requirements. Other connections shall be made in accordance with Tables R602.3(1) and (2), as appropriate.

FIGURE R610.5(2)

MAXIMUM ALLOWABLE HEIGHT OF SIP WALLS



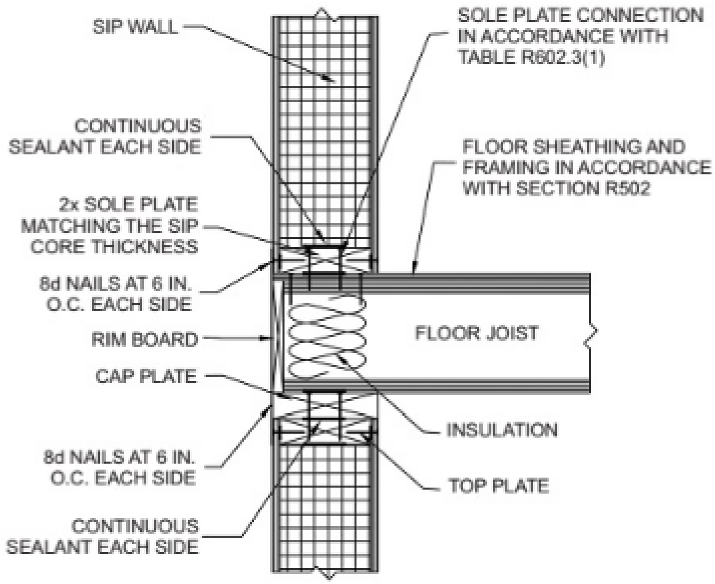
Replace the figure above by the figure below



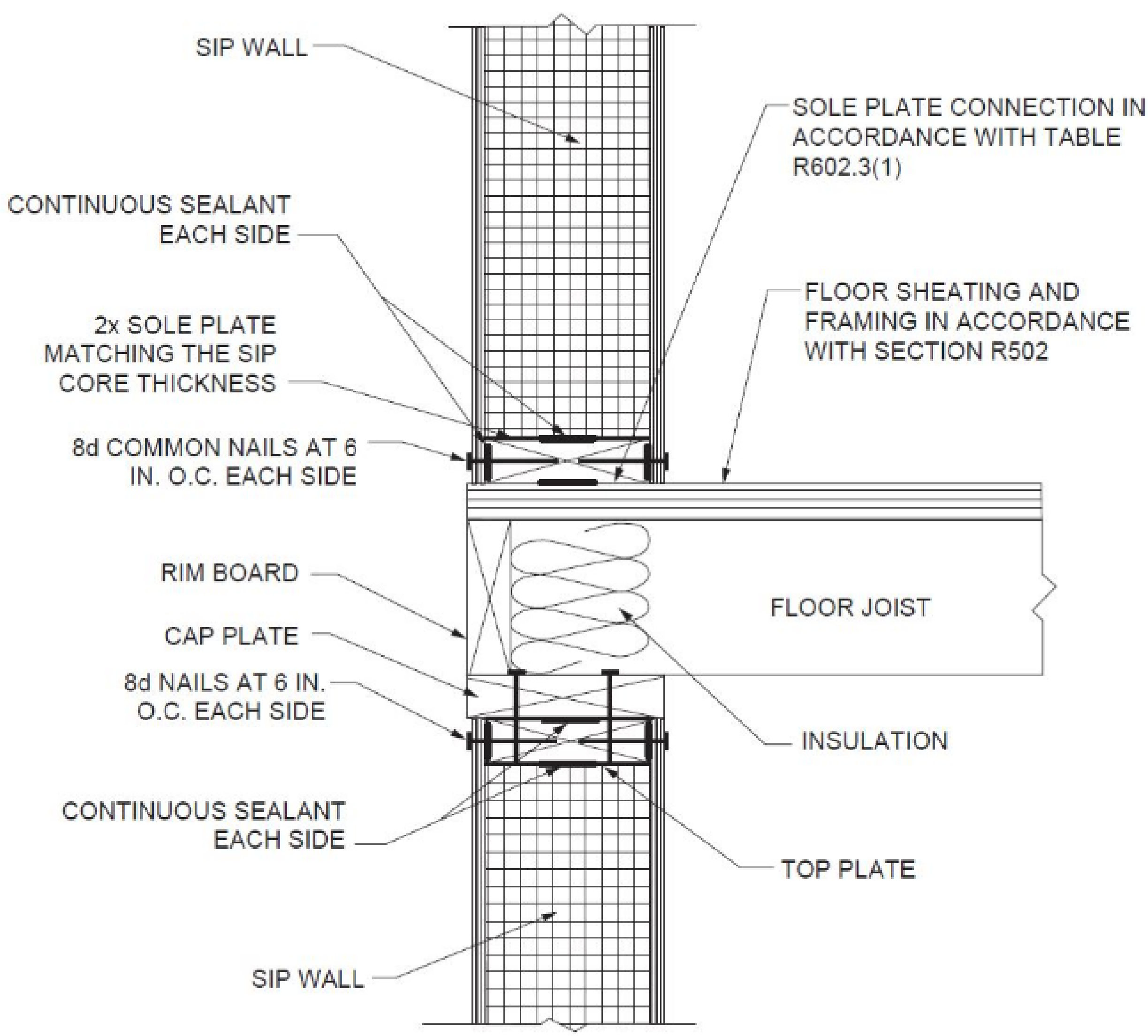
For SI: 1 inch = 25.4 mm.

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



Replace the figure above by the figure below

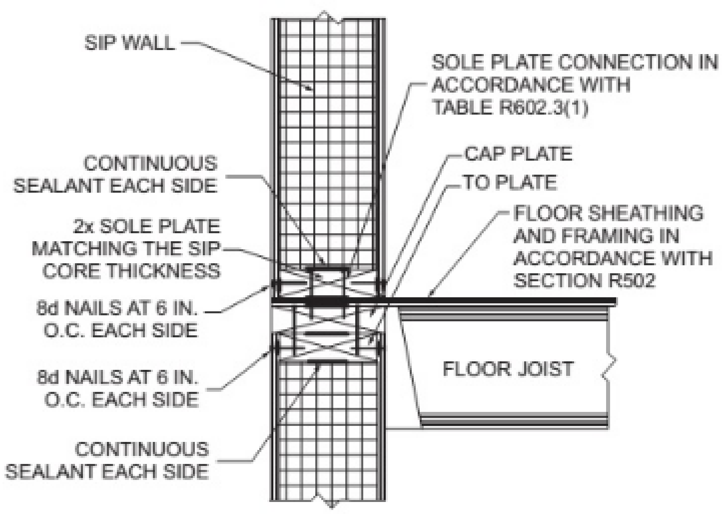


For SI: 1 inch = 25.4 mm.

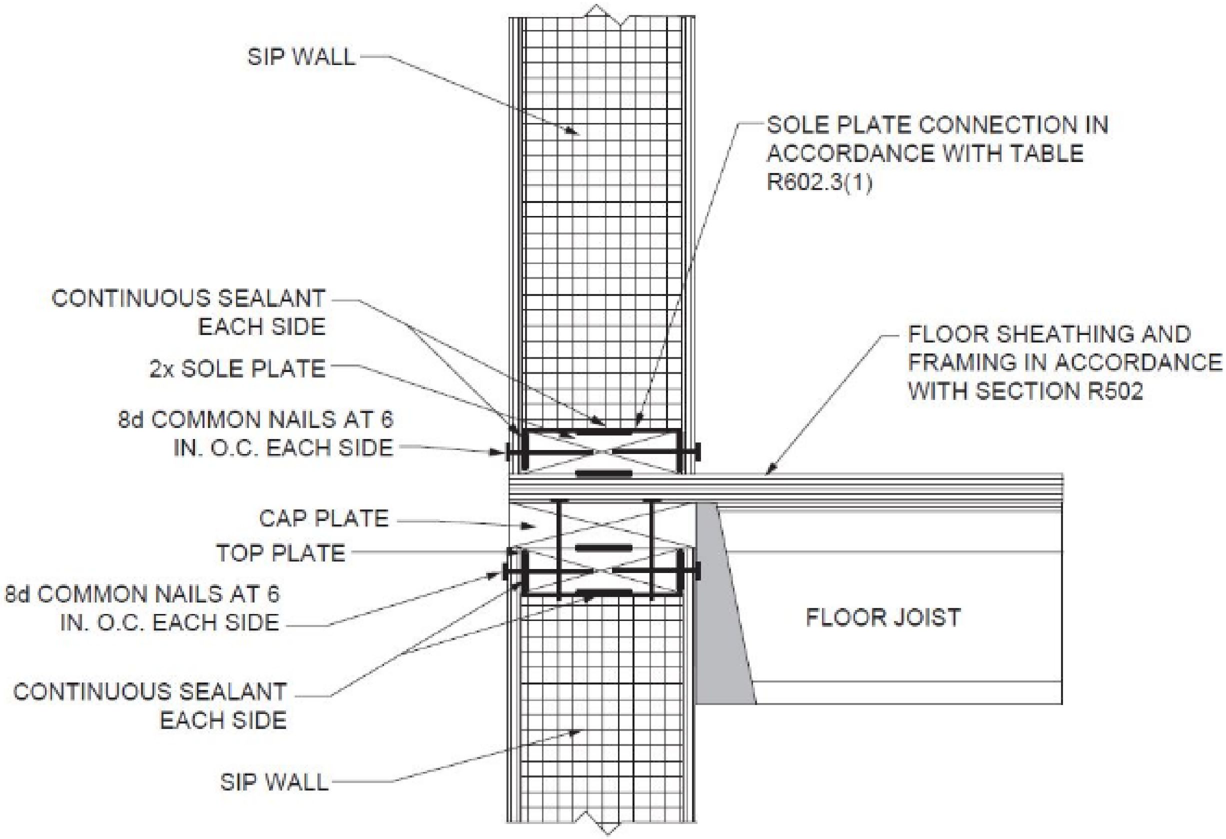
Note: Figures illustrate SIP-specific attachment requirements. Other connections shall be made in accordance with Tables R602.3(1) and (2), as appropriate.

FIGURE R610.5(4)

SIP WALL-TO-WALL PLATFORM FRAME CONNECTION



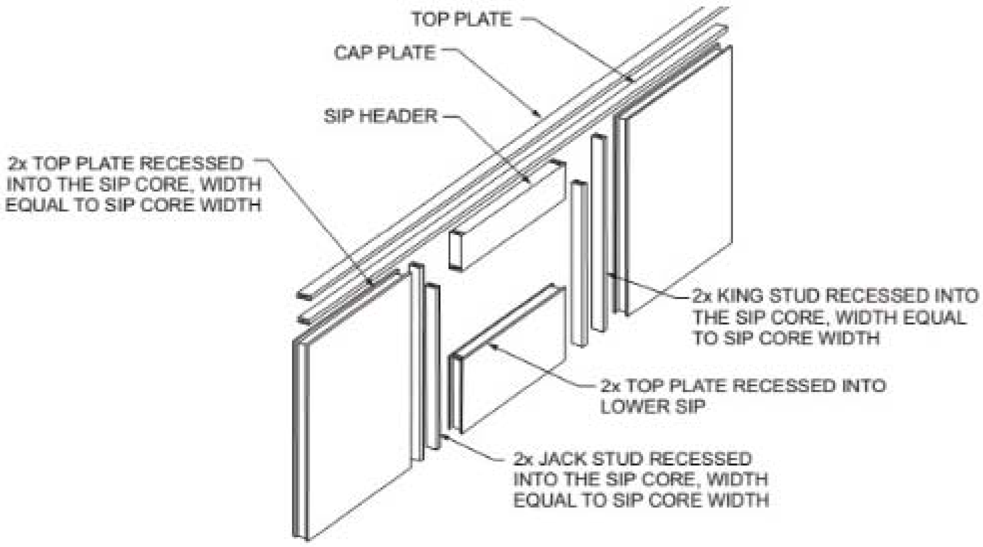
Replace the figure above by the figure below



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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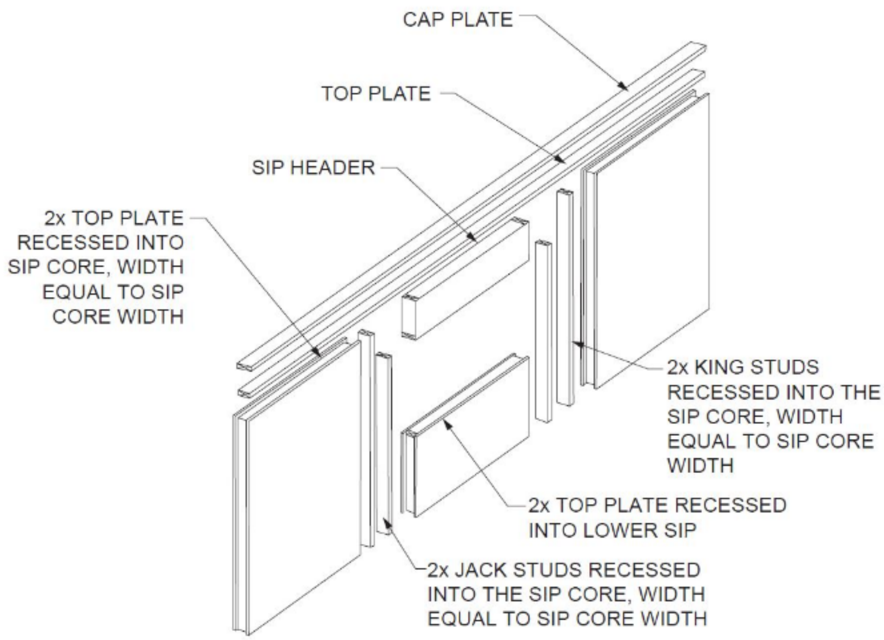


FIGURE R610.5.1

SIP WALL FRAMING CONFIGURATION

For SI: 1 inch = 25.4 mm.

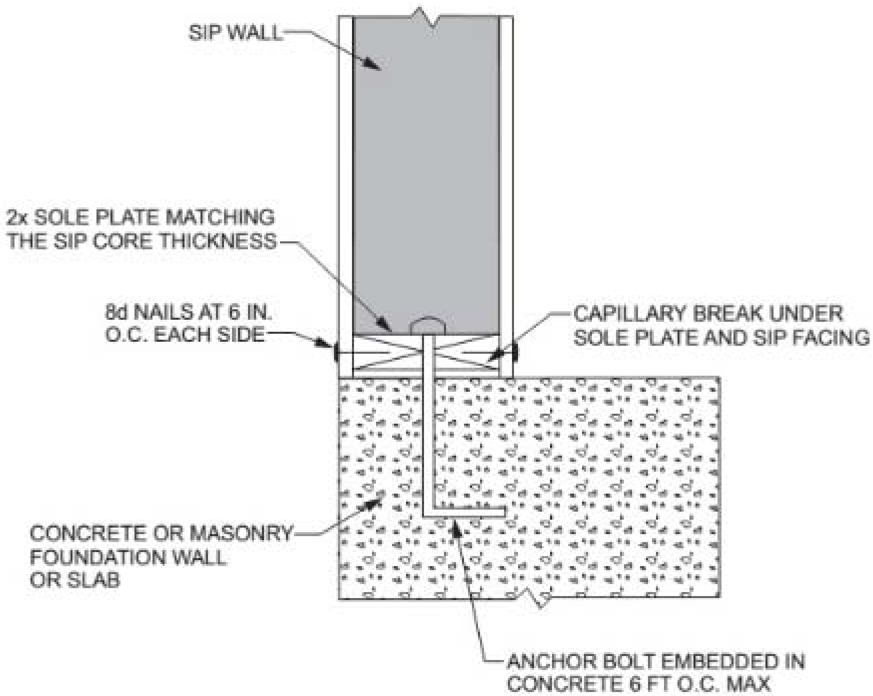
Notes:

1.Top plates shall be continuous over header.

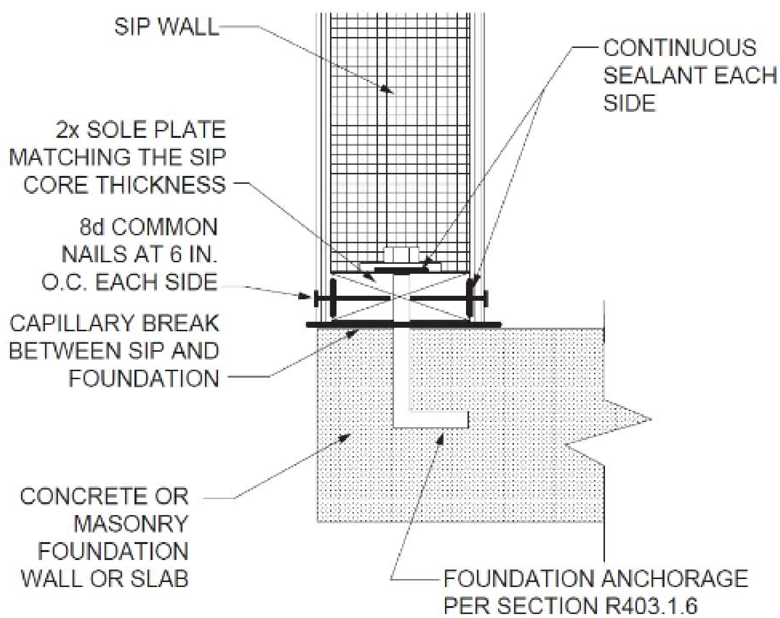
2.Lower 2x top plate shall have a width equal to the SIP core width and shall be recessed into the top edge of the panel. Cap plate shall be placed over the recessed top plate and shall have a width equal to the SIPs width.

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.~~



Replace the figure above by the figure below



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.

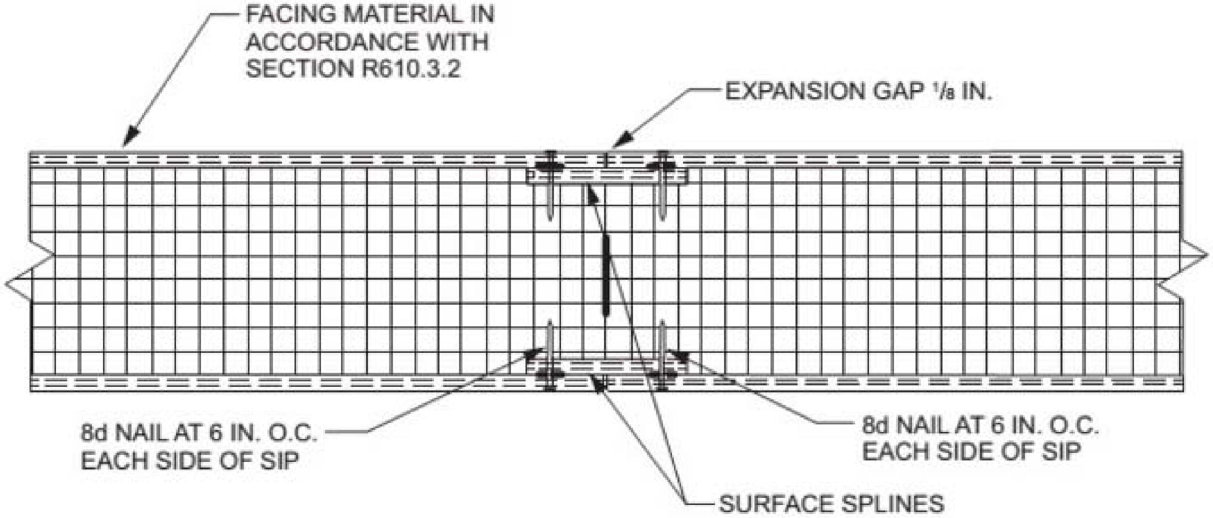
R610.5.4 Corner framing.
Corner framing of SIP walls shall be constructed in accordance with Figure R610.5.4.

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).

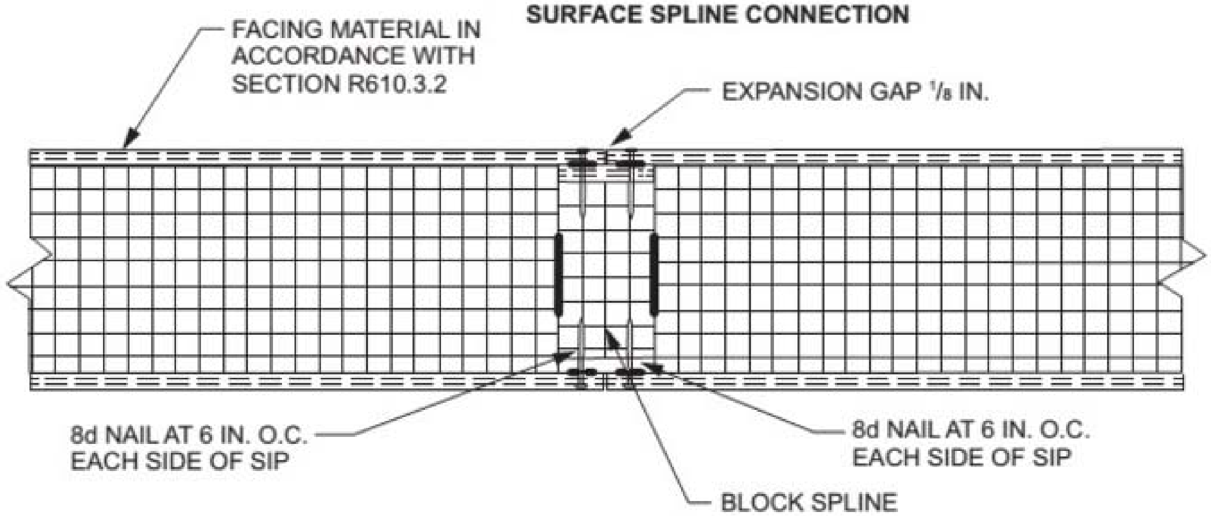
R610.6 Interior load-bearing walls.
Interior load-bearing walls shall be constructed as specified for exterior walls.

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.~~

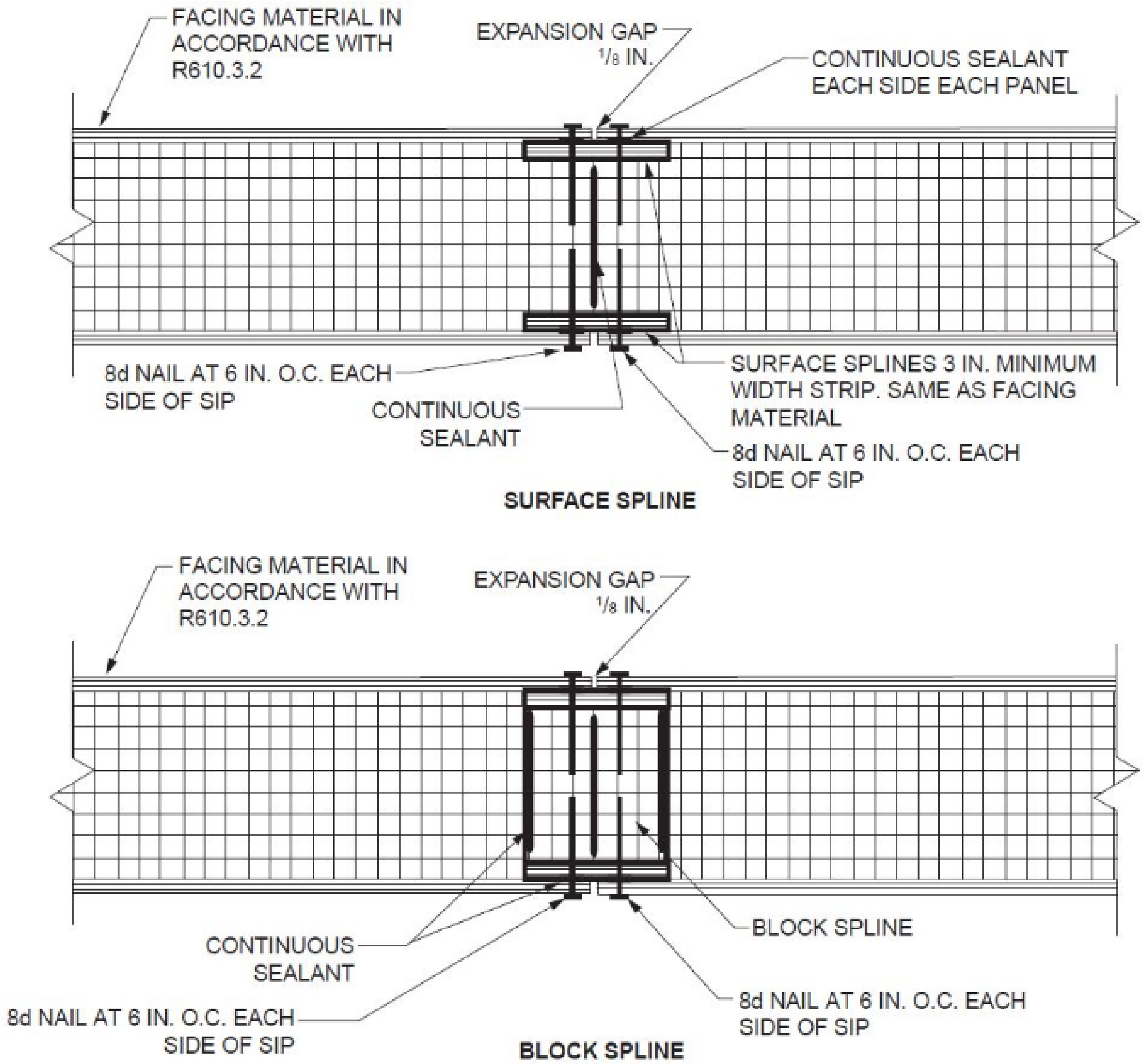


SURFACE SPLINE CONNECTION



BLOCK SPLINE CONNECTION

Replace the figure above by the figure below



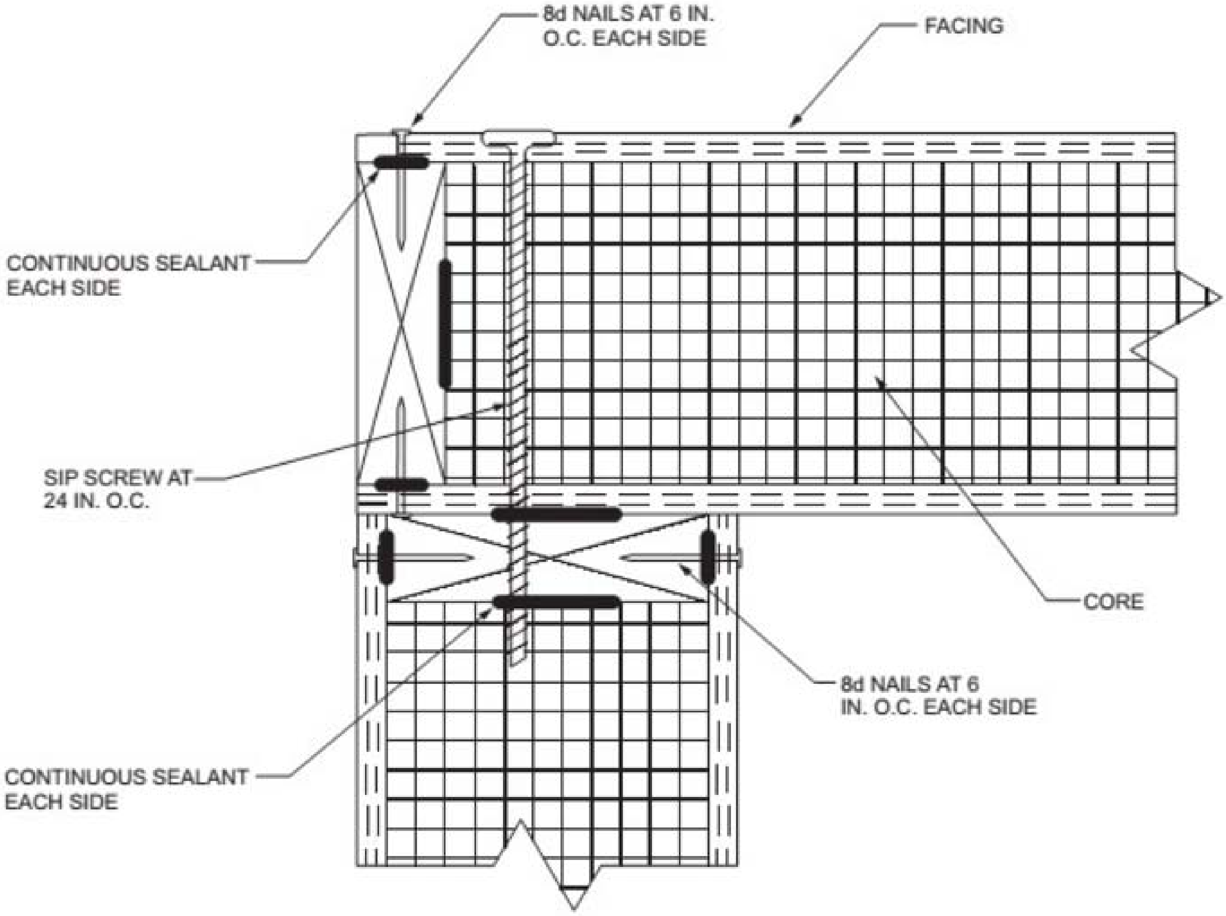
For SI: 1 inch = 25.4 mm.

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.~~



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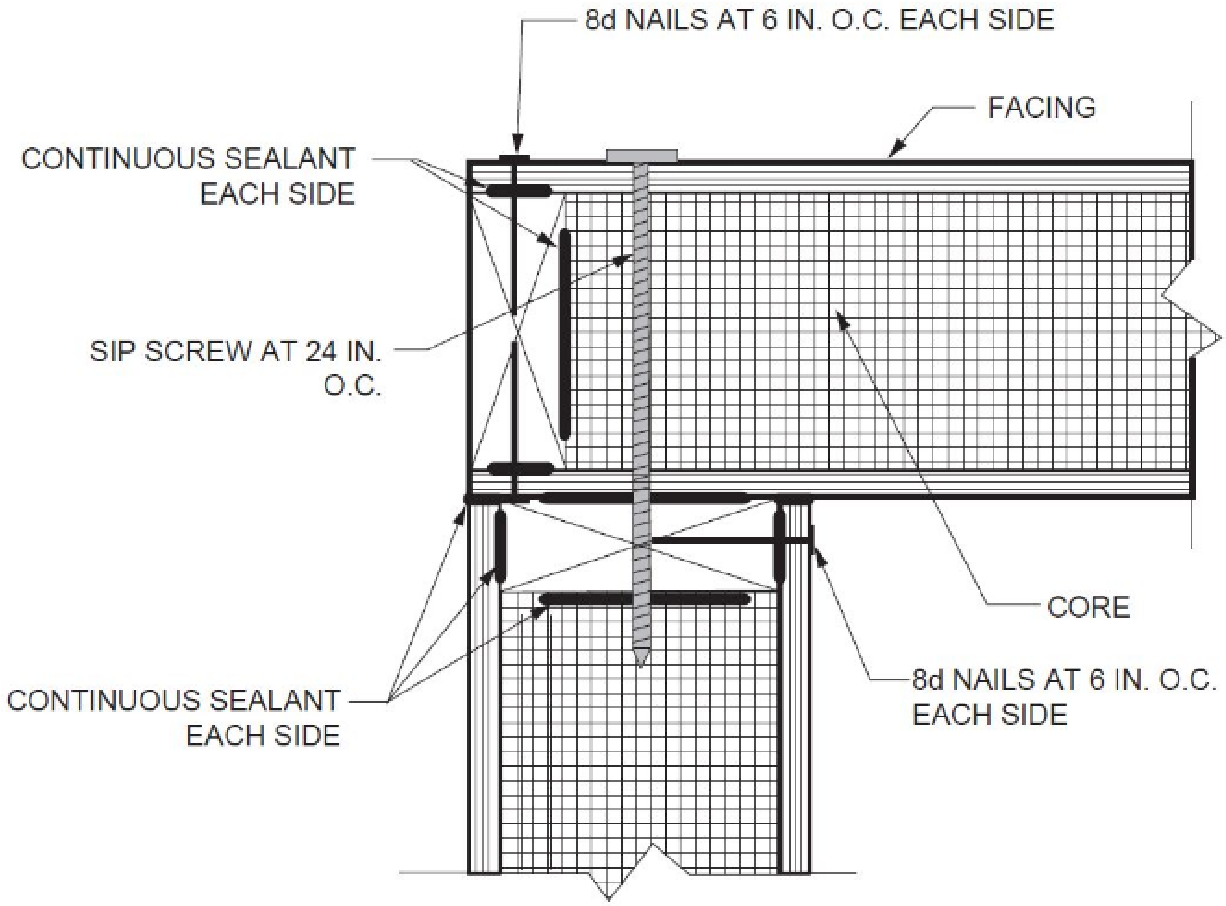


For SI: 1 inch = 25.4 mm.

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	Approved as Submitted				
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 Approved as Submitted
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.

Text of 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-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~~ 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 bracedwall 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 paneledges, 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.

S7787

Date Submitted	12/9/2018	**Section**	602.10.4.1	**Proponent**	Borjen Yeh
Chapter	6	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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

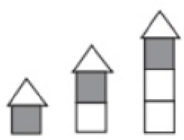
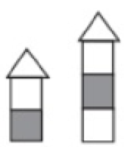
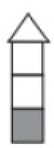
This proposal does not degrade the effectiveness of the code

Text of Mod 7787

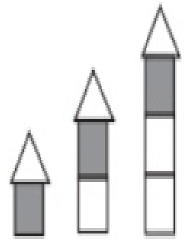
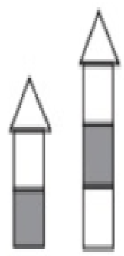
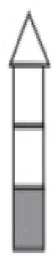
Revise

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~~ do 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	Approved as Submitted				
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

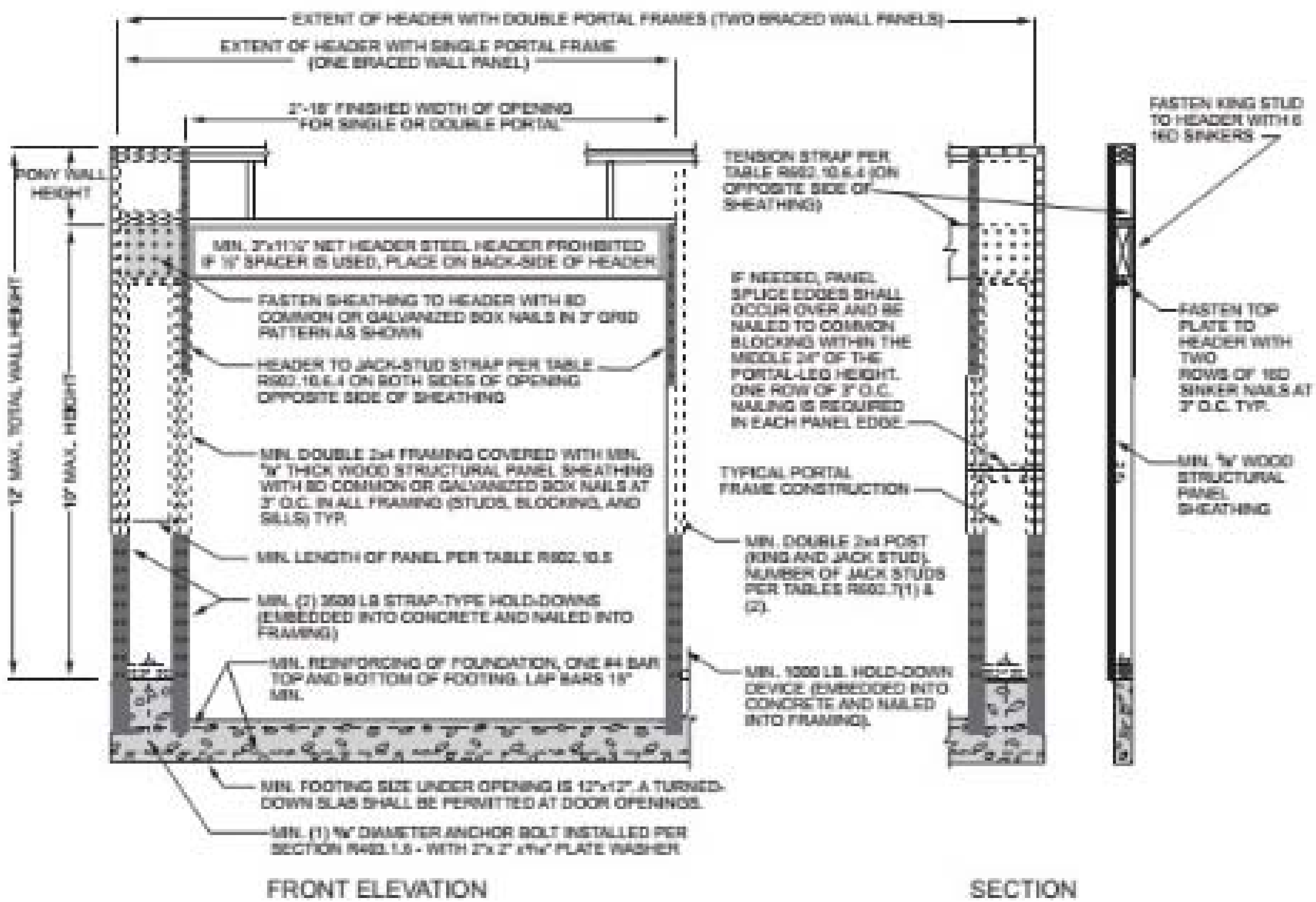
This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

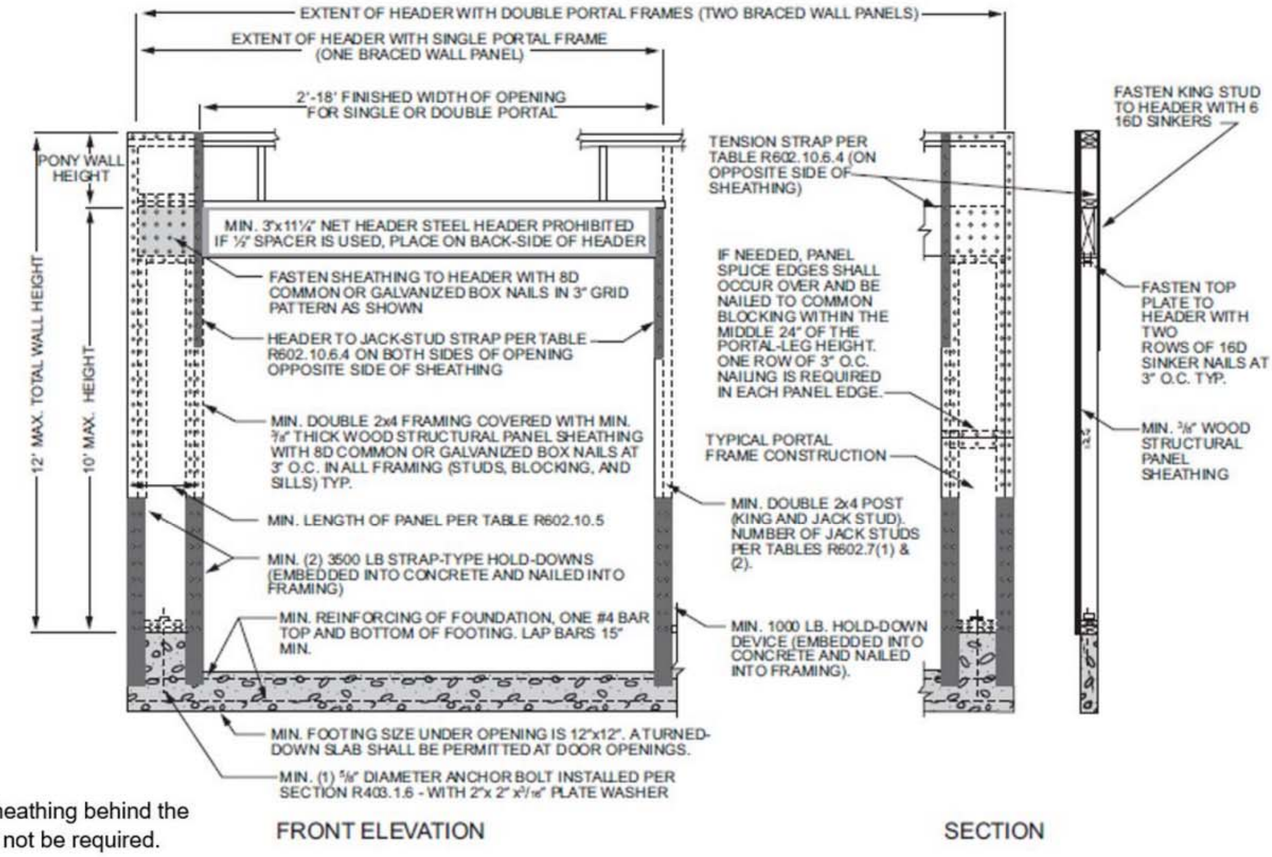
This proposal does not degrade the effectiveness of the code.

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.



Replace the figure above by the figure below.



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	**Section**	602.10.6.4	**Proponent**	Borjen Yeh
Chapter	6	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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.

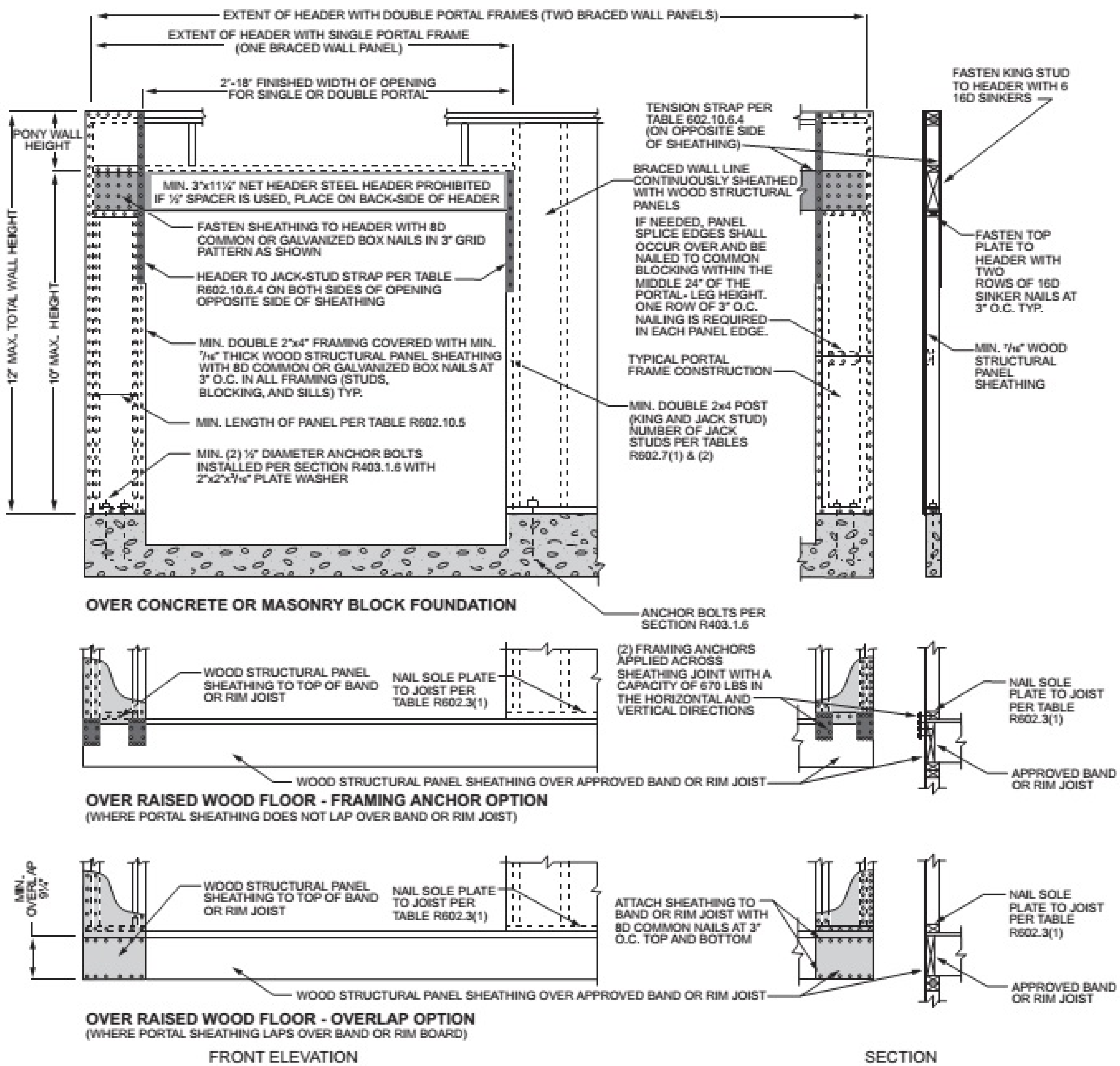
Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

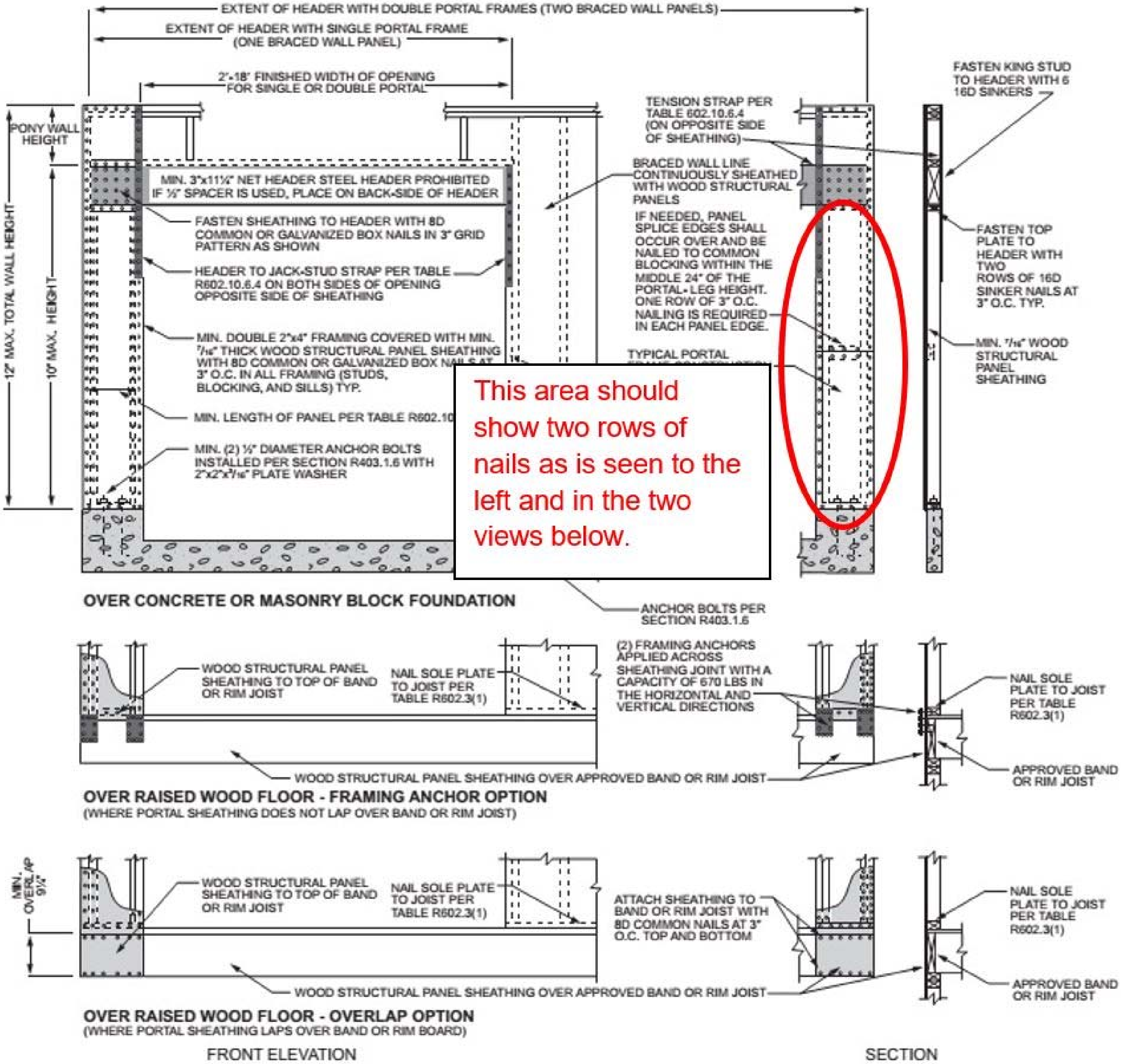
Text of Mod 7797

R602.10.6.4Method CS-PF: Continuously sheathed portal frame.

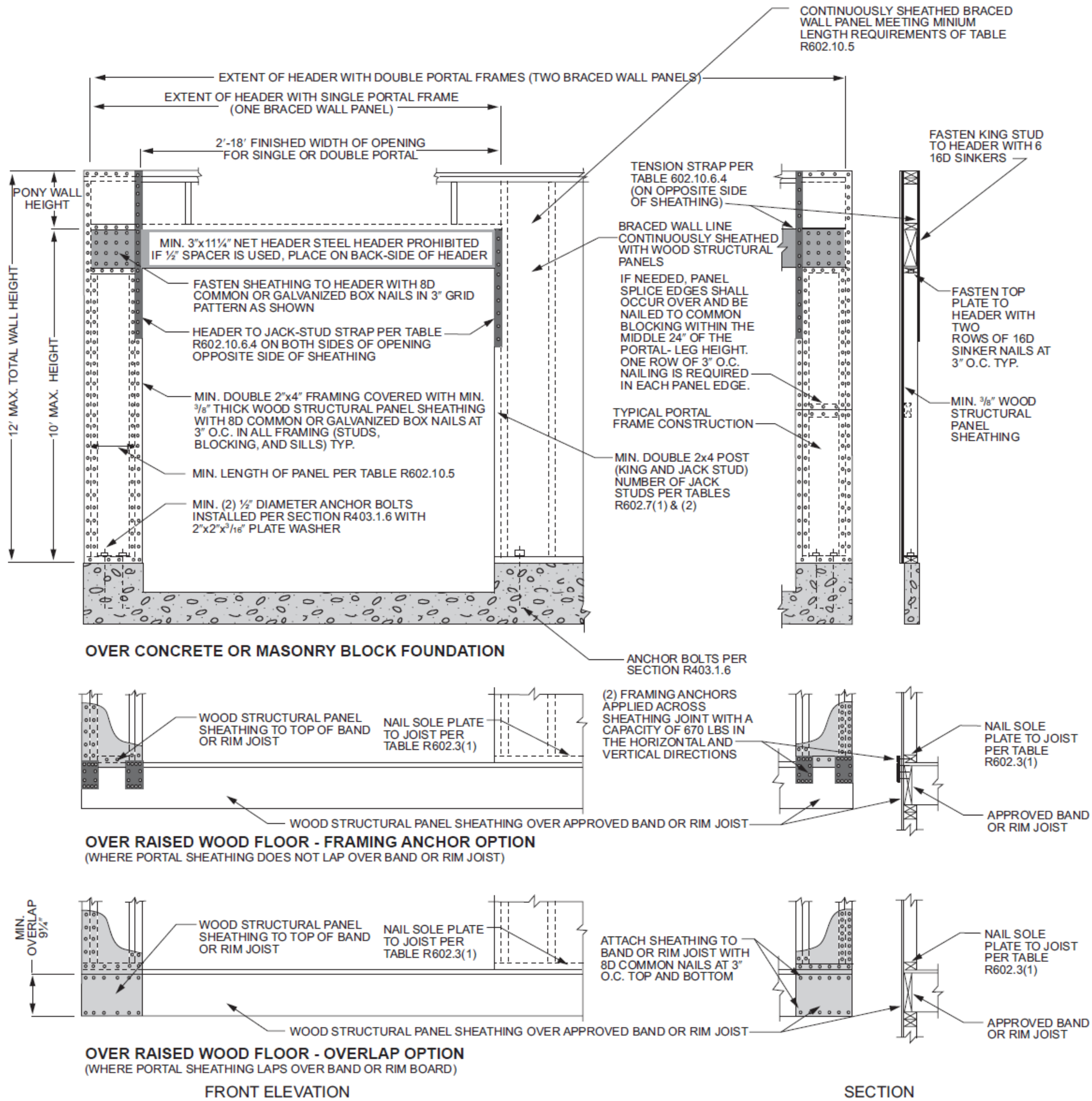
Continuously sheathed portal frame *braced wall panels* shall be constructed in accordance with Figure R602.10.6.4and Table R602.10.6.4. The number of continuously sheathed portal frame panels in a single *braced wall line* shall



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 Approved as Submitted
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.

Text of Mod 7799

R602.10.6.4Method CS-PF: Continuously sheathed portal frame.

Continuously sheathed portal frame *braced wall panels* shall be constructed in accordance with Figure R602.10.6.4 and Table R602.10.6.4. The number of continuously sheathed portal frame panels in a single *braced wall line* shall not exceed four.

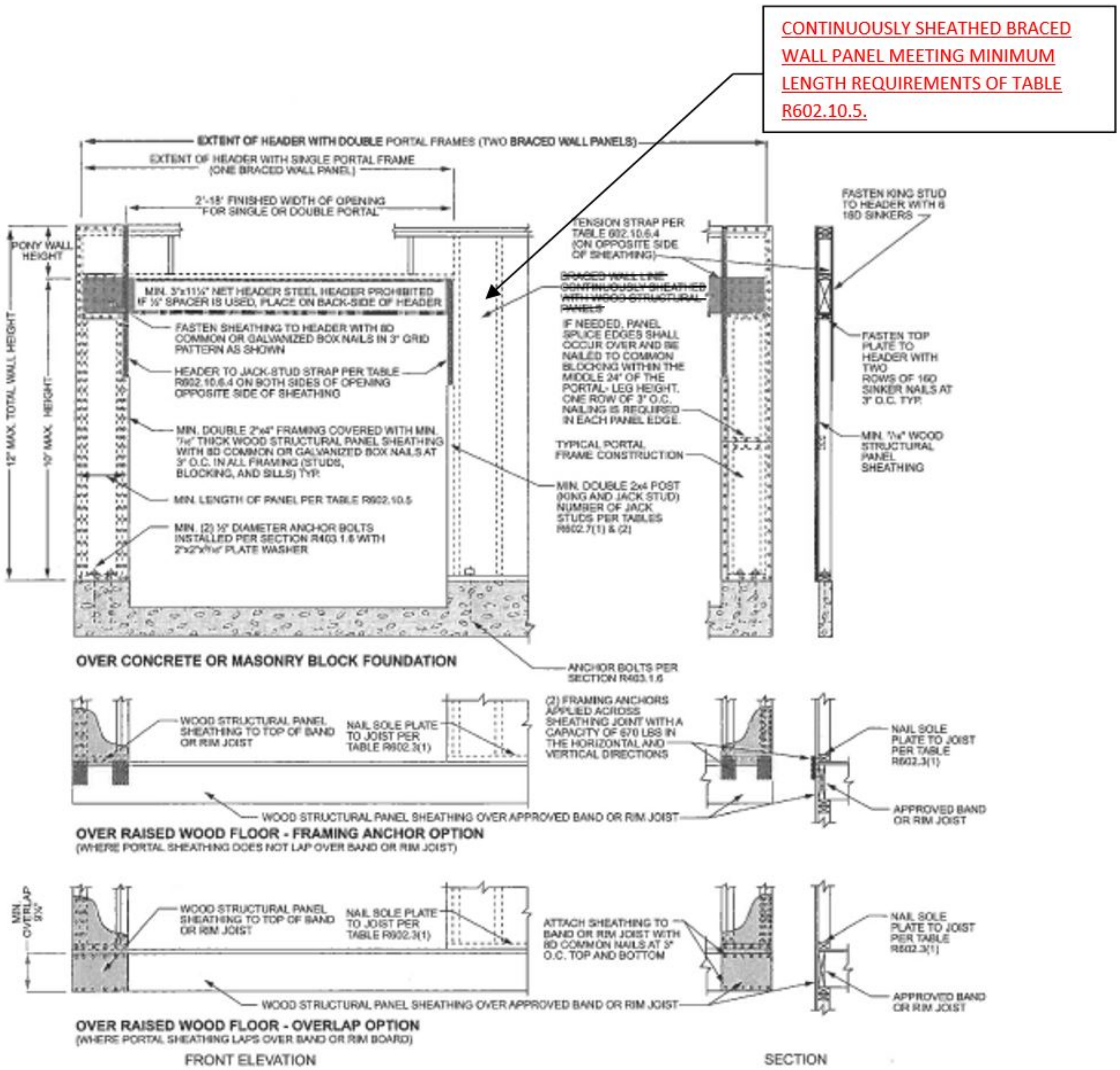


FIGURE R602.10.6.4

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	Approved as Submitted
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.

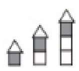
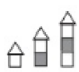
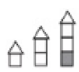
Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Text of 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.

S7857

Date Submitted	12/12/2018	**Section**	603	**Proponent**	Bonnie Manley
Chapter	6	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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*.

S7946

Date Submitted	12/11/2018	**Section**	602.10.5	**Proponent**	Borjen Yeh
Chapter	6	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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	Actualb
	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	
	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
PFH	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
CS-PF	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 Approved as Submitted
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.

S8096

Date Submitted	12/13/2018	**Section**	602.3	**Proponent**	Paul Coats
Chapter	6	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Approved as Submitted
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

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	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**

S8227

Date Submitted	12/14/2018	**Section**	602.7	**Proponent**	Paul Coats
Chapter	6	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Approved as Submitted				
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 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)**~~

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)~~

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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~~	~~3-9~~	~~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)**~~

-

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

ICC COMMITTEE ACTION HEARINGS ::: April, 2016 RB542

~~Roof, ceiling and two center-bearing floors~~	~~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~~
	~~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~~
~~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~~	~~2-0~~	~~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~~
	~~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	Approved as Submitted
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 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)**~~

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 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.

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	Approved as Submitted
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.

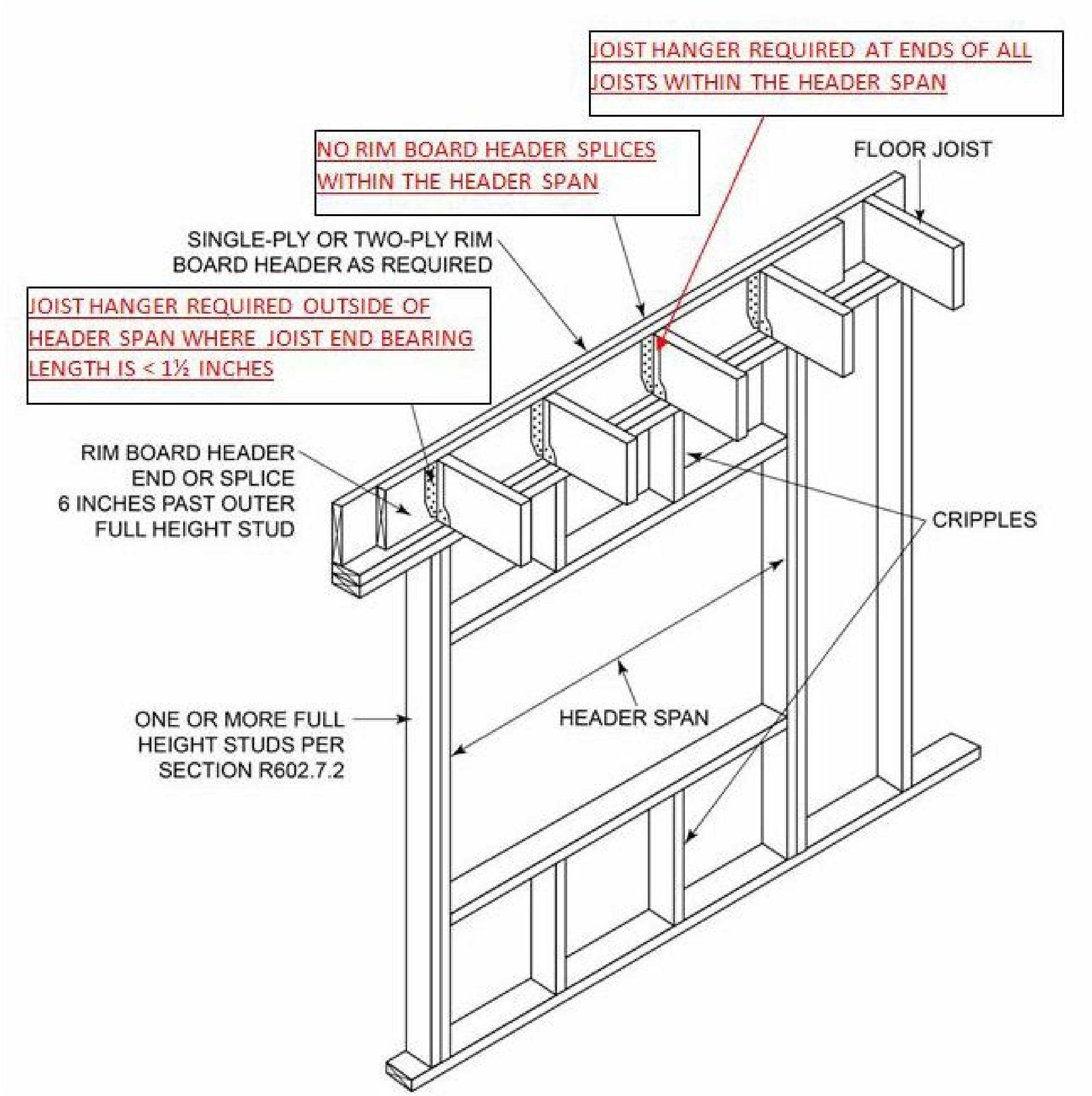
Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

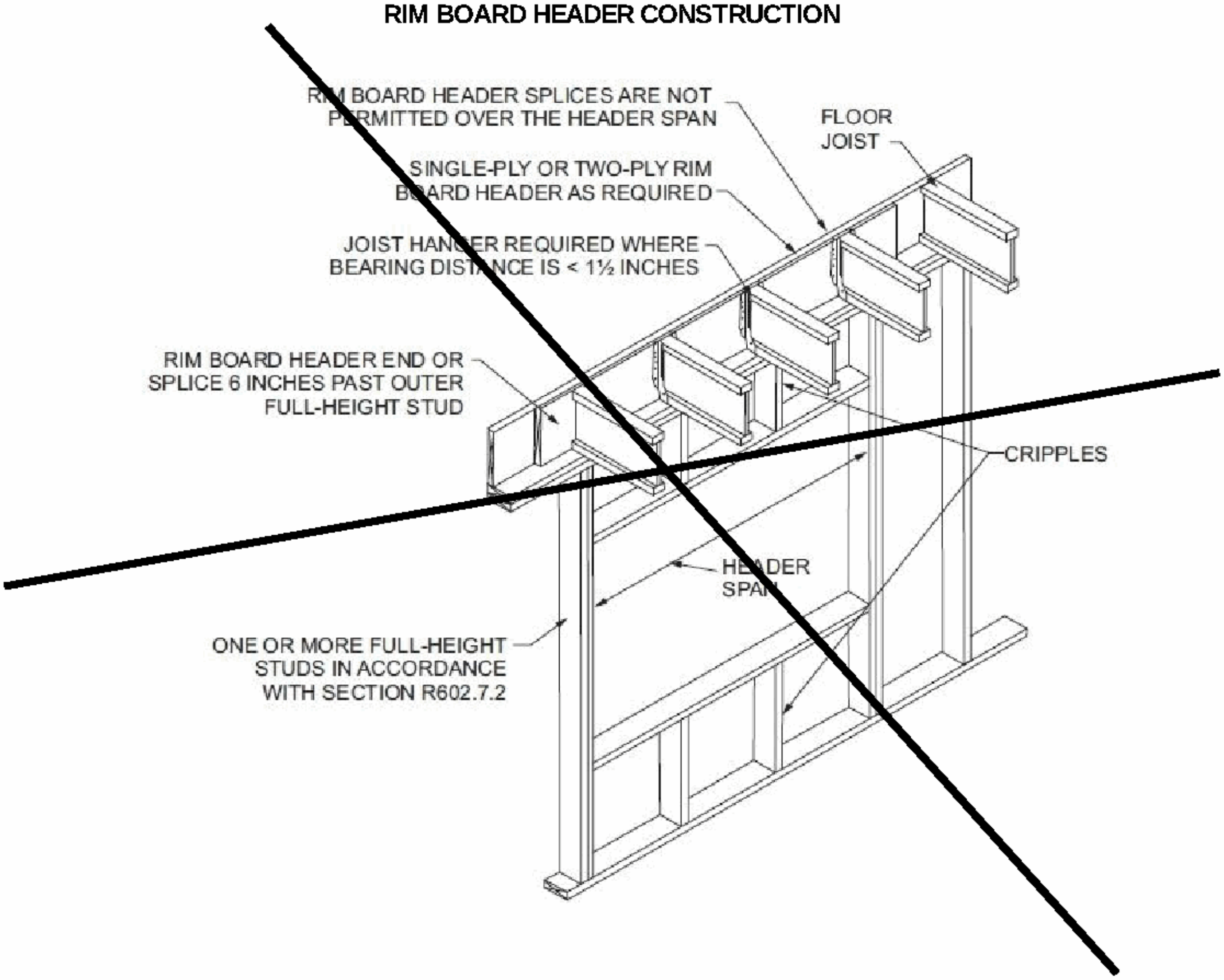
Does not degrade the effectiveness of the code.

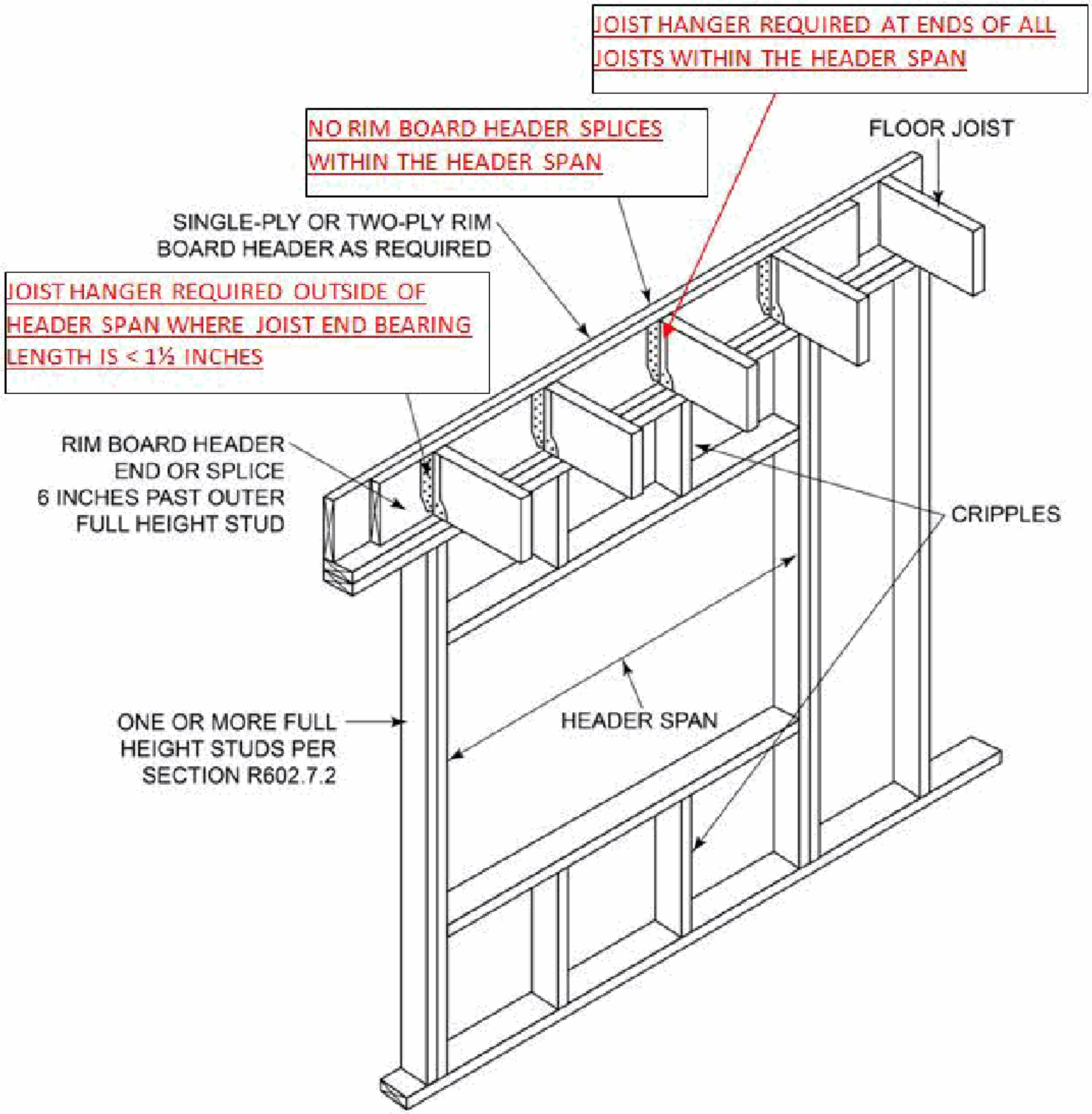
Replace Fig. R602.7.2 RIM BOARD HEADER CONSTRUCTION with the attached new figure and call-outs (underlined call-outs are new or corrected);



Revise as follows:

FIGURE R602.7.2
RIM BOARD HEADER CONSTRUCTION





For SI: 25.4 mm = 1 inch.

Final Action: AS (Approved as Submitted)

RB228-16

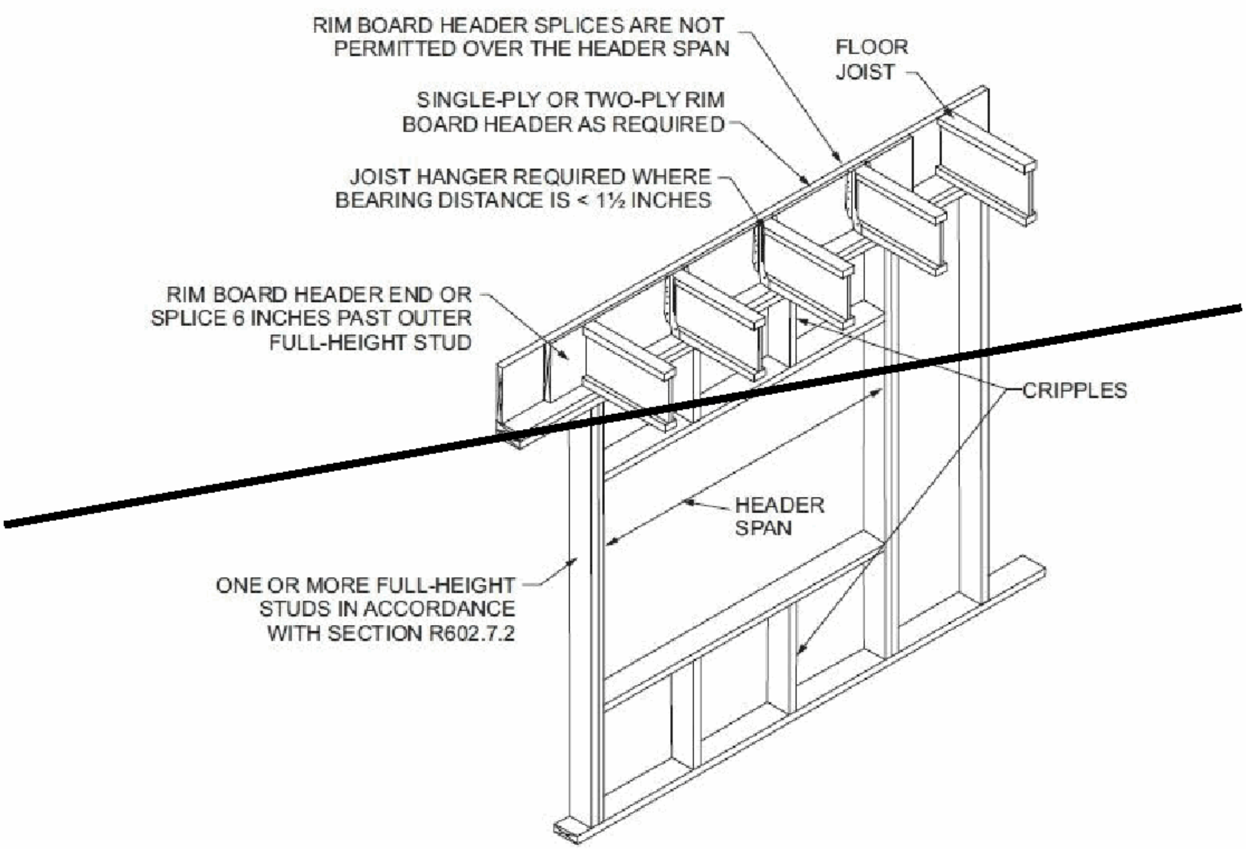
IRC: R602.7.2.

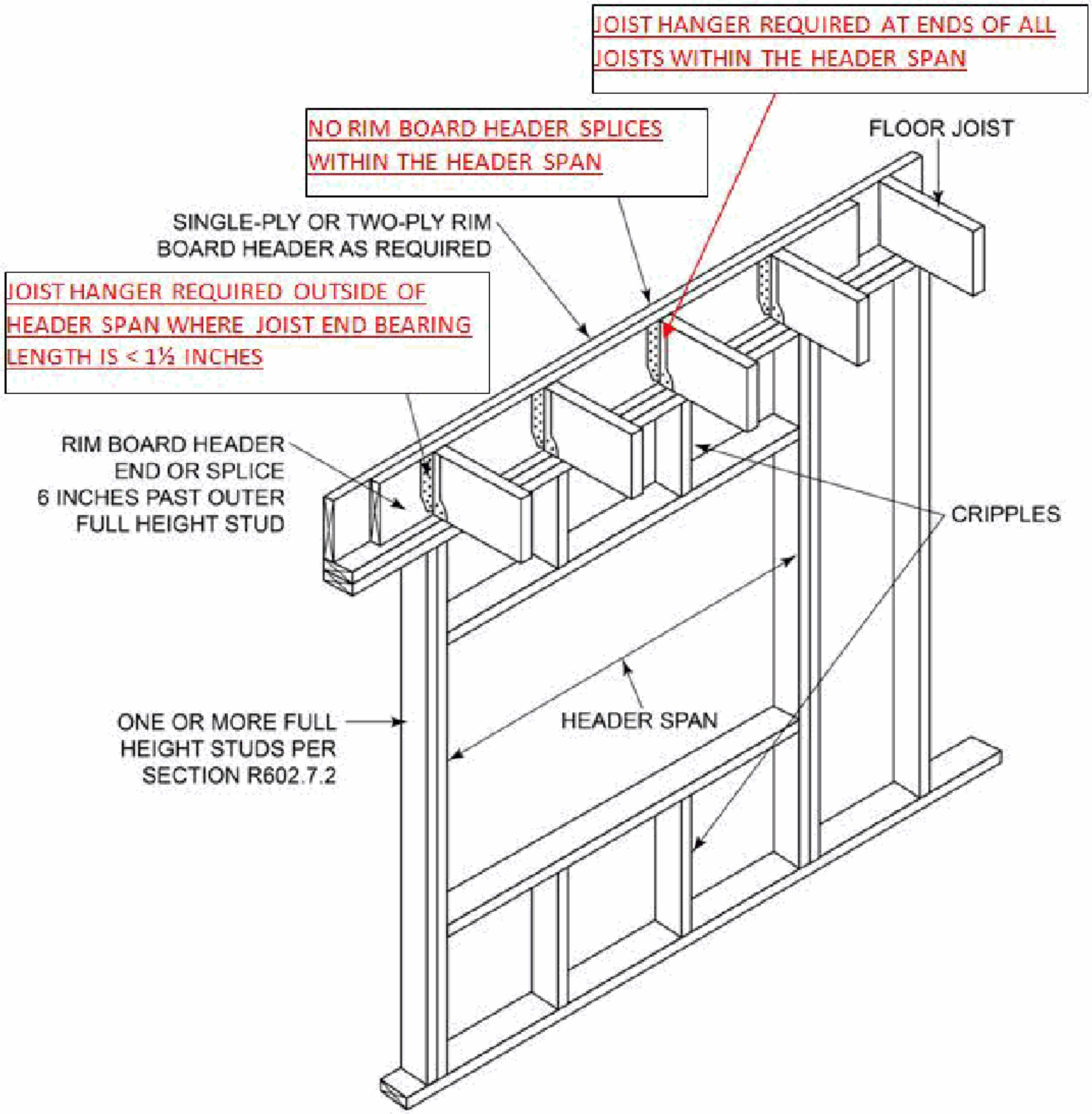
Proponent : Matthew Hunter, representing American Wood Council (mhunter@awc.org)

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)

Date Submitted 12/14/2018 **Chapter** 6

Section 602.7.5 **Affects HVHZ** No

Proponent Paul Coats **Attachments** Yes

TAC Recommendation Approved as Submitted
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	Approved as Submitted				
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 ($2^{1}/_{2}$″ 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	$^{3}/_{4}$″(1″ nominal) for maximum 24″ stud spacing		2-8d ($2^{1}/_{2}$″ long × 0.113″ dia.) nails or 2 - $1^{3}/_{4}$″ long staples	Per stud
	WSP Wood structural panel (See Section R604)	$^{3}/_{8}$″		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	$^{7}/_{16}$″	See Figure R602.10.6.5	8d common ($2^{1}/_{2}$″ × 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.

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	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 ($2^1/_2$″ 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	$^3/_4$″(1″ nominal) for maximum 24″ stud spacing		2-8d ($2^1/_2$″ long × 0.113″ dia.) nails or 2 - $1^3/_4$″ long staples	Per stud
	WSP Wood structural panel (See Section R604)	$^3/_8$″		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	$^7/_{16}$″	See Figure R602.10.6.5	8d common ($2^1/_2$″ × 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	Approved as Submitted				
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 ASTM C1691 and ASTM ~~C 1386~~ C1693 for the strength class specified.

Chapter 46 Referenced Standards.

Modify 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)

S8373

Date Submitted	12/15/2018	**Section**	606.2.6	**Proponent**	Joseph Belcher for MAF
Chapter	6	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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

S7707

Date Submitted	12/6/2018	**Section**	702.7.3	**Proponent**	Ann Russo1
Chapter	7	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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.

S7746

Date Submitted	12/7/2018	**Section**	703.11.2.3	**Proponent**	Ann Russo1
Chapter	7	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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.~~

S7779

Date Submitted	12/8/2018	Section	703.1.1	Proponent	Borjen Yeh
Chapter	7	Affects HVHZ	No	Attachments	No

TAC Recommendation	Approved as Submitted
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.

S7844

Date Submitted	12/10/2018	**Section**	703.8.4	**Proponent**	Borjen Yeh
Chapter	7	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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.

R703.8.4Anchorage.

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 1 1/2 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 withcorrugated 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. betweensheathing and '	
Wood stud backing withmetal 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 nominal1 in. between sheathingand veneer	Maximum 4 1/2in.betweer backingand ve
Cold-formed steel studbacking with adjustablemetal strand wire	W1.7 (No. 9 U.S. gage; 0.148 in.)with hook embedded in mortar joint	No. 10 screw extending throughthe steel framing a minimum ofthree exposed threads	Minimum nominal1 in. between sheathingand veneer	Maximum 4 1/2in.betweer backingan

For SI: 1 inch = 25.4 mm.

1. 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.
2. 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.

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.

S7944

Date Submitted	12/11/2018	**Section**	703	**Proponent**	Ann Russo8
Chapter	7	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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	1.605	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	1.905	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	0.901	DR	DR	2.853	DR	DR	DR
		1/4 ? lag screw	1 1/2	12	4.00	2.6 53	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.

S7989

Date Submitted	12/12/2018	**Section**	702.3.3	**Proponent**	Bonnie Manley
Chapter	7	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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~~.

S8352

Date Submitted	12/15/2018	**Section**	703.2	**Proponent**	John Woestman
Chapter	7	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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.

S8355

Date Submitted	12/15/2018	**Section**	702.3.3	**Proponent**	Joseph Crum
Chapter	7	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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	Approved as Submitted				
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.

S7714

Date Submitted	12/6/2018	**Section**	806.2	**Proponent**	Ann Russo1
Chapter	8	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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 Approved as Submitted
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

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.

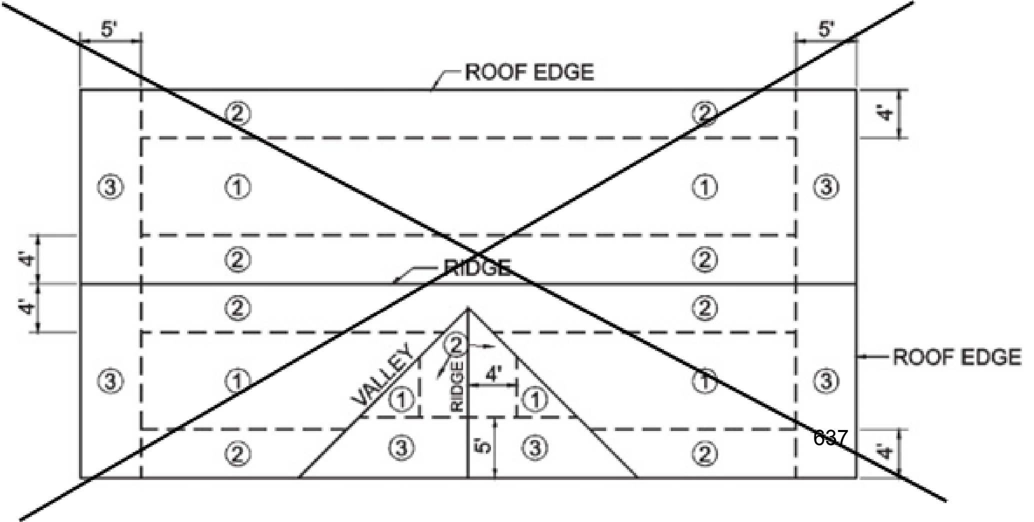
~~Where roof framing with a specific gravity, 0.42 = G < 0.49 is used, spacing of ring-shank fasteners shall be 4 inches on center in nailing zone 3 in accordance with Figure R803.2.3.1 where V_{ult} is 165 mph or greater.~~

~~**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) Exposure C	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)
Minimum Sheathing Thickness, inches	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)


5'
5'
ROOF EDGE
4'
RIDGE
4'
4'
ROOF EDGE
VALLEY
RIDGE
4'
5'
4'
1
2
3

(Panel Span Rating) Exposure D								

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**~~

S7764

Date Submitted	12/7/2018	**Section**	802.1	**Proponent**	Borjen Yeh
Chapter	8	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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 Approved as Submitted
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	Approved as Submitted				
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

Date Submitted	12/12/2018	**Section**	802	**Proponent**	Ann Russo8
Chapter	8	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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.

Text of Mod 7972

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.

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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).

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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.

-

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 following tables:

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) as R802.5.2

S8329

Date Submitted	12/15/2018	**Section**	806.5	**Proponent**	Joseph Lstiburek
Chapter	8	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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.

S8398

Date Submitted	12/15/2018	**Section**	806	**Proponent**	Michael Fischer
Chapter	8	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Approved as Submitted
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.
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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.

S7252

Date Submitted	11/13/2018	**Section**	46	**Proponent**	T Stafford
Chapter	2712	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
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—17~~13~~ Specification for Rigid Poly (Vinyl Chloride) (PVC) Siding R703.11

S7340

Date Submitted	11/20/2018	**Section**	46	**Proponent**	Jessica Ferris
Chapter	2712	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Approved as Submitted				
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	2712	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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	2712	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Approved as Submitted
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 -

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:
DOOR & ACCESS SYSTEMS MANUFACTURERS' ASSOCIATION, INTERNATIONAL
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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.

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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 ____

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.

Door & Access Systems Manufacturers Association International

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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

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American National Standard

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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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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.

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 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:

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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

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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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
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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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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

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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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CONTENTS

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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S7947

Date Submitted	12/12/2018	**Section**	46	**Proponent**	Borjen Yeh
Chapter	2712	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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

S7167

150

Date Submitted	11/2/2018	**Section**	1	**Proponent**	Michael Goolsby
Chapter	1	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Approved as Submitted
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.

Text of 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:

$$\left(\frac{known\ \#\ of\ fasteners}{max.\ design\ pressure}\right) = \left(\frac{unknown\ \#\ of\ fasteners}{elevated\ design\ pressure}\right)$$

Zone 1:

$$\left(\frac{4\ fasteners}{45\ psf}\right) = \left(\frac{X\ fasteners}{64\ psf}\right) = 5.7\ fasteners$$

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:

$$\left(\frac{4\ fasteners}{45\ psf}\right) = \left(\frac{X\ fasteners}{\cancel{56}\ 84\ psf}\right) = 7.5\ \cancel{4.9}\ fasteners$$

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:

$$\left(\frac{4\ fasteners}{45\ psf}\right) = \left(\frac{X\ fasteners}{115\ \cancel{90}\ psf}\right) = \cancel{8}\ 10.2\ fasteners$$

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:

$$FS = \frac{(60.0\ lbf) \times \left(\frac{144\ in.^2}{Ft.^2}\right)}{(64.0\ psf) \times (10.7\ inches)} = 12.6\ inches$$

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**:

$$FS = \frac{(60.0\ lbf) \times \left(\frac{144\ in.^2}{ft.^2}\right)}{(84.0\ \text{~~56.0~~}\ psf) \times (10.7\ inches)} = \text{~~14.4~~}\ 9.6\ inches$$

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:**

$$FS = \frac{(60.0\ lbf) \times \left(\frac{144\ in.^2}{ft.^2}\right)}{(\text{~~90.0~~}\ 115.0\ psf) \times (\text{~~10.7~~}\ 8\ inches)} = 9.04\ inches$$

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:~~

<u>Zone 1’</u> ~~Field Area~~:	*~~-43.0~~ <u>-37.0</u> psf*
<u>Zone 1:</u>	<u>-64.0 psf</u>
<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 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 <u>for Zone 1’ and Zone 1</u> [i.e., sheet width (36 inch) minus side lap width (3 inch) divided by the number of fastener rows (3)]. <u>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)].</u>

<u>Zone 1’</u> ~~Field Area~~:

$$FS = \frac{(38.2\ lbf) \times \left(\frac{144\ in.^2}{ft.^2}\right)}{(\sout{40.0}\ \underline{37.0}\ psf) \times (11\ inches)} = 1\sout{3}\underline{2}.5\ inches$$

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 <u>Zone 1’</u> ~~field area~~ base sheet fastener spacing.

<u>Zone 1</u> ~~Perimeter Area~~:

$$FS = \frac{(38.2\ lbf) \times \left(\frac{144\ in.^2}{ft.^2}\right)}{(\sout{47}\underline{64}.0\ psf) \times (11\ inches)} = \sout{10.7}\ \underline{7.8}\ inches$$

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.
(S7167)

S8298

Date Submitted	12/15/2018	**Section** 3		**Proponent**	Chadwick Collins
Chapter	1	**Affects HVHZ**	Yes	**Attachments**	Yes
TAC Recommendation	Approved as Submitted				
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	1	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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~~

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~~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

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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-
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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	1	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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	1	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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~~ 300 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 Zone 1, Zone 2 and Zone 3 ~~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~~ 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 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.

$$X = \frac{\underline{(18\ in \times 18\ in)}}{144} = 2.25\ ft^2$$

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.

$$\left(\frac{45\ lbf}{ft.^2}\right) \times \left(\frac{2.25\ ft.^2}{\text{fastener}}\right) = 101.25\ lbf$$

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:

$$FS = \frac{(101.25\ lbf) \times \left(\frac{144\ in.^2}{ft.^2}\right)}{(\sout{56.0}\ \underline{64.0}\ psf) \times (18\ inches)} = \sout{14.5}\ \underline{12.7}\ inches$$

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:

$$FS = \frac{(101.25\ lbf) \times \left(\frac{144\ in.^2}{ft.^2}\right)}{(\sout{90.0}\ \underline{84.0}\ psf) \times (18\ inches)} = \sout{9}\ \underline{9.6}\ inches$$

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:

$$FS = \frac{(101.25\ lbf) \times \left(\frac{144\ in.^2}{ft.^2}\right)}{(115.0\ psf) \times (18\ inches)} = 7.0\ inches$$

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
Chapter 1
Section 1
Affects HVHZ Yes
Proponent Chadwick Collins
Attachments Yes

TAC Recommendation Approved as Submitted
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	1	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Approved as Submitted				
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

S7301

Date Submitted	11/16/2018	**Section**	8	**Proponent**	Jorge Acebo
Chapter	1	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Approved as Submitted
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	1	**Affects HVHZ**	Yes	**Attachments**	Yes

TAC Recommendation Approved as Submitted
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 (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 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 Approved as Submitted
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

10.1~~7~~1.2 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~~

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).

TAC: Structural

Total Mods for **Structural** in **No Affirmative Recommendation: 11**

Total Mods for report: 182

Sub Code: Building

S8263

160

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

TAC Recommendation No Affirmative Recommendation
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>

S7441

Date Submitted	11/26/2018	**Section**	2308.2.3	**Proponent**	Rick Hopkins
Chapter	23	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	No Affirmative Recommendation				
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.

S8126

Date Submitted	12/14/2018	**Section**	2306	**Proponent**	Andy Williams
Chapter	23	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation No Affirmative Recommendation
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

SECTION 2306
ALLOWABLE STRESS DESIGN

2306.1 Allowable 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.

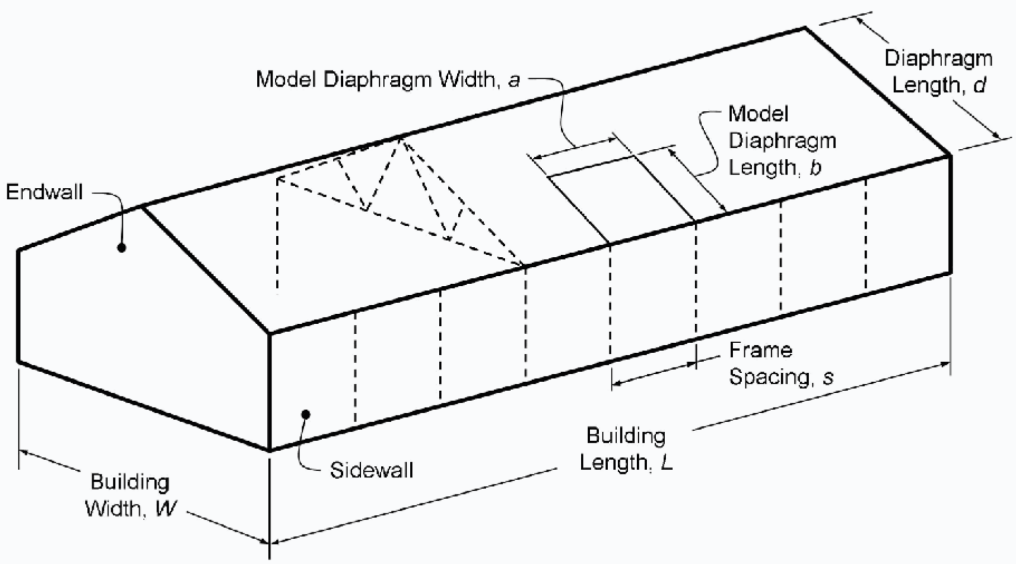

Figure 1 – Definition sketch for terminology

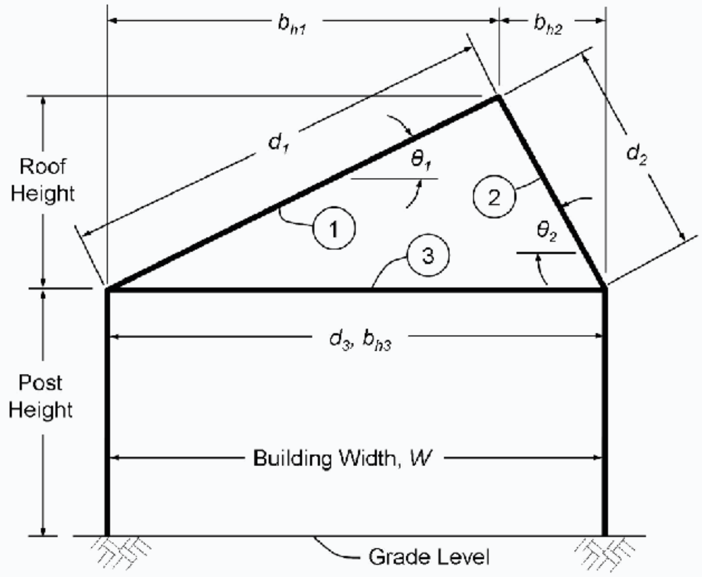

Figure 2 – Building cross section showing roof diaphragms 1 and 2, and ceiling diaphragm 3

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).

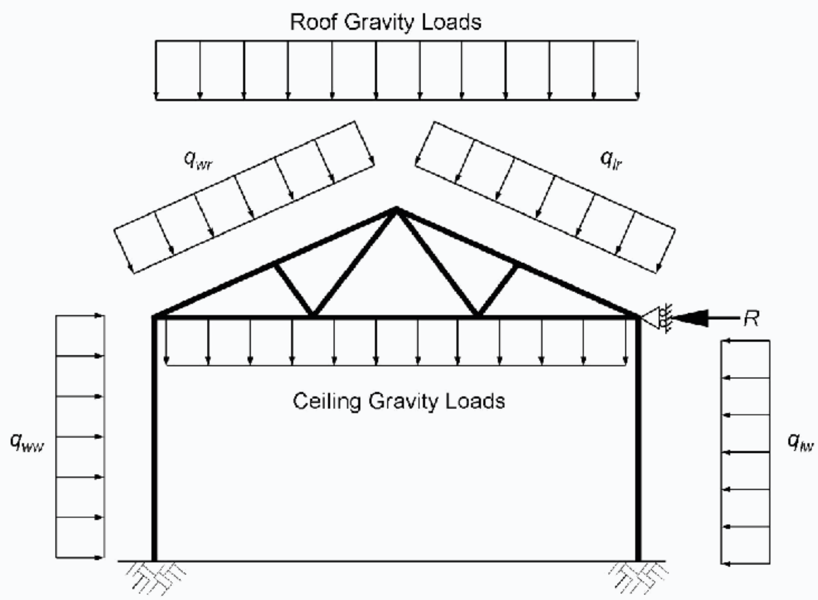

Figure 3 – Structural analog for obtaining eave load, *R*

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:

$$R = s\,[h_r\,(q_{wr} - q_{lr}) + h_w\,f\,(q_{ww} - q_{lw})] \quad (6)$$

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.

$$V_h = R\,L\,/\,(2s) \quad (7)$$

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*)

		Number of Frames (endwalls are counted as frames)													
k_e/k	C_h/k	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*)

		Number of Frames (endwalls counted as frames)													
k_e/k	C_h/k	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

$$V_h \le V_e W \qquad (12)$$

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:

$$V_h \le V_e(W - D_T) \qquad (13)$$

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.

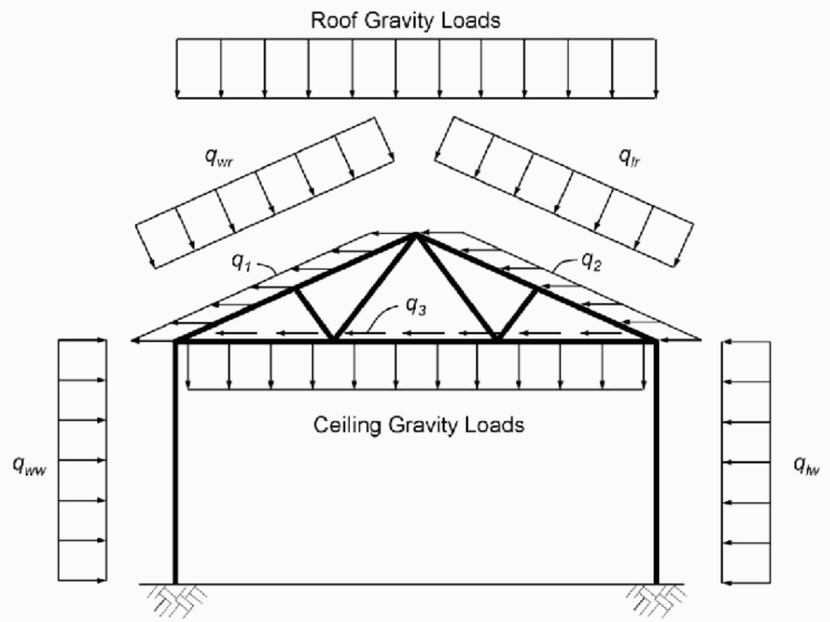

Figure 4 – Structural analog for a building with roof and ceiling diaphragms; sidesway restraining forces, Q_{is}, converted to distributed loads, q_{is}

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.

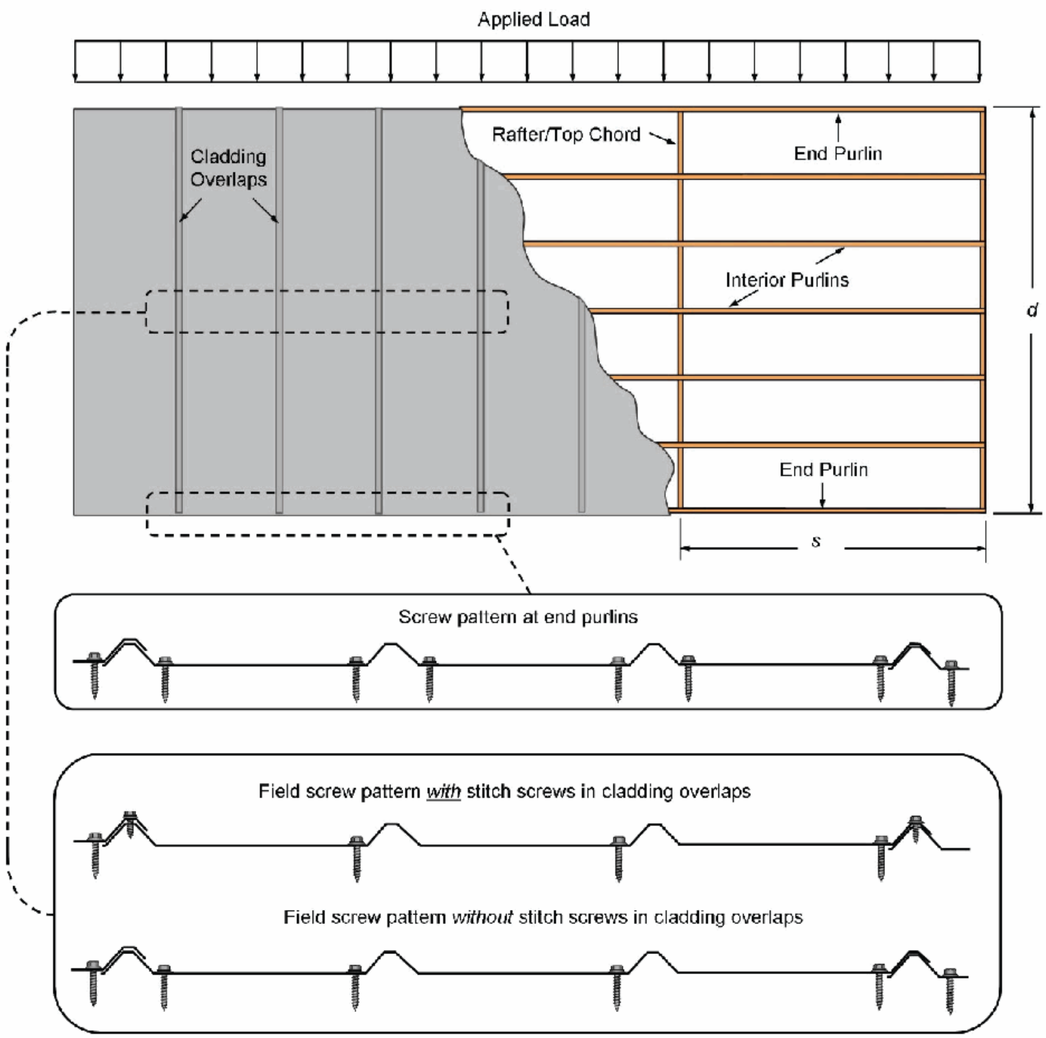

Figure 5 – Required field fastener locations for application of values in Tables 3, 4, 5 and 6. See clause 9.2.3.

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/in^2) minimum yield strength, 359 MPa (52000 lbf/in^2) 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/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)	2.91 (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.

$$V_{a,i} = F_L\,(V_{10} - V_{50}) + V_{50} \qquad (14)$$

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:

$$G = s\,/\,[(s/G') + (2d_i/K_R)] \qquad (15)$$

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/in²/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, 9.81×10^{-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

ν 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).

$$d_R = \frac{d(3\ V_G d + 4\ M_G)}{4\ V_G d + 6\ M_G} \qquad \text{for } 0 \leq d_R \leq d$$

$$\theta = \frac{12\ V_G d + 18\ M_G)}{d^4 A_E}$$

$$\Delta = \frac{9\ V_G d + 12\ M_G)}{d^3 A_E}$$

$$p_z = 6z(6M_G z/d + 4V_G z - 3dV_G - 4M_G)/(d^3 b)$$

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:

$$q_B = q_{cr} B (C_{w1} + C_{w2} d_F / B) / C_{CPT2}$$

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:

$$p_{U,z} = 3\sigma'_{v,z} K_P + (2 + z / b)\, c\, K_P^{0.5} \quad \text{for } 0 \leq z < 4b_G$$

$$p_{U,z} = 3\,(\sigma'_{v,z}\,K_P + 2\,c\,K_P^{0.5}) \quad \text{for } z \geq 4b_G$$

$$K_P = (1 + \sin\phi)\,/\,(1 - \sin\phi)$$

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:

$$M_U = b S_U [4.5 d^2 - 6 d_{RU}^2 - d_{RU}^3/(2b)] \text{ for } 0 \leq d_{RU} \leq d$$

where $d_{RU} = [64 b^2 + 4V_U/(3S_U) + 12 b d]^{0.5} - 8 b$

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 $M_U = 9 b S_U (d^2/2 - d_{RU}^2 + 16 b^2/9)$ for $0 \leq d_{RU} \leq d$

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 $4b_G$ (Figure 20) is given as:

$$M_U = S_{LU} (d^3 - 2 d_{RU}^3)/3 + 6 b c K_P^{0.5} (d^2/2 - d_{RU}^2 + b^2/4) \text{ for } 0 \leq d_{RU} \leq d$$

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:

$$M_U = b S_U (4.5 d^2 - 16 b^2) \quad \text{for } d \geq 4b_G$$

and $M_U = b d^2 S_U [3/2 + d/(2b)]$ for $d \leq 4b_G$

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:

$$M_U = d^3 b K_P \gamma + bcK_P^{0.5} (3d^2 - 32b^2/3) \quad \text{for } d \geq 4b_G$$

and $M_U = d^3 b K_P \gamma + b d^2 c K_P^{0.5} [1 + d/(3b)]$ for $d \leq 4b_G$

$$K_P = (1 + \sin \phi)/(1 - \sin \phi)$$

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 $0.1d$ at a distance $2d$ 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 $2d$ (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.

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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

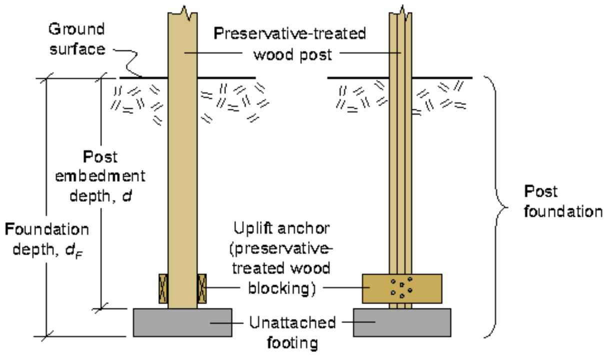


Figure 1 – Preservative-treated wood post foundation

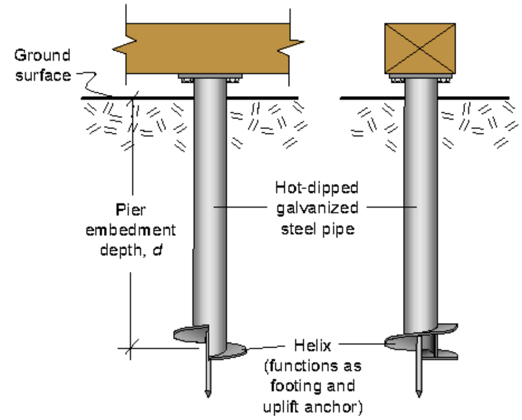


Figure 2 – Helical pier foundation

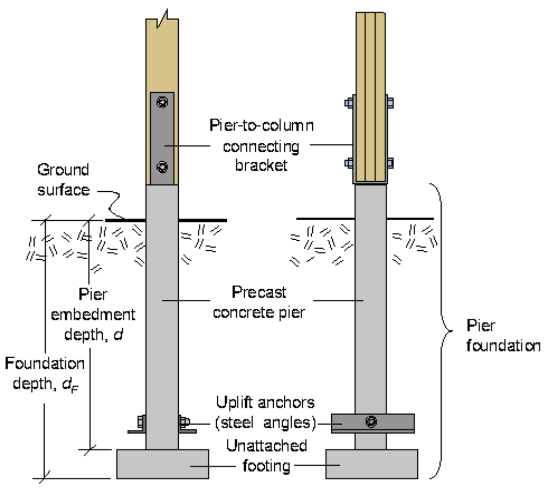


Figure 3 – Precast concrete pier foundation

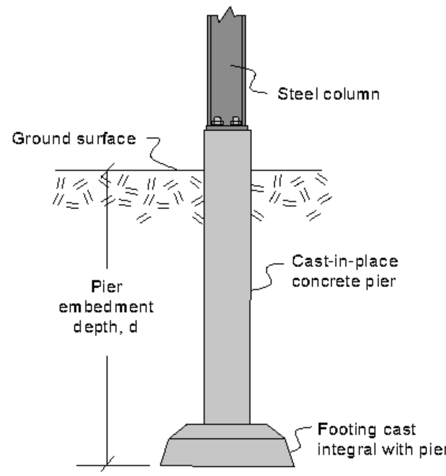


Figure 4 – Cast-in-place concrete pier foundation

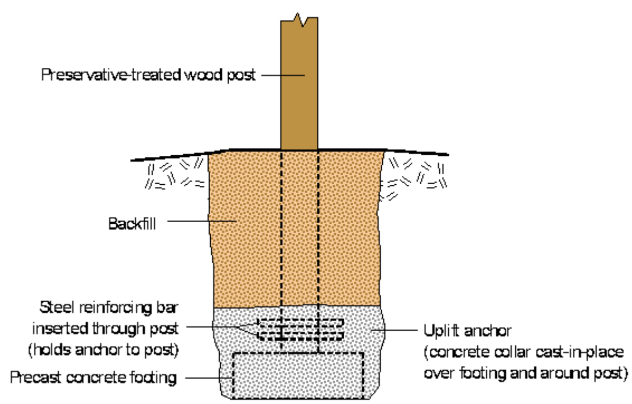


Figure 5 – Post foundation with cast-in-place concrete collar

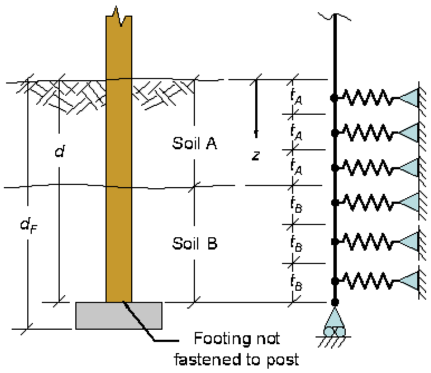


Figure 6 – Two-dimensional structural analog for a post/pier foundation. Spacing of soil springs dictated by thickness of each soil layer.

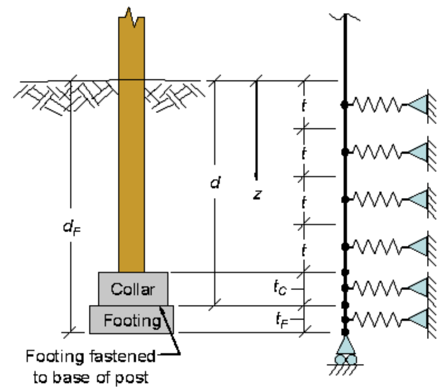


Figure 7 – Two-dimensional structural analog for a post/pier foundation. Different soil springs are used to model soil acting on the collar, attached footing, and pier/post because of the difference in width of the three foundation elements.

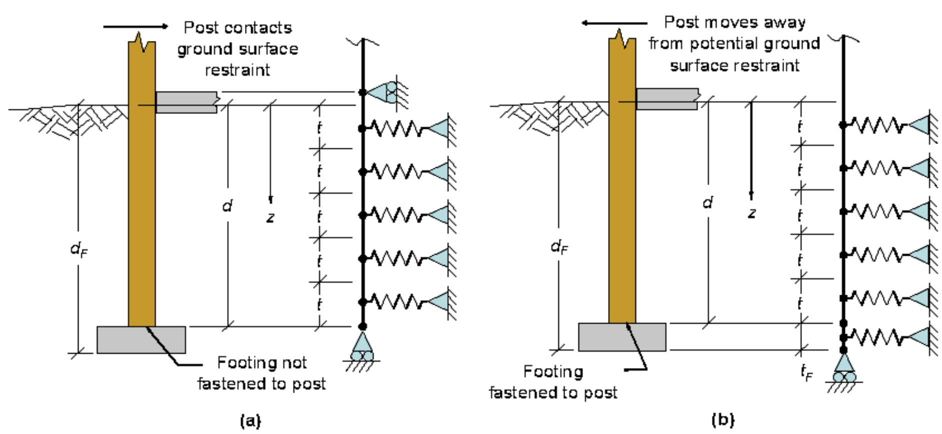


Figure 8 – Two-dimensional structural analogs for a post/pier foundation. If pier/post foundation is moving away from a surface restraint, do not model the surface restraint with a support.

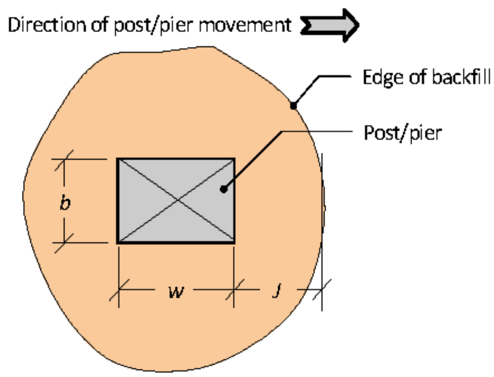


Figure 9 – Top view of foundation showing distance *J* between the post/pier and edge of backfill

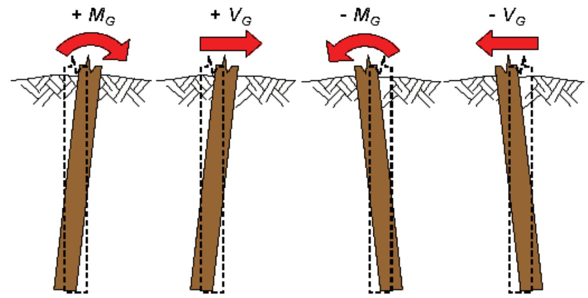


Figure 10 – Sign convention for groundline shear and groundline bending moment forces

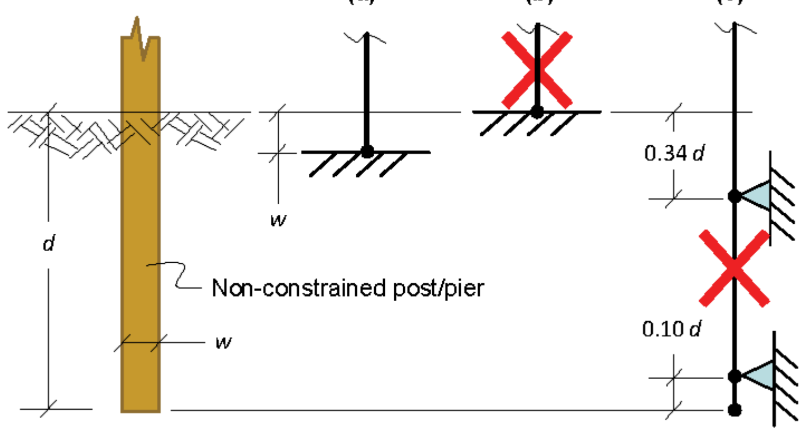


Figure 11 – Modeling analogs: (a) fixed base analog that is recommended when modeling a non-constrained pier/post to obtain M_G and V_G, (b) fixed base analog that is not recommended as it is too rigid, and (c) old two support analog that is too flexible for deeper foundations and too difficult to use.

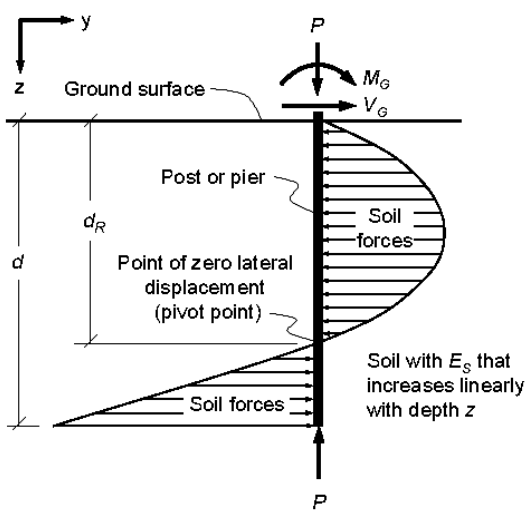


Figure 12 – Forces acting on a non-constrained post/pier of fixed width *b* when soil stiffness increases linearly with depth

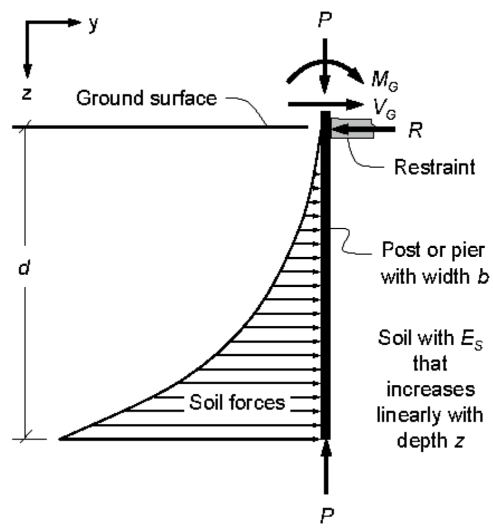


Figure 13 – Forces acting on a ground surface-constrained post/pier of fixed width *b* when soil stiffness increases linearly with depth

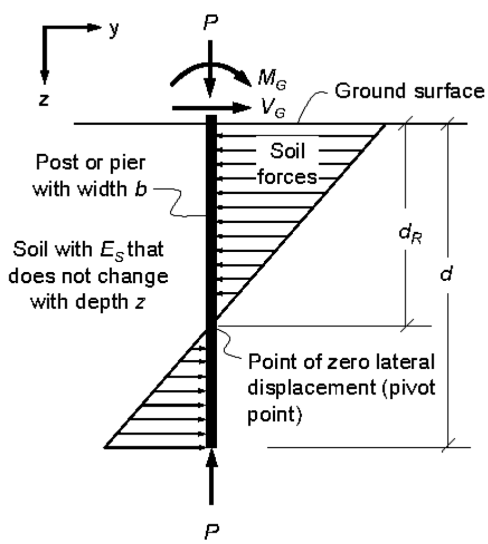


Figure 14 – Forces acting on a non-constrained post/pier of fixed width *b* when soil stiffness is constant with depth

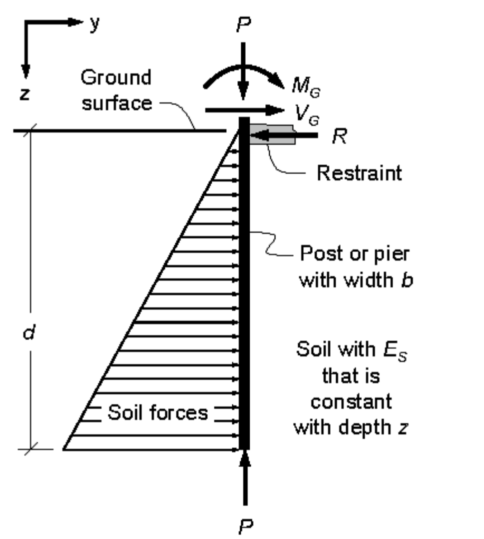


Figure 15 – Forces acting on a ground surface-constrained post/pier of fixed width *b* when soil stiffness is constant with depth

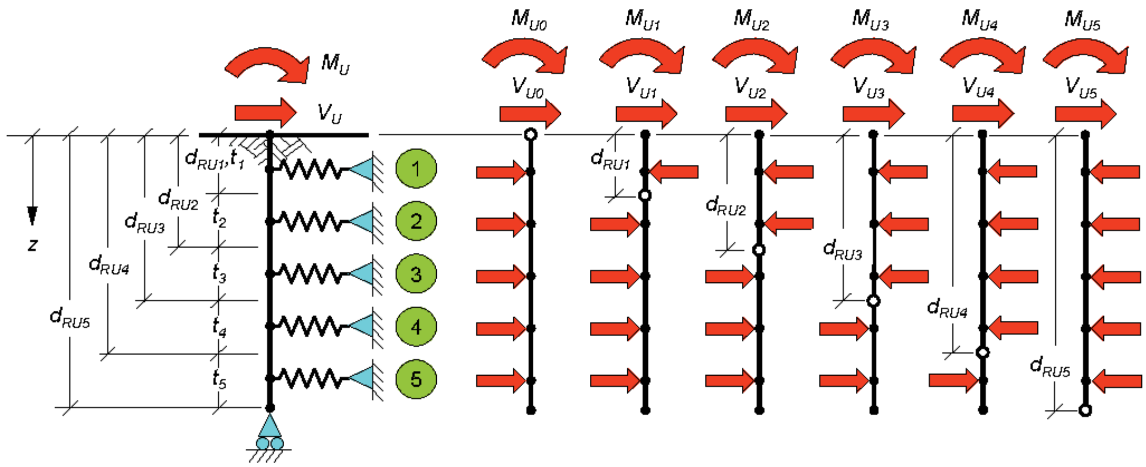


Figure 16 – Five soil spring model and associated free body diagrams for six different ultimate pivot point locations.

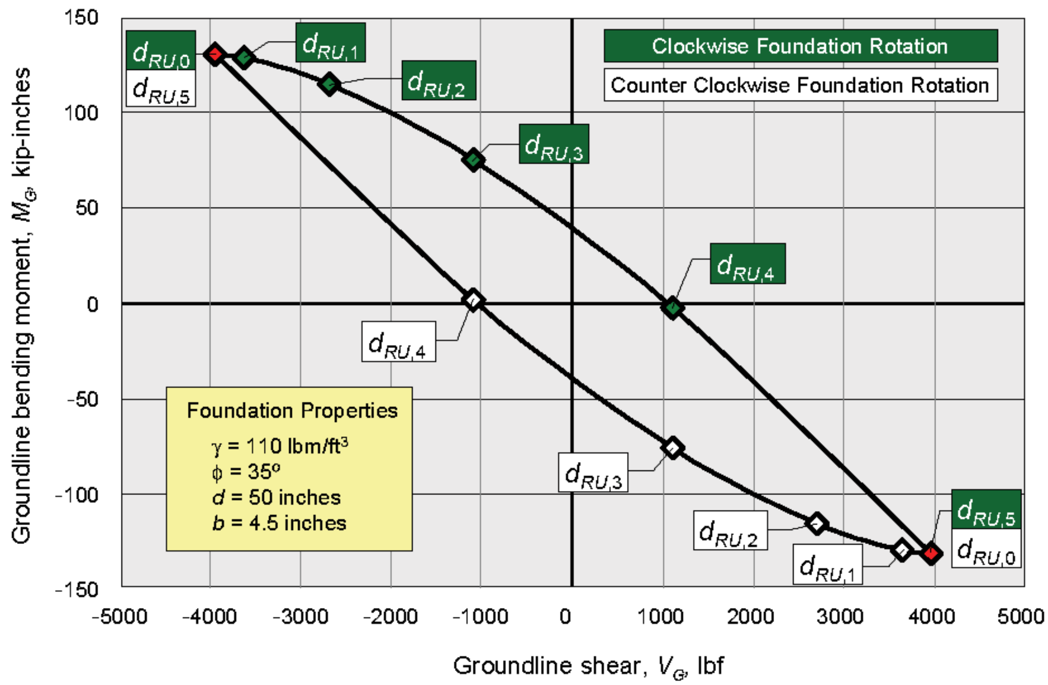


Figure 17 – V_U – M_U envelope developed using free body diagrams in Figure 16.

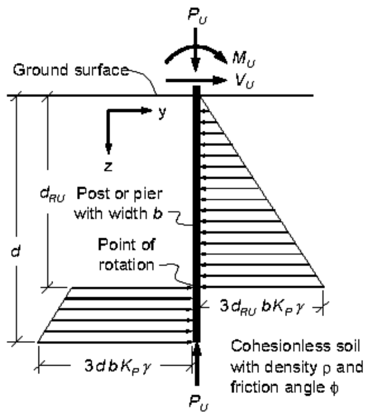


Figure 18 – Forces acting on a non-constrained post/pier of fixed width *b* in cohesionless soil at failure

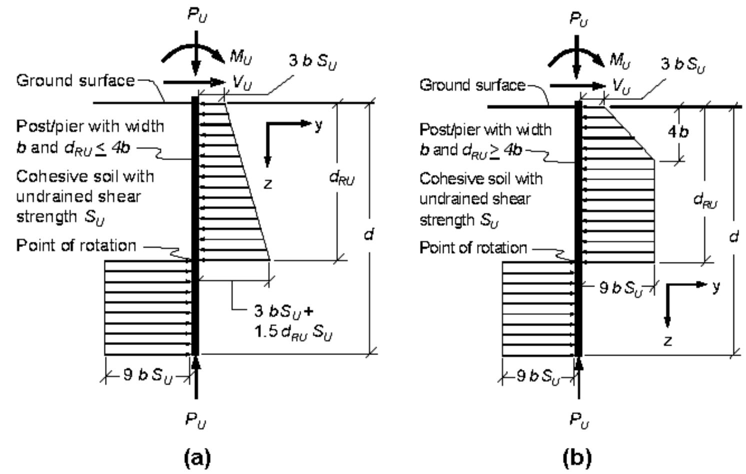


Figure 19 – Forces acting on a non-constrained post/pier of fixed width *b* in cohesive soil at failure (a) when d_{RU} is less than 4 *b*, and (b) when d_{RU} is greater than 4 *b*

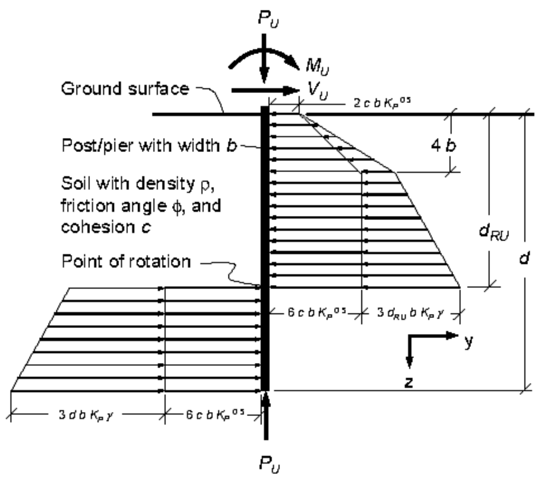


Figure 20 – Forces acting on a non-constrained post/pier of fixed width *b* in a homogenous soil at failure

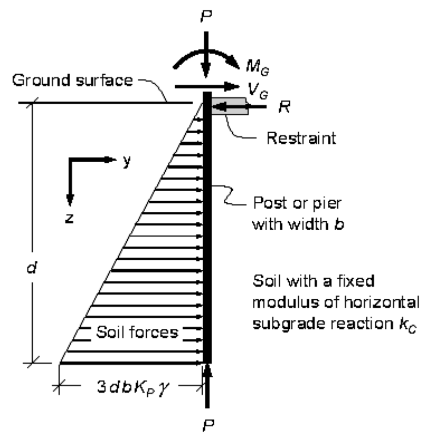
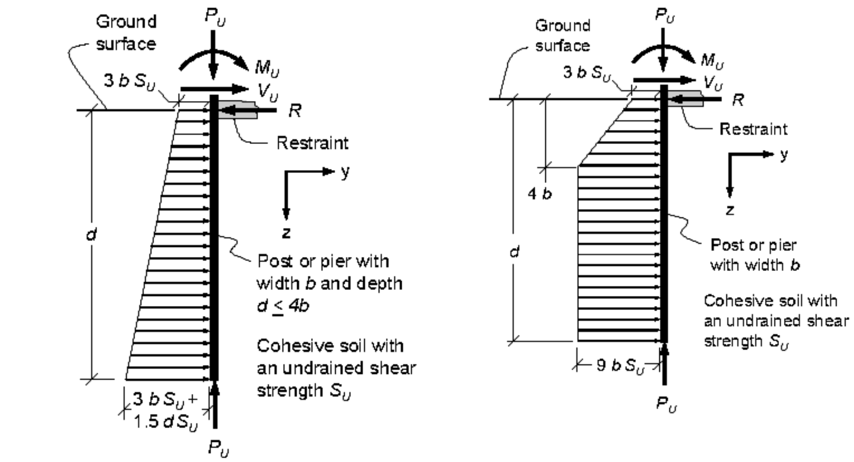
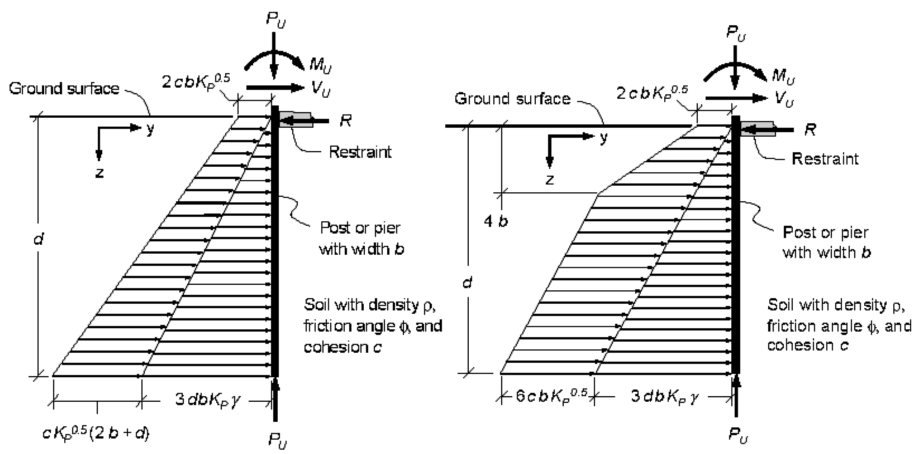


Figure 21 – Forces acting on a constrained post/pier of fixed width *b* in cohesionless soil at failure



(a) (b)

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*



(a) (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*

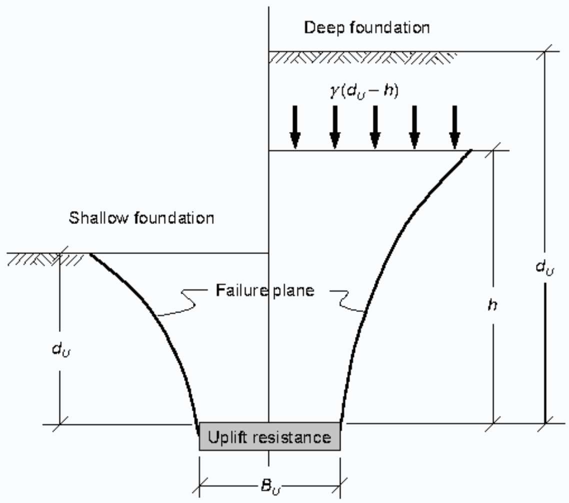


Figure 24 – Modes of uplift failure for uplift resistance systems at different depths

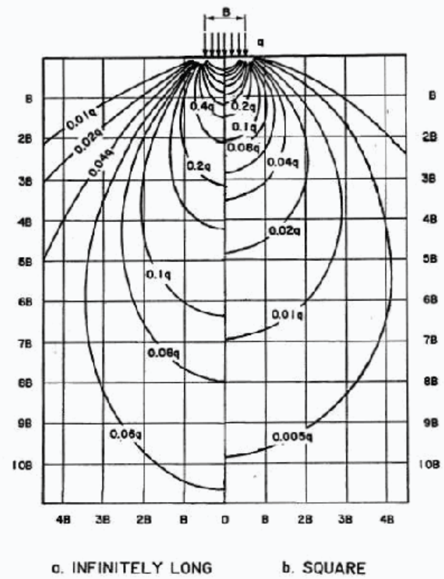


Figure 25 – Stress distributions under continuous and square footings as predicted via elastic theory

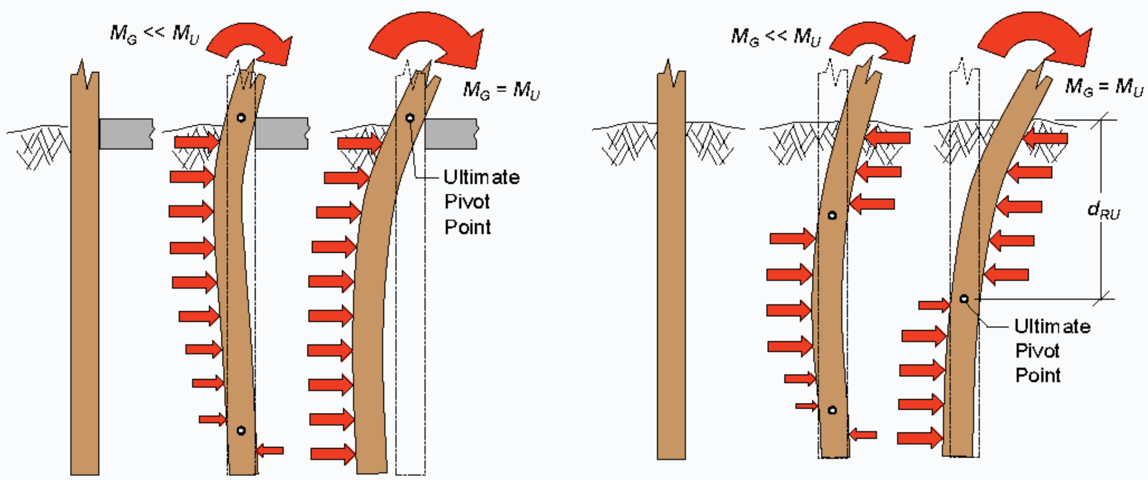


Figure 26 – Surface-constrained (left) and non-constrained (right) post foundations subjected to a groundline bending moment.

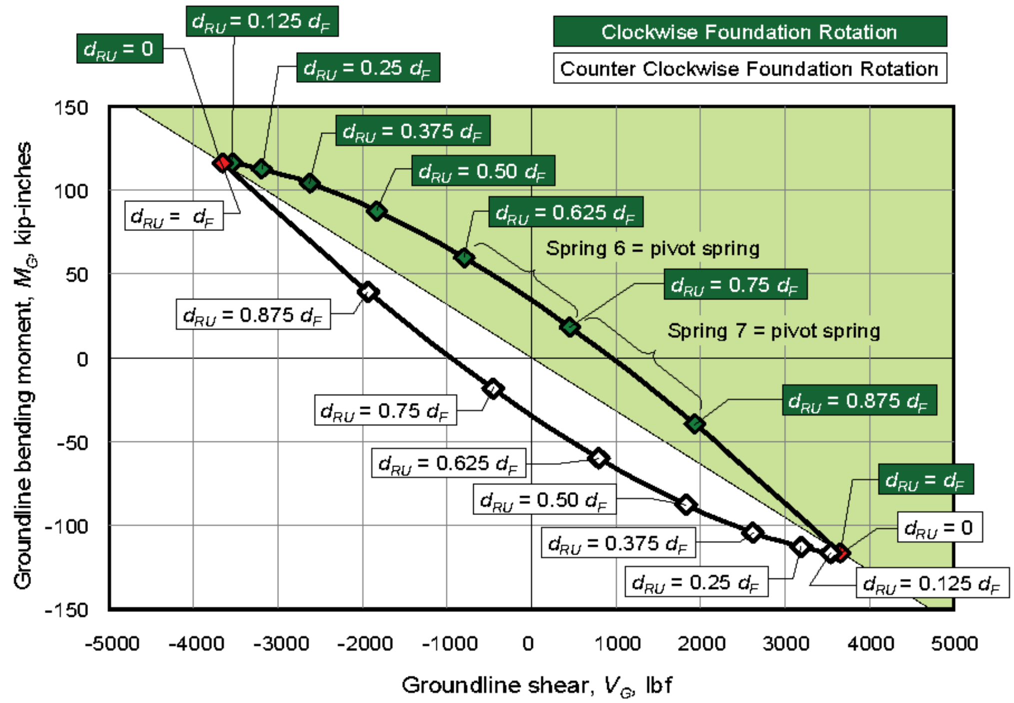


Figure 27 – A V_U – M_U envelope for an 8 soil spring model based on data in Table 7.

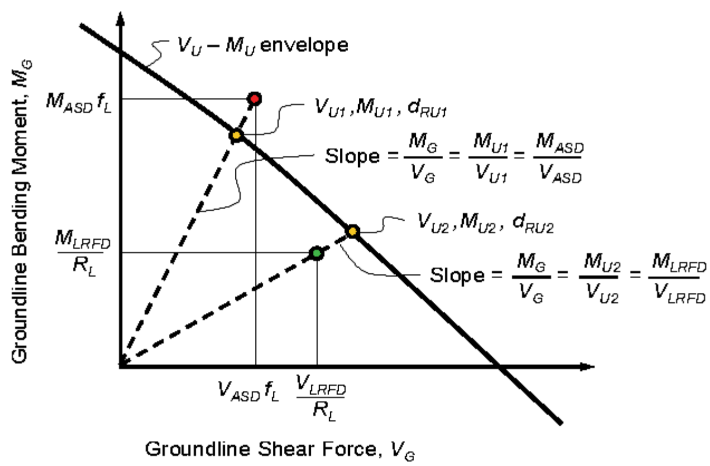


Figure 28. Using a V_U – M_U envelope to check the adequacy of a foundation.

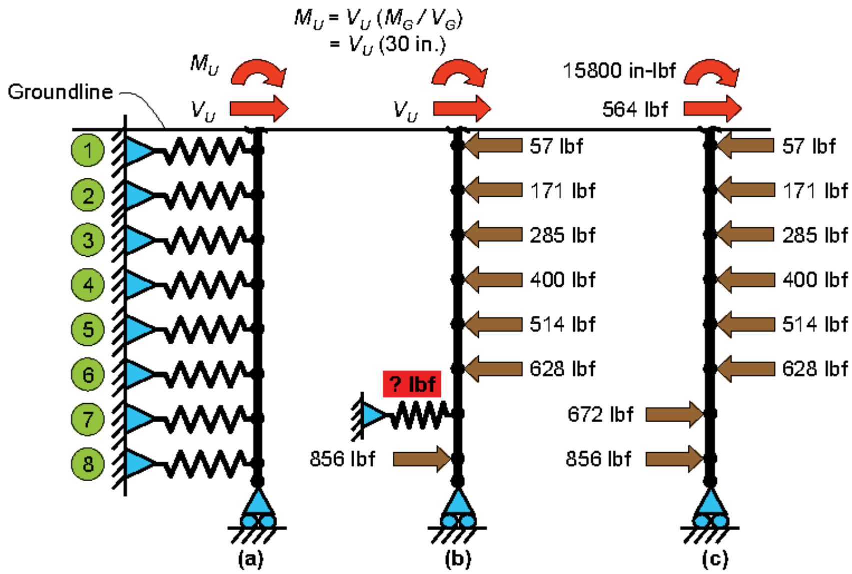


Figure 29. Determining V_U and M_U for a specified M_G/V_G ratio and associated pivot spring.

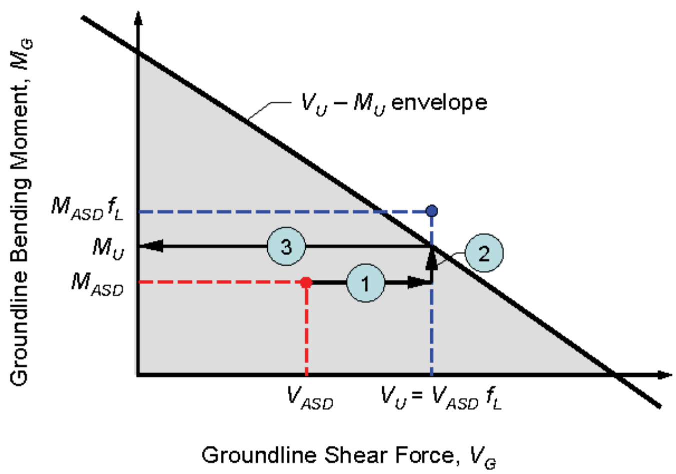


Figure 30. Graphical depiction of lateral strength checking process for Simplified Method of analysis.

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.

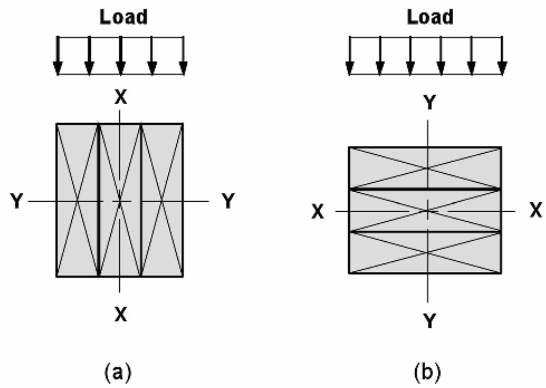

Figure 1 – (a) Vertically laminated, (b) horizontal laminated assemblies

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).

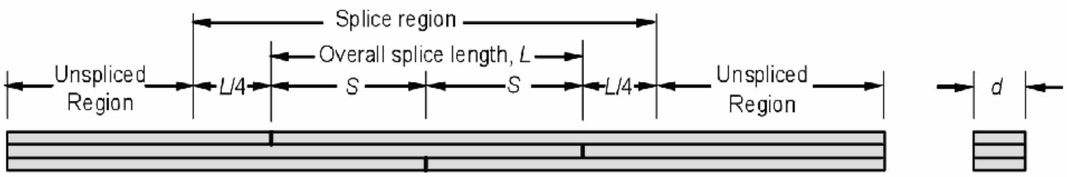

Figure 2 – Spliced assembly definitions

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.

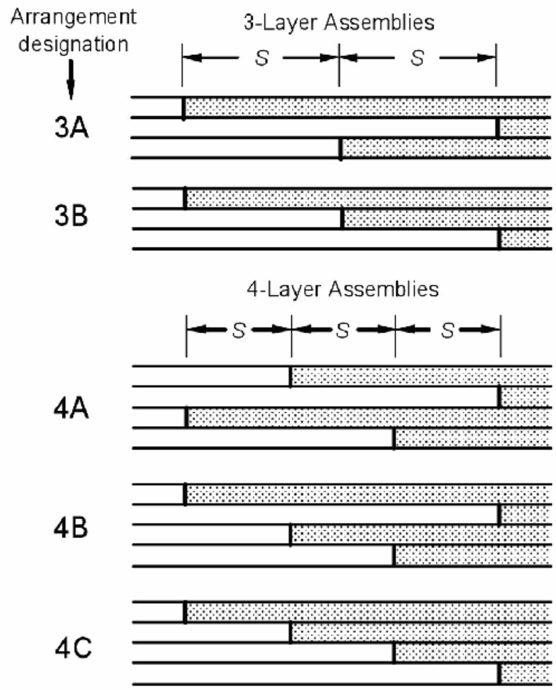

Figure 3 – Joint arrangements for three- and four-layer spliced assemblies

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:

$$V_t \geq 0.22 F_b' \, t \, d^2 / w^2 \qquad (2)$$

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.

$$\alpha = 0.887 - 1.329\left[d^3 E\, t / \left(L^5 Kp\right)\right]^{0.25} \quad (3)$$

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	Location of Deflection Measurement: 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.

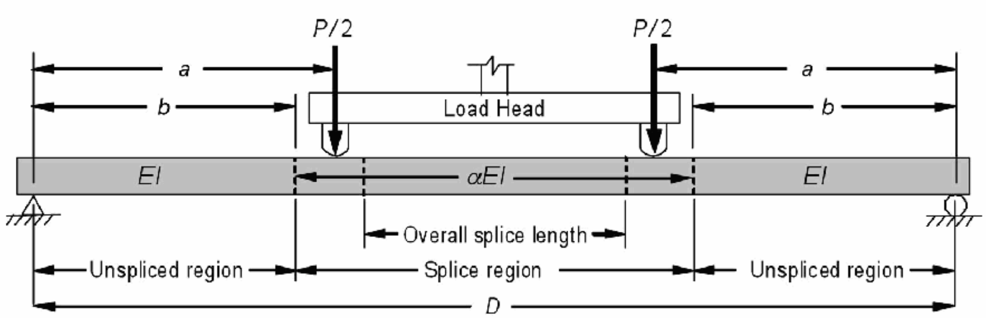

Figure 4 – Model of a spliced assembly under a two-point loading; reduced flexural stiffness in the splice region

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.

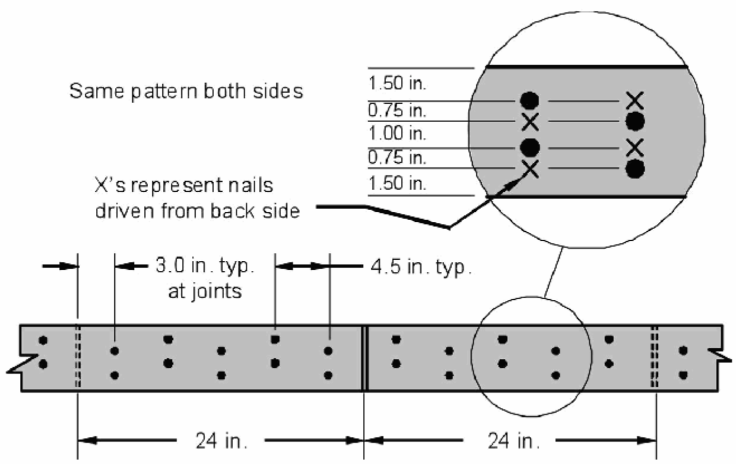

Figure 5 – Example nail pattern for a three-layer spliced assembly fabricated using 10 d common wire nails. Only a portion of the splice region is shown. The same nail pattern is used on both sides of the assembly.

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.

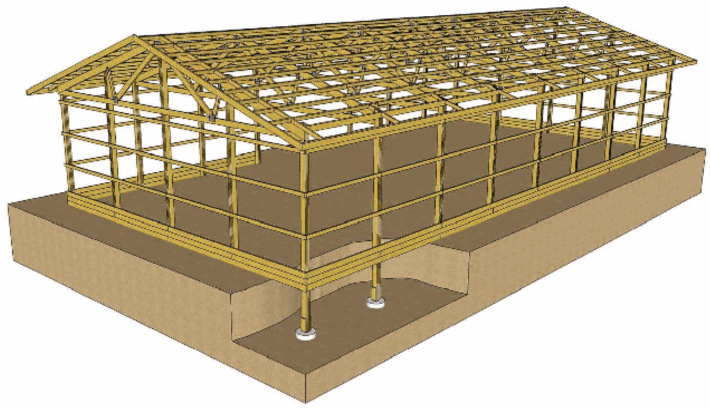

Figure 1 – Post-frame building with trusses supported directly by embedded posts

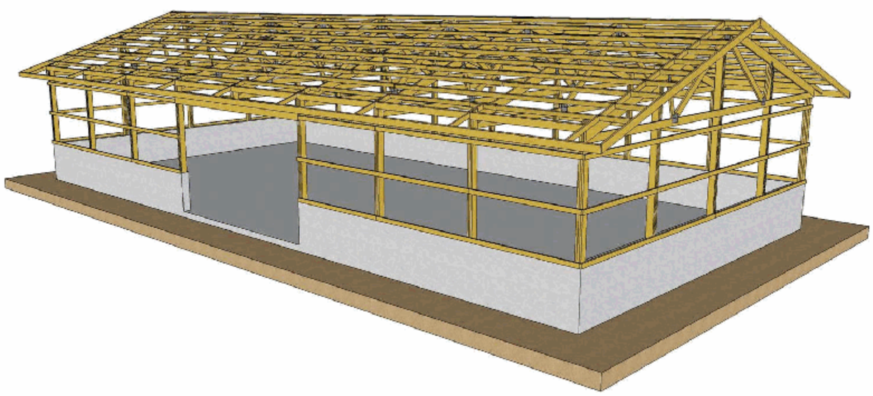

Figure 2 – Post-frame building mounted on a concrete stem wall

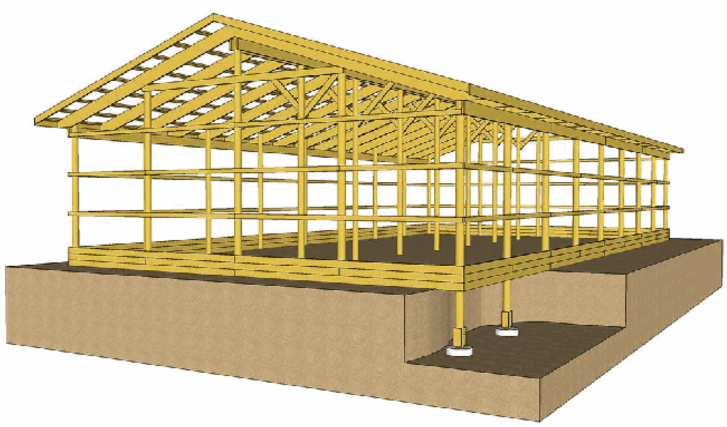

Figure 3 – Post-frame building featuring girder supported rafters and embedded poles. Since all posts are round poles, this post-frame building could also be identified as a pole building.

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.

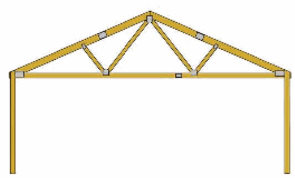

Figure 4 – A single-span, open-web primary frame

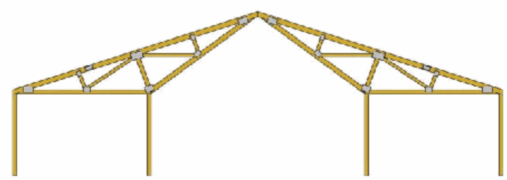

Figure 5 – A three-span, open-web primary frame featuring twin inverted trusses

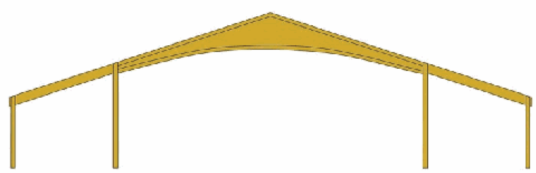

Figure 6 – A three-span, solid-web primary frame

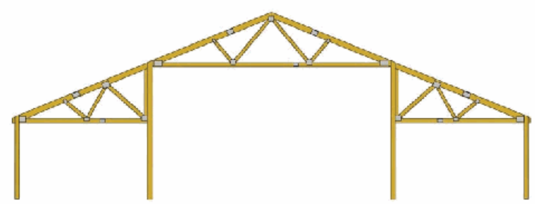

Figure 7 – A three-span, open-web primary frame featuring a raised center bay

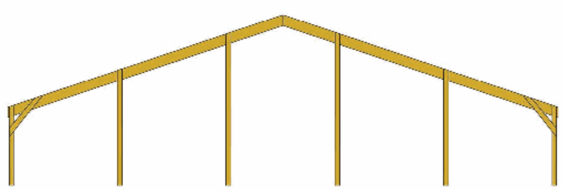

Figure 8 – A five-span, solid-web primary frame utilizing knee-braces on the sidewall posts

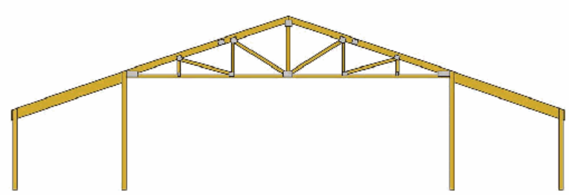

Figure 9 – A three-span, hybrid primary frame

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.

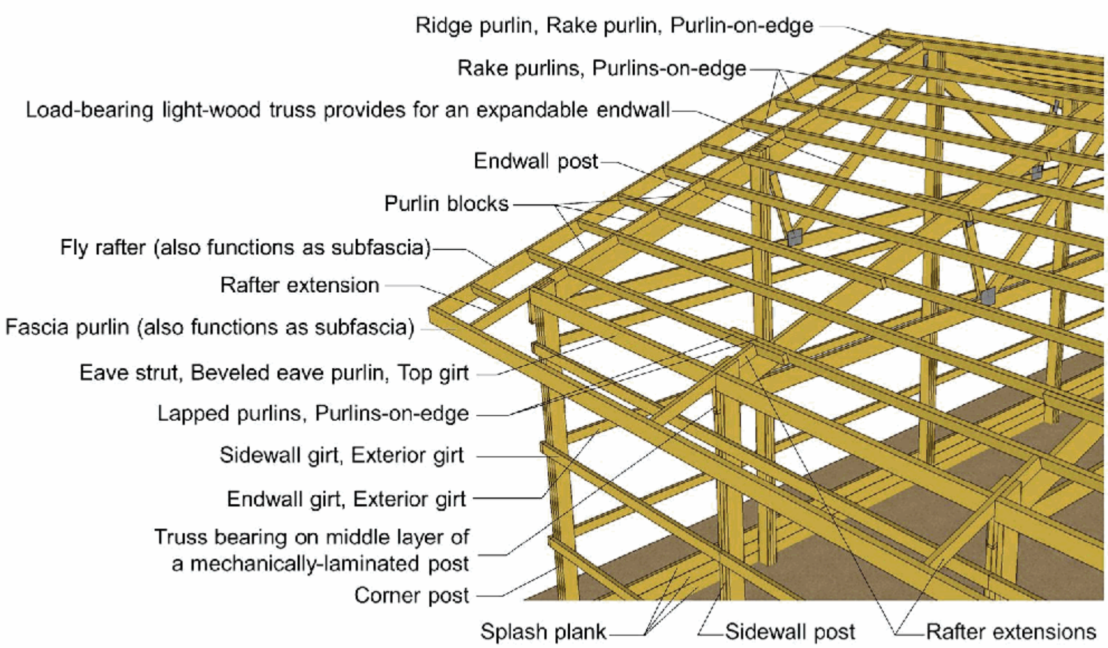

Figure 10 – Typical corner framing

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.

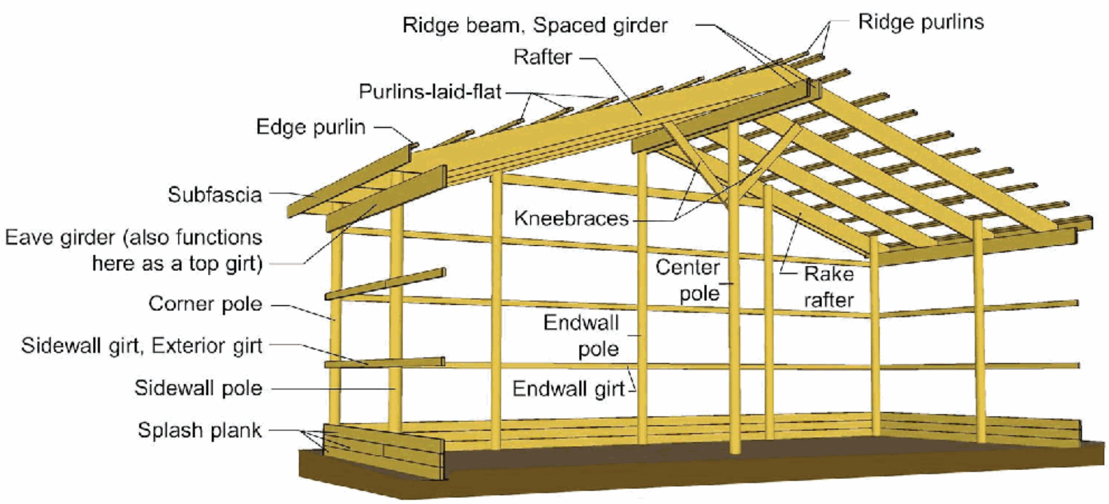

Figure 11 – Section of a pole building featuring girder-supported rafters

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.

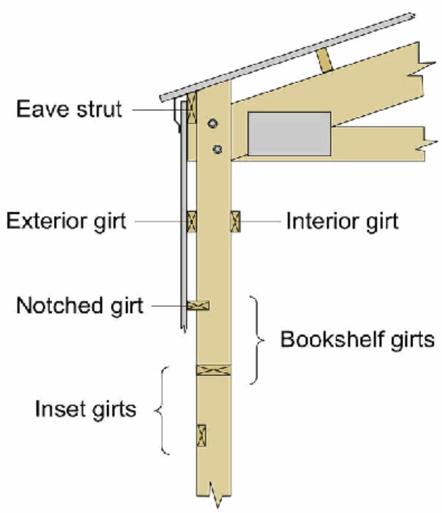

Figure 12 – Girt types

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.

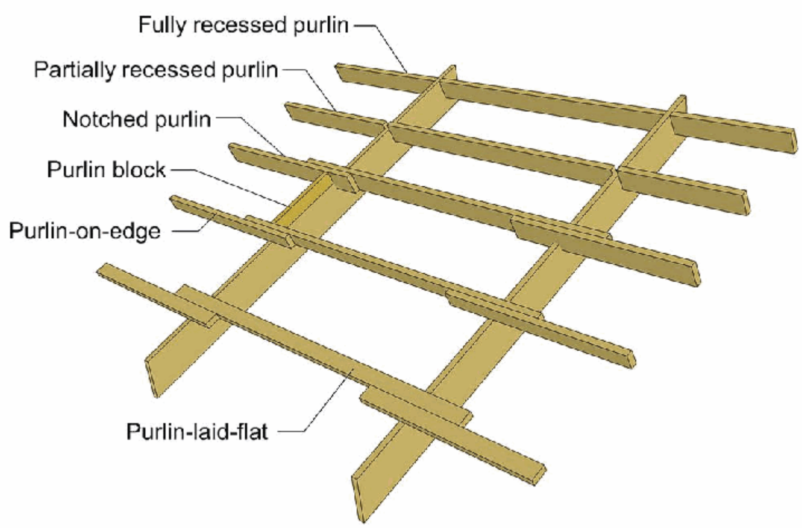

Figure 13 – Purlin types

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.

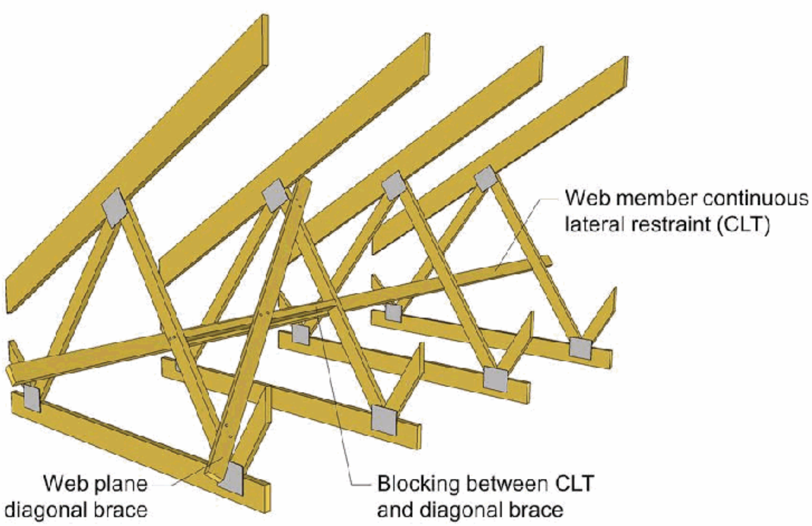

Figure 14 – Components of a continuous lateral restraint system for web members. For larger truss spacing, individual web member reinforcement may be more economical for lateral bracing of webs than a continuous lateral restraint system.

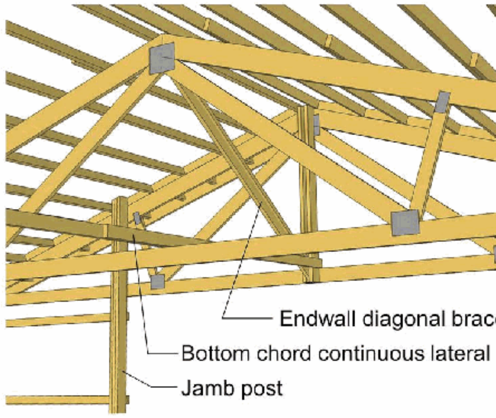

Figure 15 – Endwall diagonal brace used to transfer endwall forces into roof diaphragm and to keep bottom chord continuous lateral restraint from shifting

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.

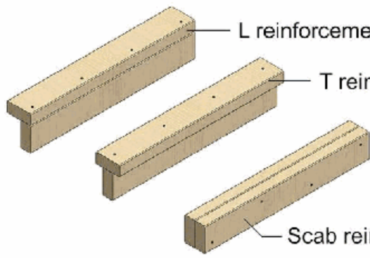

Figure 16 – Types of individual member reinforcement

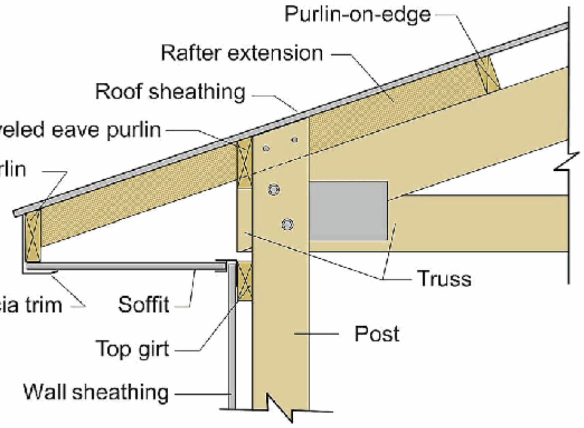

Figure 17 – Cross-sectional view through an eave overhang that is supported by a rafter extension that runs continuously from the fascia purlin/sub-fascia to the first purlin above the post. The rafter extension is fastened to the post, purlin, and top of the truss.

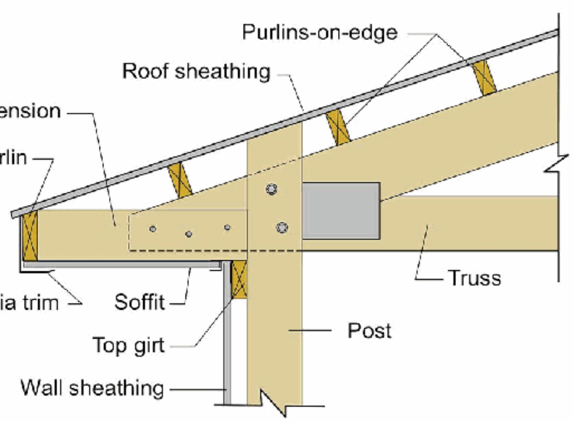

Figure 18 – Cross-sectional view through an eave overhang that is supported by rafter extensions (one on each side of the truss) that are attached to the tail end of the truss

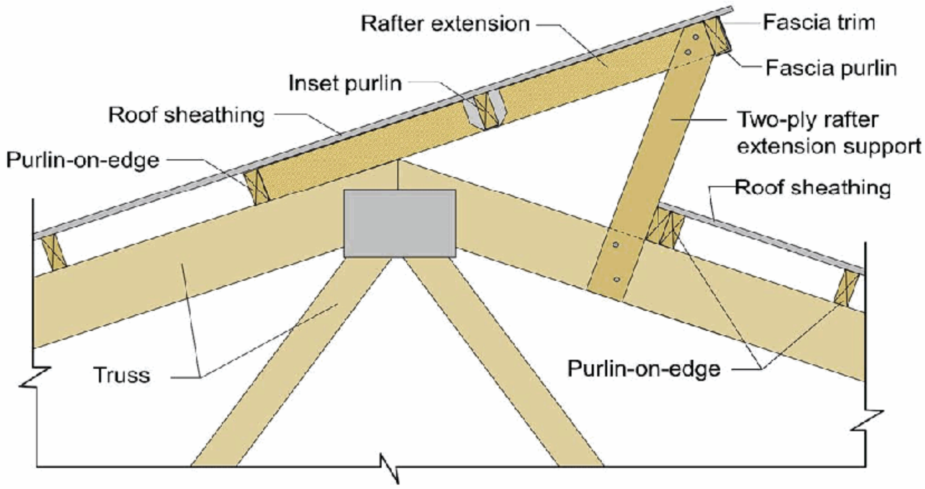

Figure 19 – Overshot ridge with rafter extension supported by a two-ply rafter extension support. One ply is located between the rafter extension and truss top chord; the second ply extends along the sides of the rafter extension and truss chord.

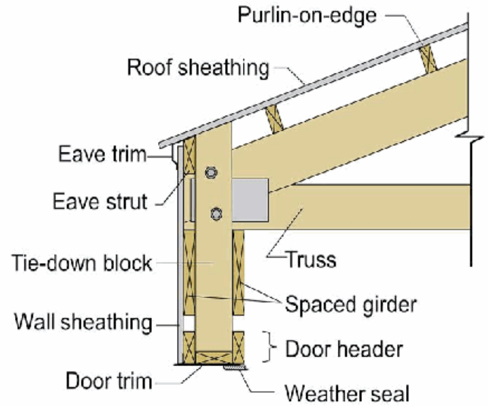

Figure 20 – Cross-sectional view through an overhead door in the sidewall of a building without an eave overhang

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.

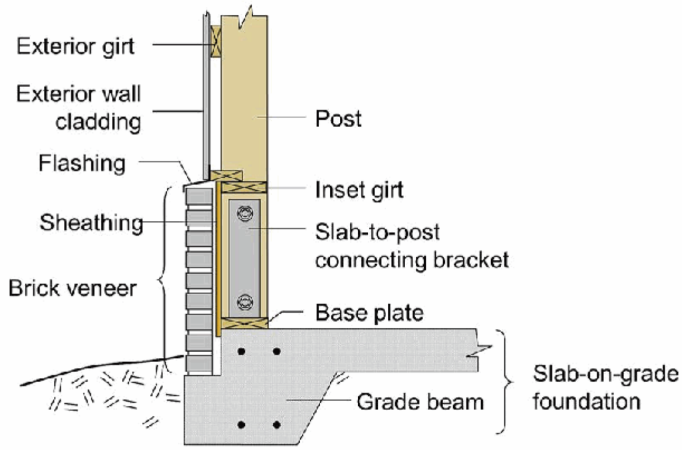

Figure 21 – Slab-on-grade foundation

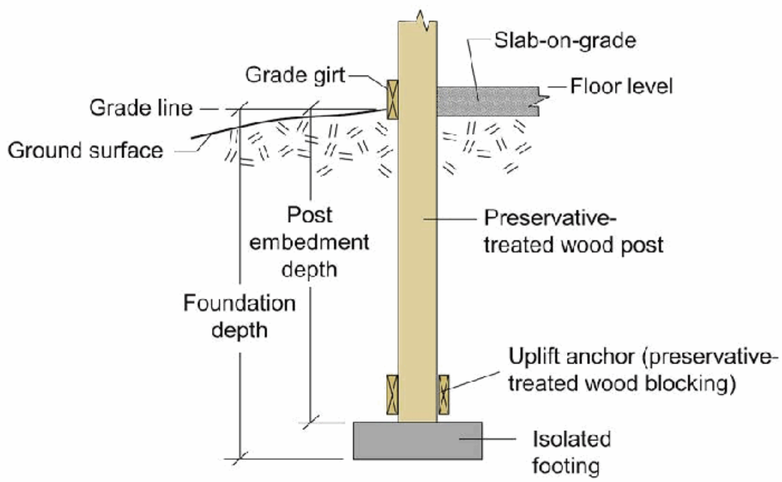

Figure 22 – Post foundation featuring preservative-treated wood blocks for uplift anchorage

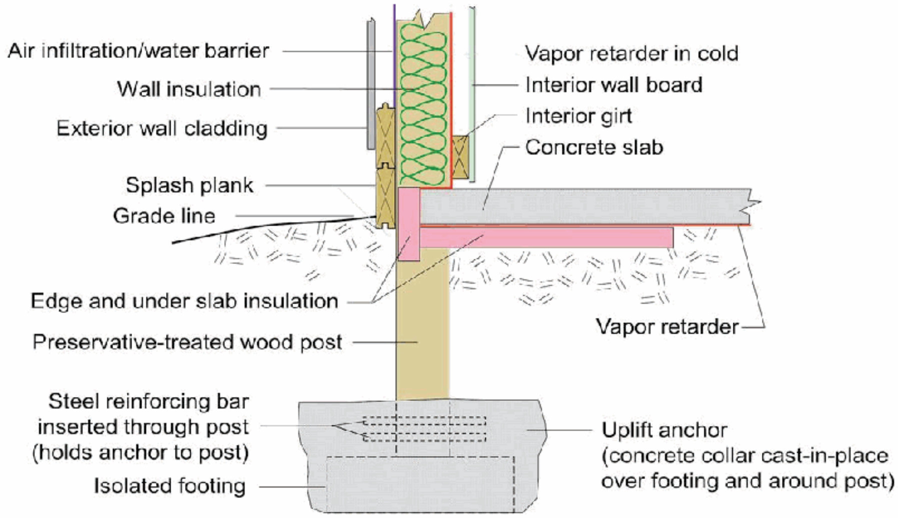

Figure 23 – Post foundation featuring a cast-in-place concrete collar for uplift anchorage and increased lateral resistance

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

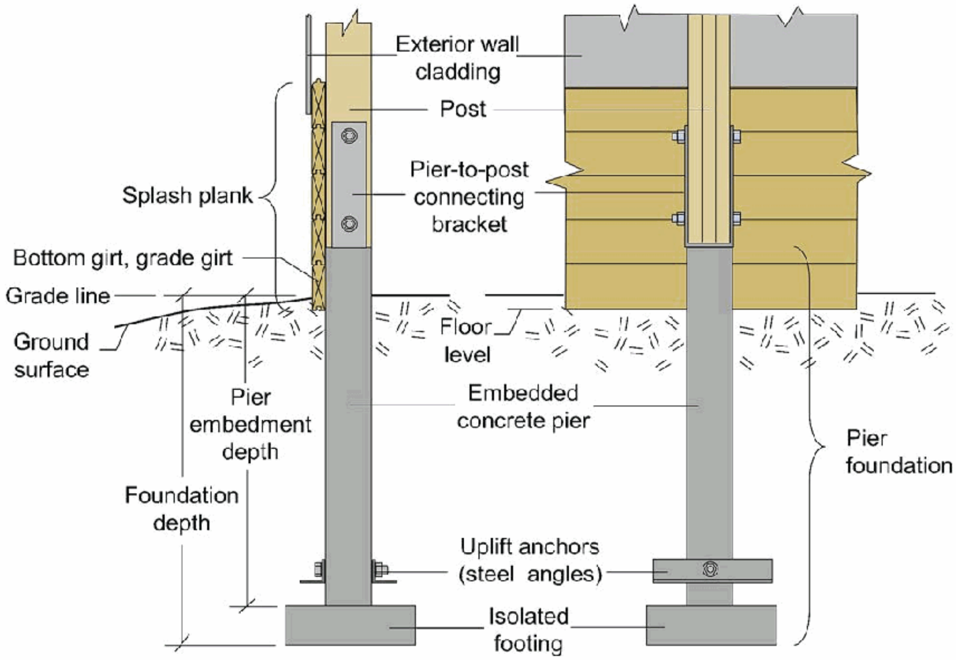

Figure 24 – Pier foundation featuring steel angles for uplift anchorage

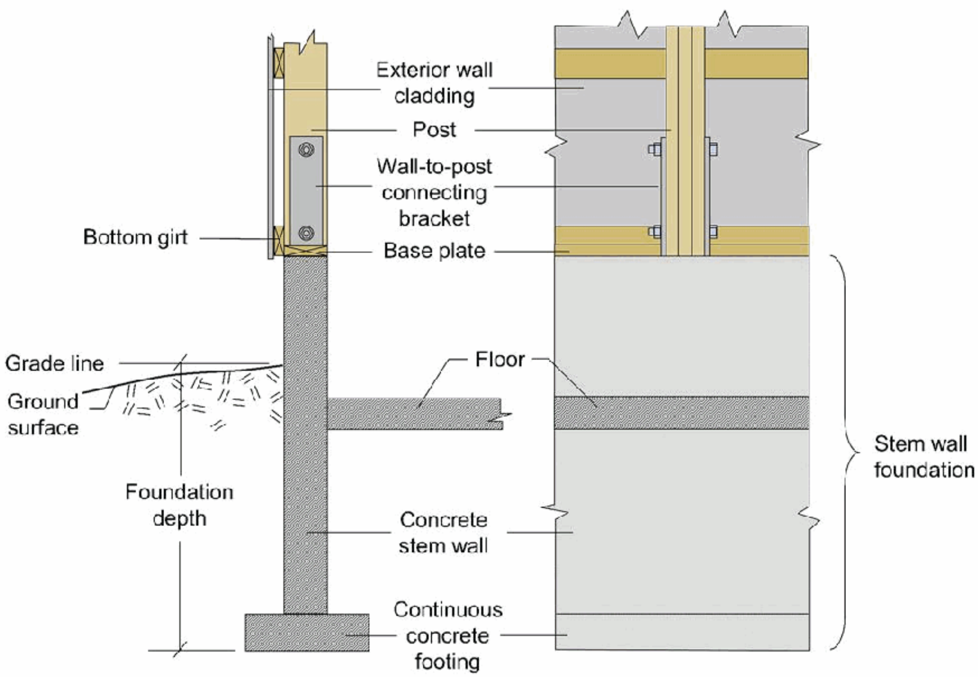

Figure 25 – Stem wall foundation

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.

S7748

Date Submitted 12/7/2018
Chapter 25
Section 2517
Affects HVHZ No
Proponent Robert Koning
Attachments No
TAC Recommendation No Affirmative Recommendation
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.

S8128

Date Submitted	12/14/2018	**Section**	35.1	**Proponent**	Andy Williams
Chapter	35	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation No Affirmative Recommendation
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

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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.

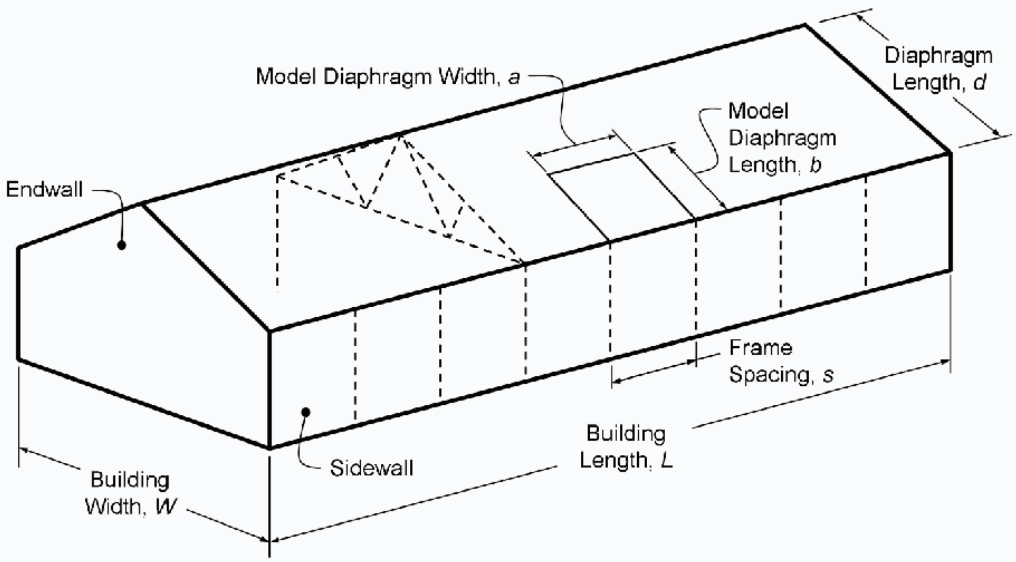

Figure 1 – Definition sketch for terminology

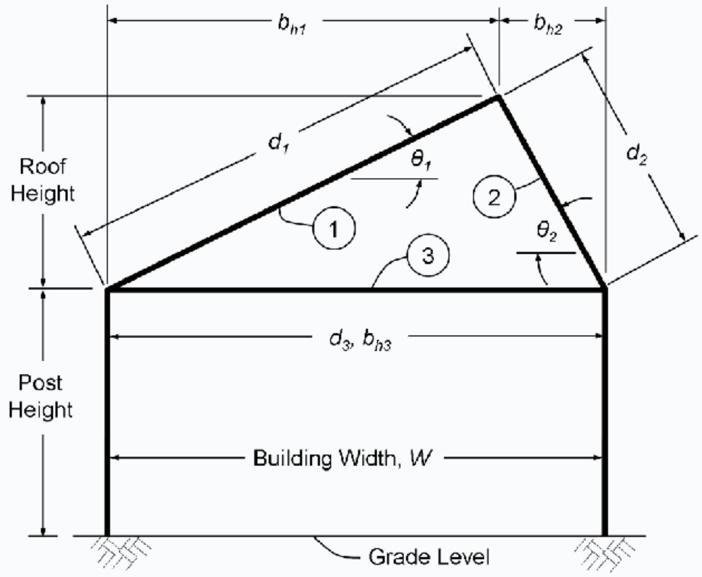

Figure 2 – Building cross section showing roof diaphragms 1 and 2, and ceiling diaphragm 3

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.

$$k = 3\sum_{i=1}^{n}\left(E_i I_i\right) / H_i^3 \quad (4)$$

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).

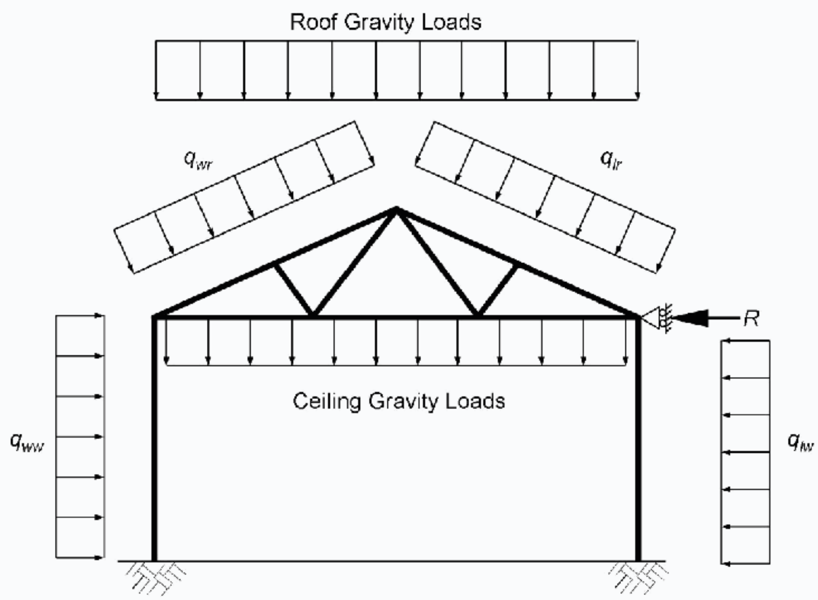

Figure 3 – Structural analog for obtaining eave load, *R*

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/m² (lbf/ft²);

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*)

		Number of Frames (endwalls are counted as frames)													
k_e/k	C_h/k	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

$$V_{p,i} = (c_{h,i} / C_h)\ V_h / (\cos \theta_i) \quad (8)$$

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:

$$V_{p,i} \le V_{a,i}\ d_i \quad (10)$$

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

$$V_h \leq V_e W \quad (12)$$

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:

$$V_h \leq V_e(W - D_T) \quad (13)$$

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.

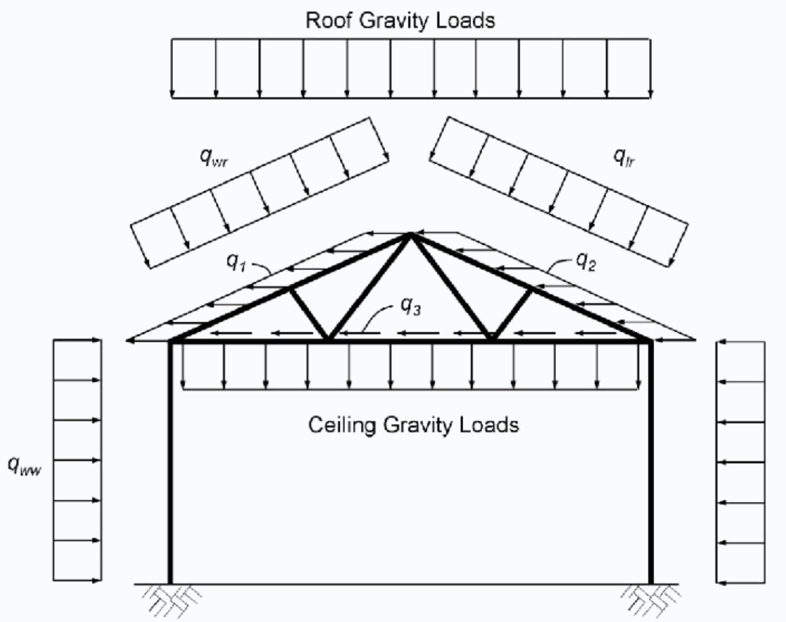

Figure 4 – Structural analog for a building with roof and ceiling diaphragms; sidesway restraining forces, Q_{is}, converted to distributed loads, q_{is}

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.

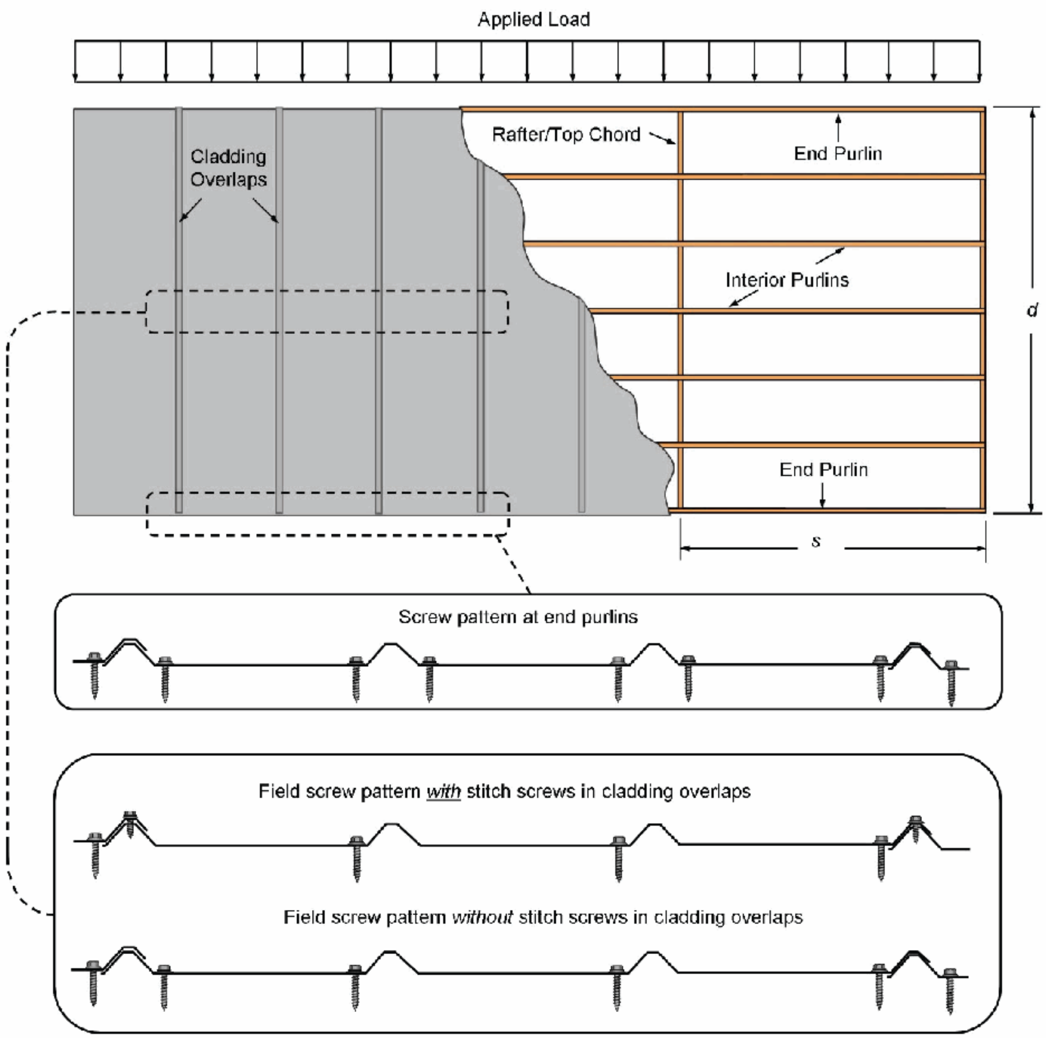

Figure 5 – Required field fastener locations for application of values in Tables 3, 4, 5 and 6. See clause 9.2.3.

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 V_{10} [b]	0.23 m (9.0 in.) Major Rib Spacing V_{50} [b]	0.23 m (9.0 in.) Major Rib Spacing G'	0.30 m (12.0 in.) Major Rib Spacing V_{10} [b]	0.30 m (12.0 in.) Major Rib Spacing V_{50} [b]	0.30 m (12.0 in.) Major Rib Spacing 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/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	13 (0.50)	4.97 (341)	5.02 (344)	5.13 (352)	5.26 (360)	5.39 (369)	5.52 (379)
	(0.75 in.)	19 (0.75)	5.43 (372)	5.47 (375)	5.56 (381)	5.67 (389)	5.79 (397)	5.92 (406)
	22 mm	13 (0.50)	6.42 (440)	6.47 (443)	6.60 (452)	6.75 (462)	6.90 (473)	7.06 (484)
	(0.87 in.)	19 (0.75)	6.99 (479)	7.03 (482)	7.15 (490)	7.27 (498)	7.41 (508)	7.56 (518)
	25 mm	13 (0.50)	8.03 (551)	8.09 (554)	8.24 (564)	8.40 (576)	8.58 (588)	8.77 (601)
	(1.0 in.)	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	13 (0.50)	4.08 (280)	4.11 (282)	4.21 (288)	4.31 (295)	4.41 (302)	4.52 (310)
	(0.75 in.)	19 (0.75)	4.46 (306)	4.49 (308)	4.57(313)	4.65 (319)	4.75 (325)	4.85 (332)
	22 mm	13 (0.50)	5.27 (361)	5.31 (364)	5.42(371)	5.53 (379)	5.66 (388)	5.79 (397)
	(0.87 in.)	19 (0.75)	5.75 (394)	5.78 (396)	5.87 (402)	5.97 (409)	6.08 (417)	6.20 (425)
	25 mm	13 (0.50)	6.61 (453)	6.65 (456)	6.77 (464)	6.90 (473)	7.04 (482)	7.19 (493)
	(1.0 in.)	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	13 (0.50)	3.44 (236)	3.47 (238)	3.56 (244)	3.65 (250)	3.75 (257)	3.86 (265)
	(0.75 in.)	19 (0.75)	3.73 (256)	3.76 (258)	3.84 (263)	3.92 (269)	4.02 (275)	4.12 (282)
	22 mm	13 (0.50)	4.45 (305)	4.49 (308)	4.59 (315)	4.70 (322)	4.82 (330)	4.95 (339)
	(0.87 in.)	19 (0.75)	4.83 (331)	4.86 (333)	4.95 (339)	5.05 (346)	5.16 (353)	5.28 (362)
	25 mm	13 (0.50)	5.59 (383)	5.63 (386)	5.74 (394)	5.87 (402)	6.01 (412)	6.15 (422)
	(1.0 in.)	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	13 (0.50)	2.79 (191)	2.82 (193)	2.89 (198)	2.96 (203)	3.04 (209)	3.13 (214)
	(0.75 in.)	19 (0.75)	3.03 (208)	3.05 (209)	3.11 (213)	3.18 (218)	3.26 (223)	3.34 (229)
	22 mm	13 (0.50)	3.62 (248)	3.65 (250)	3.73 (255)	3.82 (262)	3.91 (268)	4.01 (275)
	(0.87 in.)	19 (0.75)	3.93 (269)	3.95 (271)	4.02 (276)	4.10 (281)	4.19 (287)	4.28 (293)
	25 mm	13 (0.50)	4.55 (312)	4.58 (314)	4.67 (320)	4.77 (327)	4.88 (334)	4.99 (342)
	(1.0 in.)	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	13 (0.50)	2.90 (198)	2.92 (200)	3.00 (206)	3.08 (211)	3.17 (217)	3.26 (224)
	(0.75 in.)	19 (0.75)	3.14 (215)	3.17 (217)	3.23 (222)	3.31 (227)	3.39 (232)	3.48 (238)
	22 mm	13 (0.50)	3.76 (257)	3.79 (260)	3.88 (266)	3.97 (272)	4.08 (279)	4.18 (287)
	(0.87 in.)	19 (0.75)	4.07 (279)	4.10 (281)	4.17 (286)	4.26 (292)	4.36 (299)	4.46 (306)
	25 mm	13 (0.50)	4.72 (323)	4.76 (326)	4.85 (333)	4.96 (340)	5.08 (348)	5.21 (357)
	(1.0 in.)	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	13 (0.50)	2.35 (161)	2.37 (163)	2.43 (167)	2.50 (171)	2.57 (176)	2.64 (181)
	(0.75 in.)	19 (0.75)	2.55 (175)	2.57 (176)	2.62 (180)	2.68 (184)	2.75 (188)	2.82 (193)
	22 mm	13 (0.50)	3.07 (210)	3.10 (212)	3.17 (217)	3.25 (223)	3.34 (229)	3.43 (235)
	(0.87 in.)	19 (0.75)	3.31 (227)	3.33 (228)	3.39 (232)	3.46 (237)	3.54 (242)	3.62 (248)
	25 mm	13 (0.50)	3.86 (265)	3.89 (267)	3.97 (272)	4.07 (279)	4.17 (285)	4.27 (293)
	(1.0 in.)	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	13 (0.50)	2.36 (162)	2.39 (164)	2.45 (168)	2.52 (173)	2.60 (178)	2.67 (183)
	(0.75 in.)	19 (0.75)	2.56 (175)	2.58 (177)	2.64 (181)	2.70 (185)	2.77 (190)	2.85 (195)
	22 mm	13 (0.50)	3.07 (210)	3.10 (212)	3.17 (217)	3.25 (223)	3.34 (229)	3.43 (235)
	(0.87 in.)	19 (0.75)	3.32 (228)	3.34 (229)	3.41 (234)	3.48 (239)	3.56 (244)	3.65 (250)
	25 mm	13 (0.50)	3.86 (265)	3.89 (267)	3.97 (272)	4.07 (279)	4.17 (285)	4.27 (293)
	(1.0 in.)	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	13 (0.50)	1.92 (131)	1.94 (133)	1.99 (136)	2.04 (140)	2.10 (144)	2.17 (148)
	(0.75 in.)	19 (0.75)	2.08 (142)	2.09 (144)	2.14 (147)	2.19 (150)	2.25 (154)	2.31 (158)
	22 mm	13 (0.50)	2.49 (171)	2.51 (172)	2.57 (176)	2.64 (181)	2.71 (186)	2.78 (191)
	(0.87 in.)	19 (0.75)	2.70 (185)	2.72 (186)	2.77 (190)	2.83 (194)	2.89 (198)	2.96 (203)
	25 mm	13 (0.50)	3.14 (215)	3.16 (217)	3.23 (221)	3.30 (226)	3.38 (232)	3.47 (237)
	(1.0 in.)	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, 9.81×10^{-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 $w^3 b/12$ 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 = ρ g, kN/m^3 (lbf/ in^3)

γ_D dry unit weight of soil = ρ_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

$$S_U = 0.67\ p_L^{0.75} \qquad \text{for } S_U \text{ and } p_L \text{ in kPa}$$

$$S_U = 0.41\ p_L^{0.75} \qquad \text{for } S_U \text{ and } p_L \text{ in lbf/in}^2$$

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 $I_S = [\ln(1 + J/b)] / 1.386$ 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:

$$V_{LRFD} = V_G \quad \text{for LRFD}$$

$$M_{LRFD} = M_G \quad \text{for LRFD}$$

$$V_{ASD} = V_G \quad \text{for ASD}$$

$$M_{ASD} = M_G \quad \text{for ASD}$$

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:

$$q_B = q_{cr} B (C_{w1} + C_{w2} d_F / B) / C_{CPT2}$$

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:

$$p_{U,z} = 3\sigma'_{v,z} K_P + (2 + z / b)\, c\, K_P^{0.5} \quad \text{for } 0 \leq z < 4b_G$$

$$p_{U,z} = 3\,(\sigma'_{v,z}\,K_P + 2\,c\,K_P^{0.5}) \quad \text{for } z \geq 4b_G$$

$$K_P = (1 + \sin\phi) / (1 - \sin\phi)$$

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:

$$M_U = b\, S_U\, [4.5\, d^2 - 6\, d_{RU}^2 - d_{RU}^3 / (2b)] \text{ for } 0 \leq d_{RU} \leq d$$

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 $$M_U = 9\, b\, S_U\, (d^2 / 2 - d_{RU}^2 + 16\, b^2 / 9) \text{ for } 0 \leq d_{RU} \leq d$$

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:

$$M_U = S_{LU}\, (d^3 - 2\, d_{RU}^3) / 3 + 6\, b\, c\, K_P^{0.5}\, (d^2 / 2 - d_{RU}^2 + b^2 / 4) \text{ for } 0 \leq d_{RU} \leq d$$

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:

$$M_U = b\, S_U\, (4.5\, d^2 - 16\, b^2) \quad \text{for } d \geq 4b_G$$

and $$M_U = b\, d^2\, S_U\, [3 / 2 + d / (2b)] \quad \text{for } d \leq 4b_G$$

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:

$$M_U = d^3 b\, K_P \gamma + b c K_P^{0.5}\, (3d^2 - 32b^2 / 3) \quad \text{for } d \geq 4b_G$$

and $$M_U = d^3\, b\, K_P\, \gamma + b\, d^2 c\, K_P^{0.5}\, [1 + d / (3b)] \quad \text{for } d \leq 4b_G$$

$$K_P = (1 + \sin \phi) / (1 - \sin \phi)$$

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 $0.1d$ at a distance $2d$ 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 $2d$ (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 *ES* 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:

$$v = \frac{\sigma_3\varepsilon_1 - \sigma_1\varepsilon_3}{\sigma_1\varepsilon_1 + \sigma_3\varepsilon_1 - 2\sigma_3\varepsilon_3}$$

$$E_S = \frac{\sigma_1 - 2v\sigma_3}{\varepsilon_1}$$

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):

$$v = -\varepsilon_3 / \varepsilon_1$$

$$E_S = \sigma_1 / \varepsilon_1$$

In tests in which the specimen is restrained from moving laterally (i.e., $\varepsilon_3 = 0$) (as with tests according to ASTM D2435)

$$v = \sigma_3 / (\sigma_1 + \sigma_3)$$

$$E_S = \frac{\sigma_1(1+v)(1-2v)}{\varepsilon_1(1-v)}$$

$$M_S = \frac{\sigma_1}{\varepsilon_1} = \frac{E_S(1-\nu)}{(1+\nu)(1-2\nu)}$$

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.

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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

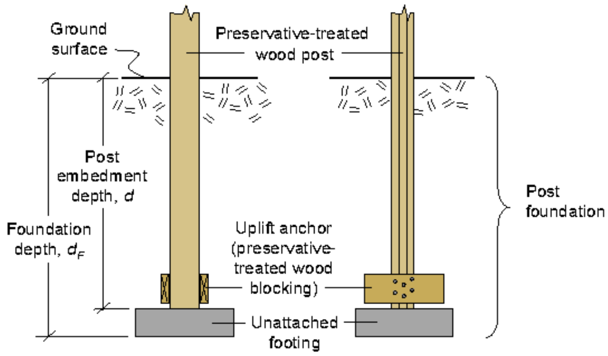

Figure 1 – Preservative-treated wood post foundation

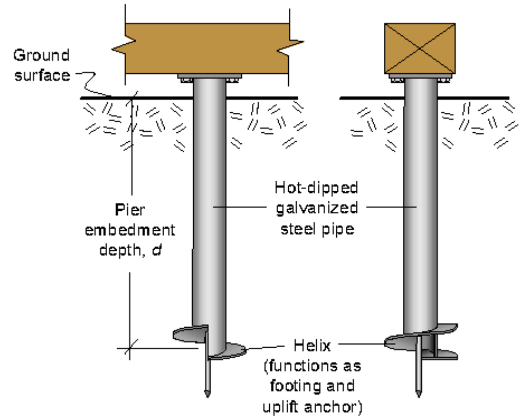

Figure 2 – Helical pier foundation

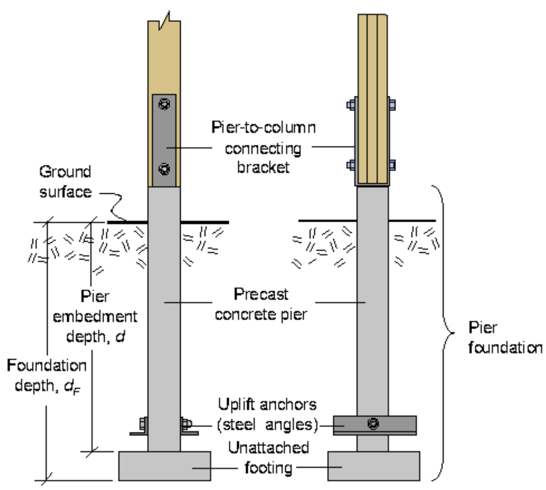

Figure 3 – Precast concrete pier foundation

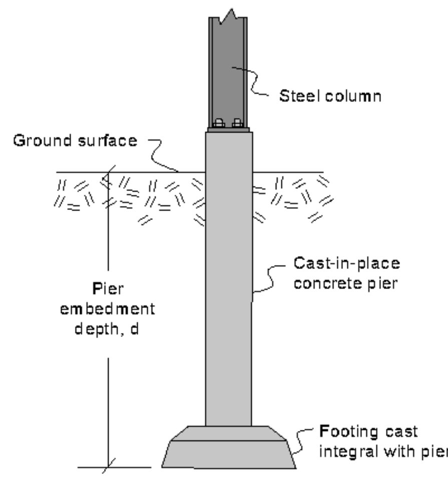

Figure 4 – Cast-in-place concrete pier foundation

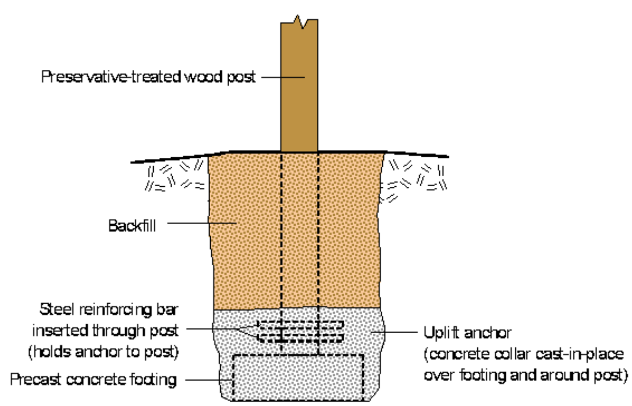

Figure 5 – Post foundation with cast-in-place concrete collar

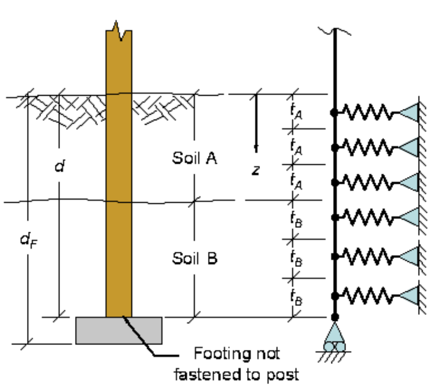

Figure 6 – Two-dimensional structural analog for a post/pier foundation. Spacing of soil springs dictated by thickness of each soil layer.

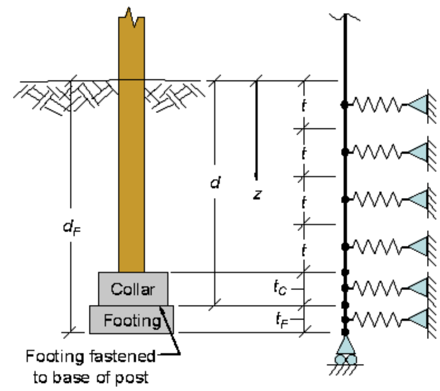

Figure 7 – Two-dimensional structural analog for a post/pier foundation. Different soil springs are used to model soil acting on the collar, attached footing, and pier/post because of the difference in width of the three foundation elements.

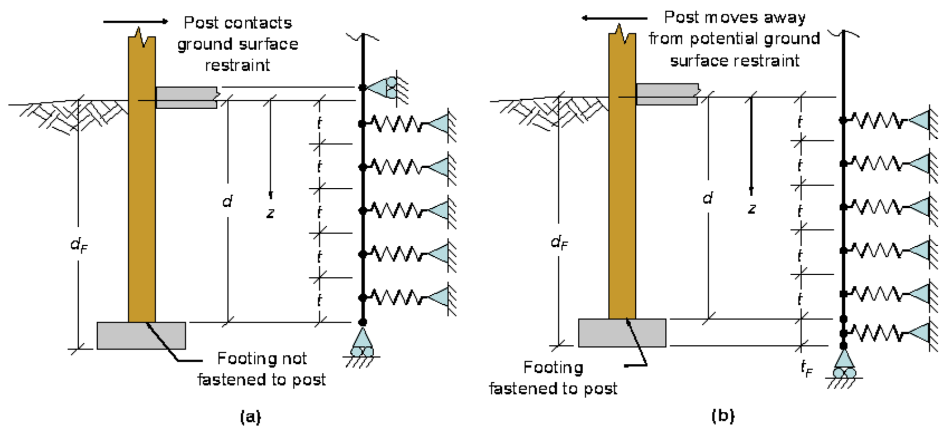

Figure 8 – Two-dimensional structural analogs for a post/pier foundation. If pier/post foundation is moving away from a surface restraint, do not model the surface restraint with a support.

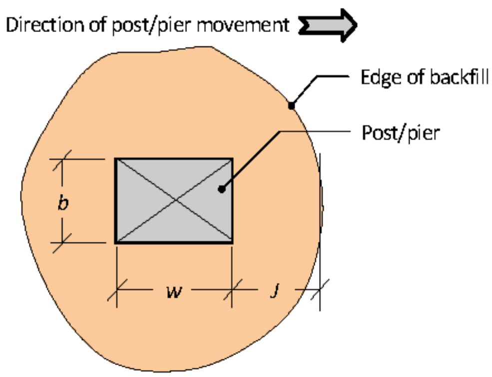

Figure 9 – Top view of foundation showing distance J between the post/pier and edge of backfill

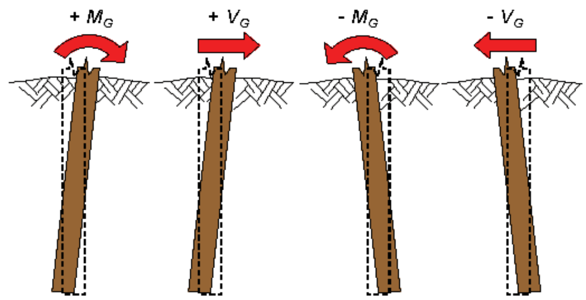

Figure 10 – Sign convention for groundline shear and groundline bending moment forces

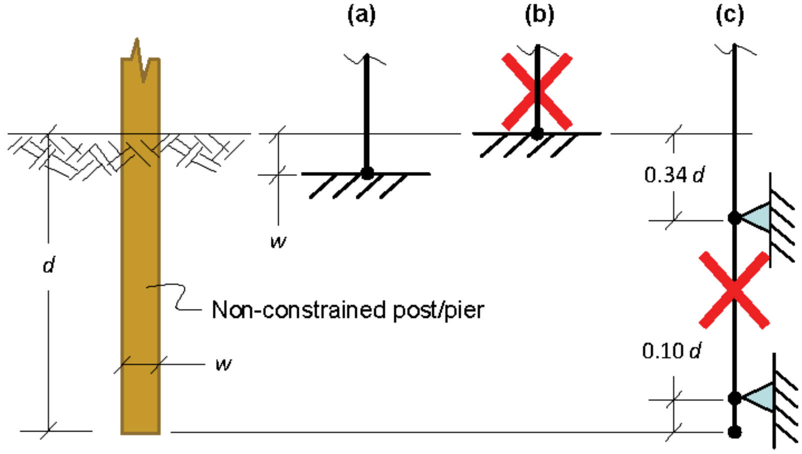

Figure 11 – Modeling analogs: (a) fixed base analog that is recommended when modeling a non-constrained pier/post to obtain M_G and V_G, (b) fixed base analog that is not recommended as it is too rigid, and (c) old two support analog that is too flexible for deeper foundations and too difficult to use.

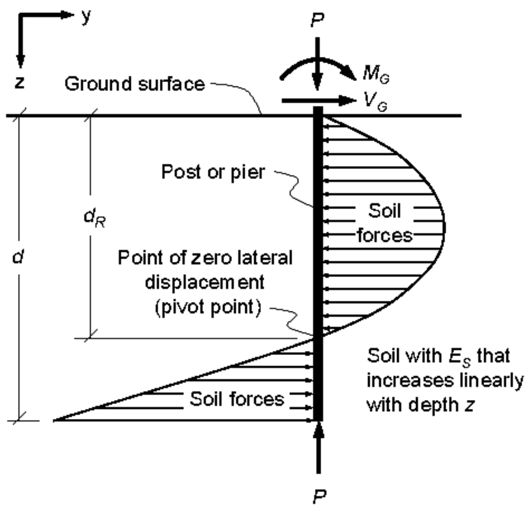

Figure 12 – Forces acting on a non-constrained post/pier of fixed width *b* when soil stiffness increases linearly with depth

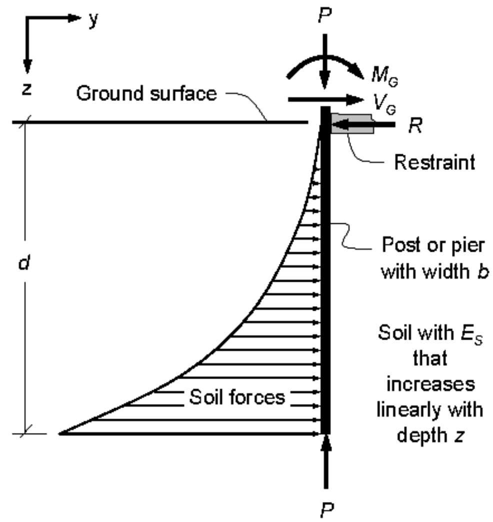

Figure 13 – Forces acting on a ground surface-constrained post/pier of fixed width *b* when soil stiffness increases linearly with depth

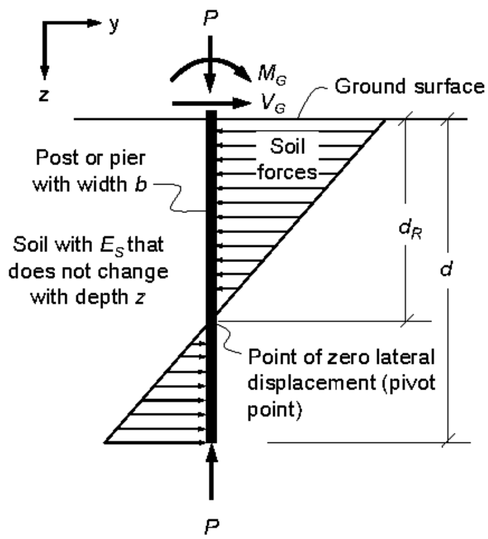

Figure 14 – Forces acting on a non-constrained post/pier of fixed width *b* when soil stiffness is constant with depth

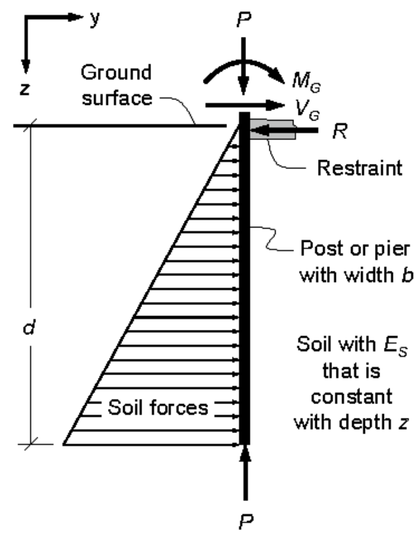

Figure 15 – Forces acting on a ground surface-constrained post/pier of fixed width *b* when soil stiffness is constant with depth

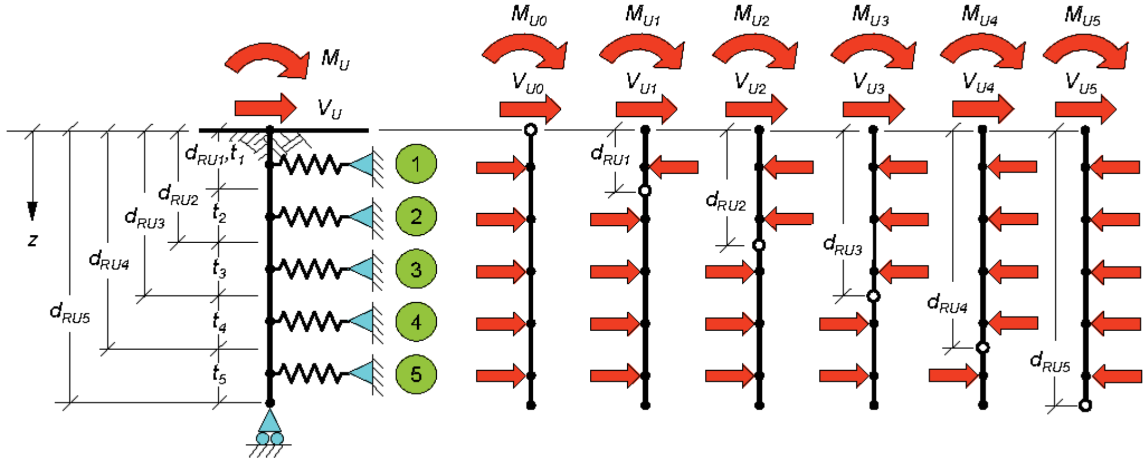

Figure 16 – Five soil spring model and associated free body diagrams for six different ultimate pivot point locations.

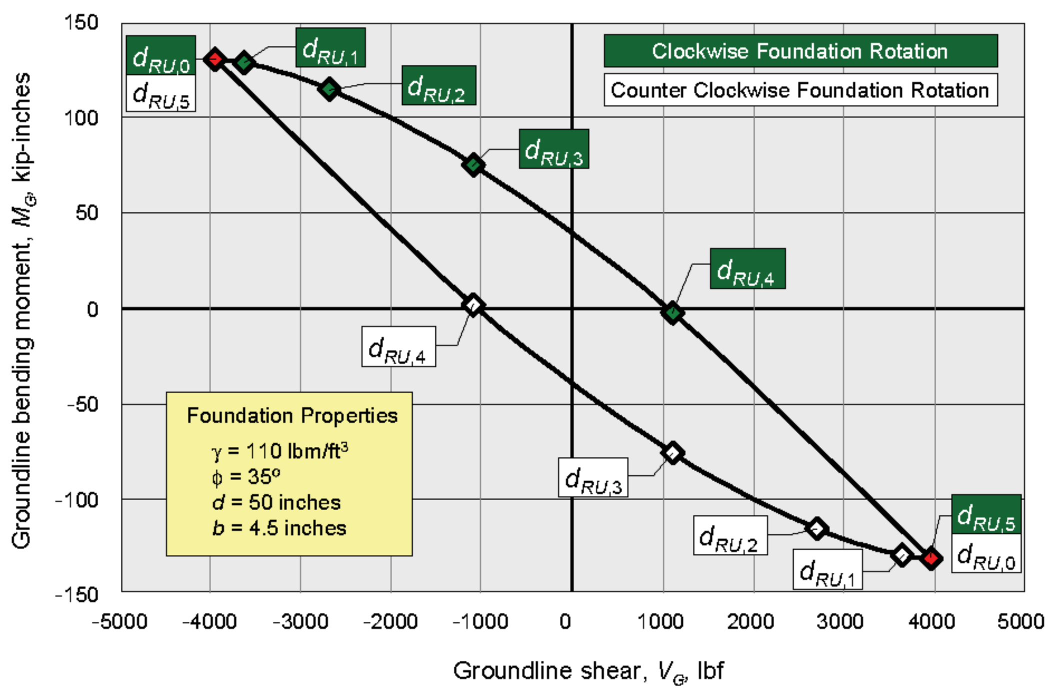

Figure 17 – V_U – M_U envelope developed using free body diagrams in Figure 16.

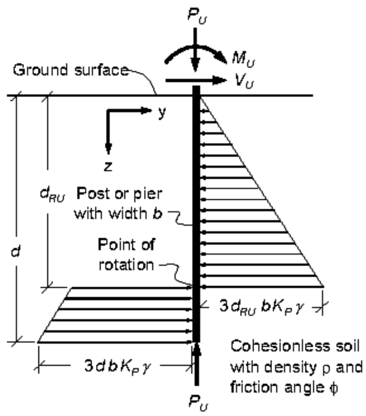

Figure 18 – Forces acting on a non-constrained post/pier of fixed width *b* in cohesionless soil at failure

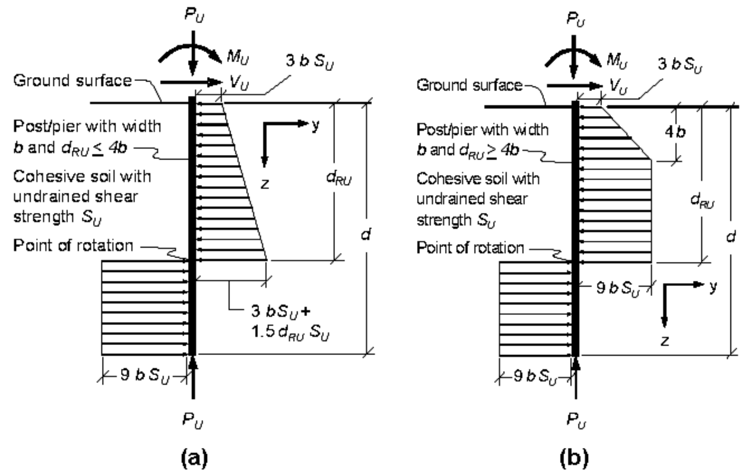

Figure 19 – Forces acting on a non-constrained post/pier of fixed width *b* in cohesive soil at failure (a) when d_{RU} is less than 4 *b*, and (b) when d_{RU} is greater than 4 *b*

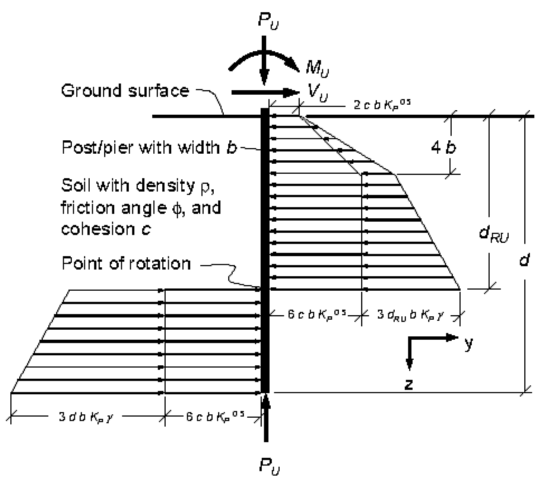

Figure 20 – Forces acting on a non-constrained post/pier of fixed width *b* in a homogenous soil at failure

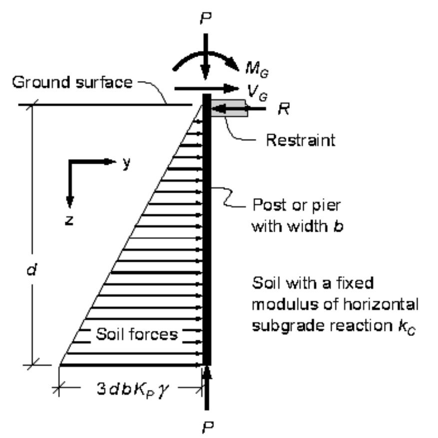

Figure 21 – Forces acting on a constrained post/pier of fixed width *b* in cohesionless soil at failure

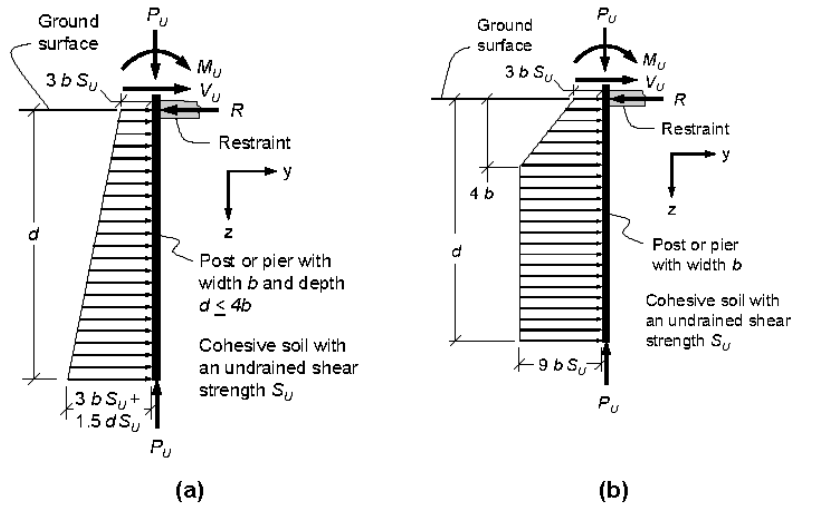

Figure 22 – Forces acting on a constrained post/pier of fixed width *b* in cohesive soil at failure (a) when *d* is less than 4 *b*, and (b) when *d* is greater than 4 *b*

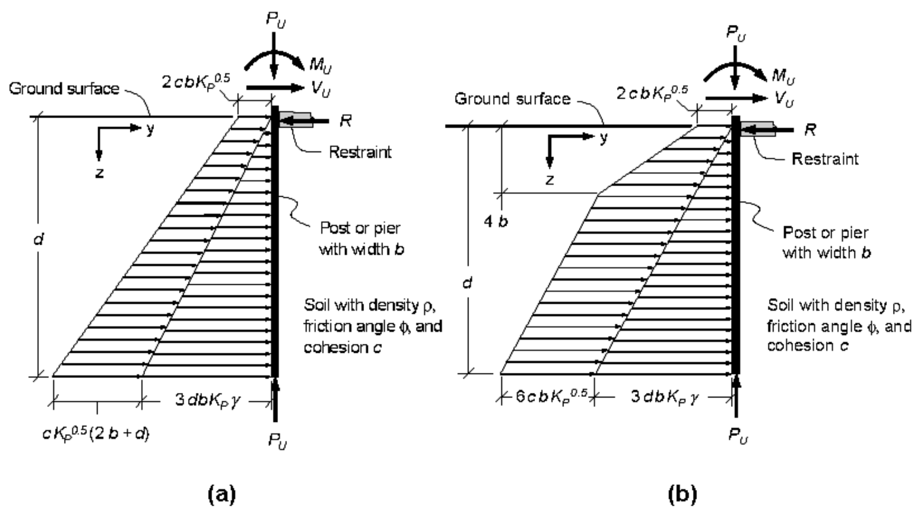

Figure 23 – Forces acting on a constrained post/pier of fixed width *b* in a homogenous soil at failure (a) when *d* is less than 4 *b*, and (b) when *d* is greater than 4 *b*

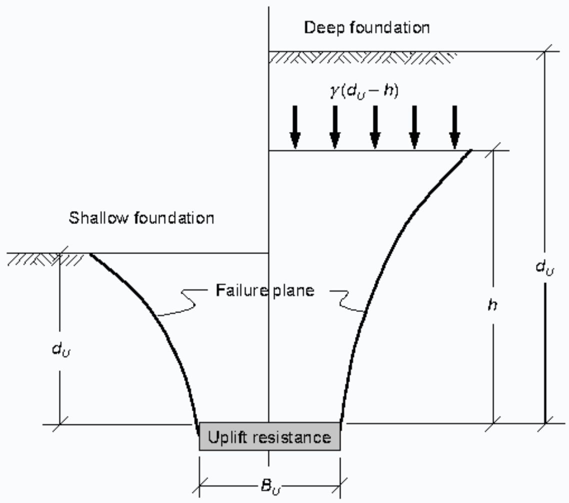

Figure 24 – Modes of uplift failure for uplift resistance systems at different depths

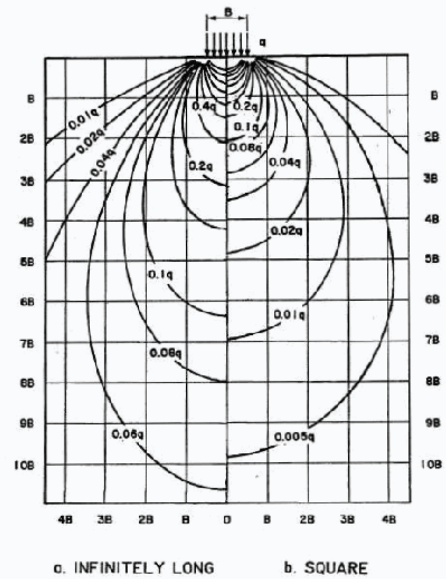

Figure 25 – Stress distributions under continuous and square footings as predicted via elastic theory

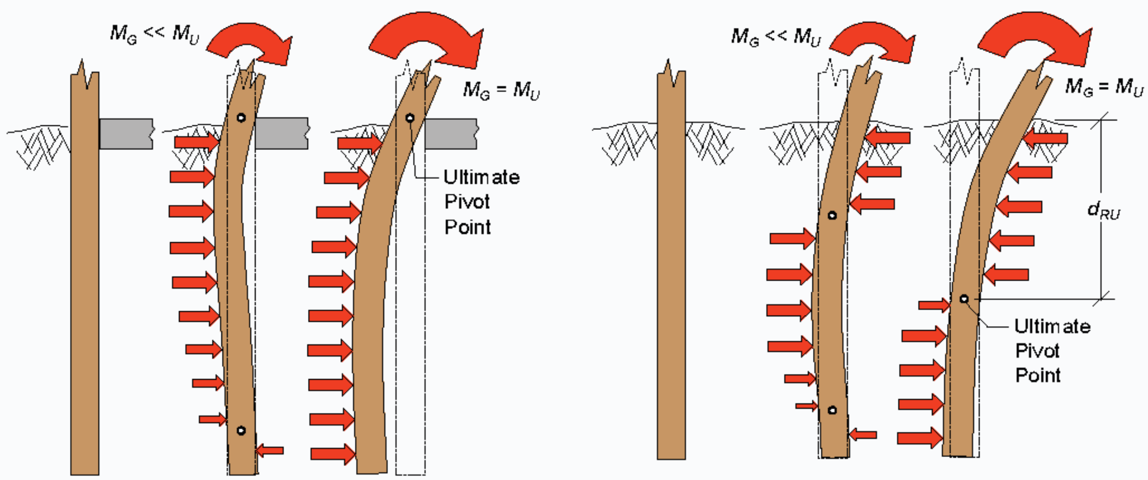

Figure 26 – Surface-constrained (left) and non-constrained (right) post foundations subjected to a groundline bending moment.

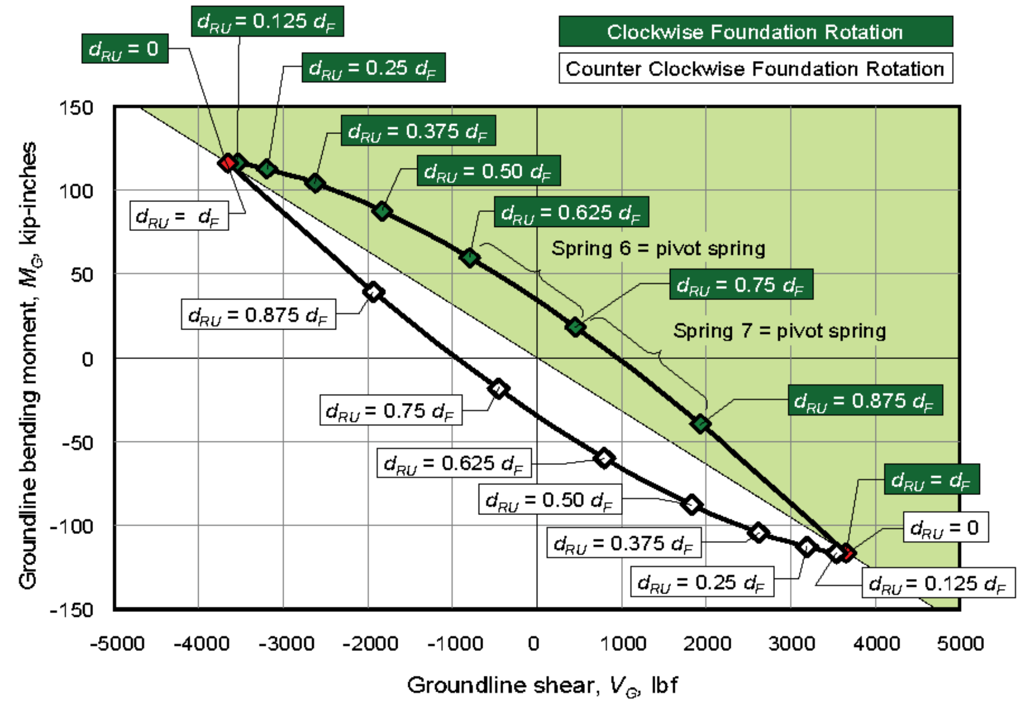

Figure 27 – A $V_U - M_U$ envelope for an 8 soil spring model based on data in Table 7.

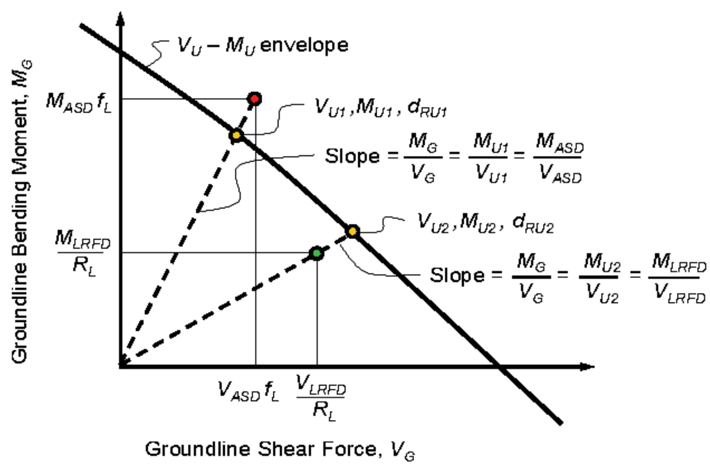

Figure 28. Using a $V_U - M_U$ envelope to check the adequacy of a foundation.

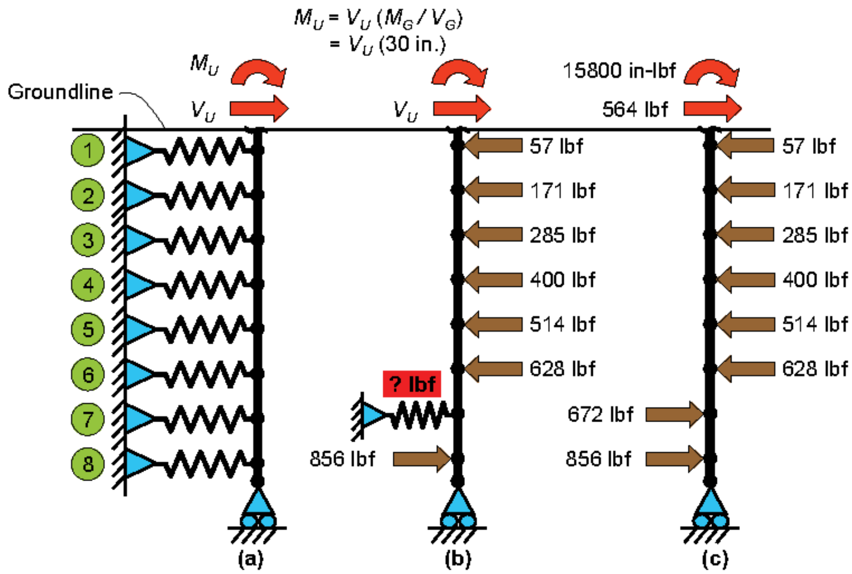

Figure 29. Determining V_U and M_U for a specified M_G/V_G ratio and associated pivot spring.

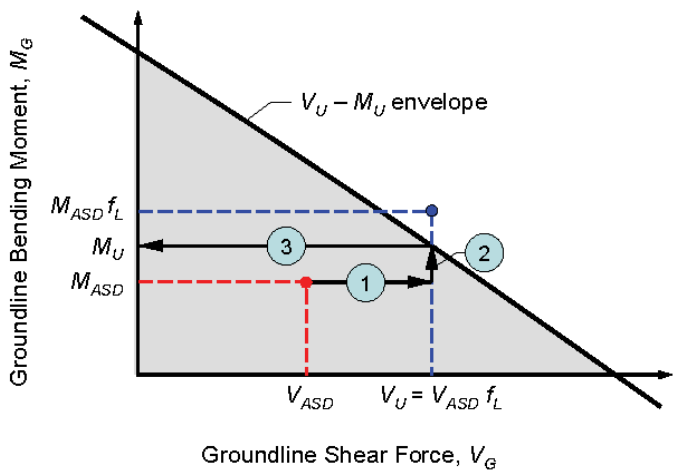

Figure 30. Graphical depiction of lateral strength checking process for Simplified Method of analysis.

ANSI/ASAE EP559.1 W/Corr. 1 AUG2010 (R2014)
Design Requirements and Bending Properties for Mechanically Laminated Wood Assemblies

American Society of
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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.

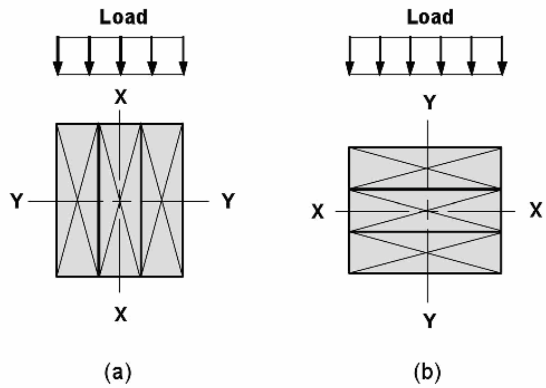

Figure 1 – (a) Vertically laminated, (b) horizontal laminated assemblies

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).

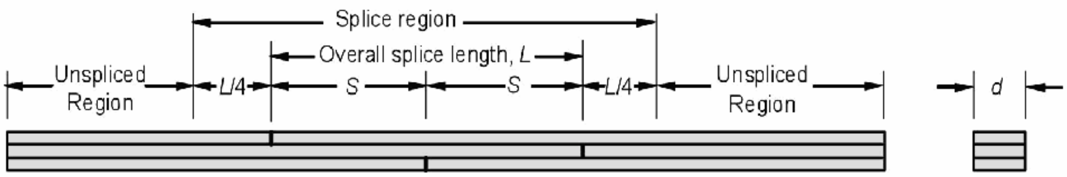

Figure 2 – Spliced assembly definitions

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/m^3 (lbm/ft^3)**									
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/m^3 (lbm/ft^3)**									
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.

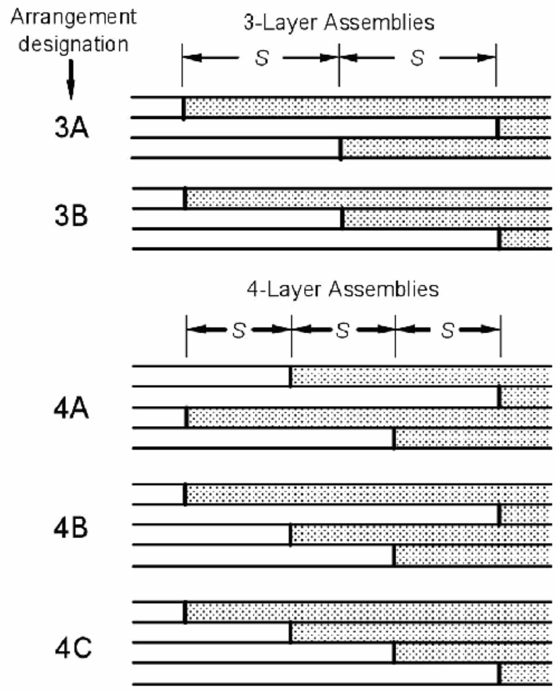

Figure 3 – Joint arrangements for three- and four-layer spliced assemblies

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:

$$V_t \geq 0.22 F_b' \, t \, d^2 / w^2 \qquad (2)$$

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.

$$\alpha = 0.887 - 1.329\left[d^3 E\,t \big/ \left(L^5 Kp\right)\right]^{0.25} \qquad (3)$$

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.

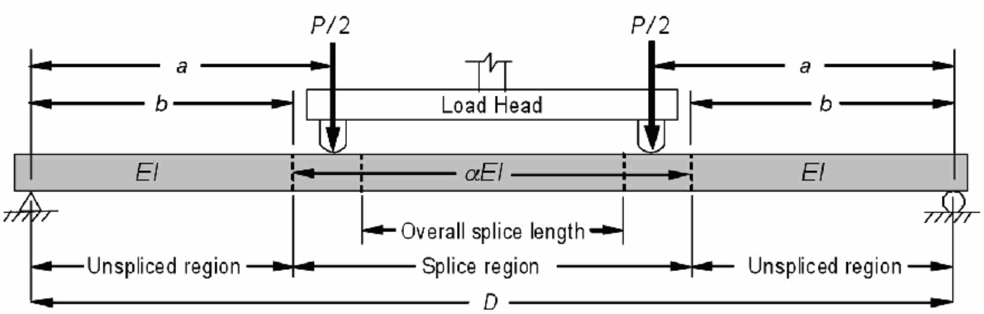

Figure 4 – Model of a spliced assembly under a two-point loading; reduced flexural stiffness in the splice region

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.

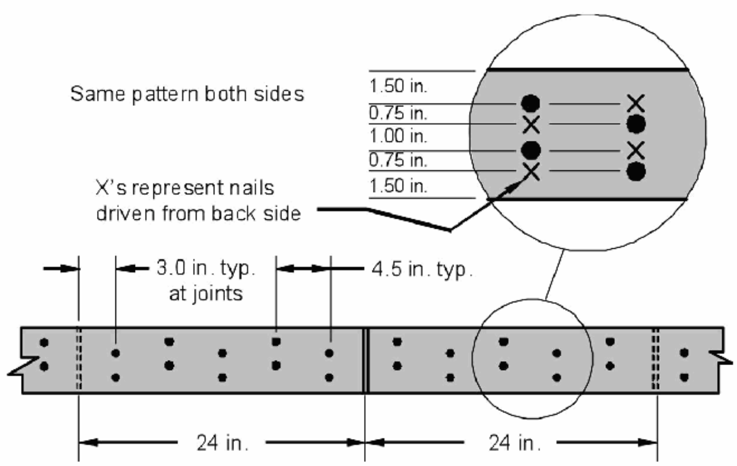

Figure 5 – Example nail pattern for a three-layer spliced assembly fabricated using 10 d common wire nails. Only a portion of the splice region is shown. The same nail pattern is used on both sides of the assembly.

S7893

165

Date Submitted	12/11/2018	**Section**	202	**Proponent**	Joseph Hetzel
Chapter	2	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
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	No Affirmative Recommendation				
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 No Affirmative Recommendation
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.

S8393

Date Submitted	12/15/2018	**Section**	317.3.1	**Proponent**	Randall Shackelford
Chapter	3	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	No Affirmative Recommendation				
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.**

S7537

Date Submitted	11/28/2018	**Section**	703.11.2	**Proponent**	T Stafford
Chapter	7	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	No Affirmative Recommendation				
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.

S8353

Date Submitted	12/15/2018	**Section**	703.7.2	**Proponent**	Joseph Crum
Chapter	7	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
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).

TAC: Structural

Total Mods for **Structural** in **Withdrawn: 12**

Total Mods for report: 182

Sub Code: Building

S7417

171

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

TAC Recommendation Withdrawn
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	12/14/2018	**Section**	202	**Proponent**	Joseph Crum
Chapter	2	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Withdrawn
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.

S7528

Date Submitted 11/28/2018
Chapter 2
Section 202
Affects HVHZ No
Proponent Joseph Crum
Attachments No
TAC Recommendation Withdrawn
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.

S7602

Date Submitted	11/30/2018	**Section**	202	**Proponent**	Ann Russo5
Chapter	2	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation	Withdrawn
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.

Date Submitted	12/14/2018	**Section**	1810.3.3.1.6	**Proponent**	Dale Biggers
Chapter	18	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Withdrawn				
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	Withdrawn				
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	Withdrawn				
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*.

S8368

Date Submitted	12/15/2018	**Section**	2101.2	**Proponent**	Joseph Belcher for MAF
Chapter	21	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Withdrawn				
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

S8266

Date Submitted	12/14/2018	**Section**	2304.12.2	**Proponent**	Joseph Crum
Chapter	23	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Withdrawn				
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.

S7486

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

TAC Recommendation Withdrawn
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.

S7631

Date Submitted	12/2/2018	**Section**	324.4.1.1	**Proponent**	Ann Russo8
Chapter	3	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Withdrawn				
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.

S7985

Date Submitted	12/13/2018	**Section**	804	**Proponent**	Ann Russo8
Chapter	8	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Withdrawn				
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.

2

Ceiling joists shall have a bearing support length of not less than 11/ 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.