STRUCTURAL TAC
WITH COMMENTS

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Total Mods for report: 112

TAC: Structural

Total Mods for **Structural** in **Approved as Submitted: 20**

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Sub Code: Building

S7448

1

Date Submitted	11/26/2018	**Section**	2304.12.2.6	**Proponent**	Paul Coats
Chapter	23	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
Commission Action Pending Review

Comments

General Comments No — **Alternate Language** Yes

Related Modifications

Summary of Modification

Introduces a new section which requires ventilation openings in enclosed wood floor framing when the floor supports an exterior balcony or walking surface that is exposed to the weather.

Rationale

This proposed modification was approved for the 2018 IBC by the ICC membership and appears in the 2018 edition of the IBC. Similar to the requirement for ventilation of unvented rafter assemblies in Section 1203.3, unvented floor assemblies that serve as exterior balconies or walking surfaces should have ventilation so the assembly can dry out if water gets into the assembly. The ventilation is important regardless of whether the wood is preservative treated or not, and the requirement is necessary especially for when wood structural members support moisture-permeable floors or roofs as permitted in Section 2304.12.2.5, the section which precedes this new proposed section.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Confirming during plan check or final inspection that ventilation is provided could be part of the same process that is currently used for required underfloor ventilation and ventilation of enclosed rafter and attic spaces, and therefore would not have a significant additional impact.

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

Similar to providing required ventilation openings in underfloor spaces and enclosed rafter and attic spaces, the impact is minimal. Leaving the floor structure unenclosed from the bottom is an alternative.

Impact to industry relative to the cost of compliance with code

Similar to providing required ventilation openings in underfloor spaces and enclosed rafter and attic spaces, the impact is minimal. Leaving the floor structure unenclosed from the bottom is an alternative.

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

Similar to providing required ventilation openings in underfloor spaces and enclosed rafter and attic spaces, the impact is minimal. Leaving the floor structure unenclosed from the bottom is an alternative.

Requirements

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

The ventilation of enclosed floor spaces beneath balconies exposed to the weather is an important safeguard in case impervious moisture barriers or flashings fail due to damage or incorrect installation. The deterioration of wood in floors due to trapped moisture can be a life safety issue.

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

Although the code currently contains provisions for the protection of wood from water in this location, the additional safeguard of ventilation will improved the code.

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

This does not discriminate against any materials, products, methods, or systems of construction. The code already requires the protection of wood in this circumstance.

Does not degrade the effectiveness of the code

This does not degrade the effectiveness of current code requirements for the protection of wood.

Alternate Language

2nd Comment Period

7448-A2

Proponent Paul Coats **Submitted** 5/25/2019 **Attachments** Yes

Rationale

A concern was expressed that the proposed modification may be interpreted to require additional ventilation for existing roofs when reroofing. This alternate language should clarify that the requirement applies to the ventilation of balconies and elevated walking surfaces that are newly constructed.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact related to this alternate language.

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

No impact related to this alternate language.

Impact to industry relative to the cost of compliance with code

No impact related to this alternate language.

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

Similar to providing required ventilation openings in underfloor spaces and enclosed rafter and attic spaces, the impact is minimal. Leaving the floor structure unenclosed from the bottom is an alternative.

Requirements

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

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

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

Add additional language to the new section as follows (underlined words indicate added words; no underline indicates the wording of the original modification):

2304.12.2.6 Ventilation required beneath balcony or elevated walking surface. <u>In new construction,</u> 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.

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.

S7433

Date Submitted	11/26/2018	**Section**	2510.3	**Proponent**	George Starks
Chapter	25	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Approved as Submitted
Commission Action Pending Review

Comments

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

Related Modifications

2511.1.1; 2511.3; 25111.4;2512.1; 2512.1.1; 2512.1.2; 2512.2; 2512.6; 2512.8; 2512.9; 2513.7;2109.3.4.8;

Summary of Modification

Seeks to update the Referenced Standards to the current published versions: C 926-18b and C 1063-18b. Significant clarifications and reorganization, to produce more user-friendly documents, have been incorporated since the 15a and 15b versions of these standards.

Rationale

Significant changes to these Standards, in the form of reorganization and re-wording, have been instituted in an effort to make the Standards more user-friendly and less confusing. Comparison files are attached.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will not impact enforcement of the code.

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

Will not impact the cost to building and property owners relative to compliance with the code.

Impact to industry relative to the cost of compliance with code

Will not impact the cost to the industry relative to compliance with the code.

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

Will not impact the cost to small business relative to compliance with the code.

Requirements

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

Proper installation of exterior cladding systems have direct impact to the health and welfare of the general public as key elements in the building envelope.

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

Improves the code by providing to the general public, as well as industry professionals, a more clear and concise standard through re-wording, reorganization and removal of some antiquated provisions.

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

Makes no discriminatory remarks or statements in regards to materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

2nd Comment Period

7433-A1

Proponent George Starks **Submitted** 4/15/2019 **Attachments** Yes

Rationale

Since the initial proposal submittal deadline, ASTM has published and released a newer version of C 1063 (19a) which includes further reorganization and re-wording for clarification purposes and to make the document more user-friendly.

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

Will not impact the cost to small business relative to compliance with the code.

Requirements

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

Proper installation of exterior cladding systems have direct impact to the health and welfare of the general public as key elements in the building envelope.

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

Improves the code by providing to the general public, as well as industry professionals, a more clear and concise standard through re-wording, reorganization and removal of some antiquated provisions.

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

Makes no discriminatory remarks or statements in regards to materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

C926-18b Specification for Application of Portland Cement-based Plaster.... 2109.3.4.8, 2510.3, Table 2511.1.1, 2511.3,2511.4,2512.1,2512.1.2,2512.2,2512.6, 2512.8.2, 2512.9, 2513.7

C1063-~~18b~~ 19a Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based
Plaster......... 2109.3.4.8, 2510.3,
Table 2511.1.1, 2512.1.1

Chapter 35

ASTM

C926 ~~15b~~18b Specification for Application of Portland Cement-based Plaster . . . . 2109.3.4.8, 2510.3, Table 2511.1.1, 2511.3, 2511.4, 2512.1,

2512.1.2, 2512.2, 2512.6, 2512.8.2, 2512.9, 2513.7

C1063 ~~15a~~18b Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-based Plaster .. . . 2109.3.4.8, 2510.3, Table 2511.1.1, 2512.1.1

INTERNATIONAL

Designation: ~~C1063 – 19~~C1063 – 19a

Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster[1]

This standard is issued under the fixed designation C1063; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification covers the minimum technical requirements for the installation of lathing and furring for the application of exterior and interior portland cement-based plaster, as in Specification C926. These requirements do not by default define a unit of work or assign responsibility for contractual purposes, which is the purview of a contract or contracts made between contracting entities.

1.2 *Table of Contents:*

1.3 Where a fire resistance rating is required for plastered assemblies and constructions, details of construction shall be in accordance with reports of fire tests of assemblies that have met the requirements of the fire rating imposed.

1.4 Where a specific degree of sound control is required for plastered assemblies and constructions, details of construction shall be in accordance with official reports of tests conducted in recognized testing laboratories in accordance with the applicable requirements of Test Method E90.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.6 ~~*Table of Contents:*~~ The text of this specification references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the specification.

[1] This specification is under the jurisdiction of ASTM Committee C11 on Gypsum and Related Building Materials and Systems and is the direct responsibility of Subcommittee C11.03 on Specifications for the Application of Gypsum and Other Products in Assemblies.

Current edition approved ~~Feb. 1, 2019~~March 1, 2019. Published ~~February 2019~~March 2019. Originally approved in 1986. Last previous edition approved in ~~2018~~2019 as ~~C1063 – 18b.~~C1063 – 19. DOI: ~~10.1520/C1063-19.~~10.1520/C1063-19A.

***A Summary of Changes section appears at the end of this standard**

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A653/A653M Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

C11 Terminology Relating to Gypsum and Related Building Materials and Systems

C847 Specification for Metal Lath

C926 Specification for Application of Portland Cement-Based Plaster

C933 Specification for Welded Wire Lath

C1032 Specification for Woven Wire Plaster Base

C1280 Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing

C1861 Specification for Lathing and Furring Accessories, and Fasteners, for Interior and Exterior Portland Cement-Based Plaster

E90 Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

2.2 *US Department of Commerce (DOC) Standards*

PS 1 Voluntary Product Standard PS 1, Structural Plywood

PS 2 Voluntary Product Standard PS 2, Performance Standard for Wood-Based Structural Use Panels

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions relating to ceilings and walls, see Terminology C11.

3.1.2 For definitions relating to lathing accessories, furring accessories and fasteners, see Specification C1861.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *building enclosure, n*—system of building assemblies and materials designed and installed in such a manner as to provide a barrier between different environments.

3.2.2 *control joint, n*—a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.

3.2.3 *expansion joint, n*—a joint that accommodates movement beyond plaster shrinkage and curing.

NOTE 1—For design consideration of control and expansion joints, see Annex A2.3.1.2 of Specification C926.

3.2.4 *framing member, n*—studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.

3.2.5 *hangers, n*—wires or steel rods or straps used to support main runners for suspended ceilings beneath floor or roof constructions.

3.2.6 *inserts, n*—devices embedded in concrete framing members to provide a loop or opening for attachment of hangers.

3.2.7 *saddle tie, n*—see Figs. A1.6 and A1.7.

3.2.8 *self-furring, adj*—a metal plaster base manufactured with evenly-spaced indentations that hold the body of the lath approximately ¼ in. (6 mm) away from solid surfaces to which it is installed.

3.2.9 *water-resistive barrier, n*—a material that resists the infiltration of liquid moisture through the building enclosure system.

4. Delivery and Storage of Materials

4.1 *Delivery of Materials:*

4.1.1 Materials shall be delivered in the original packages, containers, or bundles bearing the brand-name and manufacturer's (or supplier's) identification.

4.2 *Storage of Materials:*

4.2.1 Materials shall be kept dry. Materials shall be stacked off the ground, supported on a level platform, and protected from the weather and surface contamination.

4.2.2 Materials shall be neatly stacked with care taken to avoid damage to edges, ends, or surfaces.

4.2.3 Metal plaster bases with a factory-attached water-resistive barrier shall be handled carefully in delivery, storage, and erection to prevent puncturing or removal of the factory-attached water-resistive barrier.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

5. Materials

5.1 Metallic materials including lathing, lathing accessories, furring, furring accessories, and fasteners shall be selected for compatibility to minimize galvanic corrosion between adjacent metallic materials installed in the cement plaster cladding assembly.

5.2 *Metal Plaster Bases:*

5.2.1 *Expanded Metal Lath*—Specification C847, galvanized.

5.2.2 *Wire Laths:*

5.2.2.1 *Welded Wire Lath*—Specification C933.

5.2.2.2 *Woven Wire Lath*—Specification C1032.

5.3 *Lathing Accessories, Furring Accessories and Fasteners:*

5.3.1 *Lathing Accessories, Furring Accessories and Fasteners*—Specification C1861.

5.3.2 The selection of an appropriate type of material for lathing accessories shall be based upon applicable surrounding climatic and environmental conditions specific to the project location, such as salt air, industrial pollution, high moisture, or humidity.

6. Requirements for Substrates to Receive Metal Lathing and Furring

6.1 *Framed, or Framed and Sheathed Substrates:*

6.1.1 Framing member deflection shall not exceed L/360 (0.33 in. in 10 ft).

6.1.2 Substrates to receive lath shall be straight and true to line within ¼ in. in 10 ft. to receive the specified plaster thickness.

6.1.3 Plywood and oriented strand board sheathing panels shall be marked in accordance with DOC PS1 or DOC PS 2.

6.1.4 Plywood and oriented strand board sheathing panels shall be installed with ⅛ in. (3 mm) minimum panel edge gaps, and panel edges shall be offset 4 in. (10 cm) minimum from wall opening reentrant corners.

NOTE 2—This ⅛-in. (3 mm) gap is intended to accommodate expansion. Linear expansion that is not accommodated by an expansion gap can cause stress on the stucco membrane resulting in stucco cracks.

6.1.5 Wood framing members, plywood and oriented strand board sheathing panels shall have a moisture content not to exceed 19 % immediately before plastering.

6.1.6 Exterior gypsum sheathing panels shall be installed in compliance with Specification C1280.

7. Installation

7.1 *Workmanship*—Metal lathing, lathing accessories, furring, and furring accessories shall be erected so that the finished cement plaster surfaces are true to line (allowable tolerance of ¼ in. (6 mm) in 10 ft (3 m)), level, plumb, square, or curved as required to receive the specified cement plaster thickness.

7.2 *Installation of Metal Furring for Walls:*

7.2.1 Attachments for furring accessories shall be concrete nails driven securely into concrete or into masonry joints, power-actuated fasteners, or other devices specifically designed as spacer elements, spaced horizontally not more than 2 ft (610 mm) on centers. They shall be spaced vertically in accordance with horizontal stiffener spacing so that they project from the face of the wall in order for ties to be made.

7.2.2 Horizontal stiffeners shall be not less than ¾ in. (19 mm) cold-rolled channel furring, spaced not to exceed 54 in. (1372 mm) on centers vertically, with the lower and upper cold-rolled channel furring not more than 6 in. (152 mm) from the ends of vertical framing members and not less than ¼ in. (6 mm) clear from the wall face, securely tied to attachments with three loops of wire, or equivalent devices. Approved furring is not prohibited from use in this application.

7.2.3 Vertical framing members shall be not less than ¾ in. (19 mm) cold-rolled channel furring in accordance with the requirements of Table 1. Vertical framing members shall be saddle-tied to horizontal stiffeners with three loops of 0.0475-in. 18 gauge (1.21 mm) wire, or equivalent devices, at each crossing, and securely anchored to the floor and ceiling constructions. Where cold-rolled channel furring is not in contact with the wall, cold-rolled channel furring braces shall be installed between horizontal stiffeners and the wall, spaced horizontally not more than 2 ft (610 mm) on centers.

7.2.4 Where the water-resistive barrier has been damaged during installation of attachments, the water-resistive barrier shall be repaired with the same or an alternative material, compatible with the water-resistive barrier, before proceeding with the installation of the furring.

7.2.5 Z-furring used to support lathing and lathing accessories and its fasteners for fastening to framing members or solid bases, is a customized furring system which shall be engineered.

7.3 *Installation of Metal Plaster Bases:*

7.3.1 *General:*

7.3.1.1 Metal plaster bases shall be furred away from vertical framing members or solid surfaces at least ¼ in. (6 mm). Self-furring lath meets furring requirements; except, furring of expanded metal lath is not required on framing members having a bearing surface of 1⅝ in. (41 mm) or less.

TABLE 1 Types and Weights of Metal Plaster Bases and Corresponding Maximum Permissible Spacing of Wall and Ceiling Framing Members or Furring

<table>
<tr><th rowspan="3">Type of Metal Plaster Base</th><th rowspan="3">Minimum Weight of Metal Plaster Base, lb/yd² (kg/m²)</th><th colspan="5">Specific Installation Requirements and Maximum Permissible Spacing of Wall and Ceiling Framing Members or Furring, Center to Center, in. (mm)</th></tr>
<tr><th colspan="2">Walls</th><th colspan="3">Ceilings</th></tr>
<tr><th>24 (610)</th><th>16 (406)</th><th>24 (610)</th><th>16 (406)</th><th>12 (305)</th></tr>
<tr><td rowspan="2">Expanded Sheet Metal</td><td>2.5 (1.4)</td><td rowspan="2">Permitted only for self-furred lath on sheathed wall framing members or solid wall bases</td><td rowspan="2">Permitted</td><td rowspan="3">Not Permitted</td><td>Not Permitted</td><td>Permitted</td></tr>
<tr><td>3.4 (1.8)</td><td colspan="2" rowspan="6">Permitted</td></tr>
<tr><td>Flat Rib</td><td>2.75 (1.5)</td><td>Not Permitted</td><td>Permitted only for unsheathed wall framing members</td></tr>
<tr><td rowspan="2">3/8 in. Rib</td><td>3.4 (1.8)</td><td colspan="2" rowspan="2">Not Permitted</td><td rowspan="2">Permitted</td></tr>
<tr><td>4.0 (2.1)</td></tr>
<tr><td rowspan="2">Welded Wire</td><td>1.14 (0.618)</td><td>Not Permitted</td><td>Permitted</td><td>Not Permitted</td></tr>
<tr><td>1.95 (1.058)</td><td colspan="2">Permitted</td><td>Permitted</td></tr>
<tr><td rowspan="2">Woven Wire</td><td rowspan="2">1.4 (0.76)</td><td rowspan="2">Permitted only for wood wall framing members, wood furring</td><td rowspan="2">Permitted</td><td colspan="3">Permitted only for wood and concrete ceiling framing members</td></tr>
<tr><td>Not Permitted</td><td colspan="2">Permitted only for steel ceiling framing members</td></tr>
</table>

7.3.1.2 The spacing of framing members for the type and weight of metal plaster base shall conform to the requirements of Table 1. Metal plaster bases shall be attached to framing members at not more than 7 in. (178 mm) on center, along framing members except for 3/8-in. (10 mm) rib metal lath that shall be attached at each rib. Attachment penetrations between the framing members shall be avoided.

7.3.1.3 Lath shall be installed with the long dimension at right angles to the framing members, unless otherwise specified.

7.3.1.4 Ends of adjoining plaster bases shall be staggered.

7.3.1.5 Lath shall not be continuous through control joints, but shall be stopped and tied at each side.

7.3.1.6 Where furred or suspended ceilings butt into or are penetrated by columns, walls, beams, or other elements, the edges and ends of the ceiling lath shall be terminated at the horizontal internal corners with a casing bead lathing accessory, control joint lathing accessory, or similar device designed to keep the edges and ends of the ceiling lath and plaster free of the adjoining vertically oriented, or penetrating elements. Internal corner reinforcement lathing accessories shall not be used at these locations. A clearance of not less than 3/8 in. (10 mm) shall be maintained between the casing bead lathing accessory, control joint lathing accessory, or similar device and penetrating elements.

7.3.1.7 Where load bearing walls or partitions butt into structural walls, columns, or floor or roof slabs, the sides or ends of the wall or partition lath shall be terminated at the internal corners with a casing bead lathing accessory, expansion joint lathing accessory, control joint lathing accessory, or similar device designed to keep the sides and ends of the wall or partition lath free of the adjoining elements. Internal corner reinforcement lathing accessories shall not be used at these internal corners. A clearance of not less than 3/8 in. (10 mm) shall be maintained from abutting walls, columns, or other vertical elements.

7.3.1.8 Where solid base materials interface with framed, or framed and sheathed base materials and are to receive a continuous coat of plaster, lathing accessories to reduce cracking, to facilitate drainage, or both, as categorized in Specification C1861, shall be installed at the interface of these base materials. Omission of these accessories shall be permitted provided the contract documents require provisions that are equivalent in function and performance to control cracking and facilitate drainage, or both.

7.3.2 *Lapping of Metal Plaster Bases:*

7.3.2.1 Side laps of metal plaster bases shall be secured to framing members. They shall be tied between framing members with 0.0475-in. 18 gauge (1.21 mm) wire at intervals not more than 9 in. (229 mm).

7.3.2.2 Metal lath shall be lapped 1/2 in. (13 mm) minimum at the sides, or nest the edge ribs. Wire lath shall be lapped minimum one mesh at the sides and the ends. Lap metal lath minimum 1 in. (25 mm) at ends. Where end laps occur between the framing members, the ends of the sheets of metal plaster bases shall be laced or wire-tied with 0.0475-in. 18 gauge (1.21 mm) wire.

7.3.2.3 Where metal plaster base with a factory-attached water-resistive barrier is installed, the vertical and horizontal lap joints shall be water-resistive barrier on water-resistive barrier and metal plaster base on metal plaster base.

7.3.2.4 Where metal plaster base with a factory-attached water-resistive barrier is installed, the water-resistive barrier shall be lapped not less than 2 in. (51 mm). On walls, the water-resistive barrier shall be lapped so water will flow to the exterior. Except for weep screeds, designated drainage screeds, and drainage flashings with solid attachment flanges, the water-resistive barrier shall not be placed between metal plaster base and lathing accessory attachment flanges. Metal plaster base to lathing accessory key attachment flange contact shall be required to ensure that the metal plaster base and lathing accessory key attachment flanges are mechanically locked together.

7.3.3 *Attachments for Metal Plaster Bases to Wood Framing Members:*

7.3.3.1 Lath shall be attached to framing members with attachments spaced not more than 7 in. (178 mm) on center along framing members. Attachment penetrations between the framing members shall be avoided.

7.3.3.2 Diamond-mesh expanded metal lath, flat-rib expanded metal lath, and wire lath shall be attached to horizontal wood framing members with 1½-in. (38 mm) roofing nails driven flush with the plaster base and attached to vertical wood framing members with 6d common nails, or 1-in. (25 mm) roofing nails driven to a penetration of not less than ¾ in. (19 mm), or 1-in. (25 mm) wire staples driven flush with the plaster base. Staples shall engage not less than three strands of diamond mesh and flat rib expanded metal lath or not less than two strands of wire lath and penetrate the wood framing members not less than ¾ in. (19 mm). When metal lath is installed over sheathing, use fasteners that will penetrate the framing members not less than ¾ in. (19 mm).

7.3.3.3 Expanded ⅜ in. (10 mm) rib lath shall be attached to horizontal wood framing members with nails or staples to provide not less than 1¾-in. (44 mm) penetration into horizontal wood framing members.

7.3.3.4 Common nails shall be bent over to engage not less than three strands of diamond mesh and flat rib expanded metal lath or not less than two strands of wire lath, or be bent over a rib when rib lath is installed.

7.3.3.5 Screws used to attach metal plaster base to horizontal and vertical wood framing members shall penetrate not less than ⅝ in. (16 mm) into the member when the lath is installed. For expanded metal lath, the screw shall engage not less than three strands of lath. For wire laths, screws shall engage not less than two strands of diamond mesh and flat rib expanded metal lath or not less than two strands of wire lath. When installing expanded metal rib lath, the screw shall pass through, but not deform, the rib. When installing wire rib lath, the screw may deform the rib.

7.3.4 *Attachments for Metal Plaster Bases to Metal Framing Members:*

7.3.4.1 Except as described in 7.3.4.2, metal plaster bases shall be securely attached to metal framing members with 0.0475-in. 18 gauge (1.21 mm) wire ties, clips, or by other means of attachment which afford carrying strength and resistance to corrosion equal to or superior to that of the wire.

7.3.4.2 Rib metal lath shall be attached to open-web steel joists by single ties of wire, not less than 0.0475 in. 18 gauge (1.21 mm), with the ends of each tie twisted together 1½ times.

7.3.4.3 Screws used to attach metal plaster base to metal framing members shall extend through the metal framing member with a minimum of three (3) exposed threads when the lath is installed, and for expanded metal laths shall engage not less than three strands of lath. For wire laths, screws shall engage not less than two strands of diamond mesh and flat rib expanded metal lath or not less than two strands of wire lath. When installing expanded metal rib lath, the screw shall pass through, but not deform, the rib. When installing wire rib lath, the screw may deform the rib.

7.3.5 *Attachments for Metal Plaster Bases to Solid Bases:*

7.3.5.1 Rib metal lath shall be attached to concrete joists by loops of 0.0800-in. (2.03 mm) wire, with the ends of each loop twisted together.

7.3.5.2 Metal plaster bases shall be attached to masonry or concrete with power-actuated fasteners, or a combination of power-actuated fasteners and hardened concrete stub nails. One power-actuated fastener shall be located at each corner and one at the mid-point of the long dimension adjacent to the edge of the metal plaster base sheet. The balance of the sheet shall be fastened with power-actuated fasteners or hardened concrete stub nails. The fasteners shall be installed in rows not more than 16 in. (406 mm) on center and spaced vertically along each row not more 7 in. (178 mm) on center. Power-actuated fasteners and concrete stub nails shall be not less than ¾ in. (19 mm) long, with heads not less than ⅜ in. (10 mm) wide. Where the head diameter of the power-actuated fastener or concrete stub nail is smaller than ⅜ in. (10 mm), fastener shall use a ⅞-in. (22 mm) diameter minimum corrosion-resistant metal washer, which shall be perforated when washer diameter exceeds 1 in. (25 mm).

7.4 *Installation of Lathing Accessories:*

7.4.1 *Lathing Accessory General Requirements:*

7.4.1.1 The type, location, ground dimension, and orientation of lathing accessories shall be indicated in the contract documents.

7.4.1.2 Install lathing accessories before cement plaster application to facilitate lathing installation, cement plaster application, and functionality of the completed stucco cladding assembly.

7.4.2 *Lathing Accessory Attachment Requirements:*

7.4.2.1 Attach lathing accessory attachment flanges to substrate to ensure proper alignment during application of cement plaster. Secure lathing accessory attachment flanges at 7 in. (178 mm) maximum intervals along framing members.

7.4.2.2 Install lathing accessories with key attachment flanges to completely embed the flanges in cement plaster.

7.4.2.3 Alternatively for solid plaster base substrates, adhere lathing accessory key attachment flanges directly to solid plaster bases with adhesive applied in nominal 1 in. (25 mm) dabs at intervals in accordance with 7.4.2.1 or in a semi-continuous bead between the solid plaster base and the solid portion of the key attachment flange.

7.4.3 *Lathing Accessory Water Management Requirements:*

7.4.3.1 Where a defined drainage space is provided over the water-resistive barrier under lath and cement plaster, the ground dimension of lathing accessories with solid attachment flanges installed behind the water-resistive barrier and defined drainage space to facilitate drainage, such as weep screeds, designated drainage screeds, expansion joints and drainage flashings, shall accommodate the defined drainage space dimension and specified cement plaster thickness.

7.4.3.2 Install the water-resistive barrier and lathing to entirely cover the vertical solid attachment flange of lathing accessories with a drainage function and drainage flashings such as weep screeds, designated drainage screeds, expansion joints, and drainage flashings. Terminate lathing within ½ in. (13 mm) nominal above the lathing accessory drainage surface.

7.4.3.3 At intersections of lathing accessories exposed at the cement plaster cladding finished surface, install the vertical lathing accessory continuously through the intersection unless the horizontally intersecting lathing accessory performs an expansion or drainage function, or both. Where vertical lathing accessories terminate above a drainage screed lathing accessory or drainage flashing, the intersection shall be kept free of sealant or other materials that will impede drainage.

7.4.3.4 Lathing accessories installed over the water-resistive barrier shall not impede drainage.

7.4.4 *Foundation Weep Screed*—install a weep screed lathing accessory at the bottom of steel or wood framed exterior walls. Locate the bottom edge of the weep screed lathing accessory not less than 1 in. (25 mm) below the joint formed by the foundation and framing. Locate the weep screed lathing accessory ground 4 in. (102 mm) minimum above raw earth or 2 in. (51 mm) above paved surfaces.

7.4.5 *Designated Drainage Screed*—Install a designated drainage screed lathing accessory at locations indicated in the contract documents and follow specified requirements in the contract documents.

7.4.6 *Casing Bead*—Install a casing bead lathing accessory or other suitable means, at locations to separate cement plaster from dissimilar materials, penetrating elements, load bearing members and to avoid transfer of structural loads.

7.4.7 *Internal Corner Reinforcement*—Install an internal corner reinforcement lathing accessory at internal cement plaster corner locations except where lathing is installed continuously through the internal corner, or where an expansion joint lathing accessory or control joint lathing accessory is installed at the internal corner location.

7.4.8 *External Corner Reinforcement*—Install an external corner reinforcement lathing accessory at external cement plaster corner locations. Alternatively, where no external corner reinforcement lathing accessory is used on framed, and framed and sheathed construction, lathing shall be furred away from the substrate and installed continuously around external corners for a minimum distance of one framing member beyond the corner.

7.4.9 *Expansion Joint*—Install an expansion joint lathing accessory at an expansion joint location in the building, the substrate, or its components.

7.4.10 *Control Joints*—Install control joint lathing accessories in conformance with 7.3.1.5.

7.4.10.1 Form control joints by attaching a prefabricated control joint lathing accessory, or alternatively by attaching a pair of casing beads with key attachment flanges, back to back, with a separation spacing not less than ⅛ in. (3 mm) or as required by the anticipated thermal exposure range and a flexible barrier membrane behind the casing beads. Wall or partition height door frames shall be considered as control joints.

7.4.10.2 Install control joint lathing accessories at locations to delineate cement plaster panel areas of 144 ft^2 (13 m^2) maximum for walls and 100 ft^2 (9 m^2) maximum for horizontal installations, that is, ceilings, curves, or angle type structures.

7.4.10.3 Install control joint lathing accessories at locations to delineate cement plaster panel areas of 18 ft (5 m) maximum dimension, in either direction, or a maximum length-to-width ratio of 2½ to 1.

7.4.10.4 Install a control joint lathing accessory at locations where the ceiling framing or furring changes direction.

8. Keywords

8.1 control joint; expansion joint; lath; plaster; screed; suspended ceiling; walls

ANNEX

(Mandatory Information)

A1. INSTALLATION OF METAL FURRING FOR SUSPENDED CEILINGS

A1.1 *General*—Installation of metal furring requirements for suspended ceilings are located together in this Annex for convenience of use.

A1.2 *Hangers and Inserts:*

A1.2.1 Hangers shall be of ample length and shall conform to the requirements of Table A1.1, both as to size and maximum cement plaster panel area to be supported, except as modified in this section.

A1.2.2 When strap hangers are used, 7⁄16-in. (11 mm) diameter holes shall be provided on the center line at the upper end of the strap hanger to permit the attachment of the strap hanger. The edge of the holes in the strap hangers shall be not less than 3⁄8 in. (10 mm) from the ends.

A1.2.3 In concrete, rod or strap hangers shall be attached to inserts embedded in the concrete, or to other attachment devices designed for this purpose, and able to develop full strength of the hanger.

A1.2.4 Strap hangers shall be bolted with machine bolts. (See Fig. A1.1.)

A1.2.5 The nuts of the machine bolts shall be drawn up tight.

NOTE A1.1—Hangers required to withstand upward wind pressures shall be of a type to resist compression. Struts of formed channels shall be permitted.

A1.3 *Installation of Hangers for Suspended Ceilings Under Wood Constructions*—Hangers shall be attached to framing members by any of the following methods:

A1.3.1 A hole shall be drilled through the wood framing member not less than 3 in. (76 mm) above the bottom, with the upper end of the wire hanger passed through the hole and twisted three times around itself. (See Fig. A1.2.)

A1.3.2 Three 12d nails shall be driven, on a downward slant, into the sides of the wood framing member with not less than 1¼ in. (32 mm) penetration and not less than 5 in. (127 mm) from the bottom edges, and not more than 36 in. (914 mm) on the center with the upper end of the wire hanger wrapped around the nails and twisted three times around itself. (See Fig. A1.3.)

A1.3.3 A loop shall be formed in the upper end of the wire hanger and secured to the wood framing member by four 1½ in. (38 mm), not less than 9 gauge, 0.1483-in. (3.77 mm) diameter wire staples driven horizontally or on a downward slant into the sides of the wood framing members, three near the upper end of the loop and the fourth to fasten the loose end. (See Fig. A1.4.)

A1.3.4 Where framing members for flooring are thicker than 1½ in. (38 mm) and are spaced more than 4 ft (1.2 m) on center, eye screws (or equivalent), spaced not more than 3 ft (914 mm) on centers shall be screwed into the flooring framing members with the upper end of the wire hanger inserted through the eye screws and twisted three times around itself.

A1.3.5 Two holes shall be drilled in the upper end of the flat hangers and nailed to the sides of the wood framing members with 12d nails driven through the holes and clinched. Nails shall be not less than 3 in. (76 mm) above the bottom edge of the framing member. (See Fig. A1.5.)

A1.4 *Attachment of Hangers to Cold-rolled Channel Furring Main Runners:*

A1.4.1 Wire hangers shall be saddle-tied to cold-rolled channel furring main runners. (See Fig. A1.6.)

A1.4.2 Smooth or threaded rod hangers shall be fastened to cold-rolled channel furring main runners with special attachments appropriate to the design.

A1.4.3 The lower ends of strap hangers shall be bolted to cold-rolled channel furring main runners, or bent tightly around the cold-rolled channel furring main runners and carried up and above the cold-rolled channel furring main runners and bolted to the main part of the hanger. (See Fig. A1.1)

A1.5 *Installation of Cold-rolled Channel Furring Main Runners:*

A1.5.1 Minimum sizes and maximum spans and spacings of cold-rolled channel furring main runners for the various spans between hangers or other framing members shall be in accordance with the requirements of Table A1.1.

A1.5.2 A clearance of not less than 1 in. (25 mm) shall be maintained between the ends of the cold-rolled channel furring main runners and the abutting masonry or the concrete walls, partitions, and columns. Where special conditions require that cold-rolled channel furring main runners let into abutting masonry or concrete construction, within such constructions maintain a clearance of not less than 1 in. (25 mm) from the ends and not less than ¼ in. (6 mm) from the tops and sides of the cold-rolled channel furring main runners.

A1.5.3 A cold-rolled channel furring main runner shall be located within 6 in. (152 mm) of the paralleling walls to support the ends of the cold-rolled channel cross-furring. The ends of cold-rolled channel furring main runners shall be supported by hangers located not more than 6 in. (152 mm) from the ends.

A1.5.4 Where cold-rolled channel furring main runners are spliced, the ends shall be overlapped not less than 12 in. (305 mm) with flanges of cold-rolled channel furring main runners interlocked and securely tied near each end of the splice, with double loops of 0.0625 in. (1.59 mm) or double loops of twin strands of 0.0475-in. 18 gauge (1.21 mm) wire. However, when the splice occurs at an expansion joint or control joint, the cold-rolled channel furring shall be nested and loosely tied to hold together but still allow movement.

A1.5.5 Hanger wires shall hang straight down. If an obstacle prevents this, a trapeze type device shall be used to allow hanger wires to hang straight.

A1.6 *Installation of Cold-rolled Channel Cross-furring:*

A1.6.1 Minimum size and maximum spans and spacings of various types of cold-rolled channel cross-furring for various spans between cold-rolled channel furring main runners and framing members shall conform to the requirements of Table A1.2.

A1.6.2 Cold-rolled channel cross-furring shall be saddle-tied to cold-rolled channel furring main runners with 0.0625-in. 16 gauge (1.59 mm) wire, or a double strand of 0.0475-in. 18 gauge (1.21 mm) wire or with special galvanized clips, or equivalent attachments. (See Fig. A1.7.)

A1.6.3 Where cold-rolled channel cross-furring members are spliced, the ends shall be overlapped not less than 8 in. (203 mm), with flanges of cold-rolled channel cross-furring interlocked, and securely tied near each end of the splice with double loops of 0.0625-in. (1.59 mm) 16 gauge wire or twin strands of 0.0475-in. 18 gauge (1.21 mm) wire.

A1.6.4 Cold-rolled channel cross-furring shall not come into contact with abutting masonry or reinforced concrete walls or partitions, except, where special conditions require that cold-rolled channel cross-furring be let into abutting masonry or concrete construction, the applicable provisions of A1.6.2 shall apply.

A1.6.5 Cold-rolled channel furring main runners and cold-rolled channel cross-furring shall be interrupted at expansion joints or control joints. However when the splice occurs at an expansion joint or control joint, the cold-rolled channel furring shall be nested and loosely tied to hold together but still allow movement.

TABLE A1.1 Allowable Support or Hanger Wire Spacing ft-in. (mm) and Cold-Rolled Channel Furring Main Runner Spans, ft-in. (mm)[1–7]

Member Size, in. (mm)	Member Weight, lb/1000 ft (kg/m)	Span Condition[6,7]	Uniform Load = 12 psf (0.479 kPa)				
			Member Spacing, in. (mm)				
			24 (610)	36 (914)	48 (1220)	60 (1520)	72 (1830)
			Allowable Hanger Wire or Support Spacing, ft-in. (mm)				
1½	414	Single	3-6 (1070)	3-1 (940)	2-9 (840)	2-9 (790)	2-5 (740)
(38)	(0.615)	2 or More	4-11 (1500)	4-2 (1270)	3-7 (1090)	3-2 (970)	2-11 (890)
2	506	Single	3-9 (1140)	3-3 (990)	3-0 (910)	2-9 (840)	2-8 (810)
(51)	(0.753)	2 or More	5-2 (1570)	4-6 (1370)	4-1 (1240)	3-10 (1170)	3-7 (1090)
2½	597	Single	3-11 (1190)	3-5 (1040)	3-2 (970)	2-11 (890)	2-9 (840)
(64)	(0.888)	2 or More	5-5 (1650)	4-9 (1450)	4-4 (1320)	4.0 (1220)	3-10 (1170)

Member Size, in. (mm)	Member Weight, lb/1000 ft (kg/m)	Span Condition[6,7]	Uniform Load = 15 psf (0.287 kPa)				
			Member Spacing, in. (mm)				
			24 (610)	36 (914)	48 (1220)	60 (1520)	72 (1830)
1½	414	Single	3-3 (990)	2-10 (860)	2-7 (790)	2-4 (710)	2-2 (660)
(38)	(0.616)	2 or More	4-6 (1370)	3-8 (1120)	3-2 (970)	2-10 (860)	2-7 (790)
2	506	Single	3-6 (1070)	3-1 (940)	2-10 (880)	2-7 (790)	2-5 (740)
(51)	(0.753)	2 or More	4-10 (1470)	4-3 (1300)	3-10 (1170)	3-6 (1070)	3-3 (990)
2½	597	Single	3-8 (1120)	3-3 (990)	2-11 (890)	2-9 (840)	2-7 (790)
(64)	(0.888)	2 or More	5-0 (1520)	4-5 (1350)	4-0 (1220)	3.9 (1140)	3-6 (1070)

Allowable Spans Notes:

[1] Spans based on upper flange of main runners laterally unbraced.

[2] Maximum deflection limited to 1/360 of the span length.

[3] Uniform load 12 psf (dry density) shall be used for portland cement plaster ceilings with plaster thicknesses up to ⅞ in. (22 mm) and 15 psf shall be used for ceilings with plaster thicknesses over ⅞ in. (22 mm) and not more than 1¼ in. (32 mm).

[4] "2 or More" spans refers to two or more continuous, equal spans.

[5] For the "2 or More" span condition, listed spans represent the center-to-center distance between adjacent framing members.

[6] These tables are designed for dead loads. Specific conditions such as exterior installations in high wind areas require additional engineering.

[7] Where uplift resistance is required for suspended ceilings to resist negative forces, the architect or engineer of record shall select the method to be used.

TABLE A1.2 Spans and Spacing of Cold-Rolled Channel Cross-furring Members[A, B, C]

Design Load, 12 psf (575 Pa)		Allowable Span, Main Runners or Supports Ft-in. (mm)	
Member Depth	Spacing, in. (mm)	Simple Span	Two or More Spans[D,E]
¾ (19)	13.5 (343)	2-9 (840)	3-5 (1040)
	16 (406)	2-7 (790)	3-3 (990)
	19 (483)	2-7 (740)	3-0 (910)
	24 (610)	2-3 (690)	2-10 (860)
1½ (38)	13.5 (343)	4-6 (1370)	5-8 (1730)
	16 (406)	4-3 (1300)	5-5 (1650)
	19 (483)	4-0 (1220)	5-1 (1550)
	24 (610)	3-8 (1120)	4-9 (1450)

[A] Spans based on upper flange of cross-furring laterally unbraced.

[B] Maximum deflection limited to 1⁄360th of span length unbraced.

[C] Tabulated spans apply only to cross-furring with webs oriented vertically.

[D] "Two or more" spans refers to two or more continuous, equal spans.

[E] For the "two or more" span conditions, listed spans represent the center-to-center distance between adjacent framing members.

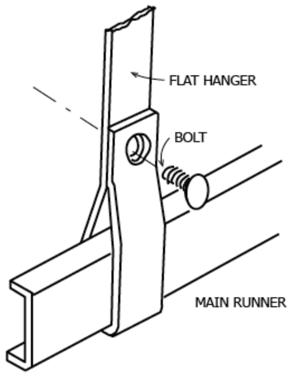

FIG. A1.1 Flat (Strap) Hanger Attached to Cold-rolled Channel Furring Main Runner Using Machine Bolt

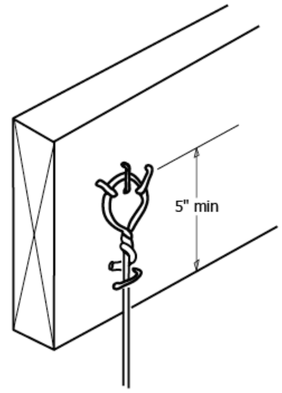

FIG. A1.4 Hanger Attached to Framing Member Using Staples

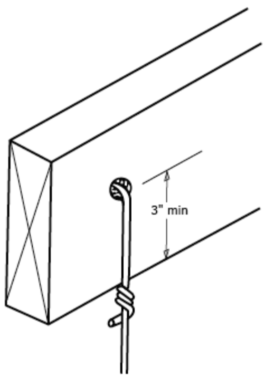

FIG. A1.2 Hanger Attached to Framing Member Through Drilled Hole

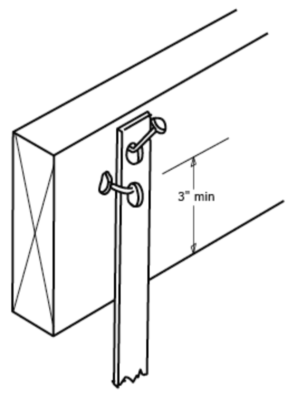

FIG. A1.5 Flat (Strap) Hanger Attached to Framing Member Using Nails

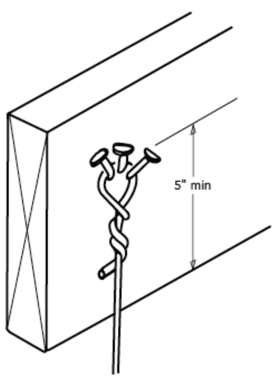

FIG. A1.3 Hanger Attached to Framing Member Using Nails

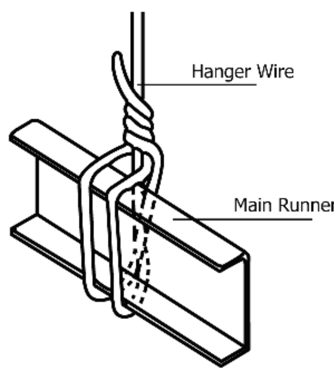

FIG. A1.6 Saddle Tie

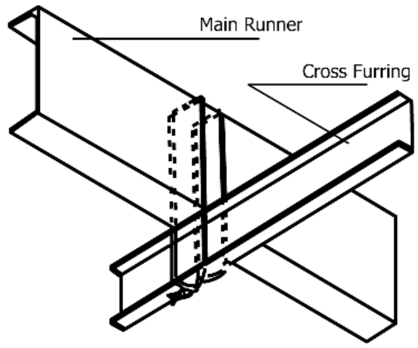

FIG. A1.7 Saddle Tie

APPENDIX

(Nonmandatory Information)

X1.1 The nominal lap values specified in 7.3.2.2 do not represent a maximum threshold value. Experience has shown that excessive lapping of expanded metal lath can inhibit proper embedment of the plaster in the underlying layer of lath which, in turn, can result in attendant corrosion and cracking of the stucco finishes. The nominal value provided in 7.3.2.2 has been shown to perform successfully; lath laps greater than this value may also perform successfully, but represent a heightened risk of embedment and cracking problems.

SUMMARY OF CHANGES

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 19) that may impact the use of this standard. (Approved March 1, 2019.)

(1) Added new 6.1.2 and renumbered subsequent sections accordingly.

~~SUMMARY OF CHANGES~~

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 18b) that may impact the use of this standard. (Approved Feb. 1, 2019.)

(1) Revised 1.1, 4.1.1 – 4.2.1, 4.2.3, 7.2, 7.2.3, 7.2.4, 7.3.1.1, 7.3.1.2, 7.3.1.7, 7.3.1.4 – 7.3.4.3, 7.4.1.
(2) Removed previous 5.2.2.3, 7.2 – 7.6.5, 7.9 – 7.9.3.1, 7.10.4 – 7.10.5, and Annex 1.
(3) Added 1.5 ("Table of Contents"), 7.9.8.1, Note 2, and Annex 1 (section and note numbers updated accordingly).
(4) Removed C841 from Section 2 ("Referenced Documents").
(5) Removed "ceiling" and "expansion" from Section 8 ("Keywords").
(6) Added "expansion joint" to Section 8 ("Keywords").
(7) Moved previous Figs. 1 – 7 to new Annex A1 and renumbered as Figs. A1.1 – A1.7 (references updated accordingly).
(8) Moved previous Tables 1 and 2 to new Annex A1 and renumbered as Tables A1.1 and A1.2 (references updated accordingly).

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 18a) that may impact the use of this standard. (Approved April 1, 2018.)

(1) Revised 7.9.2.
(2) Added new Appendix X1.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 18) that may impact the use of this standard. (Approved April 1, 2018.)

(1) Removed A0641_A0641M, B0069, B0221, C0954, C1002, D1784, and D4216 from list of referenced documents (Section 2).
(2) Added Specifications C1280 and C1861 to list of referenced documents (Section 2).
(3) Added new 3.1.2 and renumbered subsequent sections accordingly.
(4) Removed previous 6.3 – 6.3.2 with new 6 – 6.3.2.
(5) Removed previous 6.3.4 – 6.8.3.
(6) Revised 7.1, 7.2.1 – 7.2.5, 7.3.4, 7.4 – 7.5.4, 7.6 – 7.6.2, 7.7.1 – 7.7.3.
(7) Added new 7.8 and renumbered subsequent sections accordingly.
(8) Revised 7.9.2, 7.10.1.6, 7.10.1.7, 7.10.2.3, 7.10.3.2, 7.10.4, and 7.10.5.
(9) Removed previous 7.11 - 7.11.5 and replaced with new 7.11 - 7.11.11.4.
(10) Switched previous Tables 2 and 3 (and updated in-text table references accordingly).
(11) Revised Table 3 and title of Fig. 3.
(12) Removed previous A1.2 and A1.3.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 17b) that may impact the use of this standard. (Approved Jan. 1, 2018.)

(1) Revised 7.8.3, 7.8.3.1, 7.10.4.1.
(2) Replaced previous Table 3 with new Table 3.
(3) Added new 2.2.
(4) Added new Section 6, renumbered other sections accordingly.
(5) Updated titles of Sections 4 and 5.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 17a) that may impact the use of this standard. (Approved Dec. 1, 2017.)

(1) Revised 7.9.2.3 and 7.10.4.1.
(2) Combined previous Sections 4 and 5, added new Section 6, and renumbered subsequent sections accordingly.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 17a) that may impact the use of this standard. (Approved June. 1, 2017.)

(1) Added new 7.10.1.3.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 16c) that may impact the use of this standard. (Approved April 1, 2017.)

(1) Removed previous 3.2.1, 3.2.4–3.2.6, , 3.2.14, 7.9, and renumbered subsequent sections accordingly.
(2) Replaced the terms “member” and “support” with “framing member” throughout.
(3) Replaced the term “support” with “framing member”.
(4) Replaced the terms “application” and “applied” with “installation” and “installed” throughout.
(5) Removed previous Note 2 and placed its contents in new 5.3.3.
(6) Revised 7.10.1.4 and 7.9.2.2.
(7) Added new 5.1 and renumbered subsequent sections accordingly.
(8) Added new 5.8.3.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 16b) that may impact the use of this standard. (Approved Sept. 15, 2016.)

(1) Revised 5.3.2 and 7.10.1.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 16a) that may impact the use of this standard. (Approved Sept. 1, 2016.)

(1) Corrected table reference in 7.6.1.
(2) Added 7.10.1.4.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 16) that may impact the use of this standard. (Approved March 1, 2016.)

(1) Revised 1.1.
(2) Revised 7.10.1.2.

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Designation: C926–~~18b~~15b

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Standard Specification for Application of Portland Cement-Based Plaster [1]

This standard is issued under the fixed designation C926; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

IN THIS STANDARD:

1 SCOPE *A Summary of Changes section appears at the end of this standard.

1.1 This specification covers the requirements for the application of full thickness portland cement-based plaster for exterior (stucco) and interior work. ~~These requirements do not by default define a unit of work or assign responsibility for contractual purposes, which is the purview of a contract or contracts made between contracting entities.~~

1.2 This specification sets forth tables for proportioning of various plaster mixes and plaster thickness.

NOTE 1: General information will be found in Annex A1. Design considerations will be found in Annex A2.

1.3 The values stated in inch-pound units are to be regarded as the standard. The SI (metric) values given in parentheses are approximate and are provided for information purposes only.

1.4 The text of this specification references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the specification.

1.5 Details of construction for a specific assembly to achieve the required fire resistance shall be obtained from reports of fire-resistance tests, engineering evaluations, or listings from recognized fire testing laboratories. ~~1.6 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.~~

2 REFERENCED DOCUMENTS

2.1 ASTM Standards: [2]

C11 Terminology Relating to Gypsum and Related Building Materials and Systems

C25 Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime

C35 Specification for Inorganic Aggregates for Use in Gypsum Plaster

C91 Specification for Masonry Cement

C150 Specification for Portland Cement

C206 Specification for Finishing Hydrated Lime

C207 Specification for Hydrated Lime for Masonry Purposes

C219 Terminology Relating to Hydraulic Cement

C260 Specification for Air-Entraining Admixtures for Concrete

C578 Specification for Rigid, Cellular Polystyrene Thermal Insulation

C595 Specification for Blended Hydraulic Cements

C631 Specification for Bonding Compounds for Interior Gypsum Plastering

C897 Specification for Aggregate for Job-Mixed Portland Cement-Based Plasters

C932 Specification for Surface-Applied Bonding Compounds for Exterior Plastering

C1063 Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster

C1116 Specification for Fiber-Reinforced Concrete and Shotcrete

C1328 Specification for Plastic (Stucco) Cement~~ C1787 Specification for Installation of Non Metallic Plaster Bases (Lath) Used with Portland Cement Based Plaster in Vertical Wall Applications~~

E90 Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

E119 Test Methods for Fire Tests of Building Construction and Materials

E492 Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine

2.2 ANSI Standard:

A108.1 Specification for Installation of Ceramic Tile [3]

3 TERMINOLOGY

3.1 Terms shall be defined as in Terminologies C11 and C219, except as modified herein.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *accelerator, n*—an admixture that will shorten the setting time of plaster.

3.2.2 *admixture, n*—a material other than water, aggregate, or basic cementitious material added to the batch before or during job mixing.

3.2.3 *acid etching, n*—the cleansing and controlled erosion of a solid surface, using an acid wash.

3.2.4 *air entrainment, n*—the use of an air-entraining admixture or air-entraining cementitious material in a plaster mix to yield a controlled quantity of minute (typically between 10 and 1000 μm in diameter) disconnected air bubbles in the plaster (see *entrapped air*).

3.2.5 *back wrap, n*—a means of terminating a polymer-modified, fabric reinforced cementitious base coat by wrapping the reinforcing mesh, which has been affixed to the substrate onto the outboard surface of the foam plastic core to provide continuity of the reinforced base coat and protection for the foam plastic core.

3.2.6 *backplaster, n*—plaster applied to the face of metal lath opposite a previously applied plaster.

3.2.7 *barrier wall, n*—type of wall system that is intended to block or interrupt the movement of water to the interior.

3.2.8 *bond, n*—the state of adhesion between plaster coats or between plaster and plaster base.

3.2.9 *bonding compound or agent, n*—compounds surface applied or integrally mixed with plaster to improve the quality of bond between plaster and plaster base or between plaster coats.

3.2.10 cementitious material, n—a material that, when mixed with water and with or without aggregate, provides the plasticity and the cohesive and adhesive properties necessary for placement and the formation of a rigid mass.

3.2.11 coat, n—a thickness of plaster applied in a single operation.

3.2.11.1 basecoat, n—all plaster applied before the application of the finish coat.

3.2.11.2 bedding coat, n—a plaster coat that receives aggregate or other decorative material impinged into its surface before it sets.

3.2.11.3 brown coat, n—in three-coat work, the second coat, applied over the scratch coat. In two-coat work, brown coat refers to the double-up basecoat. In either use, the brown coat is the coat directly beneath the finish coat.

3.2.11.4 dash-bond coat, n—a thick wet mixture of portland cement and water, with or without aggregate, dashed onto the surface of a plaster base such as smooth monolithic concrete or concrete block surfaces to improve the mechanical key for subsequent plaster coats.

3.2.11.5 double-up coat, n—the brown-coat plaster applied to the scratch coat plaster before the scratch-coat plaster has set.

3.2.11.6 finish coat, n—the final layer of plaster applied over basecoat plaster.

3.2.11.7 fog coat, n—a light coat of cement and water, with or without aggregate or color pigment, applied by machine spray to improve color consistency.

3.2.11.8 scratch coat, n—the first coat of plaster applied to a plaster base.

3.2.11.9 skim coat, n—a thin finish coat applied to an existing plaster surface or other substrate to improve appearance.

3.2.11.10 three-coat work, n—application of plaster in three successive coats with time between coats for setting or drying, or both.

3.2.12 cold joint ("joining" or "jointing"), n—the juncture of fresh plaster application adjacent to set plaster, in the same plane.

3.2.13 curing, v—the act or processes of producing a moisture environment favorable to cement hydration, resulting in the setting or hardening of the plaster.

3.2.14 drainage wall, n—a wall system in which the cladding provides a substantial barrier to water intrusion, and which also incorporates a concealed water-resistive barrier over which drainage will occur.

3.2.15 entrapped air, n—unintentional air voids in the plaster generally larger than 1 mm.

3.2.16 factory prepared ("mill-mixed" or "ready mixed"), adj—pertaining to material combinations that have been formulated and dry-blended by the manufacturer, requiring only the addition of and mixing with water to produce plaster.

3.2.17 fiber, natural or synthetic, n—an elongated fiber or strand admixture added to plaster mix to improve cohesiveness or pumpability, or both.

3.2.18 floating, v—act of compacting and leveling brown-coat plaster to a reasonably true surface plane using a float tool or the act of bringing the aggregate to the surface of finish-coat plaster.

3.2.19 key (also mechanical key), n—plaster that physically surrounds, penetrates, or deforms to lock onto the perforations or irregularities of the plaster base or previous coat of plaster.

3.2.20 metal plaster base, n—expanded metal lath, or welded or woven wire lath.

3.2.21 plaster, n—portland cement-based cementitious mixture (see *stucco*).

3.2.22 polymer modified cementitious base coat, n—A base coat containing portland cement modified with chemical admixtures (typically polymer latexes) to improve characteristics of the finished product, such as workability, plasticity, water resistance, and adhesion.

3.2.23 required, adj—pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.

3.2.24 rustication (also "break"), n—an interruption or change in plane of a plastered surface.

3.2.25 scoring (also known as "scratching"), n—the grooving of the surface of an unset plaster coat to provide a key for a subsequent coat.

3.2.26 set, n—the chemical and physical change in plaster as it goes from a plastic, workable state to a rigid state.

3.2.27 solid plaster bases, n—substrates that do not require a metal plaster base, including cast in place and precast concrete, concrete and stone masonry, clay brick, and tile.

3.2.28 stucco, n—portland cement-based plaster used on exterior locations.

3.2.29 stucco finish, n—a factory-prepared, dry blend of materials for finish coat applications.

3.2.30 temper, v—to mix or restore unset plaster with water to a workable consistency.

3.2.31 texture, n—any surface appearance as contrasted to a smooth surface. ~~3.3 Definitions of Terms Not Specific to This Standard 3.3.1 contract documents, n—a series of several individual items that generally include drawings and specifications. Either or both of these documents may exist for any particular project.~~

4 ~~DELIVERY AND STORAGE OF~~ MATERIALS

4.1 ~~Delivery: 4.1.1 Packaged materials shall be delivered in factory-sealed, unopened, and unbroken packages, containers, or bundles. 4.1.2 Bulk materials shall be delivered in clean transport vessels, free of contaminates. 4.2 Storage: 4.2.1 Weather-sensitive materials shall be kept in a dry condition until ready for use. (See A2.4.) 4.2.2 Bulk materials shall be stored to prevent subsequent contamination and segregation. 5~~ Materials ~~5.1 Materials~~ shall conform to the requirements of the referenced specifications and standards and to the requirements specified herein. ~~5.2~~

4.2 Cement: ~~5.2.1~~

4.2.1 *Portland Cement*—Specification C150, Type I, II, and III, as specified. White where specified. ~~5.2.2~~

4.2.2 *Air-Entraining Portland Cement*—Specification C150, type as specified. White where specified. ~~5.2.3~~

4.2.3 *Masonry Cement*—Specification C91, Types N, S, and M. White where specified. ~~5.2.4~~

4.2.4 *Blended Hydraulic Cement*—Specification C595, Type IP, IS(με70), IL, and IT(Sμε70), as specified. ~~5.2.5~~

4.2.5 *Air-Entraining Blended Hydraulic Cement*—Specification C595, Type IP-(A), IS(με70)-(A), IL-(A), and IT (Sμε70)-(A), as specified. ~~5.2.6~~

4.2.6 *Plastic Cement*—Plastic Cement shall meet the requirements of Specification C1328, Standard Specification for Plastic (Stucco) Cement.

NOTE 2: Plastic cements are not available nationally. ~~5.3~~

4.3 Type "S" Hydrated Lime—A hydrated lime that contains not more than 8 % unhydrated oxides when tested in accordance with Test Methods C25. See Specifications C206 and C207 for a complete description of a Type "S" hydrated lime. ~~5.4~~

4.4 Aggregates: ~~5.4.1~~

4.4.1 *Sand for Base Coats*—Specification C897. Aggregate failing to meet gradation limits in Specification C897 shall be permitted to be used, provided the plaster made with this sand has an acceptable demonstrated performance record in similar construction and climate conditions.~~5.4.2~~

4.4.2 *Perlite*—Specification C35.~~5.4.3~~

4.4.3 *Sand for Job-Mixed Finish Coats*—Specification C897.~~5.5~~

4.5 Water—Water used in mixing, application, and finishing of plaster shall be clean, fresh, suitable for domestic water consumption, and free of such amounts of mineral or organic substances as would affect the set, the plaster, or any metal in the system.~~5.6~~

4.6 Admixtures—See 3.2.2 and A2.5.~~5.7~~

4.7 Fibers—Specification C1116 on alkali-resistant fibers, glass fibers, nylon, polypropylene or carbon fibers.~~5.8~~

5 ~~PRODUCT MARKING—PACKAGED MATERIALS SHALL BE CLEARLY MARKED OR LABELED TO INDICATE PRODUCT, BRAND NAME, THE MANUFACTURER, AND THE WEIGHT OF THE MATERIAL CONTAINED THEREIN. SIMILAR INFORMATION SHALL BE PROVIDED IN THE SHIPPING ADVICES ACCOMPANYING THE SHIPMENT OF BULK MATERIALS. 6~~ REQUIREMENTS FOR BASES TO RECEIVE PORTLAND CEMENT-BASED PLASTER~~6.1~~

5.1 Metal ~~plaster~~ bases ~~bases,~~ and ~~lathing accessories, furring~~ accessories ~~and fasteners~~ used to receive plaster shall be installed in conformance with Specification C1063, except as otherwise specified. ~~Non-metallic~~

NOTE ~~PLASTER~~ 3: ~~bases~~ All ~~used~~ metal, ~~to~~ or ~~receive~~ PVC, ~~plaster~~ or ~~shall~~ CPVC ~~be~~ plastic ~~installed~~ members ~~in~~ should ~~conformance with Specification C1787. Note 3: Plaster bases and lathing accessories shall~~ be free of deleterious amounts of rust, oil, or other foreign matter, which could cause bond failure or unsightly discoloration.~~6.2~~

5.2 Surfaces of solid bases to receive plaster, such as masonry, stone, cast-in-place or precast concrete shall be straight and true within $^1/_4$ in. ~~(6 mm)~~ in 10 ft ~~(3~~ (2.1 ~~m)~~ mm/m) and shall be free of form oil or other elements, which would interfere with bonding. Conditions where the surfaces are out of tolerance shall be corrected prior to the application of the plaster. Ferrous-containing form ties or other obstructions shall be removed or receded a minimum ~~1~~ 1/8~~/8~~ in. (3 mm) below the surface of the solid base and treated with a corrosion-resistant coating. Non-ferrous protuberances shall be permitted to be trimmed back even with the surface of the solid base.~~6.2.1~~

5.2.1 Solid surfaces shall have the suction (ability to absorb water) or surface roughness, or both, to provide the bond required for the plaster.~~6.2.2~~

5.2.2 Smooth or nonabsorbent solid surfaces, such as cast-in-place or precast concrete, shall be prepared to receive portland cement plaster by one of the following methods:~~6.2.2.1~~

5.2.2.1 Sandblasting, wire brushing, acid etching, or chipping or a combination thereof,~~6.2.2.2~~

5.2.2.2 Application of a dash-bond coat applied forcefully against the surface, left untroweled, undisturbed, and moist cured for at least 24 h, or~~6.2.2.3~~

5.2.2.3 Application of a bonding compound suitable for exterior or interior exposure solid surfaces in accordance with the manufacturer's written directions.~~6.2.3~~

5.2.3 Where bond cannot be obtained by one or more of the methods in ~~6.2.2~~ 5.2.2, a furred or self-furring metal plaster base shall be installed in accordance with Specification C1063 ~~or~~. ~~C1787 as appropriate.~~ Where metal plaster base is used in areas where bond cannot be obtained by one or more of the methods in ~~6.2.2~~ 5.2.2, accessories shall be installed in accordance with Specification C1063 ~~or~~. ~~C1787~~

6 ~~AS~~ PLASTER ~~APPROPRIATE.~~ PROPORTIONS ~~7~~ AND ~~APPLICATION~~ MIXING ~~7.1~~

6.1 ~~Plaster~~ Proportions:~~7.1.1~~

6.1.1 All portland cement plasters shall be mixed and proportioned in accordance with the following tables and accompanying requirements, using measuring devices of known volume with successive batches proportioned alike. ~~7.1.2~~

6.1.2 Plaster mix used shall be as designated and referenced to Table 1.

TABLE 1 Plaster Bases—Permissible Mixes

NOTE 1: See Table 2 for plaster mix symbols.

Property of Base	Mixes for Plaster Coats	
	First (Scratch)	Second (Brown)
Low absorption, such as dense, smooth clay tile, brick, or concrete	C	C, CL, M, or CM
	CM or MS	CM, MS, or M
	P	P
High Absorption, such as concrete masonry, absorptive brick, or tile	CL	CL
	M	M
	CM or MS	CM, MS, or M
	P	P
Metal plaster base	C	C, CL, M, CM, or MS
	CL	CL
	CM or MS	CM, MS, or M
	M	M
	CP	CP or P
	P	P ~~7.1.3~~

6.1.3 Base-coat proportions shall be as shown in Table 2 for the mix specified from Table 1.

TABLE 2 Base-Coat Proportions,[A] Parts by Volume[B]

Plaster Mix Symbols	Cementitious Materials					Volume of Aggregate per Sum of Separate Volumes of Cementitious Materials	
	Portland Cement or Blended Cement	Plastic Cement	Masonry Cement		Lime		
			N	M or S		1st Coat	2nd[C] Coat
C	1	. . .	. . .	. . .	$0–^3/_4$	$2^1/_2–4$	3–5
CL	1	. . .	. . .	. . .	$^3/_4–1^1/_2$	$2^1/_2–4$	3–5
M	. . .	. . .	1	. . .	. . .	$2^1/_2–4$	3–5
CM	1	. . .	1	. . .	. . .	$2^1/_2–4$	3–5
MS	. . .	. . .	. . .	1	. . .	$2^1/_2–4$	3–5

Plaster Mix Symbols	Cementitious Materials					Volume of Aggregate per Sum of Separate Volumes of Cementitious Materials	
	Portland Cement or Blended Cement	Plastic Cement	Masonry Cement		Lime	1st Coat	2nd Coat
			N	M or S			
P	. . .	1	. . .	. . .	. . .	$2^1/_2$–4	3–5
CP	1	1	. . .	. . .	. . .	$2^1/_2$–4	3–5

(A) The mix proportions for plaster scratch and brown coats to receive ceramic tile shall be in accordance with the applicable requirements of ANSI A108.1 series applicable to specified method of setting time.

(B) Variations in lime, sand, and perlite contents are allowed due to variation in local sands and insulation and weight requirements. A higher lime content will generally support a higher aggregate content without loss of workability. The workability of the plaster mix will govern the amounts of lime, sand, or perlite.

(C) The same or greater sand proportion shall be used in the second coat than is used in the first coat.~~7.1.3.1~~

6.1.3.1 *Measurement of Materials*—**The method of measuring materials for the plaster shall be such that the specified proportions are controlled and accurately maintained. The weights per cubic foot of the materials are considered to be as follows:**

Material	Weight, lb/ft^3 (kg/m^3)
Portland cement	94 (1505)
Blended cement	Weight printed on bag
Masonry or plastic cement	Weight printed on bag
Hydrated Lime	40 (640)
Lime Putty	80 (1280)
Sand, Damp and Loose (~~7.1.3.2~~6.1.3.2)	80 (1280) of dry sand~~7.1.3.2~~

6.1.3.2 **For purposes of this specification, a weight of 80 lb (1280 kg) of oven-dried sand shall be used. This is, in most cases, equivalent to one cubic foot of loose, damp sand.~~7.1.4~~**

6.1.4 **Finish-coat proportions for job-mixed finish coats shall be as specified in Table 3.**

TABLE 3 Job-Mixed Finish Coat Proportion Parts by Volume

Plaster Mix Symbols[A]	Cementitious Materials					Volume of Aggregate per Sum of Separate Volumes of Cementitious Materials[B]
	Portland Cement or Blended Cement	Plastic Cement	Masonry Cement[A]		Lime	
			N	M or S		
F	1	. . .	. . .	. . .	$^3/_4$–$1^1/_2$	$1^1/_2$–3
FL	1	. . .	. . .	. . .	$1^1/_2$–2	$1^1/_2$–3
FM	. . .	. . .	1	. . .	. . .	$1^1/_2$–3
FCM	1	. . .	1	. . .	. . .	$1^1/_2$–3
FMS	. . .	. . .	. . .	1	. . .	$1^1/_2$–3

Plaster Mix Symbols	Cementitious Materials					Volume of Aggregate per Sum of Separate Volumes of Cementitious Materials
	Portland Cement or Blended Cement	Plastic Cement	Masonry Cement		Lime	
			N	M or S		
FP	. . .	1	. . .	. . .	. . .	$1^1/_2$ –3

(A) Additional portland cement is not required when Type S or M masonry cement is used.

(B) In areas not subject to impact, perlite aggregate shall be permitted to be used over base-coat plaster containing perlite aggregate. ~~7.1.5~~

6.1.5 ***Factory-Prepared Finish Coats***—See 3.2.16. ~~7.1.6~~

6.1.6 Dash-bond coat proportions shall be 1 volume part portland cement and not more than 2 volume parts of aggregate mixed to a consistency that will permit application as specified in ~~7.3.5~~ 7.1.5. ~~7.1.7~~

6.1.7 Admixtures shall be proportioned, mixed, and applied in accordance with the printed directions of the manufacturer. (See A2.5.) ~~7.1.8~~

6.2 ~~Where specified, natural or synthetic fibers shall be free of contaminants and used only in the base coat(s). The quantities per batch shall be in accordance with the published directions of the fiber manufacturer. 7.2~~ Mixing: ~~7.2.1~~

6.2.1 All plaster shall be prepared in a mechanical mixer, using sufficient water to produce a workable consistency and uniform color. (See X1.1.) ~~7.2.2~~

6.2.2 Base-coat plasters that have stiffened because of evaporation of water shall be permitted to be tempered one time only to restore the required consistency. Plaster not used within $1^1/_2$ h from start of initial mixing shall be discarded.

NOTE 4: Severe hot, dry climate conditions accelerate the stiffening of plaster and require reduction of this limit. The use of cold waters will slow the stiffening process. ~~7.2.3~~

6.2.3 Finish-coat plaster shall not be tempered. ~~7.3~~

~~7 GENERAL~~ 7 APPLICATION ~~APPLICATION:~~

7.1 ~~7.3.1~~ General:

7.1.1 Portland cement plaster shall be applied by hand ~~trowel~~ or machine to the nominal thickness specified in Table 4. The nominal values expressed in Table 4 represent neither a maximum nor minimum value. They consider the inherent variation of thickness due to the nature of the application process, and the allowable variation of the substrate and the finished plane of the plaster.

TABLE 4 Nominal Plaster Thickness[A] for Three- and Two-Coat Work, in. (mm)

BASE	Vertical				Horizontal			
	1st Coat	2nd Coat	3rd Coat[B]	Total	1st Coat	2nd Coat	3rd Coat[B]	Total
	Interior/Exterior							
Three-coat work:[C]								
Metal plaster base	$^3/_8$ ~~(10)~~ (9.5)	$^3/_8$ ~~(10)~~ (9.5)	$^1/_8$ (3)	$^7/_8$ (22)	$^1/_4$ (6)	$^1/_4$ (6)	$^1/_8$ (3)	$^5/_8$ (16)
Solid plaster base:								

BASE	Vertical				Horizontal			
	1st Coat	2nd Coat	3rd Coat	Total	1st Coat	2nd Coat	3rd Coat	Total
	Interior/Exterior							
Unit masonry	1/4 (6)	1/4 (6)	1/8 (3)	5/8 (16)	Use two-coat work			
Cast-in-place or precast concrete	1/4 (6)	1/4 (6)	1/8 (3)	5/8 (16)				3/8 ~~(10),~~ (9.5), max
Metal plaster base over solid base	1/2 ~~(13)~~ (12.5)	1/4 (6)	1/8 (3)	7/8 (22)	1/2 ~~(13)~~ (12.5)	1/4 (6)	1/8 (3)	7/8 (22)
Two-coat work:								
Solid plaster base:								
Unit masonry	3/8 ~~(10)~~ (9.5)	1/8 (3)		1/2 ~~(13)~~ (12.5)				3/8 ~~(10)~~ (9.5)
Cast-in-place or pre-cast concrete	1/4 (6)	1/8 (3)		3/8 ~~(10)~~ (9.5)				3/8 ~~(10)~~ (9.5)

(A) Exclusive of texture.

(B) For solid plaster partitions, additional coats shall be applied to meet the finished thickness specified.

(C) For exposed aggregate finishes, the second (brown) coat shall become the "bedding" coat and shall be of sufficient thickness to receive and hold the aggregate. ~~7.3.2~~

7.1.2 Plaster nominal thickness shall be measured from the back plane of the metal plaster base, exclusive of ribs or dimples, or from the face of the solid backing with or without metal plaster base, to the outer surface exclusive of texture variations. ~~7.3.3~~

7.1.3 Portland cement-based plaster shall be applied on furred metal plaster base when the surface of solid backing consists of gypsum board, gypsum plaster, wood, or rigid foam board-type products.

NOTE 5: On horizontal ceiling supports or roof soffits protected by a drip ~~edge~~ edge, ~~or designated drainage screed,~~ gypsum board products shall be permitted to be used as backing for metal base to receive portland cement plaster. ~~7.3.4~~

7.1.4 Separation shall be provided where plaster abuts dissimilar construction materials or openings. (See ~~A2.1.3~~ A2.1.4.) ~~7.3.5~~

7.1.5 Each plaster coat shall be applied to an entire wall or ceiling panel without interruption to avoid cold joints and abrupt changes in the uniform appearance of succeeding coats. Wet plaster shall abut set plaster at naturally occurring interruptions in the plane of the plaster, such as corner angles, rustications, openings, expansion joints, and control joints where this is possible. Joinings, where necessary, shall be cut square and straight and not less than 6 in. (152 mm) away from a joining in the preceding coat. ~~7.3.6~~

7.1.6 Metal plaster base shall be covered with three-coat work with or without solid backing. The combined total nominal thickness shall be as shown in Table 4. A dash-bond coat shall not replace one of the specified number of coats. ~~7.3.7~~

7.1.7 Two-coat work shall be used only over solid bases meeting the requirements of ~~6.2~~ 5.2. The combined total nominal thickness shall be as shown in Table 4. A dash-bond coat shall not replace one of the specified number of coats. ~~7.3.8~~

7.1.8 Backplaster where required, shall be applied only after the coat on the opposite side has set sufficiently to resist breaking or cracking the plaster keys. ~~7.3.9~~

7.1.9 Each coat shall be permitted to set before the next coat is applied. (See X1.5.2.) ~~7.3.10~~

7.1.10 Plaster coats that have become dry shall be evenly dampened with water prior to applying subsequent coats to obtain uniform suction. There shall be no visible water on the surface when plaster is applied. ~~7.4~~

7.2 Plaster Application on Metal ~~and Non-Metallic~~ Plaster Bases: ~~7.4.1~~

7.2.1 The first (scratch) coat shall be applied with sufficient material and pressure to form full keys through, and to embed the metal base, and with sufficient thickness of material over the metal to allow for scoring the surface. ~~7.4.1.1~~

7.2.1.1 As soon as the first (scratch) coat becomes firm, the entire surface shall be scored in one direction only. The vertical surfaces shall be scored horizontally. ~~7.4.1.2~~

7.2.1.2 The first (scratch) coat shall become sufficiently rigid to support the application of the second (brown) coat without damage to the monolithic continuity of the first (scratch) coat or its key. ~~7.4.2~~

7.2.2 The second (brown) coat shall be applied with sufficient material and pressure to ensure tight contact with the first (scratch) coat and to bring the combined thickness of the base coat to the nominal thickness shown in Table 4. ~~7.4.2.1~~

7.2.2.1 The surface of the second (brown) coat shall be brought to a true, even plane with a rod or straightedge, filling surface defects in plane with plaster. Dry rodding the surface of the brown coat shall be permitted. ~~7.4.2.2~~

7.2.2.2 The surface shall be floated uniformly to promote densification of the coat and to provide a surface receptive to bonding of the finish coat. ~~7.4.3~~

7.2.3 The third (finish) coat shall be applied with sufficient material and pressure to ensure tight contact with, and complete coverage of the base coat and to the nominal thickness shown in Table 4 and ~~7.5.1.1~~ 7.3.1.1. ~~7.5~~

7.3 Plaster Application on Solid Plaster Bases: ~~7.5.1~~

7.3.1 High-suction bases shall be evenly dampened with clean water prior to the application of plaster. Do not dampen low-suction solid bases, such as dense concrete or smooth brick. ~~7.5.1.1~~

7.3.1.1 Where masonry or concrete surfaces vary in plane, plaster thickness required to produce level surfaces shall not be required to be uniform. ~~7.5.2~~

7.3.2 *Three-Coat Application on Solid Bases:* ~~7.5.2.1~~

7.3.2.1 The first (scratch) coat shall be applied with sufficient material and pressure to ensure tight contact and complete coverage of the solid base, to the nominal thickness shown in Table 4. As soon as the first (scratch) coat becomes firm, the entire surface shall be scored in one direction only. The vertical surfaces shall be scored horizontally. ~~7.5.2.2~~

7.3.2.2 The second (brown) coat shall be applied using the same procedures specified in ~~7.4.2~~ 7.2.2 and ~~7.4.2.1~~ 7.2.2.1, bringing the surface to a true, even plane with a rod or straightedge, filling any defects in plane with plaster and darbying. The surface shall be floated uniformly to provide a surface receptive to the application of the third (finish) coat. ~~7.5.2.3~~

7.3.2.3 The third (finish) coat shall be applied as specified in ~~7.4.3~~ 7.2.3. ~~7.5.3~~

7.3.3 *Two-Coat Application on Solid Plaster Bases:* ~~7.5.3.1~~

7.3.3.1 The first (scratch) coat shall be applied as specified in ~~7.5.2.1~~ 7.3.2.1. ~~7.5.3.2~~

7.3.3.2 The second (finish) coat shall be applied as specified in ~~7.4.3~~ 7.2.3. ~~7.6~~

7.4 Finish-Coat Application: ~~7.6.1~~

7.4.1 Job-mixed or factory-prepared finish coats shall be applied, by machine or by hand, as specified in ~~7.4.3~~ 7.2.3. ~~7.6.2~~

7.4.2 The use of excessive water during the application and finishing of finish-coat plaster shall be avoided. ~~7.7~~

7.5 Fog-Coat Application—Job-mixed or factory-prepared fog coats shall be applied in accordance with the directions of the manufacturer. ~~7.8~~

8 CURING AND TIME BETWEEN COATS ~~7.8.1~~

8.1 Provide sufficient moisture in the plaster mix or by moist or fog curing to permit continuous hydration of the cementitious materials. The most effective procedure for curing and time between coats will depend on climatic and job conditions. (See X1.5.2.) ~~7.8.2~~

8.2 Sufficient time between coats shall be allowed to permit each coat to cure or develop enough rigidity to resist cracking or other physical damage when the next coat is applied. (See X1.5.2.) ~~7.9~~

9 PRODUCT MARKING

9.1 Packaged materials shall be clearly marked or labeled to indicate product, brand name, the manufacturer, and the weight of the material contained therein. Similar information shall be provided in the shipping advices accompanying the shipment of bulk materials.

10 DELIVERY OF MATERIALS

10.1 Packaged materials shall be delivered in factory-sealed, unopened, and unbroken packages, containers, or bundles.

10.2 Bulk materials shall be delivered in clean transport vessels, free of contaminates.

11 PROTECTION OF MATERIALS

11.1 Weather-sensitive materials shall be kept in a dry condition until ready for use. (See A2.4.)

11.2 Bulk materials shall be stored to prevent subsequent contamination and segregation.

12 ENVIRONMENTAL ~~CONDITIONS:~~ CONDITIONS ~~7.9.1~~

12.1 Portland cement-based plaster shall not be applied to frozen base or to a base containing frost. Plaster mixes shall not contain frozen ingredients. Plaster coats shall be protected from freezing for a period of not less than 24 h after set has occurred. ~~7.9.2~~

12.2 Portland cement plaster shall be protected from uneven and excessive evaporation during dry weather and from strong blasts of dry air. ~~7.9.3~~

12.3 Plaster Application—When artificial heat is required, heaters shall be located to prevent a concentration of heat on uncured plaster. Heaters shall be vented to the outside to prevent toxic fumes and other products of combustion from adhering to or penetrating plaster bases and plaster. Adequate ventilation shall be maintained in all areas, particularly in interior areas with little or no natural air movement. ~~7.9.3.1~~

12.3.1 Interior environment shall be maintained at a temperature above 40 °F not less than 48 h prior to and during application of portland cement-based plaster. Interior temperature shall be maintained above 40 °F until normal occupancy. ~~7.9.3.2~~

12.3.2 For exteriors, plaster shall be applied when the ambient temperature is higher than 40 °F (4.4 °C), unless the work area is enclosed and heat is provided as described in ~~7.9.3~~ 12.3. ~~8~~

13 KEYWORDS ~~8.1~~

13.1 bond; brown coat; cementitious; exterior plaster; fog coat; portland cement; scratch coat; stucco

ANNEXES

(Mandatory Information)

A1 GENERAL INFORMATION

A1.1 The work shall include all labor, materials, services, equipment, and scaffolding required to complete the plastering of the project in accordance with the drawings and specifications, except heat, electric power, and potable water.

A1.2 Where a specific degree of fire resistance is required for plastered assemblies and constructions, details of construction shall be in accordance with official reports of fire tests conducted by recognized testing laboratories, in accordance with Test Methods E119. ~~A1.2~~

A1.3 Where a specific degree of sound control is required for plastered assemblies and constructions, details of construction shall be in accordance with official reports of tests conducted by recognized testing laboratories, in accordance with applicable sound tests of Test Methods E90 or E492. ~~A1.3~~

A1.4 Scaffolding shall be constructed and maintained in strict conformity with applicable laws and ordinances. ~~A1.4~~

A1.5 Work schedules shall provide for completion of work affecting supports, framework or lath of a suspended ceiling (such as loading) before plastering work is accomplished. ~~A1.5~~

A1.6 Surfaces and ~~lathing~~ accessories to receive plaster shall be examined before plastering is applied thereto. The proper authorities shall be notified and unsatisfactory conditions shall be corrected prior to the application of plaster. The plastering contractor shall use this portion of the construction specifications for acceptance or rejection of such surfaces. ~~A1.5.1~~

A1.6.1 Metal plaster bases, backing, attachment, and ~~lathing~~ accessories to receive plaster shall be examined to determine if the applicable requirements of Specification C1063 have been met unless otherwise required by the contract specifications. ~~A1.5.2~~

A1.6.2 ~~Lathing~~ Accessories ~~accessories~~ shall be installed prior to the application of plaster; therefore, their type, ~~location;~~ depth, ~~ground dimension;~~ and ~~orientation~~ location shall be included in the project contract documents. ~~Where~~

A1.6.3 ~~masonry or concrete surfaces vary in plane, plaster thickness required to produce level surfaces shall not be required to be uniform. A1.5.3~~ The construction specifier shall describe, in the proper section of the contract specifications, the physical characteristics of solid surface bases to receive plaster, including measures to promote bond. The plane tolerance shall be not more than $^1/_4$ in. ~~(6 mm)~~ in 10 ft ~~(3~~ (3.1 ~~m).~~ mm/m). The mortar joints shall be flush and not struck. Dissimilar ferrous-containing materials such as ties, reinforcing steel, and so forth, shall be cut back a minimum $^1/_8$ in. (3 mm) below the surface and treated with a corrosion-resistant coating. Dissimilar non-ferrous protuberances shall be permitted to be trimmed back even with the surface of the solid base. Masonry shall be solid at corners and where masonry changes thickness in a continuous construction. Form release compounds shall be compatible with plaster or be completely removed from surfaces to receive plaster.

A2 DESIGN CONSIDERATIONS

A2.1 Exterior plaster (stucco) is applied to outside surfaces of all types of structures to provide a durable, fire-resistant covering. Interior plaster is applied to inside surfaces that will be subjected to various exposures, such as abrasion, vibration, or to continuous or frequent moisture and wetting, or to freezing or thawing.

A2.1.1 Sufficient slope on faces of plastered surfaces shall be provided to prevent water, snow, or ice from accumulating or standing. Air-entrained portland cement plaster provides improved resistance to freeze/thaw deterioration. Resistance to rain penetration is improved where plaster has been adequately densified during application and properly cured. Plaster shall not, however, be considered to be "waterproof."

A2.1.2 The construction specifier shall describe, in the appropriate section of the contract specifications, the requirements for furnishing and application of flashing. Flashing shall be specified at openings, perimeters, and terminations to prevent water from getting behind plaster. Flashing shall be corrosion-resistant material. Aluminum flashing shall not be used. Flashing supplemented with sealant shall be permitted. ~~provided the flashing and sealant are designed in a manner that does not inhibit drainage.~~

A2.1.3 Sealing or caulking of V-grooves, exposed ends, and edges of plaster panels or exterior work to prevent entry of water shall be provided.

A2.1.4 To reduce spalling where interior plaster abuts openings, such as wood or metal door or window frames, or fascia boards, the edge of three-coat plaster shall be tooled through the second and finish coats to produce a continuous small V-joint of uniform depth and width. On two-coat work, the V-joint shall be tooled through the finish coat only.

A2.1.5 Provide in the appropriate project specification section that solid bases to receive plaster shall not be treated with bond breakers, parting compounds, form oil, or other material that will prevent or inhibit the bond of the plaster to the base.

A2.1.6 Maximum allowable deflection for vertical or horizontal framing for plaster, not including cladding, shall be L/360.

A2.2 *Provisions for Drainage Behind Exterior Plaster:*

A2.2.1 At the bottom of exterior ~~drainage~~ walls where the ~~drainage~~ wall ~~plane~~ is ~~interrupted~~ supported by a ~~floor,~~ floor ~~supporting structure,~~ or foundation, ~~or~~ a ~~when~~ drip ~~drainage~~ screed ~~wall~~ and ~~assemblies~~ throughwall ~~are~~ flashing ~~constructed~~ or ~~above~~ weep ~~barrier~~ holes ~~wall assemblies, a designated drainage screed, flashing,~~ or other effective means to drain away any water that may get behind the plaster shall be provided.

A2.2.2 Where vertical and horizontal exterior plaster surfaces meet, both surfaces shall be terminated with casing beads with the vertical surface extending at least $^1/_4$ in. (6 mm) below the intersecting horizontal plastered surface, thus providing a drip edge. The casing bead for the horizontal surface shall be terminated not less than $^1/_4$ in. ~~(6 mm)~~ from the back of the vertical surface to provide drainage.

A2.3 *Relief from Stresses:*

A2.3.1 For information on the requirements for control joints and perimeter relief, where a metal plaster base is installed; see the Installation Section of ~~Specifications~~ Specification C1063 ~~or~~. ~~C1787 as applicable.~~ Solid plaster bases are exempt from these criteria, except as stated in Specification C1063, subsection 7.11.4.3.

A2.3.1.1 ~~Clean~~ Control ~~cement~~ joints ~~plaster~~ shall ~~residue~~ be ~~from~~ cleaned ~~the~~ and ~~movement~~ clear ~~gaps~~ of ~~expansion~~ plaster ~~joints~~ within ~~and from~~ the ~~flexible~~ control ~~pleats~~ area ~~of~~ after ~~control~~ plaster ~~joints~~ application and before ~~cement~~ final plaster ~~hardens.~~ set.

A2.3.1.2 Prefabricated control joints and expansion joint members shall be installed prior to the application of plaster. Their type, location, ~~ground~~ depth, ~~dimension, orientation,~~ and method of installation shall be determined by the characteristics of the substrate and included in the project contract documents.

A2.3.1.3 A groove or cut in plaster only shall not be considered a control or expansion joint.

A2.3.2 Where plaster and metal plaster base continues across the face of a concrete column, or other structural member, ~~a~~ water-resistive ~~barrier~~ building paper or felt shall be placed between the metal plaster base and the structural member (paper or plastic-backed metal plaster base shall be permitted). Where the width of the structural member exceeds the approved span capability of the metal plaster base, self-furring metal plaster base shall be used and sparingly scatter nailed to bring ~~the~~ paper ~~plaster~~ and metal base to general plane.

A2.3.3 Where dissimilar base materials abut and are to receive a continuous coat of plaster: (*1*) a two-piece expansion joint, casing beads back-to-back, or premanufactured control-expansion joint member shall be installed; or (*2*) the juncture shall be covered with a 6-in. (152 mm) wide strip of galvanized, self-furring metal plaster base extending 3 in. (76 mm) on either side of the juncture; or (*3*) where one of the bases is metal plaster base, self-furring metal plaster base shall be extended 4 in. (102 mm) onto the abutting base.

A2.4 *Weather-Sensitive Materials*—Water-sensitive materials shall be stored off the ground or floor and under cover, avoiding contact with damp floor or wall surfaces. Temperature-sensitive materials shall be protected from freezing. Bulk materials shall be stored in the area of intended use and caution shall be exercised to prevent contamination and segregation of bulk materials prior to use.

A2.5 *Admixtures*—Admixtures shall be proportioned and mixed in accordance with the published directions of the admixture manufacturer.

A2.5.1 The quantity of admixtures required to impart the desired performance is generally very small in relation to the quantities of the other mix ingredients. Batch-to-batch quantities shall be measured accurately.

A2.5.2 Air-entraining agents cause air to be incorporated in the plaster in the form of minute bubbles, usually to improve frost or freeze-thaw resistance, or workability of the plaster during application. Air-entraining agents for portland cement-based plaster shall meet the requirements of Specification C260.

A2.6 *Design and Application of Ornamental Features*:

A2.6.1 The design and construction requirements of ornamental features that project beyond the surface of the cement plaster scratch and brown coat assembly (including quoins, bands, or other similar ornamentation) are to be described in the ~~contract~~ Contract ~~documents.~~ Documents. The ~~contract~~ Contract ~~documents~~ Documents shall provide details to indicate the location, nature, and extent of the ornamental feature. The ~~design~~ Design ~~authority~~ Authority shall be responsible for compliance with applicable building code(s) and prescribed design loads. The ~~design~~ Design ~~authority~~ Authority shall also consider fire ratings and combustibility requirements in the design and selection of the ornamental feature.

A2.6.2 Ornamental features with sky-facing top surfaces that are exposed to the elements shall include sufficient slope for drainage as required by A2.1.1 or as minimally acceptable to the finish coat manufacturer, whichever is more restrictive.

A2.6.3 Ornamental features shall be isolated from load-bearing members, penetrating elements, and wall openings (such as fenestrations) as required by Specification C1063 to avoid the transfer of structural loads and to provide separation from dissimilar materials.

A2.6.4 Ornamental features shall not obstruct the function of control joints or expansion joints. The ~~design~~ Design ~~authority~~ Authority shall provide details as to how to the ornamental feature shall interact with applicable joints.

A2.6.5 Application of Field-Coated Foam Core Ornamental Features—Field-finished ornamental features consist of foam plastic cores encapsulated with a polymer-modified cementitious base coat with an acrylic finish coat or other approved manufactured finish. The foam plastic cores are adhesively attached to the brown coat either before or after encapsulation in the field.

A2.6.5.1 Ornamental features shall be adhered to the plaster brown coat with an adhesive compatible with portland cement plaster and the ornamental core manufacturer. The ornamental feature shall be integrated with the plaster brown coat with consideration provided to crack control and moisture infiltration. The base coat of the material that encapsulates the core of the ornamental feature shall continue onto the surface of the plaster brown coat without interruption. Crack control and moisture penetration resistance of the ornamental feature shall be addressed in the ~~contract~~ Contract ~~documents~~ Documents for plaster thickness that is less than those values provided in Table 4.

A2.6.5.2 Cores of ornamental features shall be permitted to be fabricated of expanded polystyrene (EPS) conforming to Specification C578 Type I or II having a minimum density of 0.9 lb/ft^3 (14.4 kg/m^3). The thickness of the core shall be no less than ¾ in. (19 mm).

A2.6.5.3 Foam core ornamental features shall be permitted to be covered with a variety of materials. A polymer-modified, fabric reinforced cementitious base coat and an acrylic finish coat shall be an acceptable finish over the ornamental feature. The design authority shall give consideration to profile differences in the finish coat (such as variation in shade, color, and sheen) that may result at the transition of the polymer-modified and portland cement base coat materials.

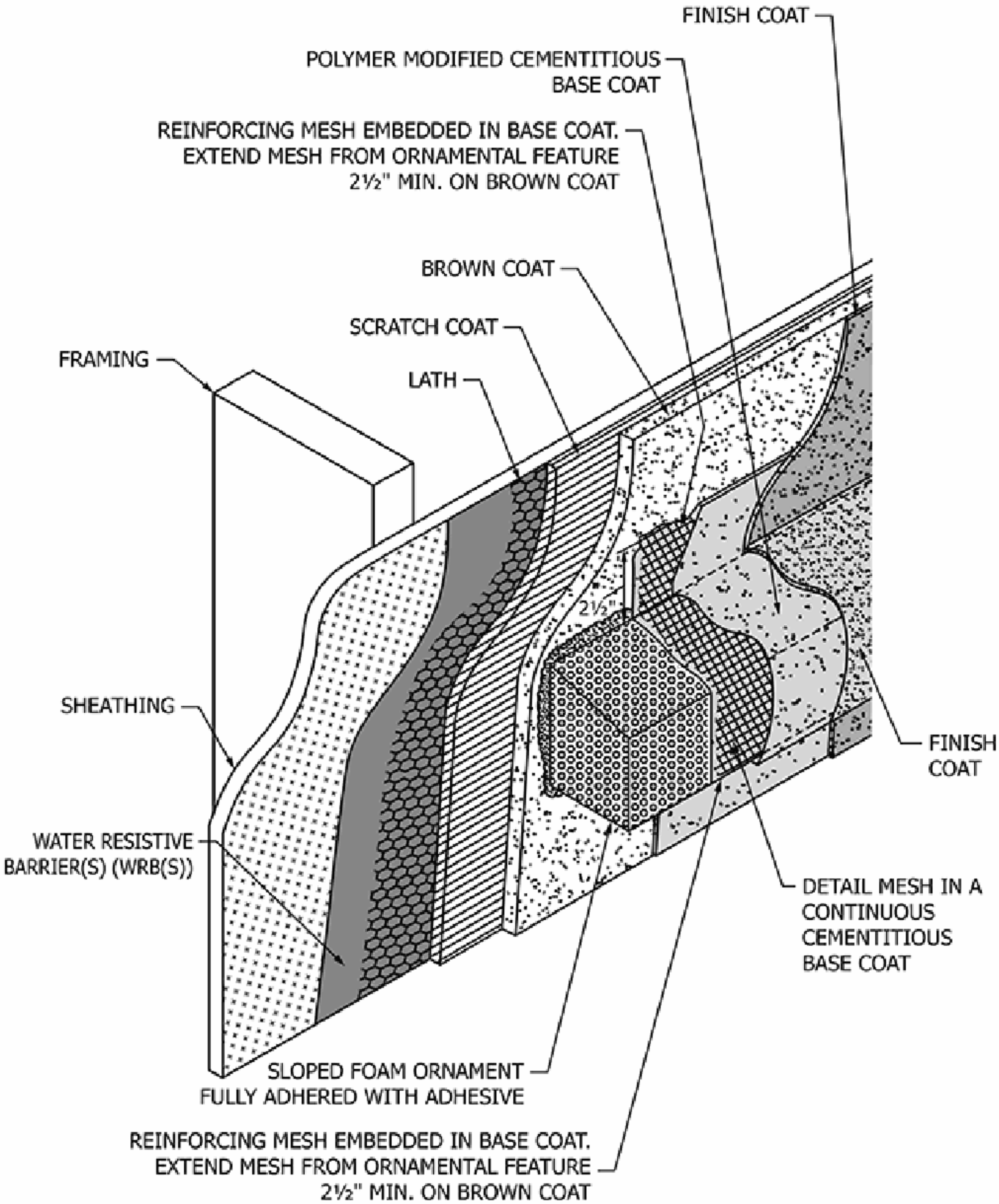
Nominal thickness for standard impact resistant base coats shall range from ~~1~~ 1/16~~/16~~ to ~~3~~ 3/32~~/32~~ in. ~~(2~~ (1.58 to ~~3~~ 2.38 mm) and be applied over nominal 4 oz/yd^2 (135.6 g/m^2) standard impact mesh. Thickness of impact-resistant base coats and nominal weight of impact-resistant mesh shall follow the manufacturer's installation instructions. The design authority shall give consideration to prevent impact damage to ornamental features.

Mesh shall be embedded in the base coat and extend a minimum of 2.5 in. ~~(64~~ (63.5 mm) beyond the ornamental feature. Where extension beyond the ornamental feature is not possible, backwrapping shall be provided.

A2.6.5.4 Application of the finish coat shall follow the manufacturer's installation instructions for the specific finish type. When cement-based finishes are applied, a bonding agent or admixture shall be used to insure proper adhesion to the polymer-modified base coat.

A2.6.5.5 A sample detail of an ornamental feature encapsulated with an exterior polymermodified cementitious base coat and detailing mesh is provided in Fig. A2.1. As depicted in the sample detail, the encapsulating material is continuous onto the surface of the plaster brown coat without interruption, providing a seamless transition between the ornamental feature and wall surface.

FIG. A2.1 Sample Detail of Ornamental Feature Consisting of Foam Plastic Core Encapsulated with Polymer Modified Cementitious Base Coat and Finish Coat



APPENDIX

(Nonmandatory Information)

X1 GENERAL INFORMATION

X1.1 *Additions*—Bonding compounds or agents may be pre-applied to a surface to receive plaster. In this usage it is not considered an admixture. Bonding compounds that are integrally mixed with plaster prior to its application are considered admixtures. Where exterior exposure and cyclic wetting are anticipated, the re-emulsification capability of the bonding material must be considered. Bonding agents are only as good as the material surface to which they are applied; therefore, form release materials must be removed from concrete or be compatible with the bonding material used. Bonding ~~agents,~~ agents in plaster mixes may increase the cohesive properties of the plaster. Bonding ~~agents,~~ agents ~~where used,~~ should meet the requirements of Specifications C631 ~~for interior plastering~~ or C932 ~~for~~. ~~exterior plastering.~~

X1.1.1 By the use of a suitable admixture or additive, it is possible to improve plaster's resistance to moisture movement. However, the use of the terms damproofing or water proofing is misleading, and their use shall be discouraged.

X1.1.2 Natural or synthetic ~~fibers~~ fibers, $^1/_2$ to 2 in. (13 to 51 mm) in length and free of contaminates may be specified to ~~mitigate~~ improve resistance to cracking or to impart improved pumpability characteristics. The quantities per batch shall be in accordance with the ~~formation~~ published directions of ~~visible~~ the ~~cracking~~ fiber ~~during~~ manufacturer. ~~hydration.~~ No more than 2 lb (0.90 kg) of fiber should be used per cubic foot of cementitious material. Asbestos fibers should not be used. Alkaline-resistant glass fibers are recommended where glass fiber is used.

X1.1.3 Plasticizers containing hydrated lime putty, air-entraining agents, or approved fatteners to increase the workability of a portland cement plaster may be used. Plaster consistency and workability are affected by plasticizers that are beneficial in proper quantities from an economic standpoint, but in excess can be detrimental to the long-term performance of the plaster in place.

X1.1.4 Color material for integral mixing with plaster should not significantly alter the setting, strength development, or durability characteristics of the plaster. Natural or mineral pigments that are produced by physical processing of materials mined directly from the earth appear to offer the best long-term performance with respect to resistance to fading. Plaster color is determined by the natural color of the cementitious materials, aggregate, and any color pigment, and their proportions to each other. The use of white cement with the desired mineral oxide pigment color material may result in truer color.

X1.1.4.1 The uniformity of color cannot be guaranteed by the materials manufacturer of the component materials or by the applicating contractor. Color uniformity is affected by the uniformity of proportioning, thoroughness of mixing, cleanliness of equipment, application technique, and curing conditions and procedure, which are generally under the control of the applicator. Color uniformity is affected to an even greater degree by variations in thickness and differences in the suction of the base coat from one area or location to another, the type of finish selected, the migration of color pigments with moisture, and with job site climatic and environmental conditions. These factors are rarely under the control of the applicator.

X1.1.5 Corrective measures for conditions cited in ~~6.2~~ 5.2 include ~~sandblasting,~~ the ~~chipping,~~ installation ~~or~~ of ~~grinding~~ a ~~of~~ furred ~~the~~ or ~~solid~~ self-furring metal plaster ~~base,~~ base; application of a repair/build-out ~~mortar,~~ mortar; ~~installation~~ grinding/chipping of ~~a~~ the ~~self-furring~~ concrete ~~plaster~~ base; ~~base,~~ or combinations thereof. Because these measures may have structural or integrity consequences, they should be considered by all concerned parties with the ultimate selection left to the discretion of the design authority as defined by the Owner-Contractor Agreement.

X1.1.6 The ~~contract~~ "Project ~~documents~~ Documents" consist of many individual items but includes both the ~~specifications~~ Project Specifications and the ~~contract~~ Contract ~~drawings.~~ Drawings. It is the intent of this standard to have the type, location, depth, and orientation of control and expansion joints both stated in the ~~specifications~~ Project Specifications as well as shown and detailed on the ~~contract~~ Contract ~~drawings~~ Drawings where either or both of these documents exist for any particular project.

X1.2 *Finish Coat Categories* (applicable to both natural and colored finishes):

X1.2.1 Texture, as a description of surface appearance, is identified generally with the method and tools used to achieve the finish. Texture can be varied by the size and shape of the aggregate used, the equipment or tools employed, the consistency of the finish coat mix, the condition of the base to which it is applied, and by subsequent decorative or protective treatment.

X1.2.2 There are many factors that affect the ultimate appearance of textured and integrally colored plaster. A suitably sized sample panel should be submitted for approval by the architect and the owner. Once approved, the sample should be maintained on site for reference and comparison.

X1.2.3 With the almost limitless variations possible for finish appearance or texture, the same term may not have the same meaning to the specifier, the contractor, and the actual applicator. The specifier is cautioned to use an approved range of sample panels. To provide some guidance, the following categories are generally understood and recognized to imply a particular method of application technique or resulting finished appearance:

X1.2.4 *Smooth Trowel*—Hand- or machine-applied plaster floated as smooth as possible and then steel-troweled. Steel troweling should be delayed as long as possible and used only to eliminate uneven points and to force aggregate particles into the plaster surface. Excessive troweling should be avoided.

X1.2.5 *Float*—A plaster devoid of coarse aggregate applied in a thin coat completely covering the base coat, followed by a second coat that is floated to a true plane surface yielding a relatively smooth to fine-textured finish, depending on the size of aggregate and technique used. It is also known as sand finish.

X1.2.6 *Trowel-Textured (such as Spanish Fan, Trowel Sweep, English Cottage)*—A freshly applied plaster coat is given various textures, designs, or stippled effects by hand troweling. The effects achieved may be individualized and may be difficult to duplicate by different applicators.

X1.2.7 *Rough-Textured (such as Rough Cast, Wet Dash, Scottish Harl)*—Coarse aggregate is mixed intimately with the plaster and is then propelled against the base coat by trowel or by hand tool. The aggregate is largely unexposed and deep textured.

X1.2.8 *Exposed Aggregate (also known at Marblecrete)*—Varying sizes of natural or manufactured stone, gravel, shell, or ceramic aggregates are embedded by hand or machine propulsion into a freshly applied finish "bedding" coat. The size of the aggregate determines the thickness of the "bedding" coat. It is generally thicker than a conventional finish coat.

X1.2.9 *Spray-Textured*—A machine-applied plaster coat directed over a previously applied thin smooth coat of the same mix. The texture achieved depends on the consistency of the sprayed mixture, moisture content of the base to which it is applied, the angle and distance of the nozzle to the surface, and the pressure of the machine.

X1.2.10 *Brush-Finish*—A method of surfacing or resurfacing new or existing plaster. The plaster is applied with a brush to a thickness of not less than $^{1}/_{16}$ in. ~~(2~~ (1.6 mm). For an existing plaster surface the bond capability must be determined by test application or a bonding compound must be applied prior to the brush application.

X1.2.11 *Miscellaneous Types*—This finish coat category is somewhat similar to trowel-textured finishes, except that the freshly applied plaster is textured with a variety of instruments other than the trowel, such as swept with a broom or brush, corrugated by raking or combing, punched with pointed or blunt instrument, scored by aid of a straightedge into designs of simulated brick, block, stone, and so forth. A variation of texturing a finish coat involves waiting until it has partially set and then flattening by light troweling of the unevenly applied plaster or by simulating architectural terracotta.

X1.2.12 *Scraffitto*—A method of applying two or more successive coats of different colored plaster and then removing parts of the overlaid coats to reveal the underlaying coats, usually following a design or pattern. This is not generally considered a finish coat operation because of the number of thickness of coats.

X1.3 When specified as alternate for final coat, trowel- or plaster machine-applied textured acrylic finishes containing aggregate may be substituted for portland cement finish coats, provided brown coat is properly prepared and finish is applied according to the manufacturer's directions.

X1.4 *Staining of Plaster*—Staining and discoloration of plaster, caused by free water draining from one plane of plaster to another or from a dissimilar material onto a plaster surface, can be minimized by providing sufficient depth and angle for drip caps and the use of water-resistive surface coatings.

X1.4.1 Staining of plaster due to entrapment of moisture behind the plaster, can be avoided or minimized by providing an air space for ventilation between the back of the plaster and adjacent material. This type of staining may occur where insulation with or without vapor barrier, or other material containing asphaltic or coal tar derivatives, fireproofing salts, and so forth, can migrate with moisture movement to the finished plaster surface.

X1.4.2 Integrally colored plaster can be discolored or altered in shade if subjected to moisture, either from uncured base coats or external sources, such as rain, too soon after applications.

X1.5 *Installation Instructions:*

X1.5.1 Hand mixing should not be permitted, except as approved by the contract specifier.

X1.5.1.1 After all ingredients are in the mixer, mix the plaster for 3 to 5 min.

X1.5.1.2 The amount of water used in the plaster mix should be determined by the plasterer. Factors such as the suction of the base, or of the previous coat, water content of the aggregate, drying conditions, and finishing operations should be considered in determining water usage. Use of excessive water may result in dropouts, fall or slide off, excessive shrinkage, high porosity, and lower strength.

X1.5.2 Time Between Coats and Curing for Portland Cement-Based Plaster:

X1.5.2.1 The timing between coats will vary with climatic conditions and types of plaster base. Temperature and relative humidity extend or reduce the time between consecutive operations. Cold or wet weather lengthens and hot or dry weather shortens the time period. Moderate changes in temperature and relative humidity can be overcome by providing additional heating materials during cold weather and by reducing the absorption of the base by pre-wetting during hot or dry weather.

X1.5.2.2 In order to provide more intimate contact and bond between coats and to reduce rapid water loss, the second coat should be applied as soon as the first coat is sufficiently rigid to resist cracking, the pressures of the second coat application, and the leveling process.

X1.5.2.3 The amount of water and the timing for curing portland cement plaster will vary with the climatic conditions, the type of base, and use or nonuse of water-retentive admixtures.

X1.5.2.4 Some moisture must be retained in or added back to freshly applied portland cement-based plaster. If the relative humidity is relatively high (above 75 %), the frequency for rewetting a surface may be reduced. If it is hot, dry, and windy, the frequency of rewetting must be increased.

X1.5.2.5 Consider the physical characteristics of the structure as well as the previously mentioned conditions when selecting the method of curing. The method can be one or a combination of the following:

(1) Moist curing is accomplished by applying a fine fog spray of water as frequently as required, generally twice daily in the morning and evening. Care must be exercised to avoid erosion damage to portland cement-based plaster surfaces. Except for severe drying conditions, the wetting of finish coat should be avoided, that is, wet the base coat prior to application of the finish coat.

(2) Plastic film, when taped or weighted down around the perimeter of the plastered area, can provide a vapor barrier to retain the moisture between the membrane and plaster. Care must be exercised in placing the film: if too soon, the film may damage surface texture; if too late, the moisture may have already escaped.

(3) Canvas, cloth, or sheet material barriers can be erected to deflect sunlight and wind, both of which will reduce the rate of evaporation. If the humidity is very low, this option alone may not provide adequate protection.

X1.5.2.6 Application of Plaster Basecoats:

(1) Conventional, three-coat plaster is applied over a metal plaster base in two, nominal $^3/_8$ in. ~~(10 mm)~~ coats. The traditional application brings the plaster brown coat out to the lathing ~~accessory~~ accessories ~~grounds~~ which are ~~installed~~ set to approximately $^3/_4$ in. ~~(19~~ ~~ofl~~ ~~mm) from~~ the substrate. ~~Lathing~~ The lathing accessories that traditionally provide ~~cement~~ the plaster thickness ~~grounds~~ screed point include ~~weep screeds at~~ the ~~base of drainage wall assemblies,~~ casing ~~beads~~ beads, used to terminate the plaster into a dissimilar ~~materials;~~ material, control ~~joints~~ and expansion ~~joints;~~ joints ~~designated~~ installed ~~drainage~~ in ~~screeds~~ accordance with Specification C1063, corner transition trims, typically used at a vertical to horizontal ~~transitions,~~ transition, and ~~external~~ outside corner reinforcement (corner aids and corner beads).

(2) The interface of other exterior wall envelope systems, such as door and window frames, metal flashings and surrounds, drift joint framing, and other components often create build up that the lathing and plastering must cover. Further impacting this build-up are self-adhering flashing and multiple layers of water-resistive barriers used to enhance the ability of the exterior wall to provide a weather-resistive exterior wall envelope.

(3) In load-bearing wood framed and wood sheathed walls, build-up can occur from the wood and sheathing and any structural connection plates and bolts required to complete the structure.

(4) As a result of these factors that can impact the thickness of the plaster and are usually out of the control of the plastering contractor, references to plaster thickness use the term nominal to qualify the required thickness. The term nominal is intentionally ambiguous so as not to unnecessarily burden the plastering contractor with an expectation to provide a thickness of plaster that cannot reliably be achieved. Nominal is a term commonly associated with lumber that was many years ago actually a dimensional reference, but due to changes in the manufacturing of studs and timber, has become simply a name, and not an exact dimension.

X1.6 Design Considerations

X1.6.1 Provisions for Drainage Behind Exterior Plaster Base Systems:

X1.6.1.1 A barrier wall system where the plaster is applied directly to a solid substrate will not require any provisions for drainage to the exterior of the wall assembly.

X1.6.1.2 A drainage wall system where plaster is applied to a metal ~~or non metallic plaster~~ base shall include a water resistive barrier and a defined drainage plane, including provisions for moisture to escape to the exterior of the wall.

SUMMARY OF CHANGES

Committee C11 has identified the location of selected changes to this standard since the last issue (C926 – ~~18a)~~ 15) that may impact the use of this standard. (Approved ~~Aug.~~ July ~~1,~~ 15, ~~2018.)~~ 2015.)

(1) Revised ~~6.1,~~ subsections ~~7.3.4,~~ 5.2 ~~A1.5 A1.5.2, A2.2.1, A2.3.1.1, A2.3.1.2,~~ and ~~X1.5.2.6(1).~~ A1.6.3 ~~(2). Revised Notes 3 and 5.~~

Committee C11 has identified the location of selected changes to this standard since the last issue (C926 – ~~18)~~ 15) that may impact the use of this standard. (Approved ~~March~~ June 1, ~~2018.)~~ 2015.)

(1) ~~*Revised*~~ Added ~~A2.1.2.~~ Specification ~~Committee~~ C578 ~~C11 has identified the location of selected changes~~ to ~~this~~ Referenced ~~standard~~ Documents ~~since~~ subsection ~~the~~ 2.1 ~~last issue (C926 17) that may impact the use of this standard. (Approved Jan. 1, 2018.) (1) Revised X1.5.2.6. Committee C11 has identified the location of selected changes to this standard since the last issue (C926 16c) that may impact the use of this standard. (Approved Jan. 1, 2017.) (1) Revised X1.1 and X1.1.1~~.

(2) Added ~~X1.1.2~~ "back~~:~~ wrap" ~~Committee~~ (~~C11~~3.2.5 ~~has~~) ~~identified~~ and ~~the~~ "polymer ~~location~~ modified ~~of~~ cementitious ~~selected~~ base ~~changes~~ coat" ~~to this standard since the last issue~~ (~~C926~~3.2.22) ~~16b) that may impact the use of this standard. (Approved Dec. 1, 2016.) (1) Removed previous Subsection A1.1. (2) Added "contract~~

~~documents"~~ to Terminology ~~(Subsection~~ Section. ~~3.3).~~

(3) ~~*Revised*~~ Added ~~1.1~~ subsections, A2.6 ~~A1.5.2~~ ~~–~~, A2.6.5.5 ~~A2.3.1.2,~~ and ~~X1.1.6~~ Fig. ~~.~~ A2.1 ~~Committee C11 has identified the location of selected changes to this standard since the last issue (C926-16a) that may impact the use of this standard. (Approved Sept. 1, 2016.) (1) Revised Subsection 7.3.1~~.

Committee C11 has identified the location of selected changes to this standard since the last issue (C926 ~~–16)~~ 14a) that may impact the use of this standard. (Approved ~~March~~ Feb. 1, ~~2016.)~~ 2015.)

(1) ~~*Added Specification C1787 to 2.1. (2)*~~ Revised ~~6.1~~ 4.2.4, ~~6.2.3~~ 4.2.5, ~~7.4, A2.3.1, A2.3.2,~~ and ~~X1.6.1.2~~ 6.1.5. ~~(3)~~

(2) ~~*Revised*~~ Renumbered ~~Note~~ X1.4 ~~3~~ ~~–.~~ X1.4.2 ~~(4)~~ (formerly ~~Revised~~ X1.3.1 ~~A2.3.2~~ through ~~.~~ X1.3.3).

Committee C11 has identified the location of selected changes to this standard since the last issue (C926 ~~–15b~~ 14) ~~e1)~~ that may impact the use of this standard. (Approved ~~Jan.~~ April ~~1,~~ 15, ~~2016.)~~ 2014.)

(1) Revised ~~A1.5.2~~ 5.2.3 ~~, A2.2.1, and X1.1.5~~.

FOOTNOTES

(1) This specification is under the jurisdiction of ASTM Committee C11 on Gypsum and Related Building Materials and Systems and is the direct responsibility of Subcommittee C11.03 on Specifications for the Application of Gypsum and Other Products in Assemblies.

Current edition approved ~~Aug.~~ July ~~1,~~ 15, ~~2018.~~ 2015. Published ~~August~~ July ~~2018.~~ 2015. Originally approved in 1981. Last previous edition approved in ~~2018~~ 2015 as **C926** ~~–18a.~~ 15a. DOI: ~~10.1520/C0926-18B.~~ 10.1520/C0926-15b.

(2) For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

(3) Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

Designation: C1063 — ~~18b~~15a

Disclaimer: This document is not an ASTM standard and is intended only to provide the user of an ASTM standard an indication of what changes have been made to the previous version. Because it may not be technically possible to adequately depict all changes accurately, ASTM recommends that users consult prior editions as appropriate. In all cases, only the current version of the standard as published by ASTM is to be considered the official document.

Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster [1]

This standard is issued under the fixed designation C1063; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

IN THIS STANDARD:

SUMMARY OF CHANGES

Footnotes

1 SCOPE

*A Summary of Changes section appears at the end of this standard.

1.1 This specification covers the minimum ~~technical~~ requirements for lathing and furring for the application of exterior and interior portland ~~cement~~ cement-based ~~a hydraulic cement produced by pulverizing clinker consisting essentially of hydraulic calcium silicates, and usually containing one or more forms of calcium sulfate as an interground addition.Subcommittee: C11.91 Standard: C11-based~~ plaster, as in Specifications C841 or C926. ~~These requirements do not by default define a unit of work or assign responsibility for contractual purposes, which is the purview of a contract or contracts made between contracting entities.~~

1.2 Where a fire resistance rating is required ~~pertaining to a mandatory obligation imposed by a force outside this standard, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C840pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C926~~ for plastered assemblies and constructions, details of construction shall be in accordance with reports of fire tests of assemblies that have met the requirements of the fire rating imposed.

1.3 Where a specific degree of sound control is required ~~pertaining to a mandatory obligation imposed by a force outside this standard, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C840pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C926~~ for plastered assemblies and constructions, details of construction shall be in accordance with official reports of tests conducted in recognized testing laboratories in accordance with the applicable requirements of Test Method E90.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard. ~~1.5~~

2 ~~THIS~~ REFERENCED ~~INTERNATIONAL~~ DOCUMENTS ~~STANDARD~~

2.1 ~~was~~ ASTM ~~developed~~ Standards: ~~in~~ [2] ~~accordance~~

A641/A641M ~~with~~ Specification ~~internationally~~ for ~~recognized~~ Zinc-Coated ~~principles~~ (Galvanized) ~~on~~ Carbon ~~standardization~~ Steel ~~established~~ Wire ~~in~~

A653/A653M ~~the~~ Specification ~~Decision on Principles~~ for ~~the~~ Steel ~~Development~~ Sheet, ~~of~~ Zinc-Coated ~~International~~ (Galvanized) ~~Standards,~~ or ~~Guides~~ Zinc-Iron ~~and~~ Alloy-Coated ~~Recommendations~~ (Galvannealed) ~~issued~~ by the ~~World~~ Hot-Dip ~~Trade~~ Process ~~Organization~~

B69 ~~Technical~~ Specification ~~Barriers~~ for ~~to~~ Rolled ~~Trade~~ Zinc ~~(TBT)~~

B221 ~~Committee. 2 Referenced Documents 2.1 ASTM Standards:2 A653/A653M~~ Specification for ~~Steel~~ Aluminum ~~Sheet,~~ and ~~Zinc-Coated~~ Aluminum-Alloy ~~(Galvanized)~~ Extruded ~~or~~ Bars, ~~Zinc-Iron~~ Rods, ~~Alloy-Coated~~ Wire, ~~(Galvannealed)~~ Profiles, ~~by~~ and ~~the~~ Tubes ~~Hot-Dip Process~~

C11 Terminology Relating to Gypsum and Related Building Materials and Systems

C841 Specification for Installation of Interior Lathing and Furring

C847 Specification for Metal Lath

C926 Specification for Application of Portland Cement-Based Plaster

C933 Specification for Welded Wire Lath ~~C1032~~

C954 Specification for ~~Woven~~ Steel ~~Wire~~ Drill ~~Plaster~~ Screws ~~Base C1280 Specification~~ for the Application of ~~Exterior~~ Gypsum Panel Products ~~for~~ or ~~Use~~ Metal ~~as~~ Plaster ~~Sheathing~~ Bases ~~C1861~~ to ~~Specification~~ Steel ~~for~~ Studs ~~Lathing~~ from ~~and~~ 0.033 ~~Furring~~ in. ~~Accessories,~~ (0.84 ~~and~~ mm) ~~Fasteners,~~ to ~~for~~ 0.112 ~~Interior~~ in. ~~and~~ (2.84 ~~Exterior~~ mm) ~~Portland~~ in ~~Cement-Based~~ Thickness ~~Plaster~~

C1002 ~~E90~~ Specification ~~Test Method~~ for ~~Laboratory~~ Steel ~~Measurement~~ Self-Piercing ~~of~~ Tapping ~~Airborne~~ Screws ~~Sound~~ for ~~Transmission~~ Application ~~Loss~~ of ~~Building~~ Gypsum ~~Partitions~~ Panel ~~and~~ Products ~~Elements~~ or ~~2.2~~ Metal ~~US~~ Plaster ~~Department~~ Bases ~~of~~ to ~~Commerce~~ Wood ~~(DOC)~~ Studs ~~Standards~~ or ~~PS~~ Steel ~~1~~ Studs ~~Voluntary~~

C1032 ~~Product~~ Specification ~~Standard~~ for ~~PS~~ Woven ~~1,~~ Wire ~~Structural~~ Plaster ~~Plywood~~ Base ~~PS~~

D1784 ~~2~~ Specification ~~Voluntary~~ for ~~Product~~ Rigid ~~Standard~~ Poly(Vinyl ~~PS~~ Chloride) ~~2,~~ (PVC) ~~Performance~~ Compounds ~~Standard~~ and ~~for~~ Chlorinated ~~Wood-Based~~ Poly(Vinyl ~~Structural~~ Chloride) ~~Use~~ (CPVC) ~~Panels~~ Compounds ~~3~~

D4216 ~~Terminology~~ Specification ~~3.1~~ for ~~Definitions:~~ Rigid ~~3.1.1~~ Poly(Vinyl ~~For~~ Chloride) ~~definitions~~ (PVC) ~~relating~~ and ~~to~~ Related ~~ceilings~~ PVC and ~~walls,~~ Chlorinated ~~see~~ Poly(Vinyl ~~Terminology~~ Chloride) ~~C11~~ (CPVC)~~,~~ Building ~~3.1.2~~ Products ~~For~~ Compounds ~~definitions~~

E90 ~~relating~~ Test ~~to~~ Method ~~lathing accessories products fabricated~~ for ~~the~~ Laboratory ~~purpose~~ Measurement of ~~forming~~ Airborne ~~corners,~~ Sound ~~edges,~~ Transmission ~~control~~ Loss ~~joints,~~ of ~~or~~ Building ~~decorative~~ Partitions ~~effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims,~~ and ~~control~~ Elements ~~joints,~~

3 ~~SUCH~~ TERMINOLOGY ~~AS~~

3.1 ~~casing~~ *Definitions*—For ~~beads,~~ definitions ~~bull~~ relating ~~noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used~~ to ~~form~~ ceilings ~~corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516. furring accessories~~ and ~~fasteners,~~ walls, see ~~Specification~~ Terminology ~~C1861~~ C11.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 ~~building~~ *barrier ~~enclosure~~ wall, ~~system~~ n*—type of ~~building~~ wall ~~assemblies~~ system ~~and~~ that ~~materials~~ is ~~designed~~ intended and to ~~installed~~ block ~~in~~ or ~~such~~ interrupt ~~a~~ the ~~manner~~ movement ~~as~~ of water to ~~provide the a~~ interior. ~~barrier~~

3.2.2 ~~between~~ *building ~~different~~ enclosure, ~~environments.Subcommittee: C11.03 Standard: C1063, n—system~~*—system of building assemblies and materials designed and installed in such a manner as to provide a barrier between different environments. ~~3.2.2~~

3.2.3 *control ~~joint~~ joint, n*—a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines. ~~Subcommittee:~~

3.2.4 ~~C11.03~~ *drainage ~~Standard:~~ plane, ~~C1063~~ n~~a~~*—surface ~~formed product used for designed or required separations~~ between ~~adjacent~~ the ~~surfaces~~ back of ~~gypsum~~ the ~~boards~~ cladding ~~or~~ and ~~gypsum~~ the ~~veneer~~ front ~~base.~~ of~~Subcommittee:~~ the ~~C11.02~~ water ~~Standard:~~ resistive ~~C1047~~ barrier, which ~~n~~ resists~~—a~~ liquid ~~joint~~ moisture ~~that~~ infiltration ~~accommodates~~ and ~~movement~~ provides ~~of~~ for ~~plaster~~ gravitational ~~shrinkage~~ flow ~~and~~ to ~~curing~~ a ~~the~~ collection ~~act~~ or ~~processes~~ exhaust ~~of~~ location. ~~producing~~

3.2.5 ~~a~~ *drainage ~~moisture~~ space, ~~environment~~ n ~~favorable~~*—volumetric ~~to~~ area ~~cement~~ that ~~hydration,~~ allows ~~resulting in~~ the ~~setting~~ gravitational ~~or~~ flow ~~hardening~~ of ~~the~~ liquid ~~plaster.~~ moisture~~Subcommittee:~~ to ~~C11.03~~ a ~~Standard:~~ collection ~~C926~~ or ~~along~~ exhaust ~~predetermined,~~ location. ~~usually~~

3.2.6 ~~straight,~~ *drainage ~~lines.~~ wall, ~~3.2.3~~ n ~~expansion joint~~*—~~a joint~~ wall ~~that~~ system ~~accommodates~~ in ~~movement~~ which ~~beyond~~ the ~~plaster~~ cladding ~~shrinkage~~ provides ~~and~~ a ~~curing.~~ substantial~~Note~~ barrier ~~1—For~~ to ~~design~~ water ~~consideration~~ intrusion, ~~of control~~ and ~~expansion~~ which ~~joints,~~ also ~~see~~ incorporates ~~Annex A2.3.1.2 of Specification C926.Subcommittee: C11.03 Standard: C1063see control (expansion-contraction) joint.Subcommittee: C11.91 Standard: C11~~ a ~~structural~~ concealed ~~separation~~ water ~~between~~ resistive ~~building~~ barrier ~~elements~~ over ~~that~~ which ~~allows~~ drainage ~~independent~~ will ~~movement~~ occur. ~~without~~

3.2.7 ~~damage~~ *expansion ~~to~~ joint, ~~the assembly.Subcommittee: C11.05 Standard: C1516,~~ n~~—a~~*—a joint that accommodates movement beyond plaster shrinkage and curing. ~~the act or processes of producing a moisture environment favorable to cement hydration, resulting in the setting or hardening of the plaster.Subcommittee: C11.03 Standard: C926.~~

NOTE 1: For design consideration of control and expansion joints, see Annex A2.3.1.2 of Specification C926. ~~3.2.4~~

3.2.8 *framing ~~member~~ member, n*—studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel. ~~Subcommittee:~~

3.2.9 ~~C11.03~~ *hangers,* ~~*Standard:*~~ *n* ~~*C1063*~~—wires ~~stud,~~ or ~~plate,~~ steel ~~track,~~ rods ~~joist,~~ or ~~furring,~~ straps ~~and~~ used ~~other~~ to support ~~to~~ main ~~which~~ runners ~~a~~ for ~~gypsum~~ suspended ~~panel~~ ceilings ~~product,~~ beneath floor or ~~metal~~ roof ~~plaster~~ constructions. ~~base~~

3.2.10 ~~is~~ *inserts,* ~~*attached.*~~ *n* ~~*Subcommittee:*~~—devices ~~C11.91~~ embedded ~~Standard:~~ in ~~C11~~ concrete ~~metal~~ structural ~~studs,~~ members ~~runners (track), and rigid furring channels designed~~ to ~~receive~~ provide ~~screw-attached~~ a ~~gypsum~~ loop ~~panel~~ or ~~products.~~ opening ~~Subcommittee:~~ for ~~C11.03~~ attachment ~~Standard:~~ of ~~C754~~ hangers. ~~that~~

3.2.11 ~~portion~~ *saddle* ~~*of*~~ *tie,* ~~*the*~~ *n* ~~*framing,*~~—see ~~furring,~~ Figs. ~~blocking,~~ 1 and ~~so~~ 2 ~~forth,~~. ~~to~~

FIG. ~~which~~ 1 ~~the~~ Saddle ~~gypsum~~ Tie ~~base~~

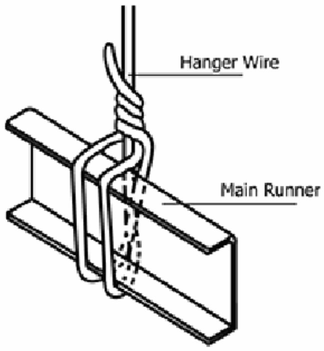
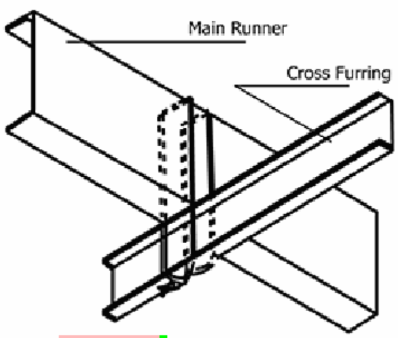


FIG. ~~is~~ 2 ~~attached.~~ Saddle ~~Unless~~ Tie ~~otherwise~~



3.2.12 ~~specified,~~ *self-furring,* ~~*the*~~ *adj* ~~*surface*~~—a ~~to~~ metal ~~which~~ plaster ~~abutting~~ base ~~edges~~ manufactured ~~or~~ with ~~ends~~ evenly-spaced ~~are~~ indentations ~~attached~~ that ~~shall~~ hold ~~be~~ the ~~not~~ body ~~less~~ of ~~than~~ the ~~1~~ lath ~~1~~ approximately ~~2 in. (38 mm) wide for wood members, not less than~~ ~~1~~$^{1}/_{4}$ in. ~~(32~~ (6.4 mm) ~~wide~~ away ~~for~~ from ~~steel~~ solid ~~members,~~ surfaces ~~and~~ to ~~not~~ which ~~less~~ it ~~than~~ is ~~6~~ applied. ~~in.~~

3.2.13 ~~(152~~ *water* ~~*mm)*~~ *resistive* ~~*wide*~~ *barrier,* ~~*for*~~ *n* ~~*gypsum*~~—a ~~studs.~~ material ~~For~~ that ~~internal~~ resists ~~corners or angles,~~ the ~~bearing~~ infiltration ~~surface~~ of ~~shall~~ liquid ~~be~~ moisture ~~not~~ through ~~less~~ the ~~than~~ building ~~3~~ enclosure system. ~~4~~

3.2.14 ~~in.~~ *water* ~~*(19*~~ *resistive* ~~*mm).*~~ *barrier* ~~*Subcommittee:*~~ *system,* ~~*C11.03*~~ *n* ~~*Standard:*~~—a ~~C844~~ combination ~~studs,~~ of ~~headers,~~ water ~~bracing,~~ resistive ~~and~~ barrier ~~blocking~~ assemblies that ~~serve~~ resist ~~to receive~~ the ~~gypsum~~ infiltration ~~panel~~ of ~~product.~~ liquid ~~Subcommittee:~~ moisture ~~C11.03~~ through ~~Standard:~~ the ~~C1280~~ building ~~studs,~~ enclosure ~~joist,~~ system. ~~runners (tracks), bridging, bracing,~~ and ~~related~~ facilitates ~~accessories~~ its ~~manufactured~~ gravitational ~~or~~ flow ~~supplied~~ to ~~in~~ a ~~wood~~ collection or ~~hot~~ drainage ~~or~~ location. ~~cold~~

4 ~~FORMED~~ DELIVERY ~~STEEL.~~ OF ~~SUBCOMMITTEE:~~ MATERIALS ~~C11.05~~

4.1 ~~Standard:~~ All ~~C1516~~ materials ~~see~~ shall ~~Specification~~ be ~~C1063.~~ delivered ~~Subcommittee:~~ in ~~C11.03~~ the ~~Standard:~~ original ~~C1787~~ packages, containers, ~~n~~ or ~~—studs,~~ bundles ~~joist,~~ bearing ~~runners~~ the ~~(track),~~ brand-name ~~bridging, bracing,~~ and ~~related~~ manufacturer's ~~accessories~~ (or ~~products~~ supplier's) ~~fabricated~~ identification. ~~for~~

5 ~~THE~~ STORAGE ~~PURPOSE~~ OF ~~FORMING~~ MATERIALS ~~CORNERS,~~

5.1 ~~edges,~~ All ~~control~~ materials ~~joints,~~ shall ~~or~~ be ~~decorative~~ kept ~~effects.~~ dry.~~Subcommittee:~~ Materials ~~C11.91~~ shall ~~Standard:~~ be ~~C11~~ stacked~~cornerbeads,~~ off ~~edge~~ the ~~trims,~~ ground, ~~and~~ supported ~~control~~ on ~~joints,~~ a ~~such~~ level ~~as~~ platform, ~~casing~~ and ~~beads,~~ protected ~~bull~~ from ~~noses,~~ the weather and ~~stops.~~ surface~~Subcommittee:~~ contamination. ~~C11.02~~

5.2 ~~Standard:~~ Materials ~~C1047~~ shall~~preformed~~ be ~~metal,~~ neatly ~~fiberglass~~ stacked ~~or~~ with ~~plastic~~ care ~~members~~ taken ~~used~~ to ~~form~~ avoid ~~corners,~~ damage to edges, ~~control~~ ends, ~~joints,~~ or ~~decorative~~ surfaces. ~~effects.~~

5.3~~Subcommittee:~~ Paper ~~C11.05~~ backed ~~Standard:~~ metal ~~C1516~~ plaster ~~manufactured~~ bases ~~or~~ shall ~~supplied~~ be ~~in~~ handled ~~wood~~ carefully ~~or~~ in ~~light~~ delivery, ~~gauge~~ storage, ~~steel.~~ and ~~3.2.5~~ erection ~~hangers~~ to ~~wires~~ prevent ~~or~~ puncturing ~~steel rods~~ or ~~straps~~ removal ~~used~~ of ~~to~~ paper. ~~support~~

6 ~~MAIN~~ MATERIALS ~~RUNNERS~~

6.1 ~~for~~ Metal ~~suspended~~ Plaster ~~ceilings~~ Bases: ~~beneath~~

6.1.1 ~~floor~~ ***Expanded*** ~~or~~ ***Metal*** ~~roof~~ ***Lath***—Specification ~~constructions.~~ C847~~Subcommittee: C11.03 Standard: C1063,~~ ~~n~~ galvanized. ~~—wires~~

6.1.2 ~~or~~ ***Wire*** ~~steel~~ ***Laths:*** ~~rods~~

6.1.2.1 ~~or~~ *Welded* ~~straps~~ *Wire* ~~used~~ *Lath*—Specification ~~to~~ C933 ~~support.~~ ~~main~~

6.1.2.2 ~~runners~~ *Woven* ~~the~~ *Wire* ~~members~~ *Lath*—Specification ~~that~~ C1032 ~~are,~~ ~~attached~~

6.1.2.3 ~~to~~ *Paper* ~~or~~ *Backed* ~~suspended~~ *Plaster* ~~from~~ *Bases*—Specification ~~the~~ C847 ~~construction.~~ ~~above~~

6.2 ~~for~~ Accessories: ~~the~~

6.2.1 ~~support~~ ***General***—All ~~of~~ accessories ~~cross~~ shall ~~furring,~~ have~~Subcommittee:~~ perforated ~~C11.03~~ or ~~Standard:~~ expanded ~~C841~~ flanges ~~for suspended ceilings beneath floor~~ or ~~roof~~ clips ~~constructions.~~ shaped ~~3.2.6~~ to ~~inserts,~~ permit ~~n~~ complete~~—devices~~ embedment ~~embedded~~ in ~~concrete~~ the ~~framing~~ plaster, ~~members~~ to provide ~~a~~ means ~~loop~~ for ~~or~~ accurate ~~opening~~ alignment, ~~for~~ and to secure attachment of ~~hangers~~ the ~~wires~~ accessory ~~or~~ to ~~steel~~ the ~~rods~~ underlying ~~or~~ surface. ~~straps~~ Accessories ~~used~~ shall be designed to ~~support~~ receive ~~main~~ application ~~runners~~ of ~~for~~ the ~~suspended~~ specified ~~ceilings~~ plaster ~~beneath~~ thickness. ~~floor~~

6.2.2 ~~or~~ Accessories ~~roof~~ shall ~~constructions.~~ be~~Subcommittee:~~ fabricated ~~C11.03~~ from ~~Standard:~~ Zinc ~~C1063~~ Alloy: (99 ~~3.2.7~~ % ~~saddle~~ pure ~~tie~~ zinc), ~~see~~ galvanized ~~Figs.~~ (zinc-coated) ~~1~~ steel, ~~and~~ rigid ~~2.~~ PVC~~Subcommittee:~~ or ~~C11.03~~ CPVC ~~Standard:~~ plastic, ~~C1063~~ or, anodized ~~n~~ aluminum ~~—see~~ alloy ~~Figs.~~ (see ~~1~~ Specification ~~and~~ B221 ~~2~~).. (See ~~FIG.~~ Table 1 ~~Saddle~~ for ~~Tie~~ minimum ~~FIG.~~ allowable ~~2~~ thicknesses.) ~~Saddle~~

TABLE ~~Tie~~ 1 ~~3.2.8~~ Minimum ~~self-furring~~ Thickness ~~a~~ of ~~metal~~ Accessories ~~plaster~~

Accessory ~~base~~	Base ~~manufactured~~ Material, ~~with~~ in. ~~evenly spaced~~ (mm) ~~indentations~~		
	Steel ~~that~~	Zinc ~~hold~~ Alloy ~~the~~	P.V.C. ~~body~~
Corner ~~of~~ Beads ~~the~~	0.0172 ~~lath~~ (0.44) ~~approximately~~	0.0207 ~~1~~ (0.53)	0.035~~4~~ (0.89) ~~in.~~
Casing ~~(6~~ Beads ~~mm)~~	0.0172 ~~away~~ (0.44) ~~from~~	0.0207 ~~solid~~ (0.53) ~~surfaces~~	0.035 ~~to~~ (0.89) ~~which~~
Weep ~~it~~ Screeds ~~is~~	0.0172 ~~installed.~~ (0.44)~~Subcommittee:~~	0.0207 ~~C11.03~~ (0.53) ~~Standard:~~	0.050 ~~C1063~~ (1.27)~~,~~
Control ~~adj~~ Joints ~~—a~~	0.0172 ~~metal~~ (0.44) ~~plaster~~	0.018 ~~base~~ (0.46) ~~manufactured~~	0.050 ~~with~~ (1.27) ~~evenly spaced~~

NOTE ~~INDENTATIONS~~ 2: ~~that~~ The ~~hold~~ selection ~~the body~~ of ~~the~~ an ~~lath~~ appropriate ~~see~~ type ~~gypsum~~ of ~~lath.~~ material~~Subcommittee:~~ for ~~C11.91~~ accessories ~~Standard:~~ shall ~~C11~~ be ~~approximately~~ determined ~~1~~ by ~~/~~ applicable ~~4~~ surrounding ~~in.~~ climatic ~~(6~~ and ~~mm)~~ environmental ~~away~~ conditions ~~from~~ specific ~~solid surfaces~~ to ~~which~~ the ~~it~~ project ~~is~~ location, ~~installed.~~ such ~~3.2.9~~ as ~~water~~ salt ~~resistive~~ air, ~~barrier~~ industrial ~~a~~ pollution, ~~material~~ high ~~that~~ moisture, ~~resists~~ or ~~the~~ humidity. ~~infiltration~~

6.2.3 of Steel—Specification liquid A653/A653M moisture and through shall the have building a enclosure G60 system. coating Subcommittee:

6.2.4 C11.03 PVC Standard: Plastic—Specification C1063 D1784; or n D4216—a. material

6.2.5 that Zinc resists Alloy—Specification the B69 infiltration, of 99 liquid % moisture pure through zinc. the

6.2.6 building Thickness enclosure system of building base assemblies material and shall materials be designed as and shown installed in such Table a 1 manner. as

6.2.7 to Cornerite—1.75 provide lb/yd a 2 barrier (0.059 between kg/m different 2 environments.),Subcommittee: galvanized C11.03 expanded Standard: metal C1063 lath, system. 1.7 4 lb/yd Delivery 2 and (0.057 Storage kg/m of 2 Materials) 4.1 galvanized Delivery woven of or Materials: welded 4.1.1 wire All fabric materials of shall 0.0410 be delivered in. the (1.04 original mm) packages, wire. containers, When or shaped bundles for bearing angle the reinforcing, brand-name it and shall manufacturer's have (or outstanding supplier's) flanges identification. (legs) 4.2 Storage of Materials: not 4.2.1 less All than materials 2 shall in. be (51 kept mm). dry.

6.3 Materials Channels—Shall shall be stacked cold-formed off from the steel ground with the minimum element 33 of 000 a psi lathing (228 accessory MPa) that yield provides strength an and edge, 0.0538 end, in. or (1.37 termination mm) for minimum a bare cement steel plaster thickness. panel Channel area, shall with have a ground protective dimension coating conforming to assist Specification in A653/A653M cement–G60, plaster or thickness have control.Subcommittee: C11.02 Standard: C1861, supported on a level protective platform, coating and with protected an from equivalent the corrosion weather resistance and for surface exterior contamination. applications, 4.2.2 or Materials shall be neatly coated stacked with care a taken rust to inhibitive avoid paint, damage for to interior edges, applications, ends and the shall end have perpendicular to the paper-bound following edge minimum or weights long in edge. poundsSubcommittee: per C11.01 1000 Standard: linear C473 ft, (kg/m). or

Sizes, surfaces. in. 4.2.3 (mm) Paper	Weight, backed lb/1000 metal ft plaster (kg/m) bases	Flange expanded Width, metal in. lath. (mm) sheet
3 metal/lath, 4 welded (19) or	277 woven (0.412) wire	1 lath./Subcommittee: 2 C11.03 (13) Standard:
1 C841 1 shall/be 2 handled (38) carefully	414 in (0.616) delivery,	1 storage,/and 2 erection (13) to
2 prevent (51) puncturing	506 or (0.753) removal	1 of/paper. 2 5 (13) Materials
2 5.1 1 Metallic/materials 2 including (64) lathing,	597 lathing (0.888) accessories	1 products/fabricated 2 for (13) the

NOTE PURPOSE 3: of Channels forming used corners, in edges, areas control subject joints, to or corrosive decorative action effects. ofSubcommittee: salt C11.01 air Standard: shall C11 becornerbeads, hot-dipped edge galvanized, trims, G60 and coating control

6.3.1 joints, External such Corner as Reinforcement—Expanded casing lath, beads, welded bull wire, noses, or and woven stops. wireSubcommittee: mesh C11.02 bent Standard: to C1047 approximatelypreformed 90 metal, ° fiberglass or plastic members used to form reinforce corners, portland edges, cement control stucco joints, at or external decorative corners. effects. ThisSubcommittee: accessory C11.05 Standard: C1516, furring, furring accessories, and fasteners shall be selected fully for embedded compatibility in to the minimize stucco. galvanic

6.3.2 corrosion Weep between Screed—Accessory adjacent used metallic to materials terminate installed portland in the cement plaster based see stucco gypsum at plaster, the gypsum bottom neat of plaster. exteriorSubcommittee: framed C11.91 walls. Standard: This C11 accessoryportland shall cement-based have cementitious a mixture sloped, (see solid, stucco). orSubcommittee: perforated, C11.03 ground, Standard: or C926 screed cladding flange assembly. to 5.2 facilitate Metal the Plaster removal Bases: of 5.2.1 moisture Expanded from Metal the Lath—Specification wall C847 cavity., and galvanized. a 5.2.2 vertical Wire attachment Laths: flange 5.2.2.1 not Welded less Wire than Lath—Specification 3 C933 1/ 5.2.2.2 2 Woven in. Wire (89 Lath—Specification mm) C1032 long.

6.4 5.2.2.3 Wire—As Paper specified Backed in Plaster Specification Bases—Specification A641/A641M C847 with, a 5.3 Class Lathing I Accessories, zinc-coated Furring (galvanized), Accessories soft-temper and steel. Fasteners: Wire 5.3.1 diameters Lathing (uncoated) Accessories, specified Furring herein Accessories correspond and with Fasteners—Specification United C1861 States. Steel 5.3.2 Wire The Gauge selection numbers of as an follows: appropriate

Wire type Gauge of (US material Steel for Wire lathing Gauge) accessories	Diameter products (in.) fabricated	mm for

No. ~~the~~ 20 ~~purpose~~	0.0348 ~~of~~	.88 ~~forming~~
No. ~~corners,~~ 19 ~~edges,~~	0.0410 ~~control~~	1.04 ~~joints,~~
No. ~~or~~ 18 ~~decorative~~	0.0475 ~~effects.~~	1.21 ~~Subcommittee:~~
No. ~~C11.91~~ 17 ~~Standard:~~	0.0540 ~~C11~~	1.37 ~~cornerbeads,~~
No. ~~edge~~ 16 ~~trims,~~	0.0625 ~~and~~	1.59 ~~control~~
No. ~~joints,~~ 14 ~~such~~	0.0800 ~~as~~	2.03 ~~casing~~
No. ~~beads,~~ 13 ~~bull~~	0.0915 ~~noses,~~	2.32 ~~and~~
No. ~~stops.~~ 12 ~~Subcommittee:~~	0.1055 ~~C11.02~~	2.68 ~~Standard:~~
No. ~~C1047~~ 11 ~~preformed~~	0.1205 ~~metal,~~	3.06 ~~fiberglass~~
No. ~~or~~ 10 ~~plastic~~	0.1350 ~~members~~	3.43 ~~used~~
No. ~~to~~ 9 ~~form~~	0.1483 ~~corners,~~	3.77 ~~edges,~~
No. ~~control~~ 8 ~~joints,~~	0.1620 ~~or~~	4.12 ~~decorative~~

6.5 ~~effects.~~ **Rod** ~~Subcommittee:~~ **and** ~~C11.05~~ **Strap** ~~Standard:~~ **Hangers**—Mild ~~C1516~~ steel, ~~shall~~ zinc ~~be~~ or ~~based~~ cadmium ~~upon~~ plated, ~~applicable~~ or ~~surrounding~~ protected ~~climatic~~ with ~~and~~ a ~~environmental~~ rust-inhibiting ~~conditions~~ paint. ~~specific~~

6.6 ~~to~~ **Clips**—Form ~~the~~ from ~~project~~ steel ~~location,~~ wire, ~~such~~ Specification ~~as~~ A641/A641M ~~salt~~ zinc-coated ~~air,~~ (galvanized), ~~industrial~~ Specification ~~pollution,~~ A641/A641M ~~high moisture,~~ or ~~humidity.~~ steel ~~6~~ sheet, ~~Requirements~~ Specification ~~for~~ A653/A653M ~~Substrates,~~ ~~to~~ depending ~~Receive~~ on ~~Metal~~ use ~~Lathing~~ and ~~Furring~~ manufacturer's ~~6.1~~ requirements. ~~Framed,~~

6.7 ~~or~~ **Fasteners:** ~~Framed~~

6.7.1 ~~and~~ *Nails*—For ~~Sheathed~~ attaching ~~Substrates:~~ metal ~~6.1.1~~ plaster ~~Framing~~ bases ~~member~~ to ~~deflection~~ wood ~~shall~~ supports, ~~not~~ 0.1205-in. ~~exceed~~ 11 ~~L/360~~ gauge ~~(0.33~~ (3.06 ~~in.~~ mm) ~~in~~ diameter, ~~10~~ 7 ~~ft).~~/ ~~6.1.2~~ 16 ~~Plywood~~-in. ~~and~~ (11.1 ~~oriented~~ mm) ~~strand~~ head, ~~board~~ barbed, ~~sheathing~~ galvanized ~~panels~~ roofing ~~shall~~ nails ~~be marked in accordance with DOC PS1~~ or ~~DOC~~ galvanized ~~PS~~ common ~~2~~ nails.

6.7.1.1 ~~6.1.3~~ Nails ~~Plywood~~ for ~~and~~ attaching ~~oriented~~ metal ~~strand~~ plaster ~~board~~ bases ~~sheathing~~ to ~~panels~~ solid substrates shall be ~~installed~~ not ~~with~~ less ~~1~~ than $^3/_8$ ~~4~~ in. ~~(3~~ (19 mm) ~~minimum panel edge the paper-bound edge, or~~ long. ~~edge,~~

6.7.2 ~~as~~ Screws ~~manufactured.~~ for ~~Subcommittee:~~ attaching ~~C11.01~~ metal ~~Standard:~~ plaster ~~C473~~ base ~~the bound edge as manufactured.Subcommittee: C11.01 Standard: C1177/C1177M, C1178/C1178M, C1396/C1396M gaps, and panel edges~~ shall be ~~offset~~ fabricated ~~4~~ in ~~(10~~ accordance ~~cm)~~ with ~~minimum~~ either ~~from~~ Specification ~~wall~~ C954 ~~opening~~ or ~~reentrant~~ C1002 ~~corners. 6.1.4 Wood framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~, ~~plywood~~ and ~~oriented strand board sheathing panels~~ shall have a ~~moisture~~ 7 ~~content~~/ ~~not~~ 16 ~~to~~ in. ~~exceed~~ (11.1 ~~19~~ mm) ~~%~~ diameter ~~immediately~~ pan ~~before~~ wafer ~~plastering.~~ head ~~6.1.5~~ and ~~Exterior~~ a ~~gypsum~~ 0.120 ~~sheathing~~ in. ~~a~~ (3.0 ~~gypsum~~ mm) ~~board~~ diameter ~~used~~ shank. ~~as~~ Screws ~~a~~ used ~~backing~~ for ~~exterior~~ attachment ~~surface~~ to ~~materials,~~ metal ~~manufactured~~ framing ~~with~~ members ~~water-repellant~~ shall ~~paper and may~~ be ~~manufactured~~ self-drilling ~~with~~ and ~~a~~ self-tapping. ~~water-resistant~~ Screws ~~core.~~ used ~~Subcommittee:~~ for ~~C11.91~~ attachment ~~Standard:~~ to ~~C11~~ wood ~~panels~~ framing members shall be ~~installed~~ sharp-point. ~~in compliance with Specification C1280.~~

7 INSTALLATION

7.1 ~~Workmanship—Metal~~ **Workmanship—Metal** ~~lathing,~~ furring ~~lathing accessories, furring,~~ and ~~furring~~ lathing ~~accessories~~ shall be erected so that the finished ~~cement~~ plaster surfaces are true to line (allowable tolerance of $^1/_4$ in. ~~(6~~ (6.4 mm) in 10 ft ~~(3~~ (3.05 m)), level, plumb, square, or curved as required to receive the specified ~~pertaining to a mandatory requirement of this standard or a referenced requirement (see 3.2.17).Subcommittee: C11.03 Standard: C840pertaining to a mandatory requirement of this specification or a referenced requirement.Subcommittee: C11.03 Standard: C1280 cement~~ plaster ~~see gypsum plaster, gypsum neat plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926~~ thickness.

7.2 Hangers and Inserts:

7.2.1 **Hangers shall be of ample length and shall conform to the requirements of** Table~~1~~ 2, **both as to size and maximum** ~~**cement plaster panel**~~ **area to be supported, except as modified in this section.**

TABLE ~~1~~ 2 Allowable Support or Hanger Wire Spacing ft-in. (mm) and Cold-Rolled Channel ~~Furring~~ Main Runner Spans, ft-in. (mm)~~1—7~~ 1–10

NOTE 1: 1 in. = 25.4 mm; 1 ft^2 = 0.093 m^2

Member Size, in. (mm)	Member Weight, lb/1000 ft (kg/m)	Span Condition~~6,7~~ 9,10	Uniform Load = 12 psf (0.479 kPa)				
			Member Spacing, in. (mm)				
			24 (610)	36 (914)	48 (1220)	60 (1520)	72 (1830)
			Allowable Hanger Wire or Support Spacing, ft-in. (mm)				
$1^1/_2$	414	Single	3-6 (1070)	3-1 (940)	2-9 (840)	2-9 (790)	2-5 (740) ~~(38)~~
(38.1)	(0.615)	2 or More	4-11 (1500)	4-2 (1270)	3-7 (1090)	3-2 (970)	2-11 (890)
2	506	Single	3-9 (1140)	3-3 (990)	3-0 (910)	2-9 (840)	2-8 (810) ~~(54)~~
(50.8)	(0.753)	2 or More	5-2 (1570)	4-6 (1370)	4-1 (1240)	3-10 (1170)	3-7 (1090)
$2^1/_2$	597	Single	3-11 (1190)	3-5 (1040)	3-2 (970)	2-11 (890)	2-9 (840) ~~(64)~~
(63.5)	(0.888)	2 or More	5-5 (1650)	4-9 (1450)	4-4 (1320)	4.0 (1220)	3-10 (1170)

Member Size, in. (mm)	Member Weight, lb/1000 ft (kg/m)	Span Condition~~6,7~~ 9,10	Uniform Load = 15 psf (0.287 kPa)				
			Member Spacing, in. (mm)				
			24 (610)	36 (914)	48 (1220)	60 (1520)	72 (1830)
$1^1/_2$	414	Single	3-3 (990)	2-10 (860)	2-7 (790)	2-4 (710)	2-2 (660) ~~(38)~~
(38.1)	(0.616)	2 or More	4-6 (1370)	3-8 (1120)	3-2 (970)	2-10 (860)	2-7 (790)
2	506	Single	3-6 (1070)	3-1 (940)	2-10 (880)	2-7 (790)	2-5 (740) ~~(54)~~
(50.8)	(0.753)	2 or More	4-10 (1470)	4-3 (1300)	3-10 (1170)	3-6 (1070)	3-3 (990)
$2^1/_2$	597	Single	3-8 (1120)	3-3 (990)	2-11 (890)	2-9 (840)	2-7 (790) ~~(64)~~
(63.5)	(0.888)	2 or More	5-0 (1520)	4-5 (1350)	4-0 (1220)	3.9 (1140)	3-6 (1070)

Allowable Spans Notes:

[1] ~~Spans~~ Bare ~~based~~ metal ~~on~~ thickness ~~upper flange~~ of cold-rolled main runners ~~the~~ shall ~~members~~ be ~~that~~ not ~~are~~ less ~~attached~~ than ~~to~~ 0.0538 ~~or~~ in. ~~suspended~~ (1.367 ~~from~~ mm). ~~the~~

[2] ~~construction~~ Inside ~~above~~ corner ~~for~~ radii ~~the~~ shall ~~support~~ not ~~of~~ be ~~cross~~ greater ~~furring.~~ than~~Subcommittee:~~ [1] ~~C11.03~~ / ~~Standard:~~ [8] ~~C841~~ in. (3.19 mm).

[3] Spans based on upper flange of main runners laterally unbraced. ~~2~~

[4] Maximum deflection limited to 1/360 of the span length. ~~3~~

[5] ~~Uniform~~ Steel ~~load~~ yield ~~12~~ stress, ~~psf~~ Fy, ~~(dry density)~~ shall be ~~used~~ not ~~for~~ less ~~portland~~ than ~~cement~~ 33 ~~plaster~~ 000 ~~a~~ psi ~~plaster~~ (228 ~~mix~~ MPa). ~~in~~

[6] ~~which~~ Uniform ~~portland~~ load ~~cement~~ 12 ~~or~~ psf ~~combinations~~ (dry ~~of~~ density) ~~portland~~ shall ~~and~~ be ~~masonry~~ used ~~cements~~ for ~~or~~ portland cement ~~and~~ plaster ~~lime are the principal cementitious materials mixed with aggregate.Subcommittee: C11.91 Standard: C11~~ ceilings with plaster thicknesses up to $^7/_8$ in. (22 mm) and 15 psf shall be used for ceilings with plaster ~~see gypsum plaster, gypsum neat plaster.Subcommittee: C11.01 Standard: C11portland cement based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926~~ thicknesses over $^7/_8$ in. (22 mm) and not more than $1^1/_4$ in. (32 mm). ~~4~~

[7] ~~"2~~ "2 or ~~More"~~ More" spans refers to two or more continuous, equal spans. ~~5~~

8 For the~~"2~~ "2 or~~More"~~ More" span condition, listed spans represent the center-to-center distance between adjacent~~framing~~ supports.~~members~~

~~9 studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007. 6~~ These tables are designed for dead loads. Specific conditions such as exterior installations in high wind areas require~~to mandate by a force outside this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C1280~~ additional engineering.~~7~~

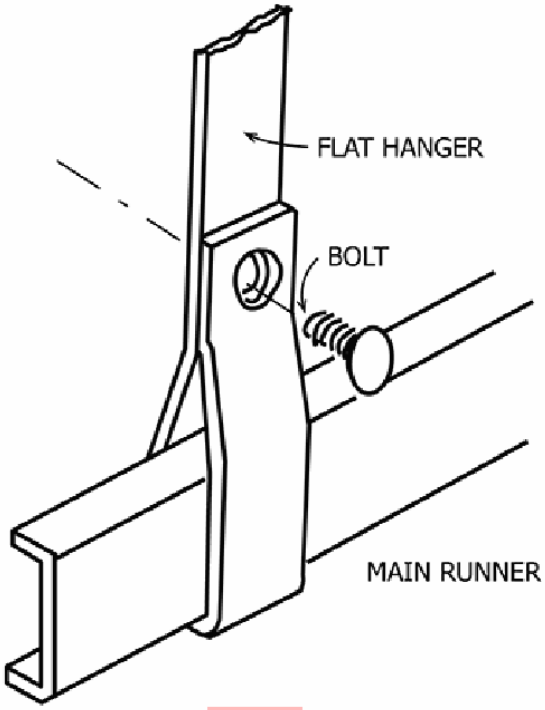
10 Where uplift resistance is required~~pertaining to a mandatory obligation imposed by a force outside this standard, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C840pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C926~~ for suspended ceilings to resist negative forces, the architect or engineer of record shall select the method to be used.~~TABLE~~

7.2.2~~2~~ When~~Spans~~ 1~~and~~ by~~Spacing of Cold-Rolled Channel Cross-Furring MembersA, B, C Design Load, 12 psf (575 Pa) Allowable Span, Main Runners or Supports Ft-in. (mm) Member Depth Spacing, in. (mm) Simple Span Two or More SpansD, E~~ $^3/$~~4 (19) 13.5 (343) 2-9 (840) 3-5 (1040)~~$_{16}$~~(406)~~-in.~~2-7~~ (25~~(790)~~ by~~3-3~~ 4.8~~(990)~~ mm)~~19~~ flat~~(483)~~ inserts~~2-7 (740) 3-0 (910) 24 (610) 2-3 (690) 2-10 (860) 11/2 (38) 13.5 (343) 4-6 (1370) 5-8 (1730) 16 (406) 4-3 (1300) 5-5 (1650) 19 (483) 4-0 (1220) 5-1 (1550) 24 (610) 3-8 (1120) 4-9 (1450)(A) Spans based on upper flange of cross-furring laterally unbraced.(B) Maximum deflection limited to 1/360 th of span length unbraced.(C) Tabulated spans apply only to cross-furring with webs oriented vertically.(D) "Two or more" spans refers to two or more continuous, equal spans.(E) For the "two or more" span conditions, listed spans represent the center-to-center distance between adjacent framing members studs joist, runners (tracks), bridging~~ and~~bracing and related accessories.Subcommittee: C11.03 Standard: C1007. TABLE 3 Types and Weights of Metal Plaster Bases and Corresponding Maximum Permissible Spacing of Wall and Ceiling Framing Members or Furring Type of Metal Plaster Base Minimum Weight of Metal Plaster Base, lb/yd2 (kg/m2) Specific Installation Requirements and Maximum Permissible Spacing of Wall and Ceiling Framing Members or Furring, Center to Center, in. (mm) Walls Ceilings 24 (610) 16 (406) 24 (610) 16 (406) 12 (305) Expanded Sheet Metal 2.5 (1.4) Permitted only for self-furred lath on sheathed wall framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 or solid wall bases Permitted Not Permitted Not Permitted Permitted 3.4 (1.8) Permitted Flat Rib 2.75 (1.5) Not Permitted Permitted only for unsheathed wall framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 3/8 in. Rib 3.4 (1.8) Not Permitted Permitted 4.0 (2.1) Welded Wire 1.14 (0.618) Not Permitted Permitted Not Permitted 1.95 (1.058) Permitted Permitted Woven Wire 1.4 (0.76) Permitted only for wood wall framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007, wood furring preparing a wall or ceiling with framing or furring members to provide a level surface or airspace.Subcommittee: C11.03 Standard: C754spacer strips fastened to a wall, ceiling, or planar element that create an even surface for the application of metal plaster bases or gypsum lath.Subcommittee: C11.03 Standard: C841spacer elements added to a building structure to facilitate fastening of gypsum panel products.Subcommittee: C11.03 Standard: C1546 Permitted Permitted only for wood and concrete ceiling framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 Not Permitted Permitted only for steel ceiling framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 7.2.2 When strap~~ hangers are used, $^7/_{16}$-in.~~(11~~ (11.1 mm) diameter holes shall be provided on the center line at the~~upper~~ lower end of the~~strap~~ insert~~hanger~~ and~~to~~ upper~~permit~~ end~~the attachment~~ of the~~strap~~ hanger~~The~~ to~~edge~~ permit the~~paper-bound~~ attachment~~edge,~~ of~~or~~ the~~long~~ hanger~~edge,~~ to~~as manufactured.Subcommittee: C11.01 Standard: C473~~ the~~bound~~ insert. The edge~~as manufactured.Subcommittee: C11.01 Standard: C1177/C1177M, C1178/C1178M, C1396/C1396M~~ of the holes in both the~~strap~~ inserts and the hangers shall be not less than $^3/_8$ in.~~(10~~ (9.5 mm) from the ends.~~the end perpendicular to the paper-bound edge or long edge.Subcommittee: C11.01 Standard: C473.~~

7.2.3 In concrete,~~rod or strap~~ hangers shall be attached to inserts~~devices~~ embedded in~~concrete framing members to provide a loop or opening for attachment of hangers.Subcommittee: C11.03 Standard: C1063 embedded in~~ the concrete, or to other attachment devices designed for this purpose, and able to develop full strength of the hanger.

7.2.4~~Strap~~ Flat, steel hangers shall be bolted to 1 by $^3/_{16}$-in. (25 by 4.8 mm) inserts with~~machine~~ $^3/_8$-in. (9.5 mm) diameter round-head stove bolts. (See Fig. 3.)

FIG. 3 Flat~~(Strap)~~ Hanger Attached to~~Cold-rolled Channel Furring~~ Main Runner Using~~Machine~~ Round-head Stove Bolt



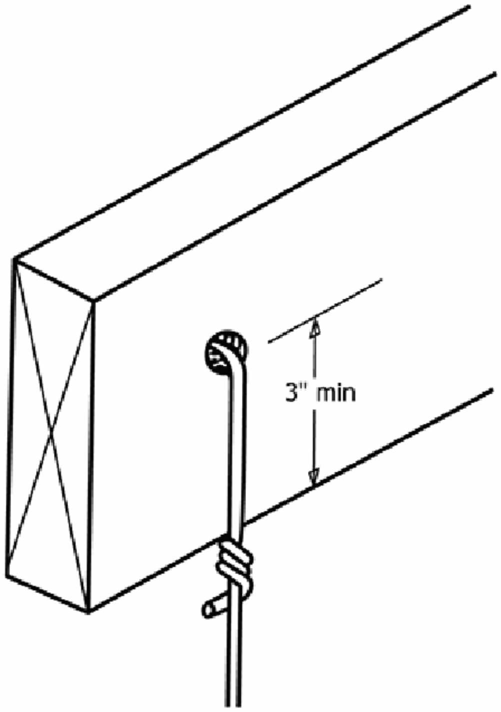
7.2.5 The nuts of the ~~machine~~ bolts shall be drawn up tight.

NOTE ~~2:~~ 4: Hangers required ~~pertaining~~ to ~~a mandatory obligation imposed by a force outside this standard, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C840pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C926 to~~ withstand upward wind pressures shall be of a type to resist compression. Struts of formed channels shall be permitted.

7.3 Installation of Hangers for Suspended Ceilings Under Wood ~~Constructions—Hangers~~ Constructions—Hangers shall be attached to ~~framing~~ supports ~~members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ by any of the following methods:

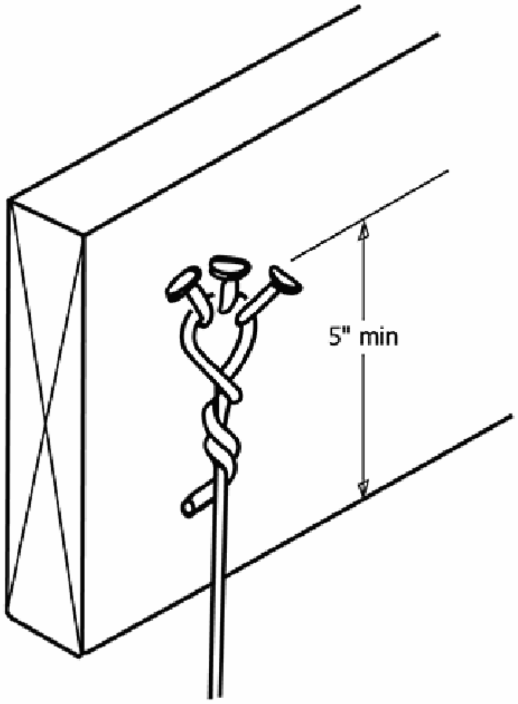
7.3.1 A hole shall be drilled through the wood ~~framing~~ member ~~studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be~~ not less than ~~112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than~~ 34 in. ~~(19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787 not less than 3 in.~~ (76 mm) above the bottom, with the upper end of the wire hanger passed through the hole and twisted three times around itself. (See Fig. 4.)

FIG. 4 Hanger Attached to ~~Framing~~ Support ~~Member~~ Through Drilled Hole



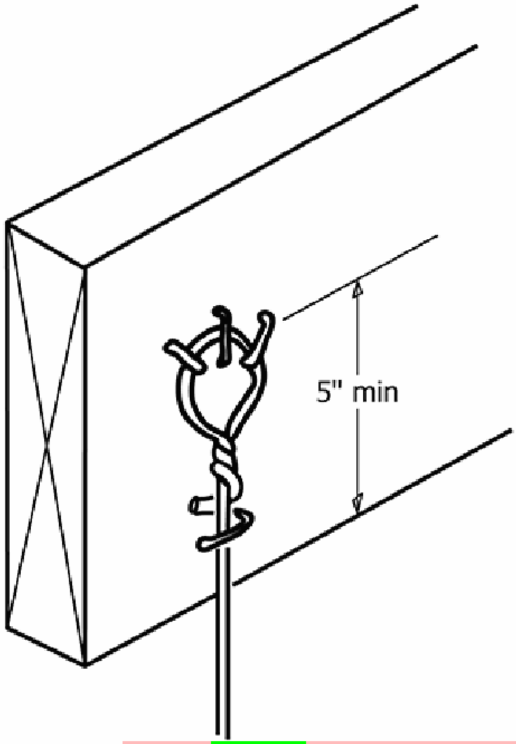
7.3.2 Three 12d nails shall be driven, on a downward slant, into the sides of the wood ~~framing~~ member ~~studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787~~ with not less than $1^1/_4$ in. ~~(32~~ (31.8 mm) penetration and not less than 5 in. (127 mm) from the bottom edges, and not more than 36 in. (914 mm) on the center with the upper end of the wire hanger wrapped around the nails and twisted three times around itself. (See Fig. 5.)

FIG. 5 Hanger Attached to ~~Framing~~ Support ~~Member~~ Using Nails



7.3.3 A loop shall be formed in the upper end of the wire hanger and secured to the wood ~~framing~~ member ~~studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787~~ by four $1^1/_2$-in. ~~(38~~ (38.1 mm), not less than 9 gauge, 0.1483-in. (3.77 mm) diameter wire staples driven horizontally or on a downward slant into the sides of the wood ~~framing~~ members, three near the upper end of the loop and the fourth to fasten the loose end. (See Fig. 6.)

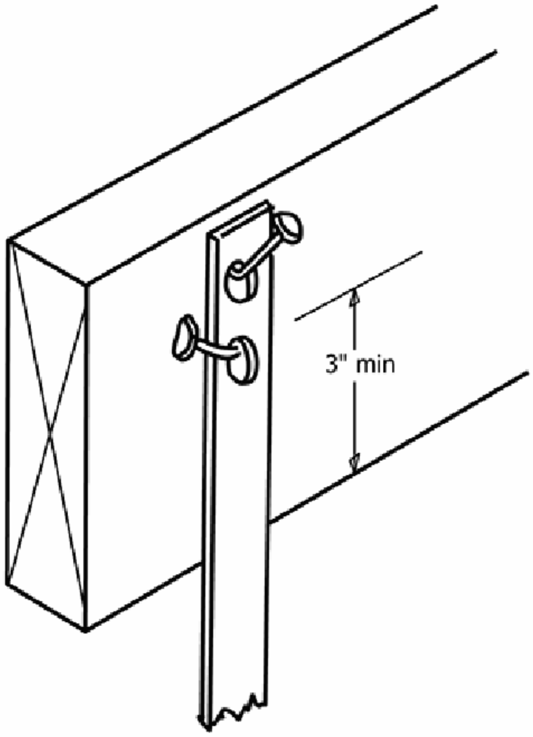
FIG. 6 Hanger Attached to ~~Framing~~ Support ~~Member~~ Using Staples



7.3.4 Where ~~framing~~ supports ~~members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ for flooring are thicker than $1\,{}^{1}/_{2}$ in. ~~(38~~ (38.1 mm) and are spaced more than 4 ft (1.2 m) on center, $1\,{}^{1}/_{2}$ in. (38.1 mm) No. 1/0 (0.3065 in.) (7.78 mm) eye screws (or equivalent), spaced not more than 3 ft ~~(914~~ (0.9 ~~mm)~~ m) on centers shall be screwed into the flooring ~~framing~~ supports ~~members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ with the upper end of the wire hanger inserted through the eye screws and twisted three times around itself.

7.3.5 Two holes shall be drilled in the upper end of the flat hangers and nailed to the sides of the wood ~~framing~~ members with 12d nails driven through the holes and clinched. Nails shall be not less than 3 in. (76 mm) above the bottom edge of the framing member. ~~studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787.~~ (See Fig. 7.)

FIG. 7 Flat ~~(Strap)~~ Hanger Attached to ~~Framing~~ Support ~~Member~~ Using Nails



7.4 Attachment of Hangers to ~~Cold-rolled Channel Furring~~ Main Runners:

7.4.1 Wire hangers shall be saddle-tied to ~~cold-rolled~~ the ~~channel furring main~~ runners. ~~the members that are attached to or suspended from the construction above for the support of cross furring.Subcommittee: C11.03 Standard: C841.~~ (See Fig. 1.)

7.4.2 Smooth or threaded rod hangers shall be fastened to ~~cold-rolled~~ the ~~channel furring main~~ runners ~~the members that are attached to or suspended from the construction above for the support of cross furring.Subcommittee: C11.03 Standard: C841~~ with special attachments appropriate to the design.

7.4.3 The lower ends of ~~strap~~ flat hangers shall be bolted to ~~cold-rolled~~ the ~~channel furring~~ main ~~runners~~ runners, ~~the members that are attached to~~ or ~~suspended from the construction above for the support of cross furring.Subcommittee: C11.03 Standard: C841, or~~ bent tightly around the ~~cold-rolled channel furring main~~ runners and carried up and above the ~~cold-rolled channel furring main~~ runners ~~the~~ and ~~members~~ bolted ~~that are attached~~ to ~~or suspended from~~ the ~~construction~~ main ~~above~~ part ~~for~~ of the ~~support~~ hanger. ~~of~~ Bolts ~~cross~~ shall ~~furring.~~ be~~Subcommittee:~~ ^{3}~~C11.03~~/~~Standard:~~$_{8}$~~C841~~-in. ~~and~~ (9.5 ~~bolted~~ mm) ~~to~~ diameter, ~~the~~ round-head ~~main~~ stove ~~part~~ bolts. ~~of the hanger.~~ (See Fig. 3.)

7.5 Installation of ~~Cold-rolled Channel Furring~~ Main Runners:

7.5.1 Minimum sizes and maximum spans and spacings of ~~cold-rolled channel furring~~ main runners for the various spans between hangers or other ~~framing~~ supports ~~members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ shall be in accordance with the requirements of Table ~~1~~ 2.

7.5.2 A clearance of not less than 1 in. (25 mm) shall be maintained between the ends of the ~~cold-rolled channel furring~~ main runners ~~the members that are attached to or suspended from the construction above for the support of cross furring.Subcommittee: C11.03 Standard: C841~~ and the abutting masonry or the concrete walls, partitions, and columns. Where special conditions require that ~~cold-rolled channel furring~~ main runners let into abutting masonry or concrete construction, within such constructions maintain a clearance of not less than 1 in. (25 mm) from the ends and not less than $^{1}/_{4}$ in. ~~(6~~ (6.4 mm) from the tops and sides of the ~~cold-rolled channel furring main~~ runners. ~~the members that are attached to or suspended from the construction above for the support of cross furring.Subcommittee: C11.03 Standard: C841.~~

7.5.3 A ~~cold-rolled channel furring~~ main runner shall be located within 6 in. (152 mm) of the paralleling walls to support the ends of the ~~cold-rolled channel~~ cross furring. ~~furring member attached perpendicular to main runners or framing members.Subcommittee: C11.03 Standard: C754furring members that are attached at right angles to the underside of the main~~

~~runners or construction above for support of the lath.Subcommittee: C11.03 Standard: C841.~~ The ends of ~~cold-rolled channel furring~~ main runners shall be supported by hangers located not more than 6 in. (152 mm) from the ends. ~~the end perpendicular to the paper-bound edge or long edge.Subcommittee: C11.01 Standard: C473.~~

7.5.4 Where ~~cold-rolled channel furring~~ main runners are spliced, the ends shall be overlapped not less than 12 in. (305 mm) with flanges of ~~cold-rolled~~ channels ~~channel furring main runners~~ interlocked and securely tied near each end of the splice, with double loops of 0.0625 in. (1.59 mm) or double loops of twin strands of 0.0475-in. (1.21 mm) galvanized wire. However, when the splice occurs at an expansion joint or control ~~joint~~ joint, ~~a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047;~~ the ~~cold-rolled~~ channel ~~furring preparing a wall or ceiling with framing or furring members to provide a level surface or airspace.Subcommittee: C11.03 Standard: C754spacer strips fastened to a wall, ceiling, or planar element that create an even surface for the application of metal plaster bases or gypsum lath.Subcommittee: C11.03 Standard: C841spacer elements added to a building structure to facilitate fastening of gypsum panel products.Subcommittee: C11.03 Standard: C1546~~ shall be nested and loosely tied to hold together but still allow movement.

7.5.5 Hanger wires shall hang straight down. If an obstacle prevents this, a trapeze type device shall be used to allow hanger wires to hang straight.

7.6 Installation of ~~Cold-rolled Channel~~ Cross Furring:

7.6.1 Minimum size and maximum spans and spacings of various types of ~~cold-rolled channel~~ cross furring for various spans between ~~cold-rolled channel furring~~ main runners and ~~framing~~ supports ~~members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ shall conform to the requirements of Table 2.

7.6.2 ~~Cold-rolled~~ Cross ~~channel cross~~ furring ~~furring member attached perpendicular to main runners or framing members.Subcommittee: C11.03 Standard: C754furring members that are attached at right angles to the underside of the main runners or construction above for support of the lath.Subcommittee: C11.03 Standard: C841~~ shall be saddle-tied to ~~cold-rolled channel furring~~ main runners with 0.0625-in. 16 gauge (1.59 mm) galvanized wire, or a double strand of 0.0475-in. 18 gauge (1.21 mm) galvanized wire or with special galvanized clips, or equivalent attachments. (See Fig. 2.)

7.6.3 Where ~~cold-rolled channel~~ cross furring ~~furring member attached perpendicular to main runners or framing members~~~~Subcommittee: C11.03 Standard: C754furring members that~~ are ~~attached at right angles to the underside of the main runners or construction above for support of the lath.Subcommittee: C11.03 Standard: C841 members are~~ spliced, the ends shall be overlapped not less than 8 in. (203 mm), with flanges of ~~cold-rolled~~ channels ~~channel cross furring furring member attached perpendicular to main runners or framing members.Subcommittee: C11.03 Standard: C754furring members that are attached at right angles to the underside of the main runners or construction above for support of the lath.Subcommittee: C11.03 Standard: C841~~ interlocked, and securely tied near each end of the splice with double loops of 0.0625-in. (1.59 mm) 16 gauge galvanized wire or twin strands of 0.0475-in. 18 gauge (1.21 mm) galvanized wire.

7.6.4 ~~Cold-rolled~~ Cross ~~channel cross~~ furring ~~furring member attached perpendicular to main runners or framing members.Subcommittee: C11.03 Standard: C754furring members that are attached at right angles to the underside of the main runners or construction above for support of the lath.Subcommittee: C11.03 Standard: C841~~ shall not come into contact with abutting masonry or reinforced concrete walls or partitions, except, where special conditions require that ~~cold-rolled channel~~ cross furring be let into abutting masonry or concrete construction, the applicable provisions of 7.5.2 shall apply.

7.6.5 ~~Cold-rolled~~ Main ~~channel furring main~~ runners and ~~cold-rolled channel~~ cross ~~furring~~ runners shall be interrupted at expansion joints or control joints. However when the splice occurs at an expansion joint or control ~~joint~~ joint, ~~a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047;~~ the ~~cold-rolled~~ channel ~~furring preparing a wall or ceiling with framing or furring members to provide a level surface or airspace.Subcommittee: C11.03 Standard: C754spacer strips fastened to a wall, ceiling, or planar element that create an even surface for the application of metal plaster bases or gypsum lath.Subcommittee: C11.03 Standard: C841spacer elements added to a building structure to facilitate fastening of gypsum panel products.Subcommittee: C11.03 Standard: C1546~~ shall be nested and loosely tied to hold together but still allow movement.

7.7 Metal Furring for Walls:

7.7.1 Attachments for furring ~~accessories~~ shall ~~products~~ be ~~fabricated~~ concrete ~~for~~ nails ~~the~~ driven ~~purpose~~ securely ~~of~~ into ~~forming~~ concrete ~~corners, edges, control joints,~~ or ~~decorative~~ into ~~effects.~~ masonry~~Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control~~ joints, ~~such~~ short ~~as~~ pieces ~~casing~~ of ~~beads,~~ 3~~bull~~/~~noses,~~4~~and~~-in. ~~stops.~~ (19.1~~Subcommittee:~~ mm) ~~C11.02~~ channels ~~Standard: C1047preformed metal, fiberglass or plastic members~~ used ~~to~~ as ~~form~~ anchors ~~corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516 shall be concrete nails~~ driven ~~securely~~ into ~~concrete or into~~ masonry joints, ~~power-actuated fasteners,~~ or other devices specifically designed as spacer elements, spaced horizontally not more than 2 ft ~~(610~~ (0.6 ~~mm)~~ m) on centers. They shall be spaced vertically in accordance with horizontal stiffener spacing so that they project from the face ~~the surface designed to be left exposed to view or to receive decoration or additional finishes.Subcommittee: C11.91 Standard: C11the coated surface.Subcommittee: C11.01 Standard: C1178/C1178M~~ of the wall in order for ties to be made.

7.7.2 Horizontal stiffeners shall be not less than $^3/_4$ in. ~~(19~~ (19.5 mm) cold-rolled ~~channel~~ channels, ~~furring,~~ spaced not to exceed 54 in. (1372 mm) on centers vertically, with the lower and upper ~~cold-rolled~~ channels ~~channel furring~~ not more than 6 in. (152 mm) from the ends of vertical ~~framing~~ members ~~studs joist, runners (tracks), bridging~~ and ~~bracing and related accessories.Subcommittee: C11.03 Standard: C1007 and~~ not less than $^1/_4$ in. ~~(6~~ (6.4 mm) clear from the wall face, securely tied to attachments with three loops of galvanized, soft-annealed wire, or equivalent devices. Approved furring ~~preparing a wall or ceiling with framing or furring members to provide a level surface or airspace.Subcommittee: C11.03 Standard: C754spacer strips fastened to a wall, ceiling, or planar element that create an even surface for the application of metal plaster bases or gypsum lath.Subcommittee: C11.03 Standard: C841spacer elements added to a building structure to facilitate fastening of gypsum panel products.Subcommittee: C11.03 Standard: C1546~~ is not prohibited from use in this application.

7.7.3 Vertical ~~framing~~ members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ shall be not less than $^3/_4$ in. ~~(19~~ (19.5 mm) cold-rolled ~~channel~~ channels ~~furring~~ in accordance with the requirements of Table 3. Vertical ~~framing~~ members shall be saddle-tied to horizontal stiffeners with three loops of 0.0475-in. (1.21 mm) galvanized soft-annealed wire, or equivalent devices, at each crossing, and securely anchored to the floor and ceiling constructions. Where ~~cold-rolled~~ furring ~~channel~~ is ~~furring~~ not ~~preparing~~ in ~~a~~ contact ~~wall~~ with ~~or~~ the ~~ceiling~~ wall, ~~with~~ channel ~~framing~~ braces ~~or~~ shall ~~furring~~ be ~~members~~ installed ~~to~~ between ~~provide~~ horizontal ~~a~~ stiffeners ~~level~~ and ~~surface~~ the ~~or~~ wall, ~~airspace.~~ spaced~~Subcommittee:~~ horizontally ~~C11.03~~ not ~~Standard:~~ more ~~C754~~ than~~spacer~~ 2 ~~strips~~ ft ~~fastened~~ (600 ~~to~~ mm) ~~a~~ on ~~wall,~~ centers. ~~ceiling,~~

TABLE ~~or~~ 3 ~~planar~~ Types ~~element~~ and ~~that~~ Weights ~~create~~ of ~~an~~ Metal ~~even~~ Plaster ~~surface~~ Bases ~~for~~ and ~~the~~ Corresponding ~~application~~ Maximum Permissible Spacing of ~~metal~~ Supports ~~plaster~~

Type ~~bases~~ of ~~or~~ Metal ~~gypsum~~ Plaster ~~lath.~~ Base~~Subcommittee:~~	Minimum ~~C11.03~~ Weight ~~Standard:~~ of ~~C841~~ Metal ~~spacer~~ Plaster ~~elements~~ Base ~~added~~ lb/yd² ~~to~~ ~~a~~ (kg/m² ~~building~~ ~~structure~~) ~~to~~	Maximum ~~facilitate~~ Permissible ~~fastening~~ Spacing of ~~gypsum~~ Supports ~~panel~~ Center ~~products.~~ to~~Subcommittee:~~ Center ~~C11.03~~ in. ~~Standard:~~ (mm) ~~C1546~~				
		Walls ~~is~~ (Partitions) ~~not~~			Ceilings ~~in~~	
		Wood ~~contact~~ Studs ~~with~~ or ~~the~~ Furring ~~wall,~~	Solid ~~cold-rolled~~ Partitions ~~channel~~ ~~furring~~ A	Steel ~~preparing~~ Studs ~~a~~ or ~~wall~~ Furring	Wood or ~~ceiling~~ Concrete ~~with~~	Metal ~~framing~~
U.S. ~~or~~ Nominal ~~furring~~ Weights: ~~members~~						
Diamond ~~to~~ Mesh ~~provide~~ B ~~a~~	2.5 ~~level~~ (1.4) ~~surface~~	16 ~~or~~ (406) ~~airspace.~~ C~~Subcommittee:~~	16 ~~C11.03~~ (406) ~~Standard:~~	16 ~~C754~~ (406) ~~spacer strips~~ C	12 ~~fastened~~ (305) ~~to~~	12 ~~a~~ (305) ~~wall,~~
	3.4 ~~ceiling,~~ (1.8) ~~or~~	16 ~~planar~~ (406) ~~element that~~ C	16 ~~create~~ (406) ~~an~~	16 ~~even~~ (406) ~~surface~~ C ~~for~~	16 ~~the~~ (406) ~~application~~	16 ~~of~~ (406) ~~metal~~
Flat ~~plaster~~ Rib ~~bases~~	2.75 ~~or~~ (1.5) ~~gypsum~~	16 ~~lath.~~ (406)~~Subcommittee:~~	16 ~~C11.03~~ (406) ~~Standard:~~	16 ~~C841~~ (406) ~~spacer~~	16 ~~elements~~ (406) ~~added~~	16 ~~to~~ (406) ~~a~~
	3.4 ~~building~~ (1.8) ~~structure~~	19 ~~to~~ (482) ~~facilitate~~	24 ~~fastening~~ (610) ~~of~~	19 ~~gypsum~~ (482) ~~panel~~	19 ~~products.~~ (482)~~Subcommittee:~~	19 ~~C11.03~~ (482) ~~Standard:~~

		of				
					or	
Flat ~~C1546~~ Rib ~~braces~~ (large ~~shall~~ opening) ~~be~~	1.8 ~~installed~~ (0.95) ~~between~~	24 ~~horizontal~~ (610) ~~stiffeners~~	24 ~~and~~ (610) ~~the~~	24 ~~wall,~~ (610) ~~spaced~~	16 ~~horizontally~~ (406) ~~not~~	16 ~~more~~ (406) ~~than~~
3 ~~2~~/~~ft~~8 ~~(610~~ in. ~~mm)~~ Rib ~~on~~	3.4 ~~centers.~~ (1.8) ~~7.7.4~~	24 ~~Where~~ (610) ~~the~~	N/A ~~water~~ D ~~resistive~~	24 ~~barrier~~ (610) ~~a~~	24 ~~material~~ (610) ~~that~~	24 ~~resists~~ (610) ~~the~~
	4.0 ~~infiltration~~ (2.1) ~~of~~	24 ~~liquid~~ (610) ~~moisture~~	N/A ~~through~~	24 ~~the~~ (610) ~~building~~	24 ~~enclosure~~ (610) ~~system.~~	24 ~~Subcommittee:~~ (610) ~~C11.03~~
3 ~~Standard:~~/~~C1063~~4 ~~has~~ in. ~~been~~ Rib ~~damaged~~	5.4 ~~during~~ (2.9) ~~installation~~	24 ~~of~~ (610) ~~attachments,~~	N/A ~~the~~	24 ~~water~~ (610) ~~resistive~~	36 ~~barrier~~ (914) ~~shall~~	36 ~~be~~ (914) ~~repaired~~
Welded ~~with~~ Wire B ~~the~~ ~~same~~	1.14 ~~or~~ (0.62) ~~an~~	16 ~~alternative~~ (406) ~~material,~~	16 ~~compatible~~ (406) ~~with~~	16 ~~the~~ (406) ~~water~~	16 ~~resistive~~ (406) ~~barrier~~	16 ~~a~~ (406) ~~material~~
	1.95 ~~that~~ (1.1) ~~resists~~	24 ~~the~~ (610) ~~infiltration~~	24 ~~of~~ (610) ~~liquid~~	24 ~~moisture~~ (610) ~~through~~	24 ~~the~~ (610) ~~building~~	24 ~~enclosure~~ (610) ~~system.~~
Woven ~~Subcommittee:~~ Wire ~~C11.03~~ B ~~Standard:~~	1.4 ~~C1063~~ (0.6) ~~;~~	24 ~~before~~ (610) ~~proceeding~~	16 ~~with~~ (406) ~~the~~	16 ~~installation~~ (406) ~~of~~	24 ~~the~~ (610) ~~furring~~	16 ~~preparing~~ (406) ~~a~~
Canadian ~~wall~~ Nominal ~~or~~ Weights: ~~ceiling~~						
Diamond ~~with~~ Mesh B ~~framing~~ ~~or~~	2.5 ~~furring~~ (1.4) ~~members~~	16 ~~to~~ (406) ~~provide~~	12 ~~a~~ (305) ~~level~~	12 ~~surface~~ (305) ~~or~~	12 ~~airspace.~~ (305) ~~Subcommittee:~~	12 ~~C11.03~~ (305) ~~Standard:~~
	3.0 ~~C754~~ (1.6) ~~spacer~~	16 ~~strips~~ (406) ~~fastened~~	12 ~~to~~ (305) ~~a~~	12 ~~wall,~~ (305) ~~ceiling,~~	12 ~~or~~ (305) ~~planar~~	12 ~~element~~ (305) ~~that~~
	3.4 ~~create~~ (1.8) ~~an~~	16 ~~even~~ (406) ~~surface~~	16 ~~for~~ (406) ~~the~~	16 ~~application~~ (406) ~~of~~	16 ~~metal~~ (406) ~~plaster~~	16 ~~bases~~ (406) ~~or~~
Flat ~~gypsum~~ Rib ~~lath.~~	2.5 ~~Subcommittee:~~ (1.4) ~~C11.03~~	16 ~~Standard:~~ (406) ~~C841~~	12 ~~spacer~~ (305) ~~elements~~	12 ~~added~~ (305) ~~to~~	12 ~~a~~ (305) ~~building~~	12 ~~structure~~ (305) ~~to~~
	3.0 ~~facilitate~~ (1.6) ~~fastening~~	16 ~~of~~ (406) ~~gypsum~~	16 ~~panel~~ (406) ~~products.~~	16 ~~Subcommittee:~~ (406) ~~C11.03~~	16 ~~Standard:~~ (406) ~~C1546~~	13 1 ~~7.8~~/~~Z-furring~~ 2 ~~used~~ (343) ~~to~~
3 ~~support~~/~~lathing~~8 ~~and~~ in. ~~lathing~~ Rib ~~accessories~~	3.0 ~~and~~ (1.6) ~~its~~	19 ~~fasteners~~ (482) ~~for~~	N/A ~~fastening~~	16 ~~to~~ (406) ~~framing~~	16 ~~members~~ (406) ~~studs~~	16 ~~joist,~~ (406) ~~runners~~
	3.5 ~~(tracks),~~ (1.9) ~~bridging~~	24 ~~and~~ (610) ~~bracing~~	N/A ~~and~~	19 ~~related~~ (482) ~~accessories.~~	19 ~~Subcommittee:~~ (482) ~~C11.03~~	19 ~~Standard:~~ (482) ~~C1007~~
	4.0 ~~or~~ (2.1) ~~solid~~	24 ~~bases,~~ (610)	N/A	24 (610)	24 (610)	24 (610)

(A) Where plywood is used for sheathing, ~~a customized~~ minimum ~~furring~~ of ~~preparing~~ 1 ~~a~~/~~wall~~8 ~~or~~ in. ~~ceiling~~ (3.2 ~~with~~ mm) ~~framing~~ separation ~~or~~ shall ~~furring~~ be ~~members~~ provided ~~to~~ between ~~provide~~ adjoining ~~a~~ sheets ~~level~~ to ~~surface~~ allow ~~or~~ for ~~airspace.~~ expansion ~~Subcommittee:~~

(B) ~~C11.03~~ Metal ~~Standard:~~ plaster ~~C754~~ bases ~~spacer~~ shall ~~strips~~ be ~~fastened~~ furred ~~to~~ away ~~a~~ from ~~wall,~~ vertical ~~ceiling,~~ supports or ~~planar~~ solid ~~element~~ surfaces ~~that~~ at ~~create~~ least ~~an~~ 1 ~~even~~/~~surface~~4 ~~for~~ in. ~~the~~ Self-furring ~~application~~ lath ~~of~~ meets ~~metal~~ furring ~~plaster~~ requirements; ~~bases~~ except ~~or~~ furring

~~gypsum~~ of ~~lath.~~ expanded~~Subcommittee:~~ metal ~~C11.03~~ lath ~~Standard:~~ is ~~C841~~ not~~spacer~~ required ~~elements~~ on ~~added~~ supports ~~to~~ having a ~~building~~ bearing ~~structure~~ surface ~~to~~ of ~~facilitate~~ 1 ~~fastening~~ 5 ~~of~~ / ~~gypsum~~ 8 ~~pane~~ in. ~~products.~~ or~~Subcommittee:~~ less. ~~C11.03~~

(C) ~~Standard:~~ These ~~C1546~~ spacings ~~system~~ are ~~which~~ based ~~shall~~ on ~~be~~ unsheathed ~~engineered.~~ walls. ~~7.9~~ Where ~~Lapping~~ self-furring ~~of~~ lath ~~Metal~~ is ~~Plaster~~ placed ~~Bases:~~ over ~~7.9.1~~ sheathing ~~Side~~ or ~~laps~~ a ~~of~~ solid ~~metal~~ surface, ~~plaster~~ the ~~bases~~ permissible ~~expanded~~ spacing ~~metal~~ of ~~lath,~~ supports ~~sheet~~ shall ~~metal~~ be ~~lath,~~ no ~~welded~~ more ~~or~~ than ~~woven~~ 24 ~~wire~~ in. ~~lath.~~ (610~~Subcommittee:~~ mm). ~~C11.03~~

(D) ~~Standard:~~ Not ~~C841~~ applicable. ~~shall~~

7.7.4 ~~be~~ Where ~~secured~~ the ~~to~~ water ~~framing~~ resistive ~~members.~~ barrier ~~They~~ has ~~shall~~ been ~~be~~ damaged ~~tied~~ during ~~between~~ installation ~~framing~~ of ~~members~~ attachments, ~~studs~~ the ~~joist,~~ water ~~runners~~ resistive ~~(tracks),~~ barrier ~~bridging~~ shall ~~and~~ be ~~bracing~~ repaired ~~and~~ with ~~related~~ the ~~accessories.~~ same~~Subcommittee:~~ or ~~C11.03~~ an ~~Standard:~~ alternative ~~C1007~~ material, compatible with ~~0.0475-in.~~ the ~~(1.21~~ water ~~mm)~~ resistive ~~wire~~ barrier, ~~at~~ before ~~intervals~~ proceeding ~~not~~ with ~~more~~ the ~~than~~ installation ~~9~~ of ~~in.~~ the ~~(229~~ furring. ~~mm).~~

TABLE ~~7.9.2~~ 4 ~~Side~~ Spans ~~laps~~ and Spacing of ~~expanded~~ Cold-Rolled ~~metal~~ Channel ~~lath~~ Cross-Furring ~~shall~~ Members ~~be~~ A ~~lapped,~~ ~~2~~ B ~~in.,~~ ~~(50~~ C ~~mm),~~ ~~nominal~~ D ~~and,~~ ~~not~~ E ~~less,~~ ~~than~~ F ~~1~~

Design ~~/~~ Load, ~~2~~ 12 ~~in.~~ psf ~~(13~~ (575 ~~mm).~~ Pa) ~~Side~~		Allowable ~~laps~~ Span, ~~of~~ Main ~~rib~~ Runners ~~lath~~ or ~~shall~~ Supports ~~be~~ Ft-in. ~~lapped~~ (mm) ~~2~~	
Member Depth	Spacing, in. ~~(50~~ (mm) ~~mm)~~	Simple ~~nominal~~ Span ~~and~~	Two ~~not~~ or ~~less~~ More ~~than~~ Spans ~~1 in.~~ G ~~/~~ ~~2~~ H
3 ~~(13~~ / ~~mm),~~ 4 ~~or~~ (19) ~~nest~~	13.5 ~~the~~ (343) ~~edge~~	2-9 ~~ribs.~~ (840) ~~End~~	3-5 ~~laps~~ (1040) ~~of~~
	16 ~~expanded~~ (406) ~~metal~~	2-7 ~~lath~~ (790) ~~and~~	3-3 ~~rib~~ (990) ~~metal~~
	19 ~~lath~~ (483) ~~2~~	2-7 ~~in.~~ (740) ~~(50~~	3-0 ~~mm)~~ (910) ~~nominal~~
	24 ~~and~~ (610) ~~not~~	2-3 ~~less~~ (690) ~~than~~	2-10 (860)
1 ~~in.~~ 1 ~~(25~~ / ~~mm),~~ 2 ~~Wire~~ (38) ~~lath~~	13.5 ~~shall~~ (343) ~~be~~	4-6 ~~lapped~~ (1370) ~~minimum~~	5-8 ~~one~~ (1730) ~~mesh~~
	16 ~~at~~ (406) ~~the~~	4-3 ~~sides~~ (1300) ~~and~~	5-5 ~~ends.~~ (1650) ~~Where~~
	19 ~~end~~ (483) ~~laps~~	4-0 ~~occur~~ (1220) ~~between~~	5-1 ~~the~~ (1550) ~~framing~~
	24 ~~members,~~ (610) ~~the~~	3-8 ~~ends~~ (1120) ~~of~~	4-9 ~~the~~ (1450) ~~sheets~~

(A) ~~of~~ Bare ~~all~~ metal ~~plaster~~ thickness ~~bases~~ of ~~expanded~~ cold-rolled ~~metal~~ members ~~lath,~~ shall ~~sheet~~ not ~~metal~~ be ~~lath,~~ less ~~welded~~ than ~~or~~ 0.0538 ~~woven~~ in. ~~wire~~ (1.367 ~~lath.~~ mm). ~~Subcommittee:~~

(B) ~~C11.03~~ Inside ~~Standard:~~ corner ~~C841~~ radii shall not be ~~laced~~ greater ~~or~~ than ~~wire~~ 1 ~~tied~~ / ~~with~~ 8 ~~0.0475-in.~~ in. ~~(1.21~~ (3.17 mm). ~~wire.~~

(C) ~~7.9.3~~ Spans ~~Where~~ based ~~metal~~ on ~~plaster~~ upper ~~base~~ flange ~~with~~ of ~~an~~ cross-furring ~~attached~~ laterally ~~water~~ unbraced. ~~resistive~~

(D) ~~barrier~~ Maximum ~~a~~ deflection ~~material~~ limited ~~that~~ to ~~resists~~ 1 ~~the~~ / ~~infiltration~~ 360 th of ~~liquid~~ span ~~moisture~~ length ~~through~~ unbraced. ~~the~~

(E) ~~building~~ Steel ~~enclosure~~ yield ~~system.~~ stress, ~~Subcommittee:~~ *Fy*, ~~C11.03~~ shall ~~Standard:~~ not ~~C1063~~ be ~~is~~ less ~~installed,~~ than ~~the~~ 33 ~~vertical~~ 000 ~~and~~ psi ~~horizontal~~ (228 ~~lap~~ MPa). ~~joints~~

(F) ~~shall~~ Tabulated ~~be~~ spans ~~water~~ apply ~~resistive~~ only ~~barrier~~ to ~~on~~ cross-furring ~~water~~ with ~~resistive~~ webs ~~barrier~~ oriented ~~a~~ vertically. ~~material~~

(G) ~~that~~ "Two ~~resists~~ or ~~the~~ more" ~~infiltration~~ spans ~~of~~ refers ~~liquid~~ to ~~moisture~~ two ~~through~~ or ~~the~~ more ~~building~~ continuous, ~~enclosure~~ equal ~~system.~~ spans. ~~Subcommittee:~~

(H) ~~C11.03~~ For ~~Standard:~~ the ~~C1063~~ "two ~~and~~ or ~~metal~~ more" ~~plaster~~ span ~~base~~ conditions, ~~expanded~~ listed ~~metal~~ spans ~~lath,~~ represent ~~or~~ the ~~welded~~ center-to-center ~~or~~ distance ~~woven~~ between ~~wire~~ adjacent ~~lath.~~ supports. ~~Subcommittee:~~

7.8 ~~C11.03~~ Lapping ~~Standard:~~ of ~~C926~~ Metal ~~on~~ Plaster ~~metal~~ Bases: ~~plaster~~

7.8.1 ~~base~~ Side ~~expanded~~ laps of metal ~~lath,~~ plaster ~~or~~ bases ~~welded~~ shall ~~or~~ be ~~woven~~ secured ~~wire~~ to ~~lath.~~ framing~~Subcommittee:~~ members. ~~C11.03~~ They ~~Standard:~~ shall ~~C926~~ be. tied ~~7.9.3.1~~ between ~~Where~~ supports ~~metal~~ with ~~plaster~~ 0.0475-in. ~~base~~ (1.21 ~~with~~ mm) ~~an~~ wire ~~attached~~ at ~~water~~ intervals ~~resistive~~ not ~~barrier~~ more ~~a~~ than ~~material~~ 9 ~~that~~ in. ~~resists~~ (229 ~~the~~ mm). ~~infiltration~~

7.8.2 ~~of~~ Metal ~~liquid~~ lath ~~moisture~~ shall ~~through~~ be ~~the~~ lapped ~~building~~ 1 ~~enclosure~~ / ~~system.~~ 2 ~~Subcommittee:~~ in. ~~C11.03~~ minimum ~~Standard:~~ (12.7 ~~C1063~~ mm) ~~is~~ at ~~installed,~~ the sides, or nest the ~~water~~ edge ~~resistive~~ ribs. ~~barrier~~ Wire lath shall be lapped ~~not~~ minimum ~~less~~ one ~~than~~ mesh ~~2~~ at ~~in.~~ the ~~(51~~ sides ~~mm).~~ and ~~shall~~ the ~~be~~ ends. ~~lapped~~ Lap ~~not~~ metal ~~less~~ lath ~~than~~ minimum ~~2~~

1 in. ~~(51~~ (25 mm) ~~On~~ at ~~walls,~~ ends. ~~the~~ Where ~~water~~ end ~~resistive~~ laps ~~barrier~~ occur ~~a~~ between ~~material~~ the ~~that~~ framing ~~resists~~ members, the ~~infiltration~~ ends of ~~liquid~~ the ~~moisture~~ sheets ~~through~~ of ~~the~~ all ~~building~~ metal ~~enclosure~~ plaster ~~system.~~ ~~basesSubcommittee:~~ shall ~~C11.03~~ be ~~Standard:~~ laced ~~C1063~~ or ~~shall~~ wire ~~be~~ tied ~~lapped~~ with ~~so~~ 0.0475-in. ~~water~~ (1.21 ~~will~~ mm) ~~flow~~ galvanized, ~~to~~ annealed steel wire.

7.8.3 Where metal plaster base with backing is used, the ~~exterior.~~ vertical ~~Except~~ and ~~for~~ horizontal ~~weep~~ lap ~~screeds,~~ joints ~~designated~~ shall ~~drainage~~ be ~~screeds,~~ backing on backing and ~~drainage~~ metal ~~flashings,~~ on ~~the~~ metal. ~~water~~

7.8.3.1 ~~resistive~~ Backing ~~barrier~~ shall ~~a~~ be ~~material~~ lapped ~~that~~ not ~~resists~~ less than 2 in. (50 mm). On walls, the ~~infiltration~~ backing ~~of~~ shall ~~liquid~~ be ~~moisture~~ lapped ~~through~~ so water will flow to the ~~building~~ exterior. ~~enclosure~~ Except ~~system.~~ for ~~Subcommittee:~~ weep ~~C11.03~~ screeds ~~Standard:~~ (as ~~C1063~~ described in 7.11.5), backing shall not be placed between ~~metal~~ plaster base (lath) and ~~lath~~ flanges ~~accessory~~ of ~~attachment~~ accessories. ~~flanges.~~ Metal ~~plaster~~ lath ~~base~~ to ~~lath accessory key attachment~~ flange contact shall be required to ensure that ~~the~~ flanges ~~metal~~ are ~~plaster~~ mechanically ~~base~~ locked ~~expanded~~ together. ~~metal~~

7.9 ~~lath,~~ **Spacing** ~~or~~ **of** ~~welded~~ **Attachments** ~~or~~ **for** ~~woven~~ **Metal** ~~wire~~ **Plaster** ~~lath.~~ **Bases—Attachments** ~~Subcommittee:~~ for ~~C11.03~~ securing ~~Standard:~~ metal ~~C926~~ plaster ~~and~~ bases ~~lath~~ to ~~accessory~~ framing ~~key~~ members ~~the~~ shall ~~grip~~ be ~~or~~ spaced ~~mechanical~~ not ~~bond~~ more ~~of~~ than ~~one~~ 7 ~~coat~~ in. ~~of~~ (178 ~~plaster~~ mm) ~~to~~ apart ~~another~~ for ~~coat,~~ diamond ~~or~~ mesh ~~to~~ and ~~a~~ flat ~~substrate.~~ rib ~~Subcommittee:~~ laths ~~C11.91~~ and ~~Standard:~~ at ~~C11~~ each ~~attachment~~ rib ~~flanges~~ for ~~are~~ $^3/_8$ ~~mechanically locked together.~~ in. (9.5 mm) rib lath.

7.10 ~~Installation~~ **Application of Metal Plaster Bases:**

7.10.1 General:

7.10.1.1 Metal plaster bases shall be furred away from vertical ~~framing~~ supports ~~members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ or solid surfaces at least $^1/_4$ in. ~~(6 mm).~~ Self furring lath meets furring requirements; except, furring of expanded metal lath is not required on ~~framing~~ supports ~~members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ having a bearing surface of $1^5/_8$ in. ~~(41 mm)~~ or less.

7.10.1.2 The spacing of framing members for the type and weight of metal plaster base ~~expanded metal lath, or welded or woven wire lath.Subcommittee: C11.03 Standard: C926~~ shall conform to the requirements of Table 3. Metal plaster bases shall be attached to framing members at not more than 7 in. (178 mm) on center, along framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ except for $^3/_8$-in. ~~(10~~ (9.5 mm) rib metal lath that shall be attached at each rib. Attachment penetrations between the framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ shall be avoided.

7.10.1.3 Lath shall be ~~installed~~ applied with the long dimension at right angles to the ~~framing~~ supports, ~~members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007,~~ unless otherwise specified. ~~pertaining to a mandatory requirement of this standard or a referenced requirement (see 3.2.17).Subcommittee: C11.03 Standard: C840pertaining to a mandatory requirement of this specification or a referenced requirement.Subcommittee: C11.03 Standard: C1280.~~

7.10.1.4 Ends of adjoining plaster bases shall be staggered.

7.10.1.5 Lath shall not be continuous through control joints, but shall be stopped and tied at each side.

7.10.1.6 Where furred or suspended ceilings butt into or are penetrated by columns, walls, beams, or other elements, the edges and ends of the ceiling lath shall be terminated at the horizontal internal ~~corners~~ angles with a casing ~~bead~~ bead, ~~lathing accessory,~~ control ~~joint~~ joint, ~~a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed~~ or ~~required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessory, or~~ similar device designed to keep the edges and ends of the ceiling lath and plaster free of the adjoining vertically oriented, or penetrating elements. ~~Internal~~ Cornerite ~~corner reinforcement lathing accessories~~ shall not be used at these locations. A clearance of not less than $^3/_8$ in. ~~(10~~ (9.5 mm) shall be maintained between the ~~casing~~ bead ~~lathing accessory, control joint a joint that accommodates movement of plaster shrinkage~~ and ~~curing~~ all ~~along~~ such ~~predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessory, or similar device and penetrating~~ elements.

7.10.1.7 Where load bearing walls or partitions butt into structural walls, columns, or floor or roof slabs, the sides or ends of the wall or partition lath shall be terminated at the internal ~~corners~~ angles with a casing ~~bead~~ bead, ~~lathing accessory,~~ expansion joint ~~lathing~~ or ~~accessory,~~ control ~~joint~~ joint, ~~a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed~~ or ~~required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessory, or~~ similar device designed to keep the sides and ends of the wall or partition lath free of the adjoining elements. ~~Internal~~ Cornerite ~~corner reinforcement lathing accessories products fabricated for the purpose of forming corners, edges, control joints, or decorative effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints, such as casing beads, bull noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516~~ shall not be used at these internal ~~corners.~~ angles. A clearance of not less than $^3/_8$ in. ~~(10~~ (9.5 mm) shall be maintained from all abutting walls, columns, or other vertical elements.

7.10.2 Attachments for Metal Plaster Bases to Wood Framing Members:

7.10.2.1 Lath shall be attached to framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ with attachments spaced not more than 7 in. (178 mm) on center along framing members. Attachment penetrations between the framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ shall be avoided.

7.10.2.2 Diamond-mesh expanded metal lath, flat-rib expanded metal lath, and wire lath shall be attached to horizontal wood framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ with $1^1/_2$-in. ~~(38~~ (38.1 mm) roofing nails driven flush with the plaster base and attached to vertical wood framing members with 6d common nails, or 1-in. (25 mm) roofing nails driven to a penetration of not less than $^3/_4$ in. ~~(19~~ (19.1 mm), or 1-in. (25 mm) wire staples driven flush with the plaster base. Staples shall have crowns not less than $^3/_4$ in. (19.05 mm) and shall engage not less than three strands of diamond mesh and flat rib expanded metal lath or not less than two strands of wire lath and penetrate the wood framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ not less than $^3/_4$ in. ~~(19~~ (19.05 mm). When metal lath is ~~installed~~ applied over sheathing, use fasteners that will penetrate the ~~framing~~ structural members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ not less than $^3/_4$ in. (19 mm).

7.10.2.3 Expanded $^3/_8$ in. ~~(10~~ (9.5 mm) rib lath shall be attached to horizontal and vertical wood framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ with nails or staples to provide not less than $1^3/_4$-in. ~~(44~~ (44.5 mm) penetration into horizontal wood framing ~~members~~ members, ~~studs~~ and ~~joist,~~ ^{3} ~~runners~~ / ~~(tracks),~~ $_4$ ~~bridging~~ -in. ~~and~~ (19.1 ~~bracing~~ mm) ~~and~~ penetration ~~related~~ into ~~accessories.~~ vertical~~Subcommittee:~~ wood ~~C11.03~~ framing ~~Standard:~~ members. ~~C1007.~~

7.10.2.4 Common nails shall be bent over to engage not less than three strands of diamond mesh and flat rib expanded metal lath ~~see gypsum lath.Subcommittee: C11.91 Standard: C11~~ or not less than two strands of wire lath, or be bent over a rib when rib lath ~~see gypsum lath.Subcommittee: C11.91 Standard: C11~~ is installed.

7.10.2.5 Screws used to attach metal plaster base ~~expanded metal lath, or welded or woven wire lath.Subcommittee: C11.03 Standard: C926~~ to horizontal and vertical wood framing members shall penetrate not less than $^5/_8$ in. ~~(16~~ (15.9 mm) into the member when the lath ~~see gypsum lath.Subcommittee: C11.91 Standard: C11~~ is installed. For expanded metal ~~lath~~ lath, ~~see gypsum lath.Subcommittee: C11.91 Standard: C11,~~ the screw shall engage not less than three strands of lath. For wire laths, screws shall engage not less than two strands of diamond mesh and flat rib expanded metal lath ~~see gypsum lath.Subcommittee: C11.91 Standard: C11~~ or not less than two strands of wire lath. ~~see gypsum lath.Subcommittee: C11.91 Standard: C11.~~ When installing expanded metal rib lath, the screw shall pass through, but not deform, the rib. When installing wire rib ~~lath~~ lath, ~~see gypsum lath.Subcommittee: C11.91 Standard: C11,~~ the screw may deform the rib.

7.10.3 Attachments for Metal Plaster Bases to Metal Framing Members:

7.10.3.1 Except as described in 7.10.3.2, all metal plaster bases shall be securely attached to metal framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ with 0.0475-in. 18 gauge (1.21 mm) wire ties, clips, or by other means of attachment which afford carrying strength and resistance to corrosion equal to or superior to that of the wire.

7.10.3.2 Rib metal lath shall be attached to open-web steel joists by single ties of galvanized, annealed steel wire, not less than 0.0475 in. (1.21 mm), with the ends ~~the end perpendicular to the paper-bound edge or long edge.Subcommittee: C11.01 Standard: C473~~ of each tie twisted together $1^1/_2$ times.

7.10.3.3 Screws used to attach metal plaster base to metal framing members shall project not less than $^3/_8$ in. ~~(10~~ (9.5 mm) through the metal framing member ~~studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787~~ when the lath is installed and for expanded metal laths shall engage not less than three strands of lath. ~~see gypsum lath.Subcommittee: C11.91 Standard: C11.~~ For wire laths, screws shall engage not less than two strands of diamond mesh and flat rib expanded metal lath ~~see gypsum lath.Subcommittee: C11.91 Standard: C11~~ or not less than two strands of wire lath. When installing expanded metal rib ~~lath~~ lath, ~~see gypsum lath.Subcommittee: C11.91 Standard: C11,~~ the screw shall pass through, but not deform, the rib. When installing wire rib ~~lath~~ lath, ~~see gypsum lath.Subcommittee: C11.91 Standard: C11,~~ the screw may deform the rib.

*7.10.4 Attachments for Metal Plaster Bases to Concrete ~~Joists—Rib~~ Joists—*Rib metal lath shall be attached to concrete joists by loops of 0.0800-in. (2.03 mm) galvanized, annealed steel wire, with the ends ~~the end perpendicular to the paper-bound edge or long edge.Subcommittee: C11.01 Standard: C473~~ of each loop twisted together.

7.10.5 Metal plaster bases shall be attached to masonry or concrete with power or powder actuated fasteners, or a combination of power or powder actuated fasteners and hardened concrete stub nails. One power or powder actuated fastener shall be located at each corner and one at the mid point of the long dimension adjacent to the edge of the metal plaster base ~~expanded metal lath, or welded or woven wire lath.Subcommittee: C11.03 Standard: C926~~ sheet. The balance of the sheet shall be fastened with power or powder actuated fasteners, or hardened concrete stub nails. The fasteners shall be installed in rows not more than 16 in. (406 mm) on center and spaced vertically along each row not more 7 in. (178 mm) on center. ~~Power-actuated~~ All fasteners ~~and~~ shall ~~concrete~~ be ~~stub~~ corrosion ~~nails~~ resistant and shall be ~~be~~ not less than $^3/_4$ in. (19 mm) long, with heads not less than $^3/_8$ in. ~~(10~~ (9.5 mm) wide. ~~Where the head diameter of the power actuated fastener or concrete stub nail is smaller than 3/8-in. (10 mm), fastener nails, screws, or staples used for the application of the gypsum base or backing board.Subcommittee: C11.03 Standard: C844nails, staples, or screws used for application of the gypsum panel product.Subcommittee: C11.03 Standard: C1280a nail, screw, staple or power actuated fastener.Subcommittee: C11.02 Standard: C1861 shall use a 7/8-in. (22 mm) diameter minimum corrosion resistant metal washer, which shall be perforated when washer diameter exceeds 1 in. (25 mm).~~

7.11 ~~Installation~~ Application of ~~Lathing~~ Accessories:

*7.11.1 ~~Lathing~~ General—*All ~~Accessory~~ metal ~~General Requirements—The type, location, ground dimension, and orientation of lathing~~ accessories shall be ~~indicated~~ installed in ~~the contract documents a series of several individual items that generally include drawings and specifications. Either or both of these documents may exist for any particular project.Subcommittee: C11.03 Standard: C926. 7.11.2 Install lathing accessories products fabricated for the purpose of forming corners, edges, control joints, or decorative effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints,~~ such ~~as casing beads, bull noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516 before cement plaster application to facilitate lathing installation, cement plaster see gypsum plaster, gypsum neat plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926 application, and functionality of the completed stucco~~ a ~~portland~~ manner ~~cement-aggregate~~ than ~~plaster mix designed for use on exterior surfaces. See portland cement plaster.Subcommittee: C11.91 Standard: C11portland cement-based plaster used on exterior locations.Subcommittee: C11.03 Standard: C926 cladding assembly. 7.11.3 Lathing Accessory Attachment Requirements: 7.11.3.1 Attach lathing accessory attachment~~ flanges ~~to substrate to ensure proper alignment during application of cement plaster. Secure lathing accessory attachment flanges at 7 in. (178 mm) maximum intervals along framing members studs joist,~~

~~runners (tracks), bridging~~ and ~~bracing~~ clips ~~and~~ provided ~~related accessories.Subcommittee: C11.03 Standard: C1007. 7.11.3.2 Install lathing accessories products fabricated~~ for ~~the~~ their ~~purpose of forming corners, edges, control joints, or decorative effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints, such as casing beads, bull noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516 with key~~ attachment ~~flanges~~ are ~~to~~ completely ~~embed~~ embedded ~~the flanges~~ in ~~cement~~ the plaster. ~~see~~

7.11.1.1 ~~gypsum~~ Accessories ~~plaster,~~ shall ~~gypsum~~ be ~~neat~~ attached ~~plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926. 7.11.3.3 Alternatively for solid plaster base substrates, adhere lathing accessory key attachment flanges directly~~ to ~~solid~~ substrate ~~plaster bases with adhesive applied~~ in ~~nominal 1 in. (25 mm) dabs at intervals in accordance with 7.11.3.1 or in a semi-continuous bead between the solid plaster base and the solid portion of the key attachment flange the attachment flange element of a lathing accessory that is full of holes or is expanded sheet metal that provides a means for accurate alignment, facilitates complete embedment of the key attachment flange and adjacent lath by cement plaster, and is used to attach the lathing accessory.Subcommittee: C11.02 Standard: C1861. 7.11.4 Lathing Accessory Water Management Requirements: 7.11.4.1 Where a defined drainage space is provided over the water-resistive barrier under lath and cement plaster, the ground dimension of lathing accessories with solid attachment flanges installed behind the water resistive barrier a material that resists the infiltration of liquid moisture through the building enclosure system.Subcommittee: C11.03 Standard: C1063 and defined drainage space to facilitate drainage,~~ such ~~as weep screeds, designated drainage screeds, expansion joints and drainage flashings, shall accommodate the defined drainage space dimension and specified cement plaster see gypsum plaster, gypsum neat plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926 thickness. 7.11.4.2 Install the water-resistive barrier and lathing to entirely cover the vertical solid attachment flange the solid attachment flange element of~~ a ~~lathing~~ manner ~~or furring accessory that provides a means for accurate alignment, facilitates drainage where drainage is required by integration of the solid attachment flange with the water-resistive barrier, and which has no holes except for optional fastener holes used to fasten the lathing accessory.Subcommittee: C11.02 Standard: C1861 of lathing accessories with a drainage function and drainage flashings such~~ as ~~weep screeds, designated drai nage screeds, expansion joints, and drainage flashings. Terminate lathing within 1/2 in. (13 mm) nominal above the lathing accessory drainage surface the sloped or non-sloped, perforated or non-perforated surface element of a lathing accessory that facilitates a drainage function, by directing water from behind the stucco cladding~~ to ~~the~~ ensure ~~exterior~~ proper ~~of~~ alignment ~~the~~ during ~~stucco~~ application ~~cladding.Subcommittee: C11.02 Standard: C1861. 7.11.4.3 At intersections~~ of ~~lathing~~ plaster. ~~accessories~~ Flanges ~~products fabricated for the purpose~~ of ~~forming corners, edges, control joints, or decorative effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints, such as casing beads, bull noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516 exposed at the cement plaster cladding finished surface, install the vertical lathing accessory continuously through the intersection unless the horizontally intersecting lathing accessory performs an expansion or drainage function, or both. Where vertical lathing~~ accessories ~~terminate above a drainage screed synonymous with ground.Subcommittee: C11.02 Standard: C1861 lathing accessory or drainage flashing, the intersection~~ shall be ~~kept~~ secured ~~free of sealant or other materials that will impede drainage. 7.11.4.4 Lathing accessories products fabricated for the purpose of forming corners, edges, control joints, or decorative effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints, such as casing beads, bull noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516 installed over the water-resistive barrier shall not impede drainage. 7.11.5 Foundation Weep Screed—install a weep screed lathing accessory~~ at ~~the bottom of steel or wood framed exterior walls. Locate the bottom edge of the weep screed lathing accessory~~ not ~~less~~ more than ~~1~~ 7 in. ~~(25~~ (178 mm) ~~below~~ intervals ~~the~~ along ~~joint~~ supports. ~~formed~~

7.11.2 ~~by~~ *Corner* ~~*the*~~ *Beads*—Corner ~~foundation~~ beads ~~and~~ shall ~~framing.~~ be ~~Locate~~ installed ~~the weep screed lathing accessory ground the element of a lathing accessory that provides an edge, end, or termination for a cement plaster panel area, with a ground dimension~~ to ~~assist~~ protect ~~in~~ all ~~cement~~ external ~~plaster~~ corners ~~thickness control.Subcommittee: C11.02 Standard: C1861 a of 4 in. (102 mm) minimum above raw earth or 2 in. (51 mm) above paved surfaces. 7.11.6 Designated Drainage Screed—Install a designated drainage screed lathing accessory at locations indicated in the contract documents a series of several individual items that generally include drawings~~ and ~~specifications. Either or both of these documents may exist for any particular project.Subcommittee: C11.03 Standard: C926 and follow specified requirements in the contract documents a series of several individual items that generally include drawings and specifications. Either or both of these documents may exist for any particular project.Subcommittee: C11.03 Standard: C926. 7.11.7 Casing Bead—Install a casing bead lathing accessory or other suitable means, at locations~~ to ~~separate~~ establish ~~cement~~ grounds. ~~plaster~~

7.11.2.1 ~~see~~ External ~~gypsum plaster, gypsum neat plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926 from dissimilar materials, penetrating elements, load bearing members in screw application of gypsum board, studs, runners (track), hat furring channels, main beams, and cross furring members of grid suspension systems or other items manufactured in accordance with this specification.Subcommittee: C11.02 Standard: C645studs, runners, tracks, bracing, bridging, accessories, or other items manufactured in accordance with this specification.Subcommittee: C11.02 Standard: C955 and to avoid transfer of structural loads. 7.11.8 Internal~~ Corner ~~Reinforcement—Install~~ Reinforcement—External ~~an internal~~ corner reinforcement ~~lathing~~ shall ~~accessory~~ be ~~at internal cement plaster corner locations except where lathing is~~ installed ~~continuously~~ to ~~through~~ reinforce ~~the~~ all ~~internal~~ external ~~corner,~~ corners ~~or~~ where ~~an~~ corner ~~expansion~~ bead ~~joint~~ is ~~lathing~~ not ~~accessory or control joint a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product~~ used. ~~for~~ Where ~~designed~~ no ~~or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessory is installed at the internal corner location. 7.11.9 External Corner Reinforcement—Install an~~ external corner reinforcement ~~lathing~~ or ~~accessory at external cement plaster~~ corner ~~locations.~~ bead ~~Alternatively, where no external corner reinforcement lathing accessory~~ is ~~used~~ used, ~~on~~ lath ~~framed, and framed and sheathed construction, lathing~~ shall be furred ~~away~~ out ~~from the substrate~~ and ~~installed~~ carried ~~continuously~~ around ~~external~~ corners ~~for~~ not ~~a~~ less ~~minimum~~ than ~~distance of~~ one ~~framing member studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other~~ support ~~to~~ on ~~which~~ frame ~~a~~ construction. ~~gypsum~~

7.11.3 ~~panel~~ Casing ~~product,~~ Beads—Non-load-bearing ~~or~~ members ~~metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached~~ shall be ~~not~~ isolated ~~less~~ from ~~than~~ load-bearing ~~112 in. (38 mm) wide for wood~~ members, ~~not less than 114 in. (32 mm) wide for steel members,~~ and ~~not~~ all ~~less~~ penetrating ~~than~~ elements, ~~6~~ with ~~in.~~ casing ~~(152~~ beads ~~mm) wide for gypsum studs. For internal corners~~ or ~~angles,~~ other ~~the~~ suitable ~~bearing~~ means, ~~surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve~~ to ~~receive~~ avoid ~~the~~ transfer ~~gypsum~~ of ~~panel~~ structural ~~product.~~ loads, ~~Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing,~~ and ~~related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787 beyond the corner. 7.11.10 Expansion Joint—Install an expansion joint lathing accessory at an expansion joint location in the building, the substrate surface~~ to ~~which~~ separate ~~the~~ from ~~DEFS~~ dissimilar ~~is~~ materials. ~~applied.~~

7.11.4 ~~Subcommittee: C11.05 Standard: C1516, or its components. 7.11.11~~ Control ~~Joints—Install~~ Joints ~~control~~ (General)—Control ~~joint~~ joints ~~a~~ shall ~~joint~~ be ~~that~~ formed ~~accommodates~~ by ~~movement~~ using ~~of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063~~ a ~~formed~~ single ~~product~~ prefabricated ~~used~~ member, ~~for designed~~ or ~~required~~ fabricated ~~separations~~ by ~~between~~ installing ~~adjacent~~ casing ~~surfaces~~ beads ~~of~~ back ~~gypsum~~ to ~~boards~~ back ~~or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessories in conformance~~ with ~~7.10.1.5. 7.11.11.1 Form control joints by attaching~~ a ~~prefabricated~~ flexible ~~control~~ barrier ~~joint~~ membrane ~~a~~ behind ~~joint~~ the ~~that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessory, or alternatively by attaching a pair of~~ casing beads. ~~with~~ The ~~key attachment flanges, back to back, with a~~ separation spacing shall be not less than $^1/_8$ in. ~~(3~~ (3.2 mm) or as required ~~pertaining to a mandatory obligation imposed~~ by ~~a force outside this standard, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C840pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C926 by~~ the anticipated thermal exposure ~~range~~ range, and ~~a flexible barrier membrane behind the casing beads. Wall or partition height door frames~~ shall be ~~considered~~ in ~~as~~ conformance ~~control~~ with ~~joints.~~ 7.10.1.5 ~~7.11.11.2. Install~~

7.11.4.1 ~~control~~ Control ~~joint~~ Joints—Control ~~a~~ (expansion ~~joint that accommodates movement of plaster shrinkage~~ and ~~curing~~ contraction) ~~along~~ joints ~~predetermined,~~ shall ~~usually~~ be ~~straight,~~ installed ~~lines.~~ in ~~Subcommittee:~~ walls ~~C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessories at locations~~ to delineate ~~cement~~ areas ~~plaster~~ not ~~see~~ more ~~gypsum~~ than ~~plaster, gypsum neat plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious~~

mixture (see stucco).Subcommittee: C11.03 Standard: C926 panel areas of 144 ft^2 (13 (13.4 m^2) maximum and for to walls delineate and areas not more than 100 ft^2 (9 (9.30 m^2) maximum for all horizontal installations, applications, that is, ceilings, curves, or angle type structures. 7.11.11.3

7.11.4.2 Install The control distance joint between a control joint joints that shall accommodates not movement exceed of 18 plaster ft shrinkage (5.5 and m) curing in along either predetermined, direction usually or straight, lines.Subcommittee: C11.03 Standard: C1063 a formed length-to-width product ratio used for designed or required separations between adjacent surfaces of gypsum 2 boards[1] or / gypsum 2 veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessories at locations to delineate 1. cement A plaster control see joint gypsum shall plaster, be gypsum installed neat where plaster. the Subcommittee: ceiling C11.91 framing Standard: or C11 furring portland changes cement-based direction. cementitious

7.11.4.3 mixture An (see expansion stucco). joint Subcommittee: shall C11.03 be Standard: installed C926 where panel an areas expansion of joint 18 occurs ft in (5 the m) base maximum exterior dimension, wall. in

7.11.4.4 either Wall direction, or a partition maximum height length-to-width door ratio frames of shall 2 be 1 considered/ as 2 to 1. 7.11.11.4 Install a control joint joints. a

7.11.5 joint *Foundation* that *Weep* accommodates *Screed*—Foundation movement weep of screed plaster shall shrinkage be and installed curing at along the predetermined; bottom usually of straight, all lines. steel Subcommittee: or C11.03 wood Standard: framed C1063 exterior a walls formed to product receive used lath for and designed plaster. or Place required the separations bottom between edge adjacent surfaces of gypsum the boards foundation or weep gypsum screed veneer not base. less Subcommittee: than C11.02 1 Standard: in. C1047 (25 lathing mm) accessory below at locations where the ceiling joint framing formed or by furring the preparing foundation a and wall or ceiling with framing. or The furring nose members of to the provide screed a shall level be surface placed or not airspace. less Subcommittee: than C11.03 4 Standard: in. C754 (102 spacer mm) strips above fastened raw to earth a wall, ceiling, or planar 2 element in. that (51 create mm) an above even paved surface surfaces. for The the weather application resistive of barrier metal and plaster bases or gypsum lath Subcommittee: shall C11.03 entirely Standard: cover C841 the spacer vertical elements attachment added flange to and a terminate building at structure the to top facilitate edge fastening of gypsum the panel nose products. or Subcommittee: ground C11.03 flange. Standard: C1546 changes direction.

8 KEYWORDS

8.1 ceiling; expansion control joints; lath; plaster; screed; suspended ceiling; walls

ANNEX

(Mandatory Information)

A1 GENERAL INFORMATION

A1.1 All wood-based sheathing shall be installed with a minimum $^1/_8$-in. (3 (3.2 mm) minimum gap around all panel edges and between openings for doors and windows.

NOTE A1.1: This $^1/_8$-in. (3 (3.2 mm) gap is intended to accommodate expansion. Linear expansion that is not accommodated by an expansion gap can cause stress on the stucco a portland cement aggregate plaster mix designed for use on exterior surfaces. See portland cement plaster.Subcommittee: C11.91 Standard: C11portland cement-based plaster used on exterior locations.Subcommittee: C11.03 Standard: C926 membrane resulting in stucco cracks.

APPENDIX

A1.2 (Nonmandatory *Expansion Information) Joints* X1.1 shall The be nominal used lap values specified pertaining to a accommodate mandatory some requirement degree of this movement standard or a referenced requirement (see 3.2.17).Subcommittee: C11.03 Standard: C840pertaining to a mandatory requirement of this specification or a referenced requirement.Subcommittee: C11.03 Standard: C1280 in 7.9.2 do not represent a maximum threshold value. Experience has shown that excessive lapping of expanded metal lath can inhibit proper embedment of the plaster in the underlying layer of lath which, in turn, can result in attendant corrosion and cracking of the stucco a membrane portland caused cement-aggregate by plaster movement mix designed for use on exterior surfaces. See portland cement plaster.Subcommittee: C11.91 Standard: C11portland cement-based plaster used on exterior locations.Subcommittee: C11.03 Standard: C926 finishes. The nominal value provided in

~~7.9.2 has been shown to perform successfully; lath see gypsum lath.Subcommittee: C11.91 Standard: C11 laps greater than this value may also perform successfully, but represent a heightened risk~~ of ~~embedment and cracking problems. SUMMARY OF CHANGES Committee C11 has identified~~ the ~~location~~ building ~~of~~ or ~~selected~~ its ~~changes~~ components to ~~this~~ minimize ~~standard~~ damage ~~since the last issue (C1063 — 18a) that may impact the use of this standard. (Approved April 1, 2018.) (1) Revised 7.9.2. (2) Added new Appendix X1. Committee C11 has identified the location of selected changes~~ to ~~this standard since~~ the ~~last~~ stucco ~~issue (C1063 — 18) that may impact the use of this standard. (Approved April 1, 2018.) (1) Removed A0641_A0641M, B0069, B0221, C0954, C1002, D1784,~~ and ~~D4216~~ water ~~from~~ resistive ~~list~~ barrier. ~~of~~

~~A1.3 referenced~~ *Control* ~~documents~~ *Joints* ~~(Section~~ shall ~~2).~~ be ~~(2)~~ installed ~~Added~~ to ~~Specifications~~ minimize ~~C1280~~ stress ~~and~~ due ~~C1861~~ to ~~list~~ stucco ~~of~~ curing ~~referenced documents (Section 2). (3) Added new 3.1.2~~ and ~~renumbered~~ drying ~~subsequent~~ shrinkage ~~sections accordingly. (4) Removed previous 6.3 — 6.3.2 with new 6 — 6.3.2. (5) Removed previous 6.3.4 — 6.8.3. (6) Revised 7.1, 7.2.1 — 7.2.5, 7.3.4, 7.4 — 7.5.4, 7.6 — 7.6.2, 7.7.1 — 7.7.3. (7) Added new 7.8~~ and ~~renumbered~~ minor ~~subsequent~~ movement, ~~sections~~ along ~~accordingly.~~ predetermined, ~~(8)~~ usually ~~Revised~~ straight ~~7.9.2,~~ lines ~~7.10.1.6, 7.10.1.7, 7.10.2.3, 7.10.3.2, 7.10.4,~~ and ~~7.10.5.~~ as ~~(9)~~ a ~~Removed~~ screed ~~previous~~ to ~~7.11~~ aid ~~–~~ in ~~7.11.5~~ stucco ~~and~~ thickness ~~replaced~~ control. ~~with~~

SUMMARY ~~NEW~~ OF ~~7.11~~ CHANGES ~~— 7.11.11.4. (10) SWITCHED PREVIOUS TABLES 2 AND 3 (AND UPDATED IN TEXT TABLE REFERENCES ACCORDINGLY). (11) REVISED TABLE 3 AND TITLE OF FIG. 3. (12) REMOVED PREVIOUS A1.2 AND A1.3.~~

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063~~—~~ –~~17b)~~ 15) that may impact the use of this standard. (Approved ~~Jan.~~ Aug. 1, ~~2018.)~~ 2015.)

(1) Revised ~~7.8.3,~~ definition ~~7.8.3.1, 7.10.4.1. (2) Replaced previous Table 3 with new Table 3. (3) Added new 2.2. (4) Added new Section 6, renumbered other sections accordingly. (5) Updated titles~~ of ~~Sections~~ "water ~~4~~ resistive ~~and~~ barrier ~~5.~~ system" ~~Committee~~ (formerly ~~C11~~ "water ~~has~~ barrier ~~identified~~ system") ~~the~~ in ~~location~~ Terminology ~~of~~ (Section ~~selected~~ 3 ~~changes~~). ~~to this standard since the last issue (C1063 — 17a) that may impact the use of this standard. (Approved Dec. 1, 2017.) (1) Revised 7.9.2.3 and 7.10.4.1. (2) Combined previous Sections 4 and 5, added new Section 6, and renumbered subsequent sections accordingly.~~

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063~~—~~ –~~17a)~~ 14d) that may impact the use of this standard. (Approved June 1, ~~2017.)~~ 2015.)

(1) ~~*Added*~~ Definition ~~new~~ for ~~7.10.1.3.~~ "drainage ~~Committee~~ plane" ~~C11 has identified the location of selected changes to this standard since the last issue~~ (~~C1063~~3.2.4 ~~—~~) ~~16c)~~ was ~~that~~ revised. ~~may impact the use of this standard. (Approved April 1, 2017.) (1) Removed previous 3.2.1, 3.2.4 — 3.2.6, , 3.2.14, 7.9, and renumbered subsequent sections accordingly.~~

~~*(2) Replaced the terms "member" and "support" with " framing member studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787" throughout. (3) Replaced the term "support" with " framing member studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in.*~~

~~*(38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787". (4) Replaced the terms "application" and "applied" with "installation" and "installed" throughout. (5) Removed previous Note 2 and placed its contents in new 5.3.3. (6)*~~ Revised ~~7.10.1.4~~ 7.10.2.2 ~~and~~, ~~7.9.2.2.~~ 7.10.2.4 ~~(7)~~, ~~Added~~ 7.10.2.5 ~~new~~, ~~5.1~~ and ~~renumbered~~ 7.10.3.3 ~~subsequent~~. ~~sections accordingly. (8) Added new 5.8.3.~~

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063~~—~~ – ~~16b)~~ 14c) that may impact the use of this standard. (Approved ~~Sept.~~ Aug. 15, ~~2016.)~~ 2014.)

(1) Revised ~~5.3.2~~ subsection ~~and~~ 7.10.1.7 ~~7.10.1.~~.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063~~—~~ – ~~16a)~~ 14b) that may impact the use of this standard. (Approved ~~Sept.~~ June 1, ~~2016.)~~ 2014.)

(1) ~~*Corrected*~~ Definition ~~table~~ for ~~reference~~ water ~~in~~ resistive ~~7.6.1.~~ barrier ~~(2)~~ was ~~Added~~ revised. ~~7.10.1.4. Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 — 16) that may impact the use of this standard. (Approved March 1, 2016.) (1) Revised 1.1.~~

(2) ~~*Revised*~~ Revisions ~~7.10.1.2.~~ were ~~Committee~~ made ~~C11~~ in ~~has~~ 7.7.4, ~~identified~~ 7.8.3.1, ~~the location of selected changes to this standard since the last issue (C1063 — 15a) that may impact the use of this standard. (Approved Jan. 1, 2016.) (1) Revised 3.2.6~~ and ~~7.9.2.2.~~ A1.2.

Committee C11 has identified the location of selected changes to this ~~standard~~ specification since the last issue (C1063~~—~~ – ~~15)~~ 14a) that may impact the use of this ~~standard.~~ specification. (Approved ~~Aug.~~ April 1, ~~2015.)~~ 2014.)

(1) ~~*Revised*~~ Addition ~~definition~~ of ~~"~~ the ~~water~~ exception ~~resistive~~ in ~~barrier~~ 7.8.3.1 ~~a~~ for ~~material~~ backing ~~that~~ to ~~resists~~ be ~~the~~ placed ~~infiltration~~ outboard of ~~liquid moisture through~~ the ~~building~~ weep ~~enclosure~~ screed ~~system.~~ flange~~Subcommittee:~~ to ~~C11.03~~ be ~~Standard:~~ consistent ~~C1063~~ with ~~system"~~ 7.11.5 ~~(formerly~~. ~~"water barrier system") in Terminology (Section 3).~~

FOOTNOTES

(1) This specification is under the jurisdiction of ASTM Committee C11 on Gypsum and Related Building Materials and Systems and is the direct responsibility of Subcommittee C11.03 on Specifications for the Application of Gypsum and Other Products in Assemblies.

Current edition approved ~~June~~ Aug. 1, ~~2010.~~ 2015. Published ~~July~~ September ~~2010.~~ 2015. Originally approved in 1986. Last previous edition approved in ~~2010~~ 2015 as **C1063**~~—~~ – ~~18a.~~ 15. DOI: ~~10.1520/C1063-18B.~~ 10.1520/C1063-15A.

(2) For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

S7365

Date Submitted	11/20/2018	**Section**	3111	**Proponent**	Bryan Holland
Chapter	31	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
Commission Action Pending Review

Comments

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

Related Modifications

7345, 7347, 7348

Summary of Modification

This proposed modification updates requirement for solar energy systems in the FBC-B.

Rationale

This proposed modification deletes the current requirements in Section 3111 and replaces them with the updated rules in 3111 of the 2018 IBC that have been correlated and harmonized with current industry standards and other applicable references. This change is similar to those proposed under Mods 7345, 7347, and 7348 for inclusion into the FBC-R. This change will also coordinate the FBC-B with the FFPC.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposed modification will not impact the local entity relative to code enforcement.

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

This proposed modification will not change the cost of compliance to building and property owners.

Impact to industry relative to the cost of compliance with code

This proposed modification will not change the cost of compliance or impact industry.

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

This proposed modification will not change the cost of compliance or impact small business.

Requirements

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

This proposed modification is directly connected to the health, safety, and welfare of the general public by coordinating the FBC-B with the FFPC for life, fire, and property safety related to solar energy system installations.

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

This proposed modification improves and strengthens the code by updating the rules for solar energy systems in the FBC-B.

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

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

Does not degrade the effectiveness of the code

This proposed modification enhances the effectiveness of the code.

Alternate Language

2nd Comment Period

7365-A2

Proponent Bryan Holland **Submitted** 5/22/2019 **Attachments** Yes

Rationale

This alternative language comment simply corrects a pointer to the applicable section of the FFPC in 3111.3.4 related to access and pathways. "Section 1204" is replaced with "Section 11.12.2.2".

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This alternative language comment will have no impact on the local entity.

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

This alternative language comment will have no impact on building owners.

Impact to industry relative to the cost of compliance with code

This alternative language comment will have no impact on industry.

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

This proposed modification will not change the cost of compliance or impact small business.

Requirements

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

This alternative language comment corrects an error in the code which relates directly to the health, safety, and welfare of the public.

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

This alternative language comment improves the code by correcting an error.

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

This alternative language comment does not discriminate against any materials, products, methods, or systems of construction.

Does not degrade the effectiveness of the code

This alternative language comment enhances the effectiveness of the code by correcting an error.

Alternate Language

2nd Comment Period

7365-A1

Proponent John Hall **Submitted** 5/22/2019 **Attachments** Yes

Rationale

This alternate language does not alter the text of the modification. It only adds references to appropriate code sections to make the modification applicable to the high velocity hurricane zone.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposed modification will not impact the local entity relative to code enforcement.

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

This proposed modification will not change the cost of compliance to building and property owners.

Impact to industry relative to the cost of compliance with code

This proposed modification will not change the cost of compliance or impact industry.

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

This proposed modification will not change the cost of compliance or impact small business.

Requirements

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

This proposed modification is directly connected to the health, safety, and welfare of the general public by coordinating the FBC-B with the FFPC for life, fire and property safety related to solar energy system installations throughout Florida including the HVHZ.

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

This proposed modification improves and strengthens the code by updating the rules for solar energy systems in the FBC-B throughout Florida including the HVHZ.

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

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

Does not degrade the effectiveness of the code

This proposed modification enhances the effectiveness of the code.

SECTION 3111

SOLAR ENERGY SYSTEMS

3111.1 General. Solar energy systems shall comply with the requirements of this section.

3111.1.1 Wind resistance. Rooftop-mounted photovoltaic panels and modules and solar thermal collectors shall be designed in accordance with Section 1609.

3111.1.2 Roof live load. Roof structures that provide support for solar energy systems shall be designed in accordance with Section 1607.13.5.

3111.2 Solar thermal systems. Solar thermal systems shall be designed and installed in accordance with the Florida Building Code-Plumbing, the Florida Building Code-Mechanical, and the Florida Fire Prevention Code.

3111.2.1 Equipment. Solar thermal systems and components shall be listed and labeled in accordance with ICC 900/SRCC 300 and ICC 901/SRCC 100.

3111.3 Photovoltaic solar energy systems. Photovoltaic solar energy systems shall be designed and installed in accordance with this section, the Florida Fire Prevention Code, NFPA 70 and the manufacturer's installation instructions.

3111.3.1 Equipment. Photovoltaic panels and modules shall be listed and labeled in accordance with UL 1703. Inverters shall be listed and labeled in accordance with UL 1741. Systems connected to the utility grid shall use inverters listed for utility interaction.

3111.3.2 Fire classification. Rooftop-mounted photovoltaic systems shall have a fire classification in accordance with Section 1505.9. Building-integrated photovoltaic systems shall have a fire classification in accordance with Section 1505.8.

3111.3.3 Building-integrated photovoltaic systems. Building-integrated photovoltaic systems that serve as roof coverings shall be designed and installed in accordance with Section 1507.18.

3111.3.4 Access and pathways. Roof access, pathways and spacing requirements shall be provided in accordance with Section ~~1204~~ 11.12.2.2 of the Florida Fire Prevention Code.

3111.3.5 Ground-mounted photovoltaic systems. Ground-mounted photovoltaic systems shall be designed and installed in accordance with Chapter 16 and the Florida Fire Prevention Code.

3111.3.5.1 Fire separation distances. Ground-mounted photovoltaic systems shall be subject to the fire separation distance requirements determined by the local jurisdiction.

~~SECTION 3111~~

~~PHOTOVOLTAIC PANELS AND MODULES~~

~~3111.1 General. Photovoltaic panels and modules shall comply with the requirements of this code and the Florida Fire Prevention Code.~~

~~3111.1.1 Rooftop-mounted photovoltaic panels and modules. Photovoltaic panels and modules installed on a roof or as an integral part of a roof assembly shall comply with the requirements of Chapter 15 and the Florida Fire Prevention Code.~~

SECTION 3111

SOLAR ENERGY SYSTEMS

3111.1 General. Solar energy systems shall comply with the requirements of this section.

3111.1.1 Wind resistance. Rooftop-mounted photovoltaic panels and modules and solar thermal collectors shall be designed in accordance with Section 1609. For buildings and structures located within the high-velocity hurricane zone refer to Section 1620.

3111.1.2 Roof live load. Roof structures that provide support for solar energy systems shall be designed in accordance with Section 1607.13.5.

3111.2 Solar thermal systems. Solar thermal systems shall be designed and installed in accordance with the Florida Building Code-Plumbing, the Florida Building Code-Mechanical, and the Florida Fire Prevention Code.

3111.2.1 Equipment. Solar thermal systems and components shall be listed and labeled in accordance with ICC 900/SRCC 300 and ICC 901/SRCC 100.

3111.3 Photovoltaic solar energy systems. Photovoltaic solar energy systems shall be designed and installed in accordance with this section, the Florida Fire Prevention Code, NFPA 70 and the manufacturer’s installation instructions.

3111.3.1 Equipment. Photovoltaic panels and modules shall be listed and labeled in accordance with UL 1703. Inverters shall be listed and labeled in accordance with UL 1741. Systems connected to the utility grid shall use inverters listed for utility interaction.

3111.3.2 Fire classification. Rooftop-mounted photovoltaic systems shall have a fire classification in accordance with Section 1505.9. Building-integrated photovoltaic systems shall have a fire classification in accordance with Section 1505.8. For buildings and structures located within the high-velocity hurricane zone refer to Section 1516.

3111.3.3 Building-integrated photovoltaic systems. Building-integrated photovoltaic systems that serve as roof coverings shall be designed and installed in accordance with Section 1507.18. For buildings and structures located within the high-velocity hurricane zone refer to Section 1518.11.

3111.3.4 Access and pathways. Roof access, pathways and spacing requirements shall be provided in accordance with Section 1204 of the Florida Fire Prevention Code.

3111.3.5 Ground-mounted photovoltaic systems. Ground-mounted photovoltaic systems shall be designed and installed in accordance with Chapter 16 and the Florida Fire Prevention Code.

3111.3.5.1 Fire separation distances. Ground-mounted photovoltaic systems shall be subject to the fire separation distance requirements determined by the local jurisdiction.

~~SECTION 3111~~

~~PHOTOVOLTAIC PANELS AND MODULES~~

~~3111.1 General. Photovoltaic panels and modules shall comply with the requirements of this code and the Florida Fire Prevention Code.~~

~~3111.1.1 Rooftop-mounted photovoltaic panels and modules. Photovoltaic panels and modules installed on a roof or as an integral part of a roof assembly shall comply with the requirements of Chapter 15 and the Florida Fire Prevention Code.~~

SECTION 3111

SOLAR ENERGY SYSTEMS

3111.1 General. Solar energy systems shall comply with the requirements of this section.

3111.1.1 Wind resistance. Rooftop-mounted photovoltaic panels and modules and solar thermal collectors shall be designed in accordance with Section 1609.

3111.1.2 Roof live load. Roof structures that provide support for solar energy systems shall be designed in accordance with Section 1607.13.5.

3111.2 Solar thermal systems. Solar thermal systems shall be designed and installed in accordance with the Florida Building Code-Plumbing, the Florida Building Code-Mechanical, and the Florida Fire Prevention Code.

3111.2.1 Equipment. Solar thermal systems and components shall be listed and labeled in accordance with ICC 900/SRCC 300 and ICC 901/SRCC 100.

3111.3 Photovoltaic solar energy systems. Photovoltaic solar energy systems shall be designed and installed in accordance with this section, the Florida Fire Prevention Code, NFPA 70 and the manufacturer's installation instructions.

3111.3.1 Equipment. Photovoltaic panels and modules shall be listed and labeled in accordance with UL 1703. Inverters shall be listed and labeled in accordance with UL 1741. Systems connected to the utility grid shall use inverters listed for utility interaction.

3111.3.2 Fire classification. Rooftop-mounted photovoltaic systems shall have a fire classification in accordance with Section 1505.9. Building-integrated photovoltaic systems shall have a fire classification in accordance with Section 1505.8.

3111.3.3 Building-integrated photovoltaic systems. Building-integrated photovoltaic systems that serve as roof coverings shall be designed and installed in accordance with Section 1507.18.

3111.3.4 Access and pathways. Roof access, pathways and spacing requirements shall be provided in accordance with Section 1204 of the Florida Fire Prevention Code.

3111.3.5 Ground-mounted photovoltaic systems. Ground-mounted photovoltaic systems shall be designed and installed in accordance with Chapter 16 and the Florida Fire Prevention Code.

3111.3.5.1 Fire separation distances. Ground-mounted photovoltaic systems shall be subject to the fire separation distance requirements determined by the local jurisdiction.

~~SECTION 3111~~

~~PHOTOVOLTAIC PANELS AND MODULES~~

~~3111.1 General. Photovoltaic panels and modules shall comply with the requirements of this code and the Florida Fire Prevention Code.~~

~~3111.1.1 Rooftop-mounted photovoltaic panels and modules. Photovoltaic panels and modules installed on a roof or as an integral part of a roof assembly shall comply with the requirements of Chapter 15 and the Florida Fire Prevention Code.~~

SECTION 3111

SOLAR ENERGY SYSTEMS

3111.1 General. Solar energy systems shall comply with the requirements of this section.

3111.1.1 Wind resistance. Rooftop-mounted photovoltaic panels and modules and solar thermal collectors shall be designed in accordance with Section 1609. For buildings and structures located within the high-velocity hurricane zone refer to Section 1620.

3111.1.2 Roof live load. Roof structures that provide support for solar energy systems shall be designed in accordance with Section 1607.13.5.

3111.2 Solar thermal systems. Solar thermal systems shall be designed and installed in accordance with the Florida Building Code-Plumbing, the Florida Building Code-Mechanical, and the Florida Fire Prevention Code.

3111.2.1 Equipment. Solar thermal systems and components shall be listed and labeled in accordance with ICC 900/SRCC 300 and ICC 901/SRCC 100.

3111.3 Photovoltaic solar energy systems. Photovoltaic solar energy systems shall be designed and installed in accordance with this section, the Florida Fire Prevention Code, NFPA 70 and the manufacturer's installation instructions.

3111.3.1 Equipment. Photovoltaic panels and modules shall be listed and labeled in accordance with UL 1703. Inverters shall be listed and labeled in accordance with UL 1741. Systems connected to the utility grid shall use inverters listed for utility interaction.

3111.3.2 Fire classification. Rooftop-mounted photovoltaic systems shall have a fire classification in accordance with Section 1505.9. Building-integrated photovoltaic systems shall have a fire classification in accordance with Section 1505.8. <u>For buildings and structures located within the high-velocity hurricane zone refer to Section 1516.</u>

3111.3.3 Building-integrated photovoltaic systems. Building-integrated photovoltaic systems that serve as roof coverings shall be designed and installed in accordance with Section 1507.18. <u>For buildings and structures located within the high-velocity hurricane zone refer to Section 1518.11.</u>

3111.3.4 Access and pathways. Roof access, pathways and spacing requirements shall be provided in accordance with Section 1204 of the Florida Fire Prevention Code.

3111.3.5 Ground-mounted photovoltaic systems. Ground-mounted photovoltaic systems shall be designed and installed in accordance with Chapter 16 and the Florida Fire Prevention Code.

3111.3.5.1 Fire separation distances. Ground-mounted photovoltaic systems shall be subject to the fire separation distance requirements determined by the local jurisdiction.

S8383

4

Date Submitted 12/15/2018
Chapter 2
Section 202
Affects HVHZ No
Proponent Craig Conner
Attachments No
TAC Recommendation Approved as Submitted
Commission Action Pending Review

Comments

General Comments Yes
Alternate Language No

Related Modifications

806.5

Summary of Modification

This adds definition of moisture diffusion port.

Rationale

This definition supports change in 806.5.2. The rationale is at modification number 8378.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

none

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

potentially lower cost because of additional options with less expensive materials

Impact to industry relative to the cost of compliance with code

potentially lower cost because of additional options with less expensive materials

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

Supports an additional option which can use less expensive materials.

Requirements

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

yes proven to mitigate moisture build up and rot in attic cavities

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

Provides a potentially less expensive option and reduces moisture condensation and problems. Improves code because it uses a better method of controlling moisture buildup.

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

Allows construction with additional materials, instead of restricting practical application to one material.

Does not degrade the effectiveness of the code

Providing usable options improves the code.

2nd Comment Period

S8383-G1

Proponent Mo Madani **Submitted** 5/17/2019 **Attachments** No

Comment:

This mod is related to mod 8378, which was voted as “NAR”.

VAPOR DIFFUSION PORT. A passageway for conveying water vapor from an unvented attic to the outside atmosphere.

Date Submitted	11/28/2018	**Section**	324.4.1	**Proponent**	Michael Savage
Chapter	3	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Submitted				
Commission Action	Pending Review				

Comments

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

Related Modifications

None.

Summary of Modification

This proposal is intended to clarify and correct the requirements for design loads for roofs with PV panels.The text is technically incorrect because it implies the PV panels themselves would be considered as live load.

Rationale

We believe the proposed code change more clearly and completely states the intended requirement. It is to be noted that Section R324.4 does not contain the wind load requirement for PV panels, although it references Section R907, which does.

The text is technically incorrect because it implies the PV panels themselves would be considered as live load. This is inconsistent with how ASCE 7 and other portions of the IRC treat fixed equipment (see Section R301.4 and the definition of "Dead Load" in Section R202).

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

There will not be an increase in the cost of construction or inspection enforcement. This proposal merely clarifies how loads are to be applied to the roof structure, so no change in cost or construction is anticipated.

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

There will not be an increase in the cost of construction or inspection enforcement. This proposal merely clarifies how loads are to be applied to the roof structure, so no change in cost or construction is anticipated.

Impact to industry relative to the cost of compliance with code

There will not be an increase in the cost of construction or inspection enforcement. This proposal merely clarifies how loads are to be applied to the roof structure, so no change in cost or construction is anticipated.

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

There will not be an increase in the cost of construction or inspection enforcement. This proposal merely clarifies how loads are to be applied to the roof structure, so no change in cost or construction is anticipated.

Requirements

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

Improves the health, safety and welfare to the public by addressing the issues with dead and live load calculation issues with regard to this solar component.

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

Provides better consistency with how ASCE 7 and other portions of the IRC treat fixed equipment (see Section R301.4 and the definition of "Dead Load" in Section R202).

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

Improves the health, safety and welfare to the public by addressing the issues with dead and live load calculation issues with regard to this solar component and provides better consistency with ASCE 7 and other portions of the IRC while not discriminating against any know products or manufacturers.

Does not degrade the effectiveness of the code

Provides better consistency with how ASCE 7 and other portions of the IRC treat fixed equipment (see Section R301.4 and the definition of "Dead Load" in Section R202).

2nd Comment Period

S7493-G1

Proponent Michael Savage **Submitted** 5/14/2019 **Attachments** No

Comment:

I agree with the proposed revision.

2nd Comment Period

S7493-G3

Proponent	Borrone Jeanette	**Submitted**	5/20/2019	**Attachments**	No

Comment:

I agree with the proposed revision.

~~R324.4.1Roof live load. Roof structures that provide support for photovoltaic panel systems shall be designed for applicable roof live load. The design of roof structures need not include roof live load in the areas covered by photovoltaic panel systems. Portions of roof structures not covered by photovoltaic panels shall be designed for roof live load. Roof structures that provide support for photovoltaic panel systems shall be designed for live load, LR, for the load case where the photovoltaic panel system is not present.~~

Portions of roof structures not covered with photovoltaic panel systems shall be designed for dead loads and roof loads in accordance with Sections R301.4 and R301.6. Portions of roof structures covered with photovoltaic panel systems shall be designed for the following load cases:
1.
1. Dead load (including photovoltaic panel weight) plus snow load in accordance with Table R301.2(1).
2.
2. Dead load (excluding photovoltaic panel weight) plus roof live load or snow load, whichever is greater, in accordance with Section R301.6.

S8144

Date Submitted	12/14/2018	**Section**	301.2.1	**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** **Yes**

Related Modifications

Summary of Modification

This proposal is intended to clarify the limits for using the prescriptive (non-high) wind criteria that's been carried forward in the FBCR from the IRC.

Rationale

This proposal is intended to clarify the applicability of the prescriptive criteria in the FBCR for wood, masonry, concrete and steel buildings. Since the first edition, the FBCR has limited the use of the prescriptive criteria that has been carried forward from the IRC. With the adoption of ASCE 7-10 in the 2010 FBCR, the prescriptive provisions have not been permitted to be used in any area of Florida. Recent editions of the FBCR have simply deleted this criteria. During the last cycle, language was added to specifically address the limits but was not as comprehensive as in previous editions. This proposal simply provides additional clarification. In addition, during Phase I of the 2020 update of the FBC, the Commission voted to update ASCE 7 from the 2010 edition to the 2016 edition (ASCE 7-16). ICC 600 has not been updated to ASCE 7-16. This proposal also makes it clear that masonry and concrete wall design is permitted in accordance with ICC 600, but wood roof framing would have to comply with the WFCM or be designed to comply with ASCE 7-16.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

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

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

No impact to building and property owners relative to cost of compliance with the code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to cost of compliance with the code.

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

No impact to small business relative to cost of compliance with the code.

Requirements

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

This proposal clarifies requirements for wind design of buildings within the scope of the FBCR.

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

This proposal improves the code by clarifying the wind design requirements of buildings within the scope of the FBCR.

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

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

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Alternate Language

2nd Comment Period

8144-A3

Proponent T Stafford **Submitted** 5/22/2019 **Attachments** Yes

Rationale

This public comment is being submitted at the request of several members of the Structural TAC during the first meetings to address proposed code changes to the FBC. The original modification simply added language clarifying the provisions of Section R606 were not permitted to be used in Florida, similar to language that was included in previous editions of the code. Since the provisions of Section R606 cannot be used in the State of Florida, the Structural TAC requested a public comment be submitted deleting these requirements. This modification does just that. It's a cleaner approach that removes construction requirements that are not acceptable for the design wind speeds in Florida in addition to removing snow seismic requirements that also do not apply 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

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 the 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 public comment simply provides further clarification of the intent of the code.

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

This public comment improves the code by providing further clarification of the intent.

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

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

Does not degrade the effectiveness of the code

This public comment does not degrade the effectiveness of the code.

Alternate Language

2nd Comment Period

8144-A2

Proponent T Stafford **Submitted** 5/20/2019 **Attachments** Yes

Rationale

This public comment simply adds ICF construction to the exceptions with the appropriate reference to its limitations. The provisions for ICF construction apply to wind speeds above 115 mph. This public comment is simply a clarification.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

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

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

No impact to building and property owners relative to cost of compliance with 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 cost of compliance with the code.

Requirements

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

This modification is simply a clarification.

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

This modification improves the code by clarifying the applicability of ICF construction.

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

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

Does not degrade the effectiveness of the code

This modification does not degrade the effectiveness of the code.

Further revise the original modification as follows:

R606.1 General. Masonry construction shall be designed andconstructed in accordance with the provisions of this section, and Section R301.2.1.1, TMS 403 or in accordance with the provisions of TMS 402/ACI 530/ASCE 5.

R606.6.4 Lateral support. Masonry walls shall be laterally supported in either the horizontal or the vertical direction in accordance with Section R301.2.1.1, TMS 403 or TMS 402/ACI 530/ASCE 5. ~~The maximum spacing between lateral supports shall not exceed the distances in Table R606.6.4. Lateral support shall be provided by cross walls, pilasters, buttresses or structural frame members where the limiting distance is taken horizontally, or by floors or roofs where the limiting distance is taken vertically.~~

Delete Table R606.6.4 and show as "Reserved:"

TABLE R606.6.4

SPACING OF LATERAL SUPPORT FOR MASONRY WALLS

Reserved

Delete Section R606.6.4.1 through R606.4.2.2 and show as reserved:

R606.6.4.1 Horizontal lateral support. Reserved.

R606.6.4.1.1 Bonding pattern. Reserved.

R606.6.4.1.2 Metal reinforcement. Reserved.

R606.6.4.2 Vertical lateral support. Reserved.

R606.6.4.2.1 Roof structures. Reserved.

R606.4.2.2 Floor diaphragms. Reserved.

Delete Section R606.11 and Figures R606.11(1), R606.11(2), and R606.11(3). Show as "Reserved" to maintain section numbering.

R606.11 Anchorage. Reserved.

FIGURE R606.11(1)

ANCHORAGE REQUIREMENTS FOR MASONRY WALLS LOCATED IN SEISMIC DESIGN CATEGORY A, B OR C AND WHERE WIND LOADS ARE LESS THAN 30 PSF

(Reserved)

FIGURE R606.11(2)

REQUIREMENTS FOR REINFORCED GROUTED MASONRY CONSTRUCTION IN SEISMIC DESIGN CATEGORY C

(Reserved)

FIGURE R606.11(3)

REQUIREMENTS FOR REINFORCED MASONRY CONSTRUCTION IN SEISMIC DESIGN CATEGORY D0, D1 OR D2

(Reserved)

Delete Section R606.12 including all subsections, figures, and tables. Show as reserved to maintain section numbering.

Revise Exceptions in the original modification as follows:

Exceptions:

1. Footings and foundations shall comply with Chapter 4.
2. Exterior windows and doors shall comply with Section R609.
3. For structural insulated panels, the provisions of this code apply in accordance with the limitations of Section R610.
4. Exterior wall coverings and soffits shall comply with Chapter 7
5. Roof sheathing shall be attached in accordance with Section R803.
6. Roof coverings shall comply with Chapter 9.
7. <u>For concrete construction, the provisions of this code apply in accordance with the limitations of Section R608.2.</u>

R301.2.1.1Wind ~~limitations and wind~~ design required. ~~The prescriptive provisions of this code for wood construction, cold-formed steel light-frame construction, and masonry construction shall not apply to the design of buildings where the ultimate design wind speed, V_{ult}, from Figure R301.2(4) equals or exceeds 115 miles per hour (51 m/s). The prescriptive provisions of this code include the sizing and attachment requirements specified in Sections R502, R503, R505, R602, R603, R606, R802 and R804.~~

-

~~**Exceptions:**~~

~~1.For concrete construction, the wind provisions of this code shall apply in accordance with the limitations of Sections R401, R402, R404 and R608.~~
~~2.For structural insulated panels, the wind provisions of this code shall apply in accordance with the limitations of Section R610.~~
~~3.Roof sheathing shall be installed in accordance with Section R803.~~

In regions where the ultimate design wind speed, V_{ult}, from Figure R301.2(4) equals or exceeds 115 miles per hour (51 m/s), the design of concrete, masonry, wood, and steel buildings for wind loads shall be in accordance with one or more of the following methods:

1. AF&PA *Wood Frame Construction Manual* (WFCM).
2. Concrete and masonry walls are permitted to be designed in accordance with ICC *Standard for Residential Construction in High-Wind Regions* (ICC 600).
3. ASCE *Minimum Design Loads for Buildings and Other Structures* (ASCE 7).
4. AISI *Standard for Cold-Formed Steel Framing— Prescriptive Method For One- and Two-Family Dwellings* (AISI S230.
5. *Florida Building Code, Building*; or
6. The MAF *Guide to Concrete Masonry Residential Construction in High Wind Areas* shall be permitted for applicable concrete masonry buildings for a basic wind speed of 130 mph (58 m/s) or less in Exposure B and 110 mph (49 m/s) or less in Exposure C in accordance with Figure R301.2(4) as converted in accordance with R301.2.1.3.

Exceptions:

1. Footings and foundations shall comply with Chapter 4.
2. Exterior windows and doors shall comply with Section R609.
3. For structural insulated panels, the provisions of this code apply in accordance with the limitations of Section R610.
4. Exterior wall coverings and soffits shall comply with Chapter 7
5. Roof sheathing shall be attached in accordance with Section R803.
6. Roof coverings shall comply with Chapter 9.

-

The elements of design not addressed by the methods in Items 1 through 6 shall be in accordance with the provisions of this code.

S7655

Date Submitted	12/3/2018	**Section**	408.3	**Proponent**	Ann Russo8
Chapter	4	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
Commission Action Pending Review

Comments

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

Related Modifications

RB187-16

Summary of Modification

This change adds an option for dehumidification for unvented crawl spaces.

Rationale

Typical conditioning measures involve supplying conditioned air from the occupied (conditioned) space of the building or exhausting air from the crawl space with make up air provided from the occupied (conditioned) space of the building. This code change allows another means of conditioning and controlling moisture, specifically dehumidification. Dehumidification is a proven technology.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Adding optional method only. No impact on code enforcement.

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

This change will not increase the cost of construction as it is only adding an optional method for treatment of unvented crawl spaces.

Impact to industry relative to the cost of compliance with code

This change will not increase the cost of construction as it is only adding an optional method for treatment of unvented crawl spaces.

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

This change will not increase the cost of construction as it is only adding an optional method for treatment of unvented crawl spaces.

Requirements

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

This change is only adding an optional method for treatment of unvented crawl spaces so will not effect the code requirements or enforcement.

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

This change is only adding an optional method for treatment of unvented crawl spaces so will not effect the code requirements or enforcement.

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

This change is only adding an optional method for treatment of unvented crawl spaces so will not effect the code requirements or enforcement. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This change is only adding an optional method for treatment of unvented crawl spaces so will not effect the code requirements or enforcement. Does not degrade the effectiveness of the code.

2nd Comment Period

S7655-G1

Proponent Borrone Jeanette **Submitted** 5/21/2019 **Attachments** No

Comment:

I agree with the proposed revision.

Revise as follows:

- **R408.3 Unvented crawl space. Ventilation openings in under-floor spaces specified in Sections R408.1 and R408.2 shall not be required where the following items are provided:**

1. Exposed earth is covered with a continuous Class I vapor retarder. Joints of the vapor retarder shall overlap by 6 inches (152mm) and shall be sealed or taped. The edges of the vapor retarder shall extend not less than 6 inches (152 mm) up the stem wall and shall be attached and sealed to the stem wall or insulation.

2. One of the following is provided for the under-floorspace:

   2.1. Continuously operated mechanical exhaust ventilation at a rate equal to 1 cubic foot per minute (0.47 L/s) for each 50 square feet (4.7 m^2) of crawl space floor area, including an air pathway to the common area (such as a duct or transfer grille), and perimeter walls insulated in accordance with the Florida Building Code, Energy Conservation.

   2.2. *Conditioned air* supply sized to deliver at a rate equal to 1 cubic foot per minute (0.47 L/s) for each 50 square feet (4.7 m^2) of under-floor area, including a return air pathway to the common area (such as a duct or transfer grille), and perimeter walls insulated in accordance with the Florida Building Code, Energy Conservation.

   2.3. Plenum in existing structures complying with Section M1601.5, if under-floor space is used as a plenum.

2.4. Dehumidification sized to provide 70 pints (33 liters) of moisture removal per day for every 1,000 ft2 (93 m2) of crawl space floor area.

S8147

Date Submitted	12/14/2018	**Section**	502.2	**Proponent**	T Stafford
Chapter	5	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
Commission Action Pending Review

Comments

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

Related Modifications

Summary of Modification

This proposal is intended to clarify the limits for using the prescriptive (non-high) wind criteria that's been carried forward in the FBCR from the IRC.

Rationale

This proposal is intended to clarify the applicability of the prescriptive criteria in the FBCR for wood, masonry, concrete and steel buildings. Since the first edition, the FBCR has limited the use of the prescriptive criteria that has been carried forward from the IRC. With the adoption of ASCE 7-10 in the 2010 FBCR, the prescriptive provisions have not been permitted to be used in any area of Florida. Recent editions of the FBCR have simply deleted this criteria. During the last cycle, language was added to specifically address the limits but was not as comprehensive as in previous editions. This proposal simply provides additional clarification.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

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

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

No impact to building and property owners relative to cost of compliance with the code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to cost of compliance with the code.

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

No impact to small business relative to cost of compliance with the code.

Requirements

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

This proposal clarifies requirements for wind design of buildings within the scope of the FBCR.

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

This proposal improves the code by clarifying the wind design requirements of buildings within the scope of the FBCR.

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

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

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Alternate Language

2nd Comment Period

8147-A2

Proponent T Stafford **Submitted** 5/22/2019 **Attachments** Yes

Rationale

This public comment is being submitted at the request of several members of the Structural TAC during the first meetings to address proposed code changes to the FBC. The original modification simply added language clarifying the provisions of Section R502.2 and R503 were not permitted to be used in Florida, similar to language that was included in previous editions of the code. Since the provisions of Sections R502.2 and R503 cannot be used in the State of Florida, the Structural TAC requested a public comment be submitted deleting these requirements. This modification does just that. It's a cleaner approach that removes construction requirements that are not acceptable for the design wind speeds 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

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 the 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 public comment simply provides further clarification of the intent of the code.

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

This public comment improves the code by providing further clarification of the intent.

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

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

Does not degrade the effectiveness of the code

This public comment does not degrade the effectiveness of the code.

Revise the original modification as follows:

R502.2 Design and construction. ~~Where the ultimate design wind speed, V_{ult}, equals or exceeds 115 mph, f~~ Floors shall be designed in accordance with Section R301.2.1.1 or ANSI AWC NDS. ~~Where ultimate design wind speed, V_{ult}, is less than 115 mph floors shall be designed and constructed in accordance with the provisions of this chapter, Figure R502.2 and Sections R317 and R318 or in accordance with ANSI AWC NDS.~~

Further Revise the original modification as follows:

Delete Sections R502.2.1 through R502.10 including all subsections, figures, and tables. Show sections as "Reserved" to maintain section numbering.

Revise the original modification as follows:

R503.1 Design and construction. ~~Where the ultimate design wind speed, V_{ult}, equals or exceeds 115 mph, f~~ Floors sheathing shall be in accordance with Section R301.2.1.1 or ANSI AWC NDS. ~~Where ultimate design wind speed, V_{ult}, is less than 115 mph floors shall be in accordance with the provisions of this section.~~

~~**R503.1.1 Lumber sheathing.** Maximum allowable spans for lumber used as floor sheathing shall conform to Tables R503.1, R503.2.1.1(1) and R503.2.1.1(2).~~

~~**R503.1.2 End joints.** End joints in lumber used as subflooring shall occur over supports unless end-matched lumber is used, in which case each piece shall bear on not less than two joists. Subflooring shall be permitted to be omitted where joist spacing does not exceed 16 inches (406 mm) and a 1-inch (25 mm) nominal tongue-and-groove wood strip flooring is applied perpendicular to the joists.~~

Further Revise the original modification as follows:

Delete Sections R503.2 through R503.3.3 including all subsections, figures, and tables. Show sections as "Reserved" to maintain section numbering.

Revise as follows:

R502.2 Design and construction. Where the ultimate design wind speed, V_{ult}, equals or exceeds 115 mph, floors shall be designed in accordance with Section R301.2.1.1 or ANSI AWC NDS. Where ultimate design wind speed, V_{ult}, is less than 115 mph~~F~~floors shall be designed and constructed in accordance with the provisions of this chapter, Figure R502.2 and Sections R317 and R318 or in accordance with ANSI AWC NDS.

Revise as follows:

R503.1 Design and construction. Where the ultimate design wind speed, V_{ult}, equals or exceeds 115 mph, floors sheathing shall be in accordance with Section R301.2.1.1 or ANSI AWC NDS. Where ultimate design wind speed, V_{ult}, is less than 115 mphfloors shall be in accordance with the provisions of this section.

R503.1.1 Lumber sheathing. Maximum allowable spans for lumber used as floor sheathing shall conform to Tables R503.1, R503.2.1.1(1) and R503.2.1.1(2)

R503.1.2~~1~~ End joints. End joints in lumber used as subflooring shall occur over supports unless end-matched lumber is used, in which case each piece shall bear on not less than two joists. Subflooring shall be permitted to be omitted where joist spacing does not exceed 16 inches (406 mm) and a 1-inch (25 mm) nominal tongue-and-groove wood strip flooring is applied perpendicular to the joists.

Revise as follows:

R506.1 General. Concrete slab-on-ground floors shall be designed and constructed in accordance with the provisions of ACI 332 and this section. Floors shall be a minimum 3 ½ inches (89 mm) thick (for expansive soils, see Section R403.1.8). The specified compressive strength of concrete shall be as set forth in Section R402.2. Footings for concrete slab-on-grade floors shall be in accordance with Chapter 4.

S8010

Date Submitted	12/12/2018	**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 Yes | **Alternate Language** No

Related Modifications

Summary of Modification

Minor editorial corrections, updates, correlations, and added options to Table 602.3(1) Fastener Schedule.

Rationale

The modification affects only items 7, 13, 23, 29, 33, and 34 of Table 602.3(1), and footnote "c" of Table R602.10.3(4). This modification was approved by the ICC committees and membership and appears in the 2018 edition of the IRC. See the reason statement in the attached uploaded support file for information about each item. The explanation exceeded the allowable space for this input field.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Improves enforceability

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

No cost-related impact.

Impact to industry relative to the cost of compliance with code

No cost-related impact.

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

No cost-related impact.

Requirements

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

Improvements to the fastener table, yes.

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

Improves the code.

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

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness.

2nd Comment Period

S8010-G1

Proponent Paul Coats **Submitted** 5/26/2019 **Attachments** No

Comment:

This modification is unnecessary or should be NAR since the TAC preferred S8151 which deletes Table R602.3(1) altogether.

Revise as follows:

TABLE R602.3(1)
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
		Roof	
1	Blocking between ceiling joists or rafters to top plate	4-8d box ($2\frac{1}{2}$″ × 0.113″) or 3-8d common ($2\frac{1}{2}$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
2	Ceiling joists to top plate	4-8d box ($2\frac{1}{2}$″ × 0.113″); or 3-8d common ($2\frac{1}{2}$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Sections R802.3.1, R802.3.2 and Table R802.5.1(9)]	4-10d box (3″ × 0.128″); or 3-16d common ($3\frac{1}{2}$″ × 0.162″); or 4-3″ × 0.131″ nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Sections R802.3.1 and R802.3.2 and Table R802.5.1(9)]	Table R802.5.1(9)	Face nail
5	Collar tie to rafter, face nail or $1\frac{1}{4}$″ × 20 ga. ridge strap to rafter	4-10d box (3″ × 0.128″); or 3-10d common (3″ × 0.148″); or 4-3″ × 0.131″ nails	Face nail each rafter
6	Rafter or roof truss to plate	3-16d box nails ($3\frac{1}{2}$″ × 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 ($3\frac{1}{2}$″ × 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 $3\frac{1}{2}$″ × 0.135″); or 2-16d common ($3\frac{1}{2}$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
		Wall	
8	Stud to stud (not at braced wall panels)	16d common ($3\frac{1}{2}$″ × 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 ($3\frac{1}{2}$″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
		16d common ($3\frac{1}{2}$″ × 0.162″)	16″ o.c. face nail
10	Built-up header (2″ to 2″ header with $\frac{1}{2}$″ spacer)	16d common ($3\frac{1}{2}$″ × 0.162″)	16″ o.c. each edge face nail
		16d box ($3\frac{1}{2}$″ × 0.135″)	12″ o.c. each edge face nail

11	Continuous header to stud	5-8d box (2 1/2 ″ × 0.113″); or 4-8d common (2 1/2 ″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toe nail
12	Top plate to top plate	16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	12″ o.c. face nail
13	Double top plate splice ~~for SDCs A-D2 with seismic braced wall line spacing~~	8-16d common (3 1/2 ″ × 0.162″); or 12-16d box (3 1/2 ″ × 0.135″); or 12-10d box (3″ × 0.128″); or 12-3″ × 0.131″ nails	Face nail on each side of end joint (minimum 24″ lap splice length each side of end joint)
	~~Double top plate splice SDCs D_0, D_1, or D_2; and braced wall line spacing ≥ 25′~~	~~12-16d (3 1/2 ″ × 0.135″)~~	

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
14	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail
		16d box (3 1/2 ″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
15	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box (3 1/2 ″ × 0.135″); or 2-16d common (3 1/2 ″ × 0.162″); or 4-3″ × 0.131″ nails	3 each 16″ o.c. face nail 2 each 16″ o.c. face nail 4 each 16″ o.c. face nail
16	Top or bottom plate to stud	4-8d box (2 1/2 ″ × 0.113″); or 3-16d box (3 1/2 ″ × 0.135″); or 4-8d common (2 1/2 ″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box (3 1/2 ″ × 0.135″); or 2-16d common (3 1/2 ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
17	Top plates, laps at corners and intersections	3-10d box (3″ × 0.128″); or 2-16d common (3 1/2 ″ × 0.162″); or 3-3″ × 0.131″ nails	Face nail
18	1″ brace to each stud and plate	3-8d box (2 1/2 ″ × 0.113″); or 2-8d common (2 1/2 ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples 1 3/4 ″	Face nail
19	1″ × 6″ sheathing to each bearing	3-8d box (2 1/2 ″ × 0.113″); or 2-8d common (2 1/2 ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., 1 3/4 ″ long	Face nail
20	1″ × 8″ and wider sheathing to each bearing	3-8d box (2 1/2 ″ × 0.113″); or 3-8d common (2 1/2 ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3 staples, 1″ crown, 16 ga., 1 3/4 ″ long	Face nail
		Wider than 1″ × 8″ 4-8d box (2 1/2 ″ × 0.113″); or 3-8d common (2 1/2 ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 4 staples, 1″ crown, 16 ga., 1 3/4 ″ long	
Floor			

21	Joist to sill, top plate or girder	4-8d box (2 1/2″ × 0.113″); or 3-8d common (2 1/2″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
22	Rim joist, band joist or blocking to sill or top plate (roof applications also)	8d box (2 1/2″ × 0.113″)	4″ o.c. toe nail
		8d common (2 1/2″ × 0.131″); or 10d box (3″ × 0.128″); or 3″ × 0.131″ nails	6″ o.c. toe nail
23	1″ × 6″ subfloor or less to each joist	3-8d box (2 1/2″ × 0.113″); or 2-8d common (2 1/2″ × 0.131″); or ~~3~~2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., 1 3/4″ long	Face nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Floor			
24	2″subfloor to joist or girder	3-16d box (3 1/2″× 0.135″); or 2-16d common (3 1/2″× 0.162″)	Blind and face nail
25	2″planks (plank & beam—floor & roof)	3-16d box (3 1/2″× 0.135″); or 2-16d common (3 1/2″× 0.162″)	At each bearing, face nail
26	Band or rim joist to joist	3-16d common (3 1/2″× 0.162″) 4-10 box (3″× 0.128″), or 4-3″× 0.131″nails; or 4-3″× 14 ga. staples, 7/16″crown	End nail
27	Built-up girders and beams, 2-inch lumber layers	20d common (4″× 0.192″); or	Nail each layer as follows: 32″o.c. at top and bottom and staggered.
		10d box (3″× 0.128″); or 3″× 0.131″nails	24″o.c. face nail at top and bottom staggered on opposite sides
		And: 2-20d common (4″× 0.192″); or 3-10d box (3″× 0.128″); or 3-3″× 0.131″nails	Face nail at ends and at each splice
28	Ledger strip supporting joists or rafters	4-16d box (3 1/2″× 0.135″); or 3-16d common (3 1/2″× 0.162″); or 4-10d box (3″× 0.128″); or 4-3″× 0.131″nails	At each joist or rafter, face nail

29	Bridging or blocking to joist	2-10d box (3″× 0.128″), or 2-8d common (2-1/2″ x 0.131″; or 2-3″ x 0.131″ nails	Each end, toe nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING OF FASTENERS	
			Edges (inches)[h]	Intermediate supports[c, e] (inches)
Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing [see Table R602.3(3) for wood structural panel *exterior* wall sheathing to wall framing]				
		6d common (2″× 0.113″) nail		

		8d common nail		

30	3/8"– 1/2"	(subfloor, wall)[i] 8d common (2 1/2"× 0.131") nail (roof)	6	12[f]
31	19/32"– 1"	(2 1/2"× 0.131")	6	12[f]
32	1 1/8"–1 1/4"	10d common (3"× 0.148") nail; or 8d (2 1/2"× 0.131") deformed nail	6	12
Other wall sheathing[g]				
33	1/2"structural cellulosic fiberboard sheathing	1 1/2"galvanized roofing nail, 7/16" head diameter, or ~~1"crown staple 16 ga.,~~ 1 1/4" long <u>16 ga. staple with 7/16" or 1" crown</u>	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~~ <u>1-1/2" long 16 ga. staple with 7/16" or 1" crown</u>	3	6
35	1/2"gypsum sheathing[d]	1 1/2"galvanized roofing nail; staple galvanized, 1 1/2"long; 1 1/4" screws, Type W or S	7	7
36	5/8"gypsum sheathing[d]	1 3/4"galvanized roofing nail; staple galvanized, 1 5/8" long; 1 5/8" screws, Type W or S	7	7
Wood structural panels, combination subfloor underlayment to framing				
37	3/4" and less	6d deformed (2"× 0.120") nail; or 8d common (2 1/2"× 0.131") nail	6	12
38	7/8"– 1"	8d common (2 1/2"× 0.131") nail; or 8d deformed (2 1/2"× 0.120") nail	6	12
39	1 1/8"– 1 1/4"	10d common (3"× 0.148") nail; or 8d deformed (2 1/2"× 0.120") nail	6	12

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.

a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.

b. Staples are 16 gage wire and have a minimum 7/16-inch on diameter crown width.

c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.

d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.

e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).

f. Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.

g. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.

h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.

i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

TABLE R602.10.3 (4)
SEISMIC ADJUSTMENT FACTORS TO THE REQUIRED LENGTH OF WALL BRACING

ITEM NUMBER	ADJUSTMENT BASED ON:	STORY	CONDITION	ADJUSTMENT FACTOR[a, b] [Multiply length from Table R602.10.3(3) by this factor]	APPLICABLE METHODS
1	Story height (Section 301.3)	Any story	≤ 10 feet	1.0	
			> 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	All methods
			> 8 psf and < 15		

4	Wall dead load	Any story	psf	1.0	
			< 8 psf	0.85	
5	Roof/ceiling dead load for wall supporting	1-, 2- or 3-story building	≤15 psf	1.0	
		2- or 3-story building	> 15 psf and ≤ 25 psf	1.1	
		1-story building	> 15 psf and ≤ 25 psf	1.2	
6	Walls with stone or masonry veneer, townhouses in SDC C[d, e]		1.0		All methods
			1.5		
			1.5		
7	Walls with stone or masonry veneer, detached one- and two-family dwellings in SDC D_0 – D_2[d, f]	Any story	See Table R602.10.6.5		BV-WSP
8	Interior gypsum board finish (or equivalent)	Any story	Omitted from inside face of braced wall panels	1.5	DWB, WSP, SFB, PBS, PCP, HPS, CS-WSP, CS-G, CS-SFB

For SI: 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. Linear interpolation shall be permitted.

b. The total length of bracing required for a given wall line is the product of all applicable adjustment factors.

c. The length-to-width ratio for the floor/roof *diaphragm* shall not exceed 3:1. ~~The top plate lap splice nailing shall be in accordance with Table R602.3(1), Item 13.~~ _

d. Applies to stone or masonry veneer exceeding the first story height.

e. The adjustment factor for stone or masonry veneer shall be applied to all exterior *braced wall lines* and all *braced wall lines* on the interior of the building, backing or perpendicular to and laterally supported veneered walls.

f. See Section R602.10.6.5 for requirements where stone or masonry veneer does not exceed the first-story height.

RB219-16

IRC: R602.10.3, R602.3.

Proponent : Paul Coats, PE CBO, American Wood Council, representing American Wood Council (pcoats@awc.org)

2015 International Residential Code

Revise as follows:

**TABLE R602.3(1)
FASTENING SCHEDULE**

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Roof			
1	Blocking between ceiling joists or rafters to top plate	4-8d box ($2^{1}/_{2}$″ × 0.113″) or 3-8d common ($2^{1}/_{2}$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
2	Ceiling joists to top plate	4-8d box ($2^{1}/_{2}$″ × 0.113″); or 3-8d common ($2^{1}/_{2}$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Sections R802.3.1, R802.3.2 and Table R802.5.1(9)]	4-10d box (3″ × 0.128″); or 3-16d common ($3^{1}/_{2}$″ × 0.162″); or 4-3″ × 0.131″ nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Sections R802.3.1 and R802.3.2 and Table R802.5.1(9)]	Table R802.5.1(9)	Face nail
5	Collar tie to rafter, face nail or $1^{1}/_{4}$″ × 20 ga. ridge strap to rafter	4-10d box (3″ × 0.128″); or 3-10d common (3″ × 0.148″); or 4-3″ × 0.131″ nails	Face nail each rafter
6	Rafter or roof truss to plate	3-16d box nails ($3^{1}/_{2}$″ × 0.135″); or 3-10d common nails (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss[i]
7	Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2″ ridge beam	4-16d ($3^{1}/_{2}$″ × 0.135″); or 3-10d common (3~~1/2~~″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box $3^{1}/_{2}$″ × 0.135″); or 2-16d common ($3^{1}/_{2}$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
Wall			
8	Stud to stud (not at braced wall panels)	16d common ($3^{1}/_{2}$″ × 0.162″)	24″ o.c. face nail
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	16″ o.c. face nail
9	Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d box ($3^{1}/_{2}$″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
		16d common ($3^{1}/_{2}$″ × 0.162″)	16″ o.c. face nail
10	Built-up header (2″ to 2″ header with $^{1}/_{2}$″ spacer)	16d common ($3^{1}/_{2}$″ × 0.162″)	16″ o.c. each edge face nail
		16d box ($3^{1}/_{2}$″ × 0.135″)	12″ o.c. each edge face nail

11	Continuous header to stud	5-8d box (2 1/2″ × 0.113″); or 4-8d common (2 1/2″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toe nail
12	Top plate to top plate	16d common (3 1/2″ × 0.162″)	16″ o.c. face nail
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	12″ o.c. face nail
13	Double top plate splice ~~for SDCs A-D2 with seismic braced wall line spacing~~	8-16d common (3 1/2″ × 0.162″); or 12-16d box (3 1/2″ × 0.135″); or 12-10d box (3″ × 0.128″); or 12-3″ × 0.131″ nails	Face nail on each side of end joint (minimum 24″ lap splice length each side of end joint)
	~~Double top plate splice SDCs D_0, D_1, or D_2; and braced wall line spacing ≥ 25′~~	~~12-16d (3 1/2″ × 0.135″)~~	

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
14	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common (3 1/2″ × 0.162″)	16″ o.c. face nail
		16d box (3 1/2″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
15	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box (3 1/2″ × 0.135″); or 2-16d common (3 1/2″ × 0.162″); or 4-3″ × 0.131″ nails	3 each 16″ o.c. face nail 2 each 16″ o.c. face nail 4 each 16″ o.c. face nail
16	Top or bottom plate to stud	4-8d box (2 1/2″ × 0.113″); or 3-16d box (3 1/2″ × 0.135″); or 4-8d common (2 1/2″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box (3 1/2″ × 0.135″); or 2-16d common (3 1/2″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
17	Top plates, laps at corners and intersections	3-10d box (3″ × 0.128″); or 2-16d common (3 1/2″ × 0.162″); or 3-3″ × 0.131″ nails	Face nail
18	1″ brace to each stud and plate	3-8d box (2 1/2″ × 0.113″); or 2-8d common (2 1/2″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples 1 3/4″	Face nail
19	1″ × 6″ sheathing to each bearing	3-8d box (2 1/2″ × 0.113″); or 2-8d common (2 1/2″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., 1 3/4″ long	Face nail
20	1″ × 8″ and wider sheathing to each bearing	3-8d box (2 1/2″ × 0.113″); or 3-8d common (2 1/2″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3 staples, 1″ crown, 16 ga., 1 3/4″ long	Face nail
		Wider than 1″ × 8″ 4-8d box (2 1/2″ × 0.113″); or 3-8d common (2 1/2″ × 0.131″); or 3-10d box (3″ × 0.128″); or 4 staples, 1″ crown, 16 ga., 1 3/4″ long	
	Floor		

21	Joist to sill, top plate or girder	4-8d box (2 1/2″ × 0.113″); or 3-8d common (2 1/2″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
22	Rim joist, band joist or blocking to sill or top plate (roof applications also)	8d box (2 1/2″ × 0.113″)	4″ o.c. toe nail
		8d common (2 1/2″ × 0.131″); or 10d box (3″ × 0.128″); or 3″ × 0.131″ nails	6″ o.c. toe nail
23	1″ × 6″ subfloor or less to each joist	3-8d box (2 1/2″ × 0.113″); or 2-8d common (2 1/2″ × 0.131″); or ~~3~~2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., 1 3/4″ long	Face nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
		Floor	
24	2″subfloor to joist or girder	3-16d box (3 1/2″× 0.135″); or 2-16d common (3 1/2″× 0.162″)	Blind and face nail
25	2″planks (plank & beam—floor & roof)	3-16d box (3 1/2″× 0.135″); or 2-16d common (3 1/2″× 0.162″)	At each bearing, face nail
26	Band or rim joist to joist	3-16d common (3 1/2″× 0.162″) 4-10 box (3″× 0.128″), or 4-3″× 0.131″nails; or 4-3″× 14 ga. staples, 7/16″crown	End nail
27	Built-up girders and beams, 2-inch lumber layers	20d common (4″× 0.192″); or	Nail each layer as follows: 32″o.c. at top and bottom and staggered.
		10d box (3″× 0.128″); or 3″× 0.131″nails	24″o.c. face nail at top and bottom staggered on opposite sides
		And: 2-20d common (4″× 0.192″); or 3-10d box (3″× 0.128″); or 3-3″× 0.131″nails	Face nail at ends and at each splice
28	Ledger strip supporting joists or rafters	4-16d box (3 1/2″× 0.135″); or 3-16d common (3 1/2″× 0.162″); or 4-10d box (3″× 0.128″); or 4-3″× 0.131″nails	At each joist or rafter, face nail
29	Bridging or blocking to joist	2-10d box (3″× 0.128″), or 2-8d common (2-1/2″ x 0.131″; or 2-3″ x 0.131″ nails	Each end, toe nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING OF FASTENERS	
			Edges (inches)[h]	Intermediate supports[c, e] (inches)
Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing [see Table R602.3(3) for wood structural panel *exterior* wall sheathing to wall framing]				
		6d common (2″× 0.113″) nail		
		8d common nail		

30	3/8"– 1/2"	(subfloor, wall)[i] 8d common (2 1/2"× 0.131") nail (roof)	6	12[f]
31	19/32"– 1"	(2 1/2"× 0.131")	6	12[f]
32	1 1/8"–1 1/4"	10d common (3"× 0.148") nail; or 8d (2 1/2"× 0.131") deformed nail	6	12
Other wall sheathing[g]				
33	1/2"structural cellulosic fiberboard sheathing	1 1/2"galvanized roofing nail, 7/16" head diameter, or ~~1"crown staple 16 ga.,~~ 1 1/4" long 16 ga. staple with 7/16" or 1" crown	3	6
34	25/32"structural cellulosic fiberboard sheathing	1 3/4"galvanized roofing nail, 7/16"head diameter, or ~~1"crown staple 16 ga., 1 1/4" long~~ 1-1/2" long 16 ga. staple with 7/16" or 1" crown	3	6
35	1/2"gypsum sheathing[d]	1 1/2"galvanized roofing nail; staple galvanized, 1 1/2"long; 1 1/4" screws, Type W or S	7	7
36	5/8"gypsum sheathing[d]	1 3/4"galvanized roofing nail; staple galvanized, 1 5/8" long; 1 5/8" screws, Type W or S	7	7
Wood structural panels, combination subfloor underlayment to framing				
37	3/4" and less	6d deformed (2"× 0.120") nail; or 8d common (2 1/2"× 0.131") nail	6	12
38	7/8"– 1"	8d common (2 1/2"× 0.131") nail; or 8d deformed (2 1/2"× 0.120") nail	6	12
39	1 1/8"– 1 1/4"	10d common (3"× 0.148") nail; or 8d deformed (2 1/2"× 0.120") nail	6	12

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.

a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.

b. Staples are 16 gage wire and have a minimum 7/16-inch on diameter crown width.

c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.

d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.

e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).

f. Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.

g. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.

h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.

i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

TABLE R602.10.3 (4)
SEISMIC ADJUSTMENT FACTORS TO THE REQUIRED LENGTH OF WALL BRACING

ITEM NUMBER	ADJUSTMENT BASED ON:	STORY	CONDITION	ADJUSTMENT FACTOR[a, b] [Multiply length from Table R602.10.3(3) by this factor]	APPLICABLE METHODS
1	Story height (Section 301.3)	Any story	≤ 10 feet	1.0	
			> 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	All methods
			> 8 psf and < 15		

4	Wall dead load	Any story	psf	1.0	
			< 8 psf	0.85	
5	Roof/ceiling dead load for wall supporting	1-, 2- or 3-story building	≤15 psf	1.0	
		2- or 3-story building	> 15 psf and ≤ 25 psf	1.1	
		1-story building	> 15 psf and ≤ 25 psf	1.2	
6	Walls with stone or masonry veneer, townhouses in SDC C[d, e]		1.0		All methods
			1.5		
			1.5		
7	Walls with stone or masonry veneer, detached one- and two-family dwellings in SDC D_0 – D_2[d, f]	Any story	See Table R602.10.6.5		BV-WSP
8	Interior gypsum board finish (or equivalent)	Any story	Omitted from inside face of braced wall panels	1.5	DWB, WSP, SFB, PBS, PCP, HPS, CS-WSP, CS-G, CS-SFB

For SI: 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. Linear interpolation shall be permitted.

b. The total length of bracing required for a given wall line is the product of all applicable adjustment factors.

c. The length-to-width ratio for the floor/roof *diaphragm* shall not exceed 3:1. ~~The top plate lap splice nailing shall be in accordance with Table R602.3(1), Item 13.~~

d. Applies to stone or masonry veneer exceeding the first story height.

e. The adjustment factor for stone or masonry veneer shall be applied to all exterior *braced wall lines* and all *braced wall lines* on the interior of the building, backing or perpendicular to and laterally supported veneered walls.

f. See Section R602.10.6.5 for requirements where stone or masonry veneer does not exceed the first-story height.

Reason: ITEM 7: The correct length of the 10d common nail is 3", not 3-1/2". 10d common is correctly shown as 3" long elsewhere in the table. This is considered to be an editorial change as a 10d common nail is 3" long per ASTM F1667 and correctly shown as 3" long elsewhere in the table.
ITEM 13: Multiple changes to the top plate splice nailing were approved in the previous code change cycle. One change, RB272-13, increased the nailing of the top plate splice to bring it in line with the 2015 IBC as well as to include nailing schedules that are of roughly equivalent lateral resistance. A second change, RB274-13, specified increased top plate splice nailing only for higher SDCs and where braced wall line spacing is greater than 25'. The combination of both proposals produced line 13 of the 2015 IRC in which the same double top plate splice nailing is shown for wall line spacing <25' and ≥25' (i.e. 12-16d (3-1/2" x 0.135" box nails). To simplify presentation of the top plate nailing schedule to the singular nailing pattern intended by RB272-13, it is proposed to delete language associated with triggering different nailing based on SDC or wall line spacing. The special reference from footnote c of Table R602.10.3(4) that addresses applicable top plate nailing is also no longer necessary with the proposed revision to a single nail schedule and is proposed to be deleted. Related: prior cycle RB272-13, RB274-13, Rb278-13.

ITEM 23: The equivalent nailing to the 8d common case is (2) 10d box versus (3) 10d box. 2 nails is consistent with item 24 in IBC Table 2304.10.1.

ITEM 29: The "bridging to joist" case was added during the previous code change cycle but included only the 10d (3" x 0.128") nail option. The 10d is clarified as a box nail size in this change. Other equivalent nail options are added and "or blocking" is added to the description to pick up the commonly used term for the application being described.

ITEMS 33 and 34: 7/16" crown was inadvertently excluded from change proposal RB278-13 which reorganized the fastening table to create a more consistent format between the IBC and IRC prescriptive fastening tables. This change restores the 7/16" crown. It also increases the staple length for 25/32" sheathing thickness which was previously proposed and approved (S75-06/07 Part II) but not picked up in publication.

REVISION TO FOOTNOTE c IN TABLE R602.10.3(4): See the explanation in Item 13 above, and the last sentence.

Cost Impact: Will not increase the cost of construction
Because these are mostly editorial corrections and correlations, it is not anticipated that the cost of construction will increase. For rows where the nailing changes slightly, current alternatives are also retained.

RB219-16 : TABLE R602.3-COATS11584

Final Action: AS (Approves as Submitted)

RB219-16

Errata: In Table R602,10.3(4), at Item 6 under story, the icons are not deleted.

Committee Action: **Approved as Submitted**

Committee Reason: The committee approved this proposal based on the proponents published reason statement.

Assembly Action: **None**

S8073

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

TAC Recommendation Approved as Submitted
Commission Action Pending Review

Comments

General Comments Yes **Alternate Language** No

Related Modifications

Summary of Modification

Adds a standardized ring shank nail to the roof sheathing row of the fastener schedule Table R602.3(1)

Rationale

This modification was approved by the ICC committee and membership and appears in the 2018 edition of the International Residential Code. Connections and fastening for wind design need to be designed per R301.2.1.1 of the code, so this table has limited applicability. However, since it appears in the Florida code the table should be kept up to date. This change adds a new standardized roof sheathing ring shank (RSRS) nail for roof sheathing applications. The RSRS nail has been standardized in ASTM F1667 and added in this proposal as equivalent to the 8d common nail to resist uplift of roof sheathing. This standard ring shank nail provides improved withdrawal resistance relative to the 8d common smooth shank nail. A head size of 0.281" diameter is specified for the RSRS- 01 in ASTM F1667 which is equivalent to the head diameter of the 8d common nail. The slightly larger net area under the head (i.e. area of head minus area of shank) is considered to provide slightly improved head pull through performance.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Adds an additional nailing option; no impact.

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

No cost-related impact.

Impact to industry relative to the cost of compliance with code

No cost-related impact.

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

No cost-related impact.

Requirements

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

Improves nailing alternatives.

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

Strengthens the code with an additional nailing alternative.

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

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

2nd Comment Period

S8073-G1

Proponent Paul Coats **Submitted** 5/26/2019 **Attachments** No

Comment:

This should be disapproved (NAR) since the TAC favored S8151 which deletes Table R602.3(1) altogether.

Add the following to the "NUMBER AND TYPE OF FASTENER" column of rows 30 and 31 of Table R602.3(1) FASTENING SCHEDULE, and a new footnote "j" as follows:

30	3/8" – 1/2"	6d common (2" × 0.113") nail (subfloor, wall)i8d common (21/2" × 0.131") nail (roof)<u>; or RSRS-01 (2-3/8"</u>
31	19/32" – 1"	8d common nail (21/2" × 0.131")<u>; or RSRS-01 (2 3/8" x 0.113") nail (roof)[j]</u>

<u>j. RSRS-01 is a Roof Sheathing Ring Shank nail meeting the specifications in ASTM F1667.</u>

TABLE R602.3 (1)
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Roof			
1	Blocking between ceiling joists or rafters to top plate	4-8d box ($2^1/_2$ " × 0.113″) or 3-8d common ($2^1/_2$ " × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
2	Ceiling joists to top plate	4-8d box ($2^1/_2$ " × 0.113″); or 3-8d common ($2^1/_2$ " × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Sections R802.3.1, R802.3.2 and Table R802.5.1(9)]	4-10d box (3″ × 0.128″); or 3-16d common ($3^1/_2$ " × 0.162″); or 4-3″ × 0.131″ nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Sections R802.3.1 and R802.3.2 and Table R802.5.1(9)]	Table R802.5.1(9)	Face nail
5	Collar tie to rafter, face nail or $1^1/_4$ " × 20 ga. ridge strap to rafter	4-10d box (3″ × 0.128″); or 3-10d common (3″ × 0.148″); or 4-3″ × 0.131″ nails	Face nail each rafter

6	Rafter or roof truss to plate	3-16d box nails (3 1/2 ″ × 0.135″); or 3-10d common nails (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss[i]
7	Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2″ ridge beam	4-16d (3 1/2 ″ × 0.135″); or 3-10d common (3 1/2 ″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box 3 1/2 ″ × 0.135″); or 2-16d common (3 1/2 ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
Wall			
8	Stud to stud (not at braced wall panels)	16d common (3 1/2 ″ × 0.162″)	24″ o.c. face nail
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	16″ o.c. face nail
9	Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d box (3 1/2 ″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
		16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail
10	Built-up header (2″ to 2″ header with 1/2 ″ spacer)	16d common (3 1/2 ″ × 0.162″)	16″ o.c. each edge face nail
		16d box (3 1/2 ″ × 0.135″)	12″ o.c. each edge face nail
11	Continuous header to stud	5-8d box (2 1/2 ″ × 0.113″); or 4-8d common (2 1/2 ″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toe nail
		16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail

12	Top plate to top plate	10d box (3″ × 0.128″); or 3″ × 0.131″ nails	12″ o.c. face nail
13	Double top plate splice for SDCs A-D2 with seismic braced wall line spacing	8-16d common ($3^1/_2$ ″ × 0.162″); or 12-16d box ($3^1/_2$ ″ × 0.135″); or 12-10d box (3″ × 0.128″); or 12-3″ × 0.131″ nails	Face nail on each side of end joint (minimum 24″ lap splice length each side of end joint)
	Double top plate splice SDCs D_0 , D_1 , or D_2 ; and braced wall line spacing ≥ 25′	12-16d ($3^1/_2$ ″ × 0.135″)	

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
14	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common ($3^1/_2$ ″ × 0.162″)	16″ o.c. face nail
		16d box ($3^1/_2$ ″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
15	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box ($3^1/_2$ ″ × 0.135″); or 2-16d common ($3^1/_2$ ″ × 0.162″); or 4-3″ × 0.131″ nails	3 each 16″ o.c. face nail 2 each 16″ o.c. face nail 4 each 16″ o.c. face nail
16	Top or bottom plate to stud	4-8d box ($2^1/_2$ ″ × 0.113″); or 3-16d box ($3^1/_2$ ″ × 0.135″); or 4-8d common ($2^1/_2$ ″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box ($3^1/_2$ ″ × 0.135″); or 2-16d common ($3^1/_2$ ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail

17	Top plates, laps at corners and intersections	3-10d box (3″ × 0.128″); or 2-16d common ($3^1/_2$ ″ × 0.162″); or 3-3″ × 0.131″ nails	Face nail
18	1″ brace to each stud and plate	3-8d box ($2^1/_2$ ″ × 0.113″); or 2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples $1^3/_4$ ″	Face nail
19	1″ × 6″ sheathing to each bearing	3-8d box ($2^1/_2$ ″ × 0.113″); or 2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	Face nail
20	1″ × 8″ and wider sheathing to each bearing	3-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	Face nail
		Wider than 1″ × 8″ 4-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 4 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	
Floor			
21	Joist to sill, top plate or girder	4-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
		8d box ($2^1/_2$ ″ × 0.113″)	4″ o.c. toe nail

22	Rim joist, band joist or blocking to sill or top plate (roof applications also)	8d common ($2^1/_2$ ″ × 0.131″); or 10d box (3″ × 0.128″); or 3″ × 0.131″ nails	6″ o.c. toe nail
23	1″ × 6″ subfloor or less to each joist	3-8d box ($2^1/_2$ ″ × 0.113″); or 2-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	Face nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Floor			
24	2″subfloor to joist or girder	3-16d box ($3^1/_2$ ″× 0.135″); or 2-16d common ($3^1/_2$ ″× 0.162″)	Blind and face nail
25	2″planks (plank & beam—floor & roof)	3-16d box ($3^1/_2$ ″× 0.135″); or 2-16d common ($3^1/_2$ ″× 0.162″)	At each bearing, face nail
26	Band or rim joist to joist	3-16d common ($3^1/_2$ ″× 0.162″) 4-10 box (3″× 0.128″), or 4-3″× 0.131″nails; or 4-3″× 14 ga. staples, $^7/_{16}$ ″crown	End nail
27	Built-up girders and beams, 2-inch lumber layers	20d common (4″× 0.192″); or	Nail each layer as follows: 32″o.c. at top and bottom and staggered.
		10d box (3″× 0.128″); or 3″× 0.131″nails	24″o.c. face nail at top and bottom staggered on opposite sides
		And: 2-20d common (4″×	

		0.192″); or 3-10d box (3″× 0.128″); or 3-3″× 0.131″nails	Face nail at ends and at each splice	
28	Ledger strip supporting joists or rafters	4-16d box (3 1/2 ″× 0.135″); or 3-16d common (3 1/2 ″× 0.162″); or 4-10d box (3″× 0.128″); or 4-3″× 0.131″nails	At each joist or rafter, face nail	
29	Bridging to joist	2-10d (3″× 0.128″)	Each end, toe nail	
ITEM	**DESCRIPTION OF BUILDING ELEMENTS**	**NUMBER AND TYPE OF FASTENER**[a, b, c]	**SPACING OF FASTENERS**	
			Edges (inches)[h]	**Intermediate supports**[c, e] **(inches)**
Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing [see Table R602.3(3) for wood structural panel *exterior* wall sheathing to wall framing]				
30	3/8 ″– 1/2 ″	6d common (2″× 0.113″) nail (subfloor, wall)[i] 8d common (2 1/2 ″× 0.131″) nail (roof); or RSRS-01 (2-3/8″ x 0.113″) nail (roof)[j]	6	12[f]
31	19/32 ″– 1″	8d common nail (2 1/2 ″× 0.131″); or RSRS-01 (2 3/8″ x 0.113″) nail (roof)[j]	6	12[f]
32	1 1/8 ″–1 1/4 ″	10d common (3″× 0.148″) nail; or 8d (2 1/2 ″× 0.131″) deformed nail	6	12
Other wall sheathing[g]				
	1/2 ″structural cellulosic	1 1/2 ″galvanized roofing nail, 7		

33	fiberboard sheathing	/16 " head diameter, or 1"crown staple 16 ga., 1 1/4 " long	3	6
34	25/32 "structural cellulosic fiberboard sheathing	1 3/4 "galvanized roofing nail, 7/16 "head diameter, or 1"crown staple 16 ga., 1 1/4 " long	3	6
35	1/2 "gypsum sheathing[d]	1 1/2 "galvanized roofing nail; staple galvanized, 1 1/2 "long; 1 1/4 " screws, Type W or S	7	7
36	5/8 "gypsum sheathing[d]	1 3/4 "galvanized roofing nail; staple galvanized, 1 5/8 " long; 1 5/8 " screws, Type W or S	7	7
Wood structural panels, combination subfloor underlayment to framing				
37	3/4 " and less	6d deformed (2"× 0.120") nail; or 8d common (2 1/2 "× 0.131") nail	6	12
38	7/8 "– 1"	8d common (2 1/2 "× 0.131") nail; or 8d deformed (2 1/2 "× 0.120") nail	6	12
39	1 1/8 "– 1 1/4 "	10d common (3"× 0.148") nail; or 8d deformed (2 1/2 "× 0.120") nail	6	12

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.

a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.

b. Staples are 16 gage wire and have a minimum 7/16-inch on diameter crown width.

c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.

d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.

e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).

f. Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.

g. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.

h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.

i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

j. RSRS-01 is a Roof Sheathing Ring Shank nail meeting the specifications in ASTM F1667.

Final Action: AS (Approved as Submitted)

RB220-16

IRC: R602.3.

Proponent : Paul Coats, PE CBO, American Wood Council, representing American Wood Council (pcoats@awc.org)

2015 International Residential Code

TABLE R602.3 (1)
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Roof			
1	Blocking between ceiling joists or rafters to top plate	4-8d box ($2^1/_2$ ″ × 0.113″) or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
2	Ceiling joists to top plate	4-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Sections R802.3.1, R802.3.2 and Table R802.5.1(9)]	4-10d box (3″ × 0.128″); or 3-16d common ($3^1/_2$ ″ × 0.162″); or 4-3″ × 0.131″ nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Sections R802.3.1 and R802.3.2 and Table R802.5.1(9)]	Table R802.5.1(9)	Face nail
5	Collar tie to rafter, face nail or $1^1/_4$ ″ × 20 ga. ridge strap to rafter	4-10d box (3″ × 0.128″); or 3-10d common (3″ × 0.148″); or 4-3″ × 0.131″ nails	Face nail each rafter

6	Rafter or roof truss to plate	3-16d box nails ($3^{1}/_{2}$″ × 0.135″); or 3-10d common nails (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss[i]
7	Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2″ ridge beam	4-16d ($3^{1}/_{2}$″ × 0.135″); or 3-10d common ($3^{1}/_{2}$″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box $3^{1}/_{2}$″ × 0.135″); or 2-16d common ($3^{1}/_{2}$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
Wall			
8	Stud to stud (not at braced wall panels)	16d common ($3^{1}/_{2}$″ × 0.162″)	24″ o.c. face nail
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	16″ o.c. face nail
9	Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d box ($3^{1}/_{2}$″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
		16d common ($3^{1}/_{2}$″ × 0.162″)	16″ o.c. face nail
10	Built-up header (2″ to 2″ header with $^{1}/_{2}$″ spacer)	16d common ($3^{1}/_{2}$″ × 0.162″)	16″ o.c. each edge face nail
		16d box ($3^{1}/_{2}$″ × 0.135″)	12″ o.c. each edge face nail
11	Continuous header to stud	5-8d box ($2^{1}/_{2}$″ × 0.113″); or 4-8d common ($2^{1}/_{2}$″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toe nail
		16d common ($3^{1}/_{2}$″ × 0.162″)	16″ o.c. face nail

12	Top plate to top plate	10d box (3″ × 0.128″); or 3″ × 0.131″ nails	12″ o.c. face nail
13	Double top plate splice for SDCs A-D2 with seismic braced wall line spacing	8-16d common ($3^1/_2$ ″ × 0.162″); or 12-16d box ($3^1/_2$ ″ × 0.135″); or 12-10d box (3″ × 0.128″); or 12-3″ × 0.131″ nails	Face nail on each side of end joint (minimum 24″ lap splice length each side of end joint)
	Double top plate splice SDCs D_0 , D_1 , or D_2 ; and braced wall line spacing ≥ 25′	12-16d ($3^1/_2$ ″ × 0.135″)	

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
14	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common ($3^1/_2$ ″ × 0.162″)	16″ o.c. face nail
		16d box ($3^1/_2$ ″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
15	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box ($3^1/_2$ ″ × 0.135″); or 2-16d common ($3^1/_2$ ″ × 0.162″); or 4-3″ × 0.131″ nails	3 each 16″ o.c. face nail 2 each 16″ o.c. face nail 4 each 16″ o.c. face nail
16	Top or bottom plate to stud	4-8d box ($2^1/_2$ ″ × 0.113″); or 3-16d box ($3^1/_2$ ″ × 0.135″); or 4-8d common ($2^1/_2$ ″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box ($3^1/_2$ ″ × 0.135″); or 2-16d common ($3^1/_2$ ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail

17	Top plates, laps at corners and intersections	3-10d box (3″ × 0.128″); or 2-16d common ($3^1/_2$ ″ × 0.162″); or 3-3″ × 0.131″ nails	Face nail
18	1″ brace to each stud and plate	3-8d box ($2^1/_2$ ″ × 0.113″); or 2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples $1^3/_4$ ″	Face nail
19	1″ × 6″ sheathing to each bearing	3-8d box ($2^1/_2$ ″ × 0.113″); or 2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	Face nail
20	1″ × 8″ and wider sheathing to each bearing	3-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	Face nail
		Wider than 1″ × 8″ 4-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 4 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	
Floor			
21	Joist to sill, top plate or girder	4-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
		8d box ($2^1/_2$ ″ × 0.113″)	4″ o.c. toe nail

22	Rim joist, band joist or blocking to sill or top plate (roof applications also)	8d common (2 1/2 ″ × 0.131″); or 10d box (3″ × 0.128″); or 3″ × 0.131″ nails	6″ o.c. toe nail
23	1″ × 6″ subfloor or less to each joist	3-8d box (2 1/2 ″ × 0.113″); or 2-8d common (2 1/2 ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., 1 3/4 ″ long	Face nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Floor			
24	2″subfloor to joist or girder	3-16d box (3 1/2 ″× 0.135″); or 2-16d common (3 1/2 ″× 0.162″)	Blind and face nail
25	2″planks (plank & beam—floor & roof)	3-16d box (3 1/2 ″× 0.135″); or 2-16d common (3 1/2 ″× 0.162″)	At each bearing, face nail
26	Band or rim joist to joist	3-16d common (3 1/2 ″× 0.162″) 4-10 box (3″× 0.128″), or 4-3″× 0.131″nails; or 4-3″× 14 ga. staples, 7/16 ″crown	End nail
27	Built-up girders and beams, 2-inch lumber layers	20d common (4″× 0.192″); or	Nail each layer as follows: 32″o.c. at top and bottom and staggered.
		10d box (3″× 0.128″); or 3″× 0.131″nails	24″o.c. face nail at top and bottom staggered on opposite sides
		And: 2-20d common (4″×	

		0.192"); or 3-10d box (3"× 0.128"); or 3-3"× 0.131"nails	Face nail at ends and at each splice	
28	Ledger strip supporting joists or rafters	4-16d box (3 1/2 "× 0.135"); or 3-16d common (3 1/2 "× 0.162"); or 4-10d box (3"× 0.128"); or 4-3"× 0.131"nails	At each joist or rafter, face nail	
29	Bridging to joist	2-10d (3"× 0.128")	Each end, toe nail	
ITEM	**DESCRIPTION OF BUILDING ELEMENTS**	**NUMBER AND TYPE OF FASTENER**[a, b, c]	**SPACING OF FASTENERS**	
			Edges (inches)[h]	**Intermediate supports**[c, e] **(inches)**
Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing [see Table R602.3(3) for wood structural panel *exterior* wall sheathing to wall framing]				
30	3/8 "– 1/2 "	6d common (2"× 0.113") nail (subfloor, wall)[i] 8d common (2 1/2 "× 0.131") nail (roof); or RSRS-01 (2-3/8" x 0.113") nail (roof)[j]	6	12[f]
31	19/32 "– 1"	8d common nail (2 1/2 "× 0.131"); or RSRS-01 (2 3/8" x 0.113") nail (roof)[j]	6	12[f]
32	11 /8 "–11 /4 "	10d common (3"× 0.148") nail; or 8d (21 /2 "× 0.131") deformed nail	6	12
Other wall sheathing[g]				
	1/2 "structural cellulosic	1 1/2 "galvanized roofing nail, 7		

33	fiberboard sheathing	/16 " head diameter, or 1"crown staple 16 ga., 1 1/4 " long	3	6
34	25 /32 "structural cellulosic fiberboard sheathing	1 3/4 "galvanized roofing nail, 7 /16 "head diameter, or 1"crown staple 16 ga., 1 1/4 " long	3	6
35	1/2 "gypsum sheathing[d]	1 1/2 "galvanized roofing nail; staple galvanized, 1 1/2 "long; 1 1/4 " screws, Type W or S	7	7
36	5/8 "gypsum sheathing[d]	1 3/4 "galvanized roofing nail; staple galvanized, 1 5/8 " long; 1 5/8 " screws, Type W or S	7	7
Wood structural panels, combination subfloor underlayment to framing				
37	3/4 " and less	6d deformed (2"× 0.120") nail; or 8d common (2 1/2 "× 0.131") nail	6	12
38	7/8 "– 1"	8d common (2 1/2 "× 0.131") nail; or 8d deformed (2 1/2 "× 0.120") nail	6	12
39	1 1/8 "– 1 1/4 "	10d common (3"× 0.148") nail; or 8d deformed (2 1/2 "× 0.120") nail	6	12

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.

a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.

b. Staples are 16 gage wire and have a minimum 7/16-inch on diameter crown width.

c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.

ICC COMMITTEE ACTION HEARINGS ::: April, 2016 RB511

d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.

e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).

f. Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.

g. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.

h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.

i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

<u>j. RSRS-01 is a Roof Sheathing Ring Shank nail meeting the specifications in ASTM F1667.</u>

Reason: This change adds a new standardized roof sheathing ring shank (RSRS) nail for roof sheathing applications. The RSRS nail has been standardized in ASTM F1667 and added in this proposal as equivalent to the 8d common nail to resist uplift of roof sheathing. This standard ring shank nail provides improved withdrawal resistance relative to the 8d common smooth shank nail. A head size of 0.281" diameter is specified for the RSRS-01 in ASTM F1667 which is equivalent to the head diameter of the 8d common nail. The slightly larger net area under the head (i.e. area of head minus area of shank) is considered to provide slightly improved head pull through performance.

Cost Impact: Will not increase the cost of construction
An alternative nail is being added only, so there is no increase in cost since the current nailing alternatives may still be used.

RB220-16 : TABLE 602.3 (1)-COATS11445

Final Action: AS (Approved as Submitted)

S8151

Date Submitted	12/14/2018	**Section**	602.3	**Proponent**	T Stafford
Chapter	6	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
Commission Action Pending Review

Comments

General Comments No

Alternate Language Yes

Related Modifications

Summary of Modification

This proposal is intended to clarify the limits for using the prescriptive (non-high) wind criteria that's been carried forward in the FBCR from the IRC.

Rationale

This proposal is intended to clarify the applicability of the prescriptive criteria in the FBCR for wood, masonry, concrete and steel buildings. Since the first edition, the FBCR has limited the use of the prescriptive criteria that has been carried forward from the IRC. With the adoption of ASCE 7-10 in the 2010 FBCR, the prescriptive provisions have not been permitted to be used in any area of Florida. Recent editions of the FBCR have simply deleted this criteria. During the last cycle, language was added to specifically address the limits but was not as comprehensive as in previous editions. This proposal simply provides additional clarification.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

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

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

No impact to building and property owners relative to cost of compliance with the code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to cost of compliance with the code.

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

No impact to small business relative to cost of compliance with the code.

Requirements

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

This proposal clarifies requirements for wind design of buildings within the scope of the FBCR.

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

This proposal improves the code by clarifying the wind design requirements of buildings within the scope of the FBCR.

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

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

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Alternate Language

2nd Comment Period

8151-A1

Proponent T Stafford **Submitted** 5/22/2019 **Attachments** Yes

Rationale

This public comment is being submitted at the request of several members of the Structural TAC during the first meetings to address proposed code changes to the FBC. The original modification simply added language clarifying the provisions of Section R602.3 were not permitted to be used in Florida, similar to language that was included in previous editions of the code. Since the provisions of Section R602.3 cannot be used in the State of Florida, the Structural TAC requested a public comment be submitted deleting these requirements. This modification does just that. It's a cleaner approach that removes construction requirements that are not acceptable for the design wind speeds in Florida in addition to removing snow and seismic requirements that also do not apply 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

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 the 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 public comment simply provides further clarification of the intent of the code.

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

This public comment improves the code by providing further clarification of the intent.

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

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

Does not degrade the effectiveness of the code

This public comment does not degrade the effectiveness of the code.

Revise the original modification as follows:

R602.3 Design and construction. ~~Where the ultimate design wind speed, V_{ult}, equals or exceeds 115 mph,~~ ~~e~~Exterior walls of wood-frame construction shall be designed in accordance with Section R301.2.1.1 or ANSI AWC NDS. ~~Where ultimate design wind speed, V_{ult}, is less than 115 mph exterior walls of wood-frame construction shall be designed and constructed in accordance with the provisions of this chapter . Wall sheathing shall be fastened directly to framing members and, where placed on the exterior side of an exterior wall, shall be capable of resisting the wind pressures listed in Table R301.2(2) adjusted for height and exposure using Table R301.2(3) and shall conform to the requirements of Table R602.3(3). Wall sheathing used only for exterior wall covering purposes shall comply with Section R703.~~

~~Studs shall be continuous from support at the sole plate to a support at the top plate to resist loads perpendicular to the wall. The support shall be a foundation or floor, ceiling or roof diaphragm or shall be designed in accordance with accepted engineering practice.~~

~~**Exception:** Jack studs, trimmer studs and cripple studs at openings in walls that comply with Tables R602.7(1) and R602.7(2).~~

Further revise Section R602.3 as follows:

Delete Section R602.3.1 through Section R602.12.8 including all subsections, tables and figures.

Revises as follows:

R602.3 Design and construction. Where the ultimate design wind speed, V_{ult}, equals or exceeds 115 mph, exterior walls of wood-frame construction shall be designed in accordance with Section R301.2.1.1 or ANSI AWC NDS. Where ultimate design wind speed, V_{ult}, is less than 115 mph~~E~~exterior walls of wood-frame construction shall be designed and constructed in accordance with the provisions of this chapter ~~and Figures R602.3(1) and R602.3(2), or in accordance with AWC NDS. Components of exterior walls shall be fastened in accordance with Tables R602.3(1) through R602.3(4)~~. Wall sheathing shall be fastened directly to framing members and, where placed on the exterior side of an exterior wall, shall be capable of resisting the wind pressures listed in Table R301.2(2) adjusted for height and exposure using Table R301.2(3) and shall conform to the requirements of Table R602.3(3). Wall sheathing used only for exterior wall covering purposes shall comply with Section R703.

Studs shall be continuous from support at the sole plate to a support at the top plate to resist loads perpendicular to the wall. The support shall be a foundation or floor, ceiling or roof diaphragm or shall be designed in accordance with accepted engineering practice.

Exception: Jack studs, trimmer studs and cripple studs at openings in walls that comply with Tables R602.7(1) and R602.7(2).

Delete without substitution:

~~TABLE R602.3(1)~~
~~FASTENING SCHEDULE~~

(table contents not shown for brevity)

~~TABLE R602.3(2)~~
~~ALTERNATE ATTACHMENTS TO TABLE R602.3(1)~~

(table contents not shown for brevity)

S7627

Date Submitted 12/2/2018
Chapter 7
Section 703.8.4
Affects HVHZ No
Proponent Ann Russo8
Attachments No
TAC Recommendation Approved as Submitted
Commission Action Pending Review

Comments

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

Related Modifications

S376-16

Summary of Modification

This code change proposal is a clarification of the existing code language. It is intended to acknowledge and reflect more closely the common practice used in the field for the construction of anchored stone and masonry veneer construction.

Rationale

This code change is intended to acknowledge that the airspace behind a well-constructed, code-compliant brick veneer will never be completely devoid of mortar. No matter how careful an experienced, seasoned mason is in constructing the veneer, some small amount of mortar from construction will be found in the airspace.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will not impact enforcement of the code.
This proposal is a clarification of the existing code language. It is intended to acknowledge and reflect more closely the common practice used in the field for the construction of anchored stone and masonry veneer construction.

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

This code change proposal is a clarification of the existing code language. It is intended to acknowledge and reflect more closely the common practice used in the field for the construction of anchored stone and masonry veneer construction. There should be no cost impact.

Impact to industry relative to the cost of compliance with code

This code change proposal is a clarification of the existing code language. It is intended to acknowledge and reflect more closely the common practice used in the field for the construction of anchored stone and masonry veneer construction. There should be no cost impact.

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

This code change proposal is a clarification of the existing code language. It is intended to acknowledge and reflect more closely the common practice used in the field for the construction of anchored stone and masonry veneer construction. There should be no cost impact.

Requirements

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

Has no impact on the code implementation.

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

This code change proposal is a clarification of the existing code language. It should improve the code by clarifying the intent.

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

This code change proposal is a clarification of the existing code language and does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This code change proposal is a clarification of the existing code language and does not degrade the effectiveness of the code.

2nd Comment Period

S7627-G1

Proponent Borrone Jeanette **Submitted** 5/21/2019 **Attachments** No

Comment:

I agree with the proposed revision.

Section: R703.8.4

Revise as follows:

TABLE R703.8.4
–
TIE ATTACHMENT AND AIRSPACE REQUIREMENTS

BACKING AND TIE	MINIMUM TIE	MINIMUM TIE FASTENER[a]	AIRSPACE[c]	
Wood stud backing with corrugated sheet metal	22 U.S. gauge (0.0299 in.) × 7/8 in. wide	8d common nail[b] (2 1/2 in. × 0.131 in.)	Nominal 1 in. between sheathing and veneer	
Wood stud backing with metal strand wire	W1.7 (No. 9 U.S. gauge; 0.148 in.) with hook embedded in mortar joint	8d common nail[b] (2 1/2 in. × 0.131 in.)	Minimum nominal 1 in. between sheathing and veneer	Maximum 4 1/2 in. between backing and veneer
Cold-formed steel stud backing with adjustable metal strand wire	W1.7 (No. 9 U.S. gauge; 0.148 in.) with hook embedded in mortar joint	No. 10 screw extending through the steel framing a minimum of three exposed threads	Minimum nominal 1 in. between sheathing and veneer	Maximum 4 1/2 in. between backing and veneer

For SI: 1 inch = 25.4 mm.

a. In Seismic Design Category D_0, D_1 or D_2, the minimum tie fastener shall be an 8d ring-shank nail (2 1/2 in. × 0.131 in.) or a No. 10 screw extending through the steel framing a minimum of three exposedthreads.

b. All fasteners shall have rust-inhibitive coating suitable for the installation in which they are being used, or be manufactured from material not susceptible to corrosion.

c. An airspace that provides drainage shall be permitted to contain some mortar from construction.

S7713

Date Submitted	12/6/2018	**Section**	703.7	**Proponent**	George Starks
Chapter	7	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Approved as Submitted
Commission Action Pending Review

Comments

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

Related Modifications

R202; R702.2.2; R702.2.2.1; R703.7; R703.7.2.14; R703.7.4; R703.7.5

Summary of Modification

Seeks to update the Referenced Standards to the current published versions: C 926-18b and C 1063-18b. Significant clarifications and reorganization, to produce more user-friendly documents, have been incorporated since the 15a and 15b versions of these standards.

Rationale

Significant changes to these Standards, in the form of reorganization and re-wording, have been instituted in an effort to make the Standards more user-friendly and less confusing. Comparison files are attached.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will not impact enforcement of the code.

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

Will not impact the cost to building and property owners relative to compliance with the code.

Impact to industry relative to the cost of compliance with code

Will not impact the cost to the industry relative to compliance with the code.

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

Will not impact the cost to small business relative to compliance with the code.
Requirements

Requirements

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

Proper installation of exterior cladding systems have direct impact to the health and welfare of the general public as key elements in the building envelope.

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

Improves the code by providing to the general public, as well as industry professionals, a more clear and concise standard through re-wording, reorganization and removal of some antiquated provisions.

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

Makes no discriminatory remarks or statements in regards to materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

Alternate Language

2nd Comment Period

7713-A1

Proponent George Starks **Submitted** 4/15/2019 **Attachments** Yes

Rationale

Significant changes to these Standards, in the form of reorganizations and re-wording, have been instituted in an effort to make the Standards more user-friendly and less confusing. Since the initial submittal deadline and just prior to the TAC meeting in February, ASTM has published and released a newer version of C 1063 (19a). The newer version includes more reorganization and rewording for clarification purposes.

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

Will not impact the cost to small business relative to compliance with the code.
Requirements

Requirements

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

Proper installation of exterior cladding systems have direct impact on the health and welfare of the general public as key elements in the building envelope.

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

Improves the code by providing to the general public, as well as industry professionals, a more clear and concise standard through re-wording, reorganization, and removal of some atiquated provisions.

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

Makes no discriminatory remarks or statements in regards to materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

Part IX

Chapter 46 Referenced Standards

C926-~~15b~~ 18b Specification for application of Portland Cement-Based Plaster.... R202, R702.2.2, R702.2.1, R703.7, R703.7.2.1, R703.7.4

C1063-~~15a 18b~~ 19a Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster.....R702.2, R702.7

Part IX

Chapter 46 Referenced Standards

C926-~~15b~~18b Specification for Application of Portland Cement-based Plaster R202, R702.2.2, R702.2.2.1, R703.7, R703.7.2.1, R703.7.4

C1063-~~15a~~18b Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-based Plaster R702.2.2, R703.7

INTERNATIONAL

Designation: ~~C1063 – 19~~C1063 – 19a

Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster[1]

This standard is issued under the fixed designation C1063; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification covers the minimum technical requirements for the installation of lathing and furring for the application of exterior and interior portland cement-based plaster, as in Specification C926. These requirements do not by default define a unit of work or assign responsibility for contractual purposes, which is the purview of a contract or contracts made between contracting entities.

1.2 *Table of Contents:*

1.3 Where a fire resistance rating is required for plastered assemblies and constructions, details of construction shall be in accordance with reports of fire tests of assemblies that have met the requirements of the fire rating imposed.

1.4 Where a specific degree of sound control is required for plastered assemblies and constructions, details of construction shall be in accordance with official reports of tests conducted in recognized testing laboratories in accordance with the applicable requirements of Test Method E90.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.6 ~~*Table of Contents:*~~ The text of this specification references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the specification.

[1] This specification is under the jurisdiction of ASTM Committee C11 on Gypsum and Related Building Materials and Systems and is the direct responsibility of Subcommittee C11.03 on Specifications for the Application of Gypsum and Other Products in Assemblies.

Current edition approved ~~Feb. 1, 2019~~March 1, 2019. Published ~~February 2019~~March 2019. Originally approved in 1986. Last previous edition approved in ~~2018~~2019 as ~~C1063 – 18b.~~C1063 – 19. DOI: ~~10.1520/C1063-19.~~10.1520/C1063-19A.

*A Summary of Changes section appears at the end of this standard

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A653/A653M Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

C11 Terminology Relating to Gypsum and Related Building Materials and Systems

C847 Specification for Metal Lath

C926 Specification for Application of Portland Cement-Based Plaster

C933 Specification for Welded Wire Lath

C1032 Specification for Woven Wire Plaster Base

C1280 Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing

C1861 Specification for Lathing and Furring Accessories, and Fasteners, for Interior and Exterior Portland Cement-Based Plaster

E90 Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

2.2 *US Department of Commerce (DOC) Standards*

PS 1 Voluntary Product Standard PS 1, Structural Plywood

PS 2 Voluntary Product Standard PS 2, Performance Standard for Wood-Based Structural Use Panels

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions relating to ceilings and walls, see Terminology C11.

3.1.2 For definitions relating to lathing accessories, furring accessories and fasteners, see Specification C1861.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *building enclosure, n*—system of building assemblies and materials designed and installed in such a manner as to provide a barrier between different environments.

3.2.2 *control joint, n*—a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.

3.2.3 *expansion joint, n*—a joint that accommodates movement beyond plaster shrinkage and curing.

NOTE 1—For design consideration of control and expansion joints, see Annex A2.3.1.2 of Specification C926.

3.2.4 *framing member, n*—studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.

3.2.5 *hangers, n*—wires or steel rods or straps used to support main runners for suspended ceilings beneath floor or roof constructions.

3.2.6 *inserts, n*—devices embedded in concrete framing members to provide a loop or opening for attachment of hangers.

3.2.7 *saddle tie, n*—see Figs. A1.6 and A1.7.

3.2.8 *self-furring, adj*—a metal plaster base manufactured with evenly-spaced indentations that hold the body of the lath approximately ¼ in. (6 mm) away from solid surfaces to which it is installed.

3.2.9 *water-resistive barrier, n*—a material that resists the infiltration of liquid moisture through the building enclosure system.

4. Delivery and Storage of Materials

4.1 *Delivery of Materials:*

4.1.1 Materials shall be delivered in the original packages, containers, or bundles bearing the brand-name and manufacturer's (or supplier's) identification.

4.2 *Storage of Materials:*

4.2.1 Materials shall be kept dry. Materials shall be stacked off the ground, supported on a level platform, and protected from the weather and surface contamination.

4.2.2 Materials shall be neatly stacked with care taken to avoid damage to edges, ends, or surfaces.

4.2.3 Metal plaster bases with a factory-attached water-resistive barrier shall be handled carefully in delivery, storage, and erection to prevent puncturing or removal of the factory-attached water-resistive barrier.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

5. Materials

5.1 Metallic materials including lathing, lathing accessories, furring, furring accessories, and fasteners shall be selected for compatibility to minimize galvanic corrosion between adjacent metallic materials installed in the cement plaster cladding assembly.

5.2 *Metal Plaster Bases:*

5.2.1 *Expanded Metal Lath*—Specification C847, galvanized.

5.2.2 *Wire Laths:*

5.2.2.1 *Welded Wire Lath*—Specification C933.

5.2.2.2 *Woven Wire Lath*—Specification C1032.

5.3 *Lathing Accessories, Furring Accessories and Fasteners:*

5.3.1 *Lathing Accessories, Furring Accessories and Fasteners*—Specification C1861.

5.3.2 The selection of an appropriate type of material for lathing accessories shall be based upon applicable surrounding climatic and environmental conditions specific to the project location, such as salt air, industrial pollution, high moisture, or humidity.

6. Requirements for Substrates to Receive Metal Lathing and Furring

6.1 *Framed, or Framed and Sheathed Substrates:*

6.1.1 Framing member deflection shall not exceed L/360 (0.33 in. in 10 ft).

6.1.2 Substrates to receive lath shall be straight and true to line within ¼ in. in 10 ft. to receive the specified plaster thickness.

6.1.3 Plywood and oriented strand board sheathing panels shall be marked in accordance with DOC PS1 or DOC PS 2.

6.1.4 Plywood and oriented strand board sheathing panels shall be installed with ⅛ in. (3 mm) minimum panel edge gaps, and panel edges shall be offset 4 in. (10 cm) minimum from wall opening reentrant corners.

NOTE 2—This ⅛-in. (3 mm) gap is intended to accommodate expansion. Linear expansion that is not accommodated by an expansion gap can cause stress on the stucco membrane resulting in stucco cracks.

6.1.5 Wood framing members, plywood and oriented strand board sheathing panels shall have a moisture content not to exceed 19 % immediately before plastering.

6.1.6 Exterior gypsum sheathing panels shall be installed in compliance with Specification C1280.

7. Installation

7.1 *Workmanship*—Metal lathing, lathing accessories, furring, and furring accessories shall be erected so that the finished cement plaster surfaces are true to line (allowable tolerance of ¼ in. (6 mm) in 10 ft (3 m)), level, plumb, square, or curved as required to receive the specified cement plaster thickness.

7.2 *Installation of Metal Furring for Walls:*

7.2.1 Attachments for furring accessories shall be concrete nails driven securely into concrete or into masonry joints, power-actuated fasteners, or other devices specifically designed as spacer elements, spaced horizontally not more than 2 ft (610 mm) on centers. They shall be spaced vertically in accordance with horizontal stiffener spacing so that they project from the face of the wall in order for ties to be made.

7.2.2 Horizontal stiffeners shall be not less than ¾ in. (19 mm) cold-rolled channel furring, spaced not to exceed 54 in. (1372 mm) on centers vertically, with the lower and upper cold-rolled channel furring not more than 6 in. (152 mm) from the ends of vertical framing members and not less than ¼ in. (6 mm) clear from the wall face, securely tied to attachments with three loops of wire, or equivalent devices. Approved furring is not prohibited from use in this application.

7.2.3 Vertical framing members shall be not less than ¾ in. (19 mm) cold-rolled channel furring in accordance with the requirements of Table 1. Vertical framing members shall be saddle-tied to horizontal stiffeners with three loops of 0.0475-in. 18 gauge (1.21 mm) wire, or equivalent devices, at each crossing, and securely anchored to the floor and ceiling constructions. Where cold-rolled channel furring is not in contact with the wall, cold-rolled channel furring braces shall be installed between horizontal stiffeners and the wall, spaced horizontally not more than 2 ft (610 mm) on centers.

7.2.4 Where the water-resistive barrier has been damaged during installation of attachments, the water-resistive barrier shall be repaired with the same or an alternative material, compatible with the water-resistive barrier, before proceeding with the installation of the furring.

7.2.5 Z-furring used to support lathing and lathing accessories and its fasteners for fastening to framing members or solid bases, is a customized furring system which shall be engineered.

7.3 *Installation of Metal Plaster Bases:*

7.3.1 *General:*

7.3.1.1 Metal plaster bases shall be furred away from vertical framing members or solid surfaces at least ¼ in. (6 mm). Self-furring lath meets furring requirements; except, furring of expanded metal lath is not required on framing members having a bearing surface of 1⅝ in. (41 mm) or less.

TABLE 1 Types and Weights of Metal Plaster Bases and Corresponding Maximum Permissible Spacing of Wall and Ceiling Framing Members or Furring

<table>
<tr><th rowspan="3">Type of Metal Plaster Base</th><th rowspan="3">Minimum Weight of Metal Plaster Base, lb/yd² (kg/m²)</th><th colspan="5">Specific Installation Requirements and Maximum Permissible Spacing of Wall and Ceiling Framing Members or Furring, Center to Center, in. (mm)</th></tr>
<tr><th colspan="2">Walls</th><th colspan="3">Ceilings</th></tr>
<tr><th>24 (610)</th><th>16 (406)</th><th>24 (610)</th><th>16 (406)</th><th>12 (305)</th></tr>
<tr><td rowspan="2">Expanded Sheet Metal</td><td>2.5 (1.4)</td><td rowspan="2">Permitted only for self-furred lath on sheathed wall framing members or solid wall bases</td><td rowspan="2">Permitted</td><td rowspan="3">Not Permitted</td><td>Not Permitted</td><td>Permitted</td></tr>
<tr><td>3.4 (1.8)</td><td colspan="2" rowspan="6">Permitted</td></tr>
<tr><td>Flat Rib</td><td>2.75 (1.5)</td><td>Not Permitted</td><td>Permitted only for unsheathed wall framing members</td></tr>
<tr><td rowspan="2">⅜ in. Rib</td><td>3.4 (1.8)</td><td colspan="2" rowspan="2">Not Permitted</td><td rowspan="2">Permitted</td></tr>
<tr><td>4.0 (2.1)</td></tr>
<tr><td rowspan="2">Welded Wire</td><td>1.14 (0.618)</td><td>Not Permitted</td><td>Permitted</td><td>Not Permitted</td></tr>
<tr><td>1.95 (1.058)</td><td colspan="2">Permitted</td><td>Permitted</td></tr>
<tr><td rowspan="2">Woven Wire</td><td rowspan="2">1.4 (0.76)</td><td rowspan="2">Permitted only for wood wall framing members, wood furring</td><td rowspan="2">Permitted</td><td colspan="3">Permitted only for wood and concrete ceiling framing members</td></tr>
<tr><td>Not Permitted</td><td colspan="2">Permitted only for steel ceiling framing members</td></tr>
</table>

7.3.1.2 The spacing of framing members for the type and weight of metal plaster base shall conform to the requirements of Table 1. Metal plaster bases shall be attached to framing members at not more than 7 in. (178 mm) on center, along framing members except for ⅜-in. (10 mm) rib metal lath that shall be attached at each rib. Attachment penetrations between the framing members shall be avoided.

7.3.1.3 Lath shall be installed with the long dimension at right angles to the framing members, unless otherwise specified.

7.3.1.4 Ends of adjoining plaster bases shall be staggered.

7.3.1.5 Lath shall not be continuous through control joints, but shall be stopped and tied at each side.

7.3.1.6 Where furred or suspended ceilings butt into or are penetrated by columns, walls, beams, or other elements, the edges and ends of the ceiling lath shall be terminated at the horizontal internal corners with a casing bead lathing accessory, control joint lathing accessory, or similar device designed to keep the edges and ends of the ceiling lath and plaster free of the adjoining vertically oriented, or penetrating elements. Internal corner reinforcement lathing accessories shall not be used at these locations. A clearance of not less than ⅜ in. (10 mm) shall be maintained between the casing bead lathing accessory, control joint lathing accessory, or similar device and penetrating elements.

7.3.1.7 Where load bearing walls or partitions butt into structural walls, columns, or floor or roof slabs, the sides or ends of the wall or partition lath shall be terminated at the internal corners with a casing bead lathing accessory, expansion joint lathing accessory, control joint lathing accessory, or similar device designed to keep the sides and ends of the wall or partition lath free of the adjoining elements. Internal corner reinforcement lathing accessories shall not be used at these internal corners. A clearance of not less than ⅜ in. (10 mm) shall be maintained from abutting walls, columns, or other vertical elements.

7.3.1.8 Where solid base materials interface with framed, or framed and sheathed base materials and are to receive a continuous coat of plaster, lathing accessories to reduce cracking, to facilitate drainage, or both, as categorized in Specification C1861, shall be installed at the interface of these base materials. Omission of these accessories shall be permitted provided the contract documents require provisions that are equivalent in function and performance to control cracking and facilitate drainage, or both.

7.3.2 *Lapping of Metal Plaster Bases:*

7.3.2.1 Side laps of metal plaster bases shall be secured to framing members. They shall be tied between framing members with 0.0475-in. 18 gauge (1.21 mm) wire at intervals not more than 9 in. (229 mm).

7.3.2.2 Metal lath shall be lapped ½ in. (13 mm) minimum at the sides, or nest the edge ribs. Wire lath shall be lapped minimum one mesh at the sides and the ends. Lap metal lath minimum 1 in. (25 mm) at ends. Where end laps occur between the framing members, the ends of the sheets of metal plaster bases shall be laced or wire-tied with 0.0475-in. 18 gauge (1.21 mm) wire.

7.3.2.3 Where metal plaster base with a factory-attached water-resistive barrier is installed, the vertical and horizontal lap joints shall be water-resistive barrier on water-resistive barrier and metal plaster base on metal plaster base.

7.3.2.4 Where metal plaster base with a factory-attached water-resistive barrier is installed, the water-resistive barrier shall be lapped not less than 2 in. (51 mm). On walls, the water-resistive barrier shall be lapped so water will flow to the exterior. Except for weep screeds, designated drainage screeds, and drainage flashings with solid attachment flanges, the water-resistive barrier shall not be placed between metal plaster base and lathing accessory attachment flanges. Metal plaster base to lathing accessory key attachment flange contact shall be required to ensure that the metal plaster base and lathing accessory key attachment flanges are mechanically locked together.

7.3.3 *Attachments for Metal Plaster Bases to Wood Framing Members:*

7.3.3.1 Lath shall be attached to framing members with attachments spaced not more than 7 in. (178 mm) on center along framing members. Attachment penetrations between the framing members shall be avoided.

7.3.3.2 Diamond-mesh expanded metal lath, flat-rib expanded metal lath, and wire lath shall be attached to horizontal wood framing members with 1½-in. (38 mm) roofing nails driven flush with the plaster base and attached to vertical wood framing members with 6d common nails, or 1-in. (25 mm) roofing nails driven to a penetration of not less than ¾ in. (19 mm), or 1-in. (25 mm) wire staples driven flush with the plaster base. Staples shall engage not less than three strands of diamond mesh and flat rib expanded metal lath or not less than two strands of wire lath and penetrate the wood framing members not less than ¾ in. (19 mm). When metal lath is installed over sheathing, use fasteners that will penetrate the framing members not less than ¾ in. (19 mm).

7.3.3.3 Expanded ⅜ in. (10 mm) rib lath shall be attached to horizontal wood framing members with nails or staples to provide not less than 1¾-in. (44 mm) penetration into horizontal wood framing members.

7.3.3.4 Common nails shall be bent over to engage not less than three strands of diamond mesh and flat rib expanded metal lath or not less than two strands of wire lath, or be bent over a rib when rib lath is installed.

7.3.3.5 Screws used to attach metal plaster base to horizontal and vertical wood framing members shall penetrate not less than ⅝ in. (16 mm) into the member when the lath is installed. For expanded metal lath, the screw shall engage not less than three strands of lath. For wire laths, screws shall engage not less than two strands of diamond mesh and flat rib expanded metal lath or not less than two strands of wire lath. When installing expanded metal rib lath, the screw shall pass through, but not deform, the rib. When installing wire rib lath, the screw may deform the rib.

7.3.4 *Attachments for Metal Plaster Bases to Metal Framing Members:*

7.3.4.1 Except as described in 7.3.4.2, metal plaster bases shall be securely attached to metal framing members with 0.0475-in. 18 gauge (1.21 mm) wire ties, clips, or by other means of attachment which afford carrying strength and resistance to corrosion equal to or superior to that of the wire.

7.3.4.2 Rib metal lath shall be attached to open-web steel joists by single ties of wire, not less than 0.0475 in. 18 gauge (1.21 mm), with the ends of each tie twisted together 1½ times.

7.3.4.3 Screws used to attach metal plaster base to metal framing members shall extend through the metal framing member with a minimum of three (3) exposed threads when the lath is installed, and for expanded metal laths shall engage not less than three strands of lath. For wire laths, screws shall engage not less than two strands of diamond mesh and flat rib expanded metal lath or not less than two strands of wire lath. When installing expanded metal rib lath, the screw shall pass through, but not deform, the rib. When installing wire rib lath, the screw may deform the rib.

7.3.5 *Attachments for Metal Plaster Bases to Solid Bases:*

7.3.5.1 Rib metal lath shall be attached to concrete joists by loops of 0.0800-in. (2.03 mm) wire, with the ends of each loop twisted together.

7.3.5.2 Metal plaster bases shall be attached to masonry or concrete with power-actuated fasteners, or a combination of power-actuated fasteners and hardened concrete stub nails. One power-actuated fastener shall be located at each corner and one at the mid-point of the long dimension adjacent to the edge of the metal plaster base sheet. The balance of the sheet shall be fastened with power-actuated fasteners or hardened concrete stub nails. The fasteners shall be installed in rows not more than 16 in. (406 mm) on center and spaced vertically along each row not more 7 in. (178 mm) on center. Power-actuated fasteners and concrete stub nails shall be not less than ¾ in. (19 mm) long, with heads not less than ⅜ in. (10 mm) wide. Where the head diameter of the power-actuated fastener or concrete stub nail is smaller than ⅜ in. (10 mm), fastener shall use a ⅞-in. (22 mm) diameter minimum corrosion-resistant metal washer, which shall be perforated when washer diameter exceeds 1 in. (25 mm).

7.4 *Installation of Lathing Accessories:*

7.4.1 *Lathing Accessory General Requirements:*

7.4.1.1 The type, location, ground dimension, and orientation of lathing accessories shall be indicated in the contract documents.

7.4.1.2 Install lathing accessories before cement plaster application to facilitate lathing installation, cement plaster application, and functionality of the completed stucco cladding assembly.

7.4.2 *Lathing Accessory Attachment Requirements:*

7.4.2.1 Attach lathing accessory attachment flanges to substrate to ensure proper alignment during application of cement plaster. Secure lathing accessory attachment flanges at 7 in. (178 mm) maximum intervals along framing members.

7.4.2.2 Install lathing accessories with key attachment flanges to completely embed the flanges in cement plaster.

7.4.2.3 Alternatively for solid plaster base substrates, adhere lathing accessory key attachment flanges directly to solid plaster bases with adhesive applied in nominal 1 in. (25 mm) dabs at intervals in accordance with 7.4.2.1 or in a semi-continuous bead between the solid plaster base and the solid portion of the key attachment flange.

7.4.3 *Lathing Accessory Water Management Requirements:*

7.4.3.1 Where a defined drainage space is provided over the water-resistive barrier under lath and cement plaster, the ground dimension of lathing accessories with solid attachment flanges installed behind the water-resistive barrier and defined drainage space to facilitate drainage, such as weep screeds, designated drainage screeds, expansion joints and drainage flashings, shall accommodate the defined drainage space dimension and specified cement plaster thickness.

7.4.3.2 Install the water-resistive barrier and lathing to entirely cover the vertical solid attachment flange of lathing accessories with a drainage function and drainage flashings such as weep screeds, designated drainage screeds, expansion joints, and drainage flashings. Terminate lathing within ½ in. (13 mm) nominal above the lathing accessory drainage surface.

7.4.3.3 At intersections of lathing accessories exposed at the cement plaster cladding finished surface, install the vertical lathing accessory continuously through the intersection unless the horizontally intersecting lathing accessory performs an expansion or drainage function, or both. Where vertical lathing accessories terminate above a drainage screed lathing accessory or drainage flashing, the intersection shall be kept free of sealant or other materials that will impede drainage.

7.4.3.4 Lathing accessories installed over the water-resistive barrier shall not impede drainage.

7.4.4 *Foundation Weep Screed*—install a weep screed lathing accessory at the bottom of steel or wood framed exterior walls. Locate the bottom edge of the weep screed lathing accessory not less than 1 in. (25 mm) below the joint formed by the foundation and framing. Locate the weep screed lathing accessory ground 4 in. (102 mm) minimum above raw earth or 2 in. (51 mm) above paved surfaces.

7.4.5 *Designated Drainage Screed*—Install a designated drainage screed lathing accessory at locations indicated in the contract documents and follow specified requirements in the contract documents.

7.4.6 *Casing Bead*—Install a casing bead lathing accessory or other suitable means, at locations to separate cement plaster from dissimilar materials, penetrating elements, load bearing members and to avoid transfer of structural loads.

7.4.7 *Internal Corner Reinforcement*—Install an internal corner reinforcement lathing accessory at internal cement plaster corner locations except where lathing is installed continuously through the internal corner, or where an expansion joint lathing accessory or control joint lathing accessory is installed at the internal corner location.

7.4.8 *External Corner Reinforcement*—Install an external corner reinforcement lathing accessory at external cement plaster corner locations. Alternatively, where no external corner reinforcement lathing accessory is used on framed, and framed and sheathed construction, lathing shall be furred away from the substrate and installed continuously around external corners for a minimum distance of one framing member beyond the corner.

7.4.9 *Expansion Joint*—Install an expansion joint lathing accessory at an expansion joint location in the building, the substrate, or its components.

7.4.10 *Control Joints*—Install control joint lathing accessories in conformance with 7.3.1.5.

7.4.10.1 Form control joints by attaching a prefabricated control joint lathing accessory, or alternatively by attaching a pair of casing beads with key attachment flanges, back to back, with a separation spacing not less than ⅛ in. (3 mm) or as required by the anticipated thermal exposure range and a flexible barrier membrane behind the casing beads. Wall or partition height door frames shall be considered as control joints.

7.4.10.2 Install control joint lathing accessories at locations to delineate cement plaster panel areas of 144 ft^2 (13 m^2) maximum for walls and 100 ft^2 (9 m^2) maximum for horizontal installations, that is, ceilings, curves, or angle type structures.

7.4.10.3 Install control joint lathing accessories at locations to delineate cement plaster panel areas of 18 ft (5 m) maximum dimension, in either direction, or a maximum length-to-width ratio of 2½ to 1.

7.4.10.4 Install a control joint lathing accessory at locations where the ceiling framing or furring changes direction.

8. Keywords

8.1 control joint; expansion joint; lath; plaster; screed; suspended ceiling; walls

ANNEX

(Mandatory Information)

A1. INSTALLATION OF METAL FURRING FOR SUSPENDED CEILINGS

A1.1 *General*—Installation of metal furring requirements for suspended ceilings are located together in this Annex for convenience of use.

A1.2 *Hangers and Inserts:*

A1.2.1 Hangers shall be of ample length and shall conform to the requirements of Table A1.1, both as to size and maximum cement plaster panel area to be supported, except as modified in this section.

A1.2.2 When strap hangers are used, 7⁄16-in. (11 mm) diameter holes shall be provided on the center line at the upper end of the strap hanger to permit the attachment of the strap hanger. The edge of the holes in the strap hangers shall be not less than 3⁄8 in. (10 mm) from the ends.

A1.2.3 In concrete, rod or strap hangers shall be attached to inserts embedded in the concrete, or to other attachment devices designed for this purpose, and able to develop full strength of the hanger.

A1.2.4 Strap hangers shall be bolted with machine bolts. (See Fig. A1.1.)

A1.2.5 The nuts of the machine bolts shall be drawn up tight.

NOTE A1.1—Hangers required to withstand upward wind pressures shall be of a type to resist compression. Struts of formed channels shall be permitted.

A1.3 *Installation of Hangers for Suspended Ceilings Under Wood Constructions*—Hangers shall be attached to framing members by any of the following methods:

A1.3.1 A hole shall be drilled through the wood framing member not less than 3 in. (76 mm) above the bottom, with the upper end of the wire hanger passed through the hole and twisted three times around itself. (See Fig. A1.2.)

A1.3.2 Three 12d nails shall be driven, on a downward slant, into the sides of the wood framing member with not less than 1¼ in. (32 mm) penetration and not less than 5 in. (127 mm) from the bottom edges, and not more than 36 in. (914 mm) on the center with the upper end of the wire hanger wrapped around the nails and twisted three times around itself. (See Fig. A1.3.)

A1.3.3 A loop shall be formed in the upper end of the wire hanger and secured to the wood framing member by four 1½ in. (38 mm), not less than 9 gauge, 0.1483-in. (3.77 mm) diameter wire staples driven horizontally or on a downward slant into the sides of the wood framing members, three near the upper end of the loop and the fourth to fasten the loose end. (See Fig. A1.4.)

A1.3.4 Where framing members for flooring are thicker than 1½ in. (38 mm) and are spaced more than 4 ft (1.2 m) on center, eye screws (or equivalent), spaced not more than 3 ft (914 mm) on centers shall be screwed into the flooring framing members with the upper end of the wire hanger inserted through the eye screws and twisted three times around itself.

A1.3.5 Two holes shall be drilled in the upper end of the flat hangers and nailed to the sides of the wood framing members with 12d nails driven through the holes and clinched. Nails shall be not less than 3 in. (76 mm) above the bottom edge of the framing member. (See Fig. A1.5.)

A1.4 *Attachment of Hangers to Cold-rolled Channel Furring Main Runners:*

A1.4.1 Wire hangers shall be saddle-tied to cold-rolled channel furring main runners. (See Fig. A1.6.)

A1.4.2 Smooth or threaded rod hangers shall be fastened to cold-rolled channel furring main runners with special attachments appropriate to the design.

A1.4.3 The lower ends of strap hangers shall be bolted to cold-rolled channel furring main runners, or bent tightly around the cold-rolled channel furring main runners and carried up and above the cold-rolled channel furring main runners and bolted to the main part of the hanger. (See Fig. A1.1)

A1.5 *Installation of Cold-rolled Channel Furring Main Runners:*

A1.5.1 Minimum sizes and maximum spans and spacings of cold-rolled channel furring main runners for the various spans between hangers or other framing members shall be in accordance with the requirements of Table A1.1.

A1.5.2 A clearance of not less than 1 in. (25 mm) shall be maintained between the ends of the cold-rolled channel furring main runners and the abutting masonry or the concrete walls, partitions, and columns. Where special conditions require that cold-rolled channel furring main runners let into abutting masonry or concrete construction, within such constructions maintain a clearance of not less than 1 in. (25 mm) from the ends and not less than ¼ in. (6 mm) from the tops and sides of the cold-rolled channel furring main runners.

A1.5.3 A cold-rolled channel furring main runner shall be located within 6 in. (152 mm) of the paralleling walls to support the ends of the cold-rolled channel cross-furring. The ends of cold-rolled channel furring main runners shall be supported by hangers located not more than 6 in. (152 mm) from the ends.

A1.5.4 Where cold-rolled channel furring main runners are spliced, the ends shall be overlapped not less than 12 in. (305 mm) with flanges of cold-rolled channel furring main runners interlocked and securely tied near each end of the splice, with double loops of 0.0625 in. (1.59 mm) or double loops of twin strands of 0.0475-in. 18 gauge (1.21 mm) wire. However, when the splice occurs at an expansion joint or control joint, the cold-rolled channel furring shall be nested and loosely tied to hold together but still allow movement.

A1.5.5 Hanger wires shall hang straight down. If an obstacle prevents this, a trapeze type device shall be used to allow hanger wires to hang straight.

A1.6 *Installation of Cold-rolled Channel Cross-furring:*

A1.6.1 Minimum size and maximum spans and spacings of various types of cold-rolled channel cross-furring for various spans between cold-rolled channel furring main runners and framing members shall conform to the requirements of Table A1.2.

A1.6.2 Cold-rolled channel cross-furring shall be saddle-tied to cold-rolled channel furring main runners with 0.0625-in. 16 gauge (1.59 mm) wire, or a double strand of 0.0475-in. 18 gauge (1.21 mm) wire or with special galvanized clips, or equivalent attachments. (See Fig. A1.7.)

A1.6.3 Where cold-rolled channel cross-furring members are spliced, the ends shall be overlapped not less than 8 in. (203 mm), with flanges of cold-rolled channel cross-furring interlocked, and securely tied near each end of the splice with double loops of 0.0625-in. (1.59 mm) 16 gauge wire or twin strands of 0.0475-in. 18 gauge (1.21 mm) wire.

A1.6.4 Cold-rolled channel cross-furring shall not come into contact with abutting masonry or reinforced concrete walls or partitions, except, where special conditions require that cold-rolled channel cross-furring be let into abutting masonry or concrete construction, the applicable provisions of A1.6.2 shall apply.

A1.6.5 Cold-rolled channel furring main runners and cold-rolled channel cross-furring shall be interrupted at expansion joints or control joints. However when the splice occurs at an expansion joint or control joint, the cold-rolled channel furring shall be nested and loosely tied to hold together but still allow movement.

TABLE A1.1 Allowable Support or Hanger Wire Spacing ft-in. (mm) and Cold-Rolled Channel Furring Main Runner Spans, ft-in. (mm)[1–7]

Member Size, in. (mm)	Member Weight, lb/1000 ft (kg/m)	Span Condition[6,7]	Uniform Load = 12 psf (0.479 kPa)				
			Member Spacing, in. (mm)				
			24 (610)	36 (914)	48 (1220)	60 (1520)	72 (1830)
			Allowable Hanger Wire or Support Spacing, ft-in. (mm)				
1½	414	Single	3-6 (1070)	3-1 (940)	2-9 (840)	2-9 (790)	2-5 (740)
(38)	(0.615)	2 or More	4-11 (1500)	4-2 (1270)	3-7 (1090)	3-2 (970)	2-11 (890)
2	506	Single	3-9 (1140)	3-3 (990)	3-0 (910)	2-9 (840)	2-8 (810)
(51)	(0.753)	2 or More	5-2 (1570)	4-6 (1370)	4-1 (1240)	3-10 (1170)	3-7 (1090)
2½	597	Single	3-11 (1190)	3-5 (1040)	3-2 (970)	2-11 (890)	2-9 (840)
(64)	(0.888)	2 or More	5-5 (1650)	4-9 (1450)	4-4 (1320)	4.0 (1220)	3-10 (1170)

Member Size, in. (mm)	Member Weight, lb/1000 ft (kg/m)	Span Condition[6,7]	Uniform Load = 15 psf (0.287 kPa)				
			Member Spacing, in. (mm)				
			24 (610)	36 (914)	48 (1220)	60 (1520)	72 (1830)
1½	414	Single	3-3 (990)	2-10 (860)	2-7 (790)	2-4 (710)	2-2 (660)
(38)	(0.616)	2 or More	4-6 (1370)	3-8 (1120)	3-2 (970)	2-10 (860)	2-7 (790)
2	506	Single	3-6 (1070)	3-1 (940)	2-10 (880)	2-7 (790)	2-5 (740)
(51)	(0.753)	2 or More	4-10 (1470)	4-3 (1300)	3-10 (1170)	3-6 (1070)	3-3 (990)
2½	597	Single	3-8 (1120)	3-3 (990)	2-11 (890)	2-9 (840)	2-7 (790)
(64)	(0.888)	2 or More	5-0 (1520)	4-5 (1350)	4-0 (1220)	3.9 (1140)	3-6 (1070)

Allowable Spans Notes:
[1] Spans based on upper flange of main runners laterally unbraced.
[2] Maximum deflection limited to 1/360 of the span length.
[3] Uniform load 12 psf (dry density) shall be used for portland cement plaster ceilings with plaster thicknesses up to ⅞ in. (22 mm) and 15 psf shall be used for ceilings with plaster thicknesses over ⅞ in. (22 mm) and not more than 1¼ in. (32 mm).
[4] "2 or More" spans refers to two or more continuous, equal spans.
[5] For the "2 or More" span condition, listed spans represent the center-to-center distance between adjacent framing members.
[6] These tables are designed for dead loads. Specific conditions such as exterior installations in high wind areas require additional engineering.
[7] Where uplift resistance is required for suspended ceilings to resist negative forces, the architect or engineer of record shall select the method to be used.

TABLE A1.2 Spans and Spacing of Cold-Rolled Channel Cross-furring Members[A, B, C]

Design Load, 12 psf (575 Pa)		Allowable Span, Main Runners or Supports Ft-in. (mm)	
Member Depth	Spacing, in. (mm)	Simple Span	Two or More Spans[D,E]
¾ (19)	13.5 (343)	2-9 (840)	3-5 (1040)
	16 (406)	2-7 (790)	3-3 (990)
	19 (483)	2-7 (740)	3-0 (910)
	24 (610)	2-3 (690)	2-10 (860)
1½ (38)	13.5 (343)	4-6 (1370)	5-8 (1730)
	16 (406)	4-3 (1300)	5-5 (1650)
	19 (483)	4-0 (1220)	5-1 (1550)
	24 (610)	3-8 (1120)	4-9 (1450)

[A] Spans based on upper flange of cross-furring laterally unbraced.
[B] Maximum deflection limited to ¹⁄₃₆₀th of span length unbraced.
[C] Tabulated spans apply only to cross-furring with webs oriented vertically.
[D] "Two or more" spans refers to two or more continuous, equal spans.
[E] For the "two or more" span conditions, listed spans represent the center-to-center distance between adjacent framing members.

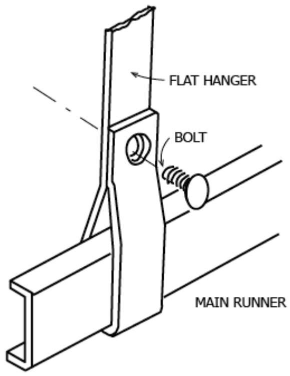

FIG. A1.1 Flat (Strap) Hanger Attached to Cold-rolled Channel Furring Main Runner Using Machine Bolt

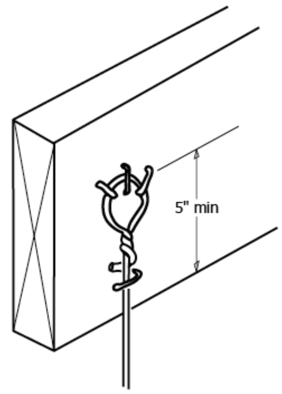

FIG. A1.4 Hanger Attached to Framing Member Using Staples

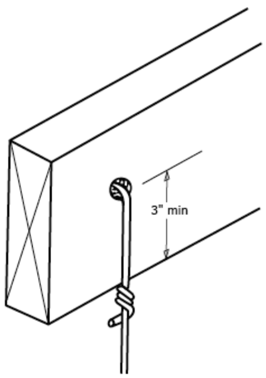

FIG. A1.2 Hanger Attached to Framing Member Through Drilled Hole

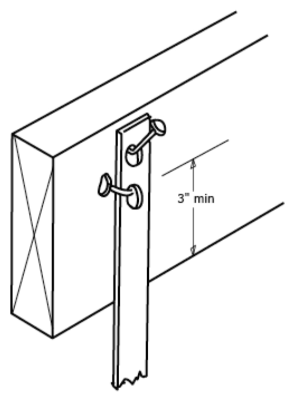

FIG. A1.5 Flat (Strap) Hanger Attached to Framing Member Using Nails

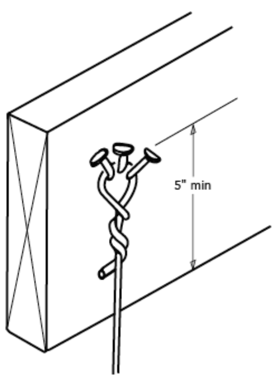

FIG. A1.3 Hanger Attached to Framing Member Using Nails

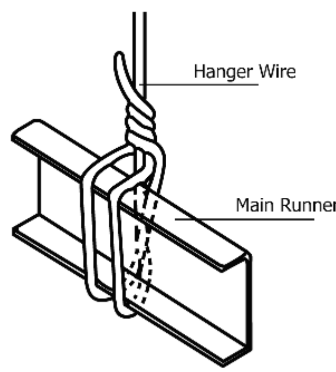

FIG. A1.6 Saddle Tie

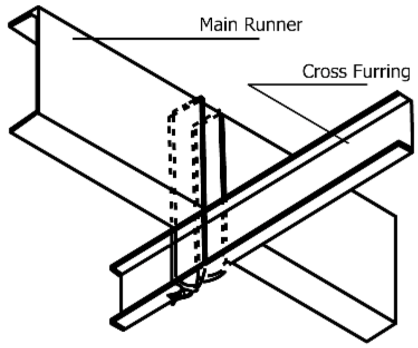

FIG. A1.7 Saddle Tie

APPENDIX

(Nonmandatory Information)

X1.1 The nominal lap values specified in 7.3.2.2 do not represent a maximum threshold value. Experience has shown that excessive lapping of expanded metal lath can inhibit proper embedment of the plaster in the underlying layer of lath which, in turn, can result in attendant corrosion and cracking of the stucco finishes. The nominal value provided in 7.3.2.2 has been shown to perform successfully; lath laps greater than this value may also perform successfully, but represent a heightened risk of embedment and cracking problems.

SUMMARY OF CHANGES

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 19) that may impact the use of this standard. (Approved March 1, 2019.)

(1) Added new 6.1.2 and renumbered subsequent sections accordingly.

~~SUMMARY OF CHANGES~~

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 18b) that may impact the use of this standard. (Approved Feb. 1, 2019.)

(1) Revised 1.1, 4.1.1 – 4.2.1, 4.2.3, 7.2, 7.2.3, 7.2.4, 7.3.1.1, 7.3.1.2, 7.3.1.7, 7.3.1.4 – 7.3.4.3, 7.4.1.
(2) Removed previous 5.2.2.3, 7.2 – 7.6.5, 7.9 – 7.9.3.1, 7.10.4 – 7.10.5, and Annex 1.
(3) Added 1.5 ("Table of Contents"), 7.9.8.1, Note 2, and Annex 1 (section and note numbers updated accordingly).
(4) Removed C841 from Section 2 ("Referenced Documents").
(5) Removed "ceiling" and "expansion" from Section 8 ("Keywords").
(6) Added "expansion joint" to Section 8 ("Keywords").
(7) Moved previous Figs. 1 – 7 to new Annex A1 and renumbered as Figs. A1.1 – A1.7 (references updated accordingly).
(8) Moved previous Tables 1 and 2 to new Annex A1 and renumbered as Tables A1.1 and A1.2 (references updated accordingly).

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 18a) that may impact the use of this standard. (Approved April 1, 2018.)

(1) Revised 7.9.2.
(2) Added new Appendix X1.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 18) that may impact the use of this standard. (Approved April 1, 2018.)

(1) Removed A0641_A0641M, B0069, B0221, C0954, C1002, D1784, and D4216 from list of referenced documents (Section 2).
(2) Added Specifications C1280 and C1861 to list of referenced documents (Section 2).
(3) Added new 3.1.2 and renumbered subsequent sections accordingly.
(4) Removed previous 6.3 – 6.3.2 with new 6 – 6.3.2.
(5) Removed previous 6.3.4 – 6.8.3.
(6) Revised 7.1, 7.2.1 – 7.2.5, 7.3.4, 7.4 – 7.5.4, 7.6 – 7.6.2, 7.7.1 – 7.7.3.
(7) Added new 7.8 and renumbered subsequent sections accordingly.
(8) Revised 7.9.2, 7.10.1.6, 7.10.1.7, 7.10.2.3, 7.10.3.2, 7.10.4, and 7.10.5.
(9) Removed previous 7.11 - 7.11.5 and replaced with new 7.11 - 7.11.11.4.
(10) Switched previous Tables 2 and 3 (and updated in-text table references accordingly).
(11) Revised Table 3 and title of Fig. 3.
(12) Removed previous A1.2 and A1.3.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 17b) that may impact the use of this standard. (Approved Jan. 1, 2018.)

(1) Revised 7.8.3, 7.8.3.1, 7.10.4.1.
(2) Replaced previous Table 3 with new Table 3.
(3) Added new 2.2.
(4) Added new Section 6, renumbered other sections accordingly.
(5) Updated titles of Sections 4 and 5.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 17a) that may impact the use of this standard. (Approved Dec. 1, 2017.)

(1) Revised 7.9.2.3 and 7.10.4.1.
(2) Combined previous Sections 4 and 5, added new Section 6, and renumbered subsequent sections accordingly.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 17a) that may impact the use of this standard. (Approved June. 1, 2017.)

(1) Added new 7.10.1.3.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 16c) that may impact the use of this standard. (Approved April 1, 2017.)

(1) Removed previous 3.2.1, 3.2.4–3.2.6, , 3.2.14, 7.9, and renumbered subsequent sections accordingly.
(2) Replaced the terms “member” and “support” with “framing member” throughout.
(3) Replaced the term “support” with “framing member”.
(4) Replaced the terms “application” and “applied” with “installation” and “installed” throughout.
(5) Removed previous Note 2 and placed its contents in new 5.3.3.
(6) Revised 7.10.1.4 and 7.9.2.2.
(7) Added new 5.1 and renumbered subsequent sections accordingly.
(8) Added new 5.8.3.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 16b) that may impact the use of this standard. (Approved Sept. 15, 2016.)

(1) Revised 5.3.2 and 7.10.1.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 16a) that may impact the use of this standard. (Approved Sept. 1, 2016.)

(1) Corrected table reference in 7.6.1.
(2) Added 7.10.1.4.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 – 16) that may impact the use of this standard. (Approved March 1, 2016.)

(1) Revised 1.1.
(2) Revised 7.10.1.2.

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Standard Specification for Application of Portland Cement-Based Plaster [1]

This standard is issued under the fixed designation C926; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

IN THIS STANDARD:

1 SCOPE

*A Summary of Changes section appears at the end of this standard.

1.1 This specification covers the requirements for the application of full thickness portland cement-based plaster for exterior (stucco) and interior work. ~~These requirements do not by default define a unit of work or assign responsibility for contractual purposes, which is the purview of a contract or contracts made between contracting entities.~~

1.2 This specification sets forth tables for proportioning of various plaster mixes and plaster thickness.

NOTE 1: General information will be found in Annex A1. Design considerations will be found in Annex A2.

1.3 The values stated in inch-pound units are to be regarded as the standard. The SI (metric) values given in parentheses are approximate and are provided for information purposes only.

1.4 The text of this specification references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the specification.

1.5 Details of construction for a specific assembly to achieve the required fire resistance shall be obtained from reports of fire-resistance tests, engineering evaluations, or listings from recognized fire testing laboratories. ~~1.6 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.~~

2 REFERENCED DOCUMENTS

2.1 ASTM Standards: [2]

C11 Terminology Relating to Gypsum and Related Building Materials and Systems

C25 Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime

C35 Specification for Inorganic Aggregates for Use in Gypsum Plaster

C91 Specification for Masonry Cement

C150 Specification for Portland Cement

C206 Specification for Finishing Hydrated Lime

C207 Specification for Hydrated Lime for Masonry Purposes

C219 Terminology Relating to Hydraulic Cement

C260 Specification for Air-Entraining Admixtures for Concrete

C578 Specification for Rigid, Cellular Polystyrene Thermal Insulation

C595 Specification for Blended Hydraulic Cements

C631 Specification for Bonding Compounds for Interior Gypsum Plastering

C897 Specification for Aggregate for Job-Mixed Portland Cement-Based Plasters

C932 Specification for Surface-Applied Bonding Compounds for Exterior Plastering

C1063 Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster

C1116 Specification for Fiber-Reinforced Concrete and Shotcrete

C1328 Specification for Plastic (Stucco) Cement~~ C1787 Specification for Installation of Non Metallic Plaster Bases (Lath) Used with Portland Cement Based Plaster in Vertical Wall Applications~~

E90 Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

E119 Test Methods for Fire Tests of Building Construction and Materials

E492 Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine

2.2 ANSI Standard:

A108.1 Specification for Installation of Ceramic Tile [3]

3 TERMINOLOGY

3.1 Terms shall be defined as in Terminologies C11 and C219, except as modified herein.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *accelerator, n*—an admixture that will shorten the setting time of plaster.

3.2.2 *admixture, n*—a material other than water, aggregate, or basic cementitious material added to the batch before or during job mixing.

3.2.3 *acid etching, n*—the cleansing and controlled erosion of a solid surface, using an acid wash.

3.2.4 *air entrainment, n*—the use of an air-entraining admixture or air-entraining cementitious material in a plaster mix to yield a controlled quantity of minute (typically between 10 and 1000 μm in diameter) disconnected air bubbles in the plaster (see *entrapped air*).

3.2.5 *back wrap, n*—a means of terminating a polymer-modified, fabric reinforced cementitious base coat by wrapping the reinforcing mesh, which has been affixed to the substrate onto the outboard surface of the foam plastic core to provide continuity of the reinforced base coat and protection for the foam plastic core.

3.2.6 *backplaster, n*—plaster applied to the face of metal lath opposite a previously applied plaster.

3.2.7 *barrier wall, n*—type of wall system that is intended to block or interrupt the movement of water to the interior.

3.2.8 *bond, n*—the state of adhesion between plaster coats or between plaster and plaster base.

3.2.9 *bonding compound or agent, n*—compounds surface applied or integrally mixed with plaster to improve the quality of bond between plaster and plaster base or between plaster coats.

3.2.10 cementitious material, n—a material that, when mixed with water and with or without aggregate, provides the plasticity and the cohesive and adhesive properties necessary for placement and the formation of a rigid mass.

3.2.11 coat, n—a thickness of plaster applied in a single operation.

3.2.11.1 *basecoat, n*—all plaster applied before the application of the finish coat.

3.2.11.2 *bedding coat, n*—a plaster coat that receives aggregate or other decorative material impinged into its surface before it sets.

3.2.11.3 *brown coat, n*—in three-coat work, the second coat, applied over the scratch coat. In two-coat work, brown coat refers to the double-up basecoat. In either use, the brown coat is the coat directly beneath the finish coat.

3.2.11.4 *dash-bond coat, n*—a thick wet mixture of portland cement and water, with or without aggregate, dashed onto the surface of a plaster base such as smooth monolithic concrete or concrete block surfaces to improve the mechanical key for subsequent plaster coats.

3.2.11.5 *double-up coat, n*—the brown-coat plaster applied to the scratch coat plaster before the scratch-coat plaster has set.

3.2.11.6 *finish coat, n*—the final layer of plaster applied over basecoat plaster.

3.2.11.7 *fog coat, n*—a light coat of cement and water, with or without aggregate or color pigment, applied by machine spray to improve color consistency.

3.2.11.8 *scratch coat, n*—the first coat of plaster applied to a plaster base.

3.2.11.9 *skim coat, n*—a thin finish coat applied to an existing plaster surface or other substrate to improve appearance.

3.2.11.10 *three-coat work, n*—application of plaster in three successive coats with time between coats for setting or drying, or both.

3.2.12 cold joint ("joining" or "jointing"), n—the juncture of fresh plaster application adjacent to set plaster, in the same plane.

3.2.13 curing, v—the act or processes of producing a moisture environment favorable to cement hydration, resulting in the setting or hardening of the plaster.

3.2.14 drainage wall, n—a wall system in which the cladding provides a substantial barrier to water intrusion, and which also incorporates a concealed water-resistive barrier over which drainage will occur.

3.2.15 entrapped air, n—unintentional air voids in the plaster generally larger than 1 mm.

3.2.16 factory prepared ("mill-mixed" or "ready mixed"), adj—pertaining to material combinations that have been formulated and dry-blended by the manufacturer, requiring only the addition of and mixing with water to produce plaster.

3.2.17 fiber, natural or synthetic, n—an elongated fiber or strand admixture added to plaster mix to improve cohesiveness or pumpability, or both.

3.2.18 floating, v—act of compacting and leveling brown-coat plaster to a reasonably true surface plane using a float tool or the act of bringing the aggregate to the surface of finish-coat plaster.

3.2.19 key (also mechanical key), n—plaster that physically surrounds, penetrates, or deforms to lock onto the perforations or irregularities of the plaster base or previous coat of plaster.

3.2.20 metal plaster base, n—expanded metal lath, or welded or woven wire lath.

3.2.21 plaster, n—portland cement-based cementitious mixture (see *stucco*).

3.2.22 polymer modified cementitious base coat, n—A base coat containing portland cement modified with chemical admixtures (typically polymer latexes) to improve characteristics of the finished product, such as workability, plasticity, water resistance, and adhesion.

3.2.23 required, adj—pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.

3.2.24 rustication (also "break"), n—an interruption or change in plane of a plastered surface.

3.2.25 scoring (also known as "scratching"), n—the grooving of the surface of an unset plaster coat to provide a key for a subsequent coat.

3.2.26 set, n—the chemical and physical change in plaster as it goes from a plastic, workable state to a rigid state.

3.2.27 solid plaster bases, n—substrates that do not require a metal plaster base, including cast in place and precast concrete, concrete and stone masonry, clay brick, and tile.

3.2.28 stucco, n—portland cement-based plaster used on exterior locations.

3.2.29 stucco finish, n—a factory-prepared, dry blend of materials for finish coat applications.

3.2.30 temper, v—to mix or restore unset plaster with water to a workable consistency.

3.2.31 texture, n—any surface appearance as contrasted to a smooth surface. ~~3.3 Definitions of Terms Not Specific to This Standard 3.3.1 contract documents, n—a series of several individual items that generally include drawings and specifications. Either or both of these documents may exist for any particular project.~~

4 ~~DELIVERY AND STORAGE OF~~ MATERIALS

4.1 ~~Delivery: 4.1.1 Packaged materials shall be delivered in factory-sealed, unopened, and unbroken packages, containers, or bundles. 4.1.2 Bulk materials shall be delivered in clean transport vessels, free of contaminates. 4.2 Storage: 4.2.1 Weather-sensitive materials shall be kept in a dry condition until ready for use. (See A2.4.) 4.2.2 Bulk materials shall be stored to prevent subsequent contamination and segregation. 5~~ Materials ~~5.1 Materials~~ shall conform to the requirements of the referenced specifications and standards and to the requirements specified herein. ~~5.2~~

4.2 Cement: ~~5.2.1~~

4.2.1 *Portland Cement*—Specification C150, Type I, II, and III, as specified. White where specified. ~~5.2.2~~

4.2.2 *Air-Entraining Portland Cement*—Specification C150, type as specified. White where specified. ~~5.2.3~~

4.2.3 *Masonry Cement*—Specification C91, Types N, S, and M. White where specified. ~~5.2.4~~

4.2.4 *Blended Hydraulic Cement*—Specification C595, Type IP, IS(µε70), IL, and IT(Sµε70), as specified. ~~5.2.5~~

4.2.5 *Air-Entraining Blended Hydraulic Cement*—Specification C595, Type IP-(A), IS(µε70)-(A), IL-(A), and IT (Sµε70)-(A), as specified. ~~5.2.6~~

4.2.6 *Plastic Cement*—Plastic Cement shall meet the requirements of Specification C1328, Standard Specification for Plastic (Stucco) Cement.

NOTE 2: Plastic cements are not available nationally. ~~5.3~~

4.3 Type "S" Hydrated Lime—A hydrated lime that contains not more than 8 % unhydrated oxides when tested in accordance with Test Methods C25. See Specifications C206 and C207 for a complete description of a Type "S" hydrated lime. ~~5.4~~

4.4 Aggregates: ~~5.4.1~~

4.4.1 *Sand for Base Coats*—Specification C897. Aggregate failing to meet gradation limits in Specification C897 shall be permitted to be used, provided the plaster made with this sand has an acceptable demonstrated performance record in similar construction and climate conditions. ~~5.4.2~~

4.4.2 *Perlite*—Specification C35. ~~5.4.3~~

4.4.3 *Sand for Job-Mixed Finish Coats*—Specification C897. ~~5.5~~

4.5 Water—Water used in mixing, application, and finishing of plaster shall be clean, fresh, suitable for domestic water consumption, and free of such amounts of mineral or organic substances as would affect the set, the plaster, or any metal in the system. ~~5.6~~

4.6 Admixtures—See 3.2.2 and A2.5. ~~5.7~~

4.7 Fibers—Specification C1116 on alkali-resistant fibers, glass fibers, nylon, polypropylene or carbon fibers. ~~5.8~~

5 ~~PRODUCT MARKING—PACKAGED MATERIALS SHALL BE CLEARLY MARKED OR LABELED TO INDICATE PRODUCT, BRAND NAME, THE MANUFACTURER, AND THE WEIGHT OF THE MATERIAL CONTAINED THEREIN. SIMILAR INFORMATION SHALL BE PROVIDED IN THE SHIPPING ADVICES ACCOMPANYING THE SHIPMENT OF BULK MATERIALS. 6~~ REQUIREMENTS FOR BASES TO RECEIVE PORTLAND CEMENT-BASED PLASTER ~~6.1~~

5.1 Metal ~~plaster~~ bases ~~bases,~~ and ~~lathing accessories, furring~~ accessories ~~and fasteners~~ used to receive plaster shall be installed in conformance with Specification C1063, except as otherwise specified. ~~Non-metallic~~

NOTE ~~PLASTER~~ 3: ~~bases~~ All ~~used~~ metal, ~~to~~ or ~~receive~~ PVC, ~~plaster~~ or ~~shall~~ CPVC ~~be~~ plastic ~~installed~~ members ~~in~~ should ~~conformance with Specification C1787. Note 3: Plaster bases and lathing accessories shall~~ be free of deleterious amounts of rust, oil, or other foreign matter, which could cause bond failure or unsightly discoloration. ~~6.2~~

5.2 Surfaces of solid bases to receive plaster, such as masonry, stone, cast-in-place or precast concrete shall be straight and true within 1/4 in. ~~(6 mm)~~ in 10 ft ~~(3~~ (2.1 ~~m)~~ mm/m) and shall be free of form oil or other elements, which would interfere with bonding. Conditions where the surfaces are out of tolerance shall be corrected prior to the application of the plaster. Ferrous-containing form ties or other obstructions shall be removed or receded a minimum ~~1~~ 1/8~~/8~~ in. (3 mm) below the surface of the solid base and treated with a corrosion-resistant coating. Non-ferrous protuberances shall be permitted to be trimmed back even with the surface of the solid base. ~~6.2.1~~

5.2.1 Solid surfaces shall have the suction (ability to absorb water) or surface roughness, or both, to provide the bond required for the plaster. ~~6.2.2~~

5.2.2 Smooth or nonabsorbent solid surfaces, such as cast-in-place or precast concrete, shall be prepared to receive portland cement plaster by one of the following methods: ~~6.2.2.1~~

5.2.2.1 Sandblasting, wire brushing, acid etching, or chipping or a combination thereof, ~~6.2.2.2~~

5.2.2.2 Application of a dash-bond coat applied forcefully against the surface, left untroweled, undisturbed, and moist cured for at least 24 h, or ~~6.2.2.3~~

5.2.2.3 Application of a bonding compound suitable for exterior or interior exposure solid surfaces in accordance with the manufacturer's written directions. ~~6.2.3~~

5.2.3 Where bond cannot be obtained by one or more of the methods in ~~6.2.2~~ 5.2.2, a furred or self-furring metal plaster base shall be installed in accordance with Specification C1063 ~~or~~. ~~C1787 as appropriate.~~ Where metal plaster base is used in areas where bond cannot be obtained by one or more of the methods in ~~6.2.2~~ 5.2.2, accessories shall be installed in accordance with Specification C1063 ~~or~~. ~~C1787~~

6 ~~AS~~ PLASTER ~~APPROPRIATE.~~ PROPORTIONS ~~7~~ AND ~~APPLICATION~~ MIXING ~~7.1~~

6.1 ~~Plaster~~ Proportions: ~~7.1.1~~

6.1.1 All portland cement plasters shall be mixed and proportioned in accordance with the following tables and accompanying requirements, using measuring devices of known volume with successive batches proportioned alike. ~~7.1.2~~

6.1.2 Plaster mix used shall be as designated and referenced to Table 1.

TABLE 1 Plaster Bases—Permissible Mixes

NOTE 1: See Table 2 for plaster mix symbols.

Property of Base	Mixes for Plaster Coats	
	First (Scratch)	Second (Brown)
Low absorption, such as dense, smooth clay tile, brick, or concrete	C	C, CL, M, or CM
	CM or MS	CM, MS, or M
	P	P
High Absorption, such as concrete masonry, absorptive brick, or tile	CL	CL
	M	M
	CM or MS	CM, MS, or M
	P	P
Metal plaster base	C	C, CL, M, CM, or MS
	CL	CL
	CM or MS	CM, MS, or M
	M	M
	CP	CP or P
	P	P ~~7.1.3~~

6.1.3 Base-coat proportions shall be as shown in Table 2 for the mix specified from Table 1.

TABLE 2 Base-Coat Proportions,[A] Parts by Volume[B]

Plaster Mix Symbols	Cementitious Materials					Volume of Aggregate per Sum of Separate Volumes of Cementitious Materials	
	Portland Cement or Blended Cement	Plastic Cement	Masonry Cement		Lime		
			N	M or S		1st Coat	2nd[C] Coat
C	1	. . .	. . .	. . .	0–3/4	2 1/2–4	3–5
CL	1	. . .	. . .	. . .	3/4–1 1/2	2 1/2–4	3–5
M	. . .	. . .	1	. . .	. . .	2 1/2–4	3–5
CM	1	. . .	1	. . .	. . .	2 1/2–4	3–5
MS	. . .	. . .	. . .	1	. . .	2 1/2–4	3–5

Plaster Mix Symbols	Cementitious Materials					Volume of Aggregate per Sum of Separate Volumes of Cementitious Materials	
	Portland Cement or Blended Cement	Plastic Cement	Masonry Cement		Lime	1st Coat	2nd Coat
			N	M or S			
P	. . .	1	. . .	. . .	. . .	$2^1/_2$–4	3–5
CP	1	1	. . .	. . .	. . .	$2^1/_2$–4	3–5

(A) The mix proportions for plaster scratch and brown coats to receive ceramic tile shall be in accordance with the applicable requirements of ANSI A108.1 series applicable to specified method of setting time.

(B) Variations in lime, sand, and perlite contents are allowed due to variation in local sands and insulation and weight requirements. A higher lime content will generally support a higher aggregate content without loss of workability. The workability of the plaster mix will govern the amounts of lime, sand, or perlite.

(C) The same or greater sand proportion shall be used in the second coat than is used in the first coat.~~7.1.3.1~~

6.1.3.1 Measurement of Materials—**The method of measuring materials for the plaster shall be such that the specified proportions are controlled and accurately maintained. The weights per cubic foot of the materials are considered to be as follows:**

Material	Weight, lb/ft^3 (kg/m^3)
Portland cement	94 (1505)
Blended cement	Weight printed on bag
Masonry or plastic cement	Weight printed on bag
Hydrated Lime	40 (640)
Lime Putty	80 (1280)
Sand, Damp and Loose (~~7.1.3.2~~6.1.3.2)	80 (1280) of dry sand~~7.1.3.2~~

6.1.3.2 **For purposes of this specification, a weight of 80 lb (1280 kg) of oven-dried sand shall be used. This is, in most cases, equivalent to one cubic foot of loose, damp sand.~~7.1.4~~**

6.1.4 **Finish-coat proportions for job-mixed finish coats shall be as specified in Table 3.**

TABLE 3 Job-Mixed Finish Coat Proportion Parts by Volume

Plaster Mix Symbols[A]	Cementitious Materials					Volume of Aggregate per Sum of Separate Volumes of Cementitious Materials[B]
	Portland Cement or Blended Cement	Plastic Cement	Masonry Cement[A]		Lime	
			N	M or S		
F	1	. . .	. . .	. . .	$^3/_4$–$1^1/_2$	$1^1/_2$–3
FL	1	. . .	. . .	. . .	$1^1/_2$–2	$1^1/_2$–3
FM	. . .	. . .	1	. . .	. . .	$1^1/_2$–3
FCM	1	. . .	1	. . .	. . .	$1^1/_2$–3
FMS	. . .	. . .	. . .	1	. . .	$1^1/_2$–3

Plaster Mix Symbols	Cementitious Materials					Volume of Aggregate per Sum of Separate Volumes of Cementitious Materials
	Portland Cement or Blended Cement	Plastic Cement	Masonry Cement		Lime	
			N	M or S		
FP	. . .	1	. . .	. . .	. . .	$1^1/_2$–3

(A) Additional portland cement is not required when Type S or M masonry cement is used.

(B) In areas not subject to impact, perlite aggregate shall be permitted to be used over base-coat plaster containing perlite aggregate.~~7.1.5~~

6.1.5 ***Factory-Prepared Finish Coats***—See 3.2.16.~~7.1.6~~

6.1.6 Dash-bond coat proportions shall be 1 volume part portland cement and not more than 2 volume parts of aggregate mixed to a consistency that will permit application as specified in ~~7.3.5~~ 7.1.5. ~~7.1.7~~

6.1.7 Admixtures shall be proportioned, mixed, and applied in accordance with the printed directions of the manufacturer. (See A2.5.)~~7.1.8~~

6.2 ~~Where specified, natural or synthetic fibers shall be free of contaminants and used only in the base coat(s). The quantities per batch shall be in accordance with the published directions of the fiber manufacturer. 7.2~~ Mixing:~~7.2.1~~

6.2.1 All plaster shall be prepared in a mechanical mixer, using sufficient water to produce a workable consistency and uniform color. (See X1.1.)~~7.2.2~~

6.2.2 Base-coat plasters that have stiffened because of evaporation of water shall be permitted to be tempered one time only to restore the required consistency. Plaster not used within $1^1/_2$ h from start of initial mixing shall be discarded.

NOTE 4: Severe hot, dry climate conditions accelerate the stiffening of plaster and require reduction of this limit. The use of cold waters will slow the stiffening process.~~7.2.3~~

6.2.3 Finish-coat plaster shall not be tempered.~~7.3~~

7 ~~GENERAL~~ APPLICATION ~~APPLICATION:~~

7.1 ~~7.3.1~~ General:

7.1.1 Portland cement plaster shall be applied by hand ~~trowel~~ or machine to the nominal thickness specified in Table 4. The nominal values expressed in Table 4 represent neither a maximum nor minimum value. They consider the inherent variation of thickness due to the nature of the application process, and the allowable variation of the substrate and the finished plane of the plaster.

TABLE 4 Nominal Plaster Thickness[A] for Three- and Two-Coat Work, in. (mm)

BASE	Vertical				Horizontal			
	1st Coat	2nd Coat	3rd Coat[B]	Total	1st Coat	2nd Coat	3rd Coat[B]	Total
	Interior/Exterior							
Three-coat work:[C]								
Metal plaster base	$^3/_8$ ~~(10)~~ (9.5)	$^3/_8$ ~~(10)~~ (9.5)	$^1/_8$ (3)	$^7/_8$ (22)	$^1/_4$ (6)	$^1/_4$ (6)	$^1/_8$ (3)	$^5/_8$ (16)
Solid plaster base:								

BASE	Vertical				Horizontal			
	1st Coat	2nd Coat	3rd Coat	Total	1st Coat	2nd Coat	3rd Coat	Total
	Interior/Exterior							
Unit masonry	1/4 (6)	1/4 (6)	1/8 (3)	5/8 (16)	Use two-coat work			
Cast-in-place or precast concrete	1/4 (6)	1/4 (6)	1/8 (3)	5/8 (16)				3/8 ~~(10),~~ (9.5), max
Metal plaster base over solid base	1/2 ~~(13)~~ (12.5)	1/4 (6)	1/8 (3)	7/8 (22)	1/2 ~~(13)~~ (12.5)	1/4 (6)	1/8 (3)	7/8 (22)
Two-coat work:								
Solid plaster base:								
Unit masonry	3/8 ~~(10)~~ (9.5)	1/8 (3)		1/2 ~~(13)~~ (12.5)				3/8 ~~(10)~~ (9.5)
Cast-in-place or pre-cast concrete	1/4 (6)	1/8 (3)		3/8 ~~(10)~~ (9.5)				3/8 ~~(10)~~ (9.5)

(A) Exclusive of texture.

(B) For solid plaster partitions, additional coats shall be applied to meet the finished thickness specified.

(C) For exposed aggregate finishes, the second (brown) coat shall become the "bedding" coat and shall be of sufficient thickness to receive and hold the aggregate. ~~7.3.2~~

7.1.2 Plaster nominal thickness shall be measured from the back plane of the metal plaster base, exclusive of ribs or dimples, or from the face of the solid backing with or without metal plaster base, to the outer surface exclusive of texture variations. ~~7.3.3~~

7.1.3 Portland cement-based plaster shall be applied on furred metal plaster base when the surface of solid backing consists of gypsum board, gypsum plaster, wood, or rigid foam board-type products.

NOTE 5: On horizontal ceiling supports or roof soffits protected by a drip ~~edge~~ edge, ~~or designated drainage screed,~~ gypsum board products shall be permitted to be used as backing for metal base to receive portland cement plaster. ~~7.3.4~~

7.1.4 Separation shall be provided where plaster abuts dissimilar construction materials or openings. (See ~~A2.1.3~~ A2.1.4.) ~~7.3.5~~

7.1.5 Each plaster coat shall be applied to an entire wall or ceiling panel without interruption to avoid cold joints and abrupt changes in the uniform appearance of succeeding coats. Wet plaster shall abut set plaster at naturally occurring interruptions in the plane of the plaster, such as corner angles, rustications, openings, expansion joints, and control joints where this is possible. Joinings, where necessary, shall be cut square and straight and not less than 6 in. (152 mm) away from a joining in the preceding coat. ~~7.3.6~~

7.1.6 Metal plaster base shall be covered with three-coat work with or without solid backing. The combined total nominal thickness shall be as shown in Table 4. A dash-bond coat shall not replace one of the specified number of coats. ~~7.3.7~~

7.1.7 Two-coat work shall be used only over solid bases meeting the requirements of ~~6.2~~ 5.2. The combined total nominal thickness shall be as shown in Table 4. A dash-bond coat shall not replace one of the specified number of coats. ~~7.3.8~~

7.1.8 Backplaster where required, shall be applied only after the coat on the opposite side has set sufficiently to resist breaking or cracking the plaster keys. ~~7.3.9~~

7.1.9 Each coat shall be permitted to set before the next coat is applied. (See X1.5.2.) ~~7.3.10~~

7.1.10 Plaster coats that have become dry shall be evenly dampened with water prior to applying subsequent coats to obtain uniform suction. There shall be no visible water on the surface when plaster is applied. ~~7.4~~

7.2 Plaster Application on Metal ~~and Non-Metallic~~ Plaster Bases: ~~7.4.1~~

7.2.1 The first (scratch) coat shall be applied with sufficient material and pressure to form full keys through, and to embed the metal base, and with sufficient thickness of material over the metal to allow for scoring the surface. ~~7.4.1.1~~

7.2.1.1 As soon as the first (scratch) coat becomes firm, the entire surface shall be scored in one direction only. The vertical surfaces shall be scored horizontally. ~~7.4.1.2~~

7.2.1.2 The first (scratch) coat shall become sufficiently rigid to support the application of the second (brown) coat without damage to the monolithic continuity of the first (scratch) coat or its key. ~~7.4.2~~

7.2.2 The second (brown) coat shall be applied with sufficient material and pressure to ensure tight contact with the first (scratch) coat and to bring the combined thickness of the base coat to the nominal thickness shown in Table 4. ~~7.4.2.1~~

7.2.2.1 The surface of the second (brown) coat shall be brought to a true, even plane with a rod or straightedge, filling surface defects in plane with plaster. Dry rodding the surface of the brown coat shall be permitted. ~~7.4.2.2~~

7.2.2.2 The surface shall be floated uniformly to promote densification of the coat and to provide a surface receptive to bonding of the finish coat. ~~7.4.3~~

7.2.3 The third (finish) coat shall be applied with sufficient material and pressure to ensure tight contact with, and complete coverage of the base coat and to the nominal thickness shown in Table 4 and ~~7.5.1.1~~ 7.3.1.1. ~~7.5~~

7.3 Plaster Application on Solid Plaster Bases: ~~7.5.1~~

7.3.1 High-suction bases shall be evenly dampened with clean water prior to the application of plaster. Do not dampen low-suction solid bases, such as dense concrete or smooth brick. ~~7.5.1.1~~

7.3.1.1 Where masonry or concrete surfaces vary in plane, plaster thickness required to produce level surfaces shall not be required to be uniform. ~~7.5.2~~

7.3.2 *Three-Coat Application on Solid Bases:* ~~7.5.2.1~~

7.3.2.1 The first (scratch) coat shall be applied with sufficient material and pressure to ensure tight contact and complete coverage of the solid base, to the nominal thickness shown in Table 4. As soon as the first (scratch) coat becomes firm, the entire surface shall be scored in one direction only. The vertical surfaces shall be scored horizontally. ~~7.5.2.2~~

7.3.2.2 The second (brown) coat shall be applied using the same procedures specified in ~~7.4.2~~ 7.2.2 and ~~7.4.2.1~~ 7.2.2.1, bringing the surface to a true, even plane with a rod or straightedge, filling any defects in plane with plaster and darbying. The surface shall be floated uniformly to provide a surface receptive to the application of the third (finish) coat. ~~7.5.2.3~~

7.3.2.3 The third (finish) coat shall be applied as specified in ~~7.4.3~~ 7.2.3. ~~7.5.3~~

7.3.3 *Two-Coat Application on Solid Plaster Bases:* ~~7.5.3.1~~

7.3.3.1 The first (scratch) coat shall be applied as specified in ~~7.5.2.1~~ 7.3.2.1. ~~7.5.3.2~~

7.3.3.2 The second (finish) coat shall be applied as specified in ~~7.4.3~~ 7.2.3. ~~7.6~~

7.4 Finish-Coat Application: ~~7.6.1~~

7.4.1 Job-mixed or factory-prepared finish coats shall be applied, by machine or by hand, as specified in ~~7.4.3~~ 7.2.3. ~~*7.6.2*~~

7.4.2 The use of excessive water during the application and finishing of finish-coat plaster shall be avoided. ~~*7.7*~~

7.5 Fog-Coat Application—Job-mixed or factory-prepared fog coats shall be applied in accordance with the directions of the manufacturer. ~~*7.8*~~

8 CURING AND TIME BETWEEN COATS ~~7.8.1~~

8.1 Provide sufficient moisture in the plaster mix or by moist or fog curing to permit continuous hydration of the cementitious materials. The most effective procedure for curing and time between coats will depend on climatic and job conditions. (See X1.5.2.) ~~*7.8.2*~~

8.2 Sufficient time between coats shall be allowed to permit each coat to cure or develop enough rigidity to resist cracking or other physical damage when the next coat is applied. (See X1.5.2.) ~~*7.9*~~

9 PRODUCT MARKING

9.1 Packaged materials shall be clearly marked or labeled to indicate product, brand name, the manufacturer, and the weight of the material contained therein. Similar information shall be provided in the shipping advices accompanying the shipment of bulk materials.

10 DELIVERY OF MATERIALS

10.1 Packaged materials shall be delivered in factory-sealed, unopened, and unbroken packages, containers, or bundles.

10.2 Bulk materials shall be delivered in clean transport vessels, free of contaminates.

11 PROTECTION OF MATERIALS

11.1 Weather-sensitive materials shall be kept in a dry condition until ready for use. (See A2.4.)

11.2 Bulk materials shall be stored to prevent subsequent contamination and segregation.

12 ENVIRONMENTAL ~~CONDITIONS:~~ CONDITIONS ~~7.9.1~~

12.1 Portland cement-based plaster shall not be applied to frozen base or to a base containing frost. Plaster mixes shall not contain frozen ingredients. Plaster coats shall be protected from freezing for a period of not less than 24 h after set has occurred. ~~*7.9.2*~~

12.2 Portland cement plaster shall be protected from uneven and excessive evaporation during dry weather and from strong blasts of dry air. ~~*7.9.3*~~

12.3 Plaster Application—When artificial heat is required, heaters shall be located to prevent a concentration of heat on uncured plaster. Heaters shall be vented to the outside to prevent toxic fumes and other products of combustion from adhering to or penetrating plaster bases and plaster. Adequate ventilation shall be maintained in all areas, particularly in interior areas with little or no natural air movement. ~~*7.9.3.1*~~

12.3.1 Interior environment shall be maintained at a temperature above 40 °F not less than 48 h prior to and during application of portland cement-based plaster. Interior temperature shall be maintained above 40 °F until normal occupancy. ~~*7.9.3.2*~~

12.3.2 For exteriors, plaster shall be applied when the ambient temperature is higher than 40 °F (4.4 °C), unless the work area is enclosed and heat is provided as described in ~~7.9.3~~ 12.3. ~~8~~

13 KEYWORDS ~~8.1~~

13.1 bond; brown coat; cementitious; exterior plaster; fog coat; portland cement; scratch coat; stucco

ANNEXES

(Mandatory Information)

A1 GENERAL INFORMATION

A1.1 The work shall include all labor, materials, services, equipment, and scaffolding required to complete the plastering of the project in accordance with the drawings and specifications, except heat, electric power, and potable water.

A1.2 Where a specific degree of fire resistance is required for plastered assemblies and constructions, details of construction shall be in accordance with official reports of fire tests conducted by recognized testing laboratories, in accordance with Test Methods E119. ~~A1.2~~

A1.3 Where a specific degree of sound control is required for plastered assemblies and constructions, details of construction shall be in accordance with official reports of tests conducted by recognized testing laboratories, in accordance with applicable sound tests of Test Methods E90 or E492. ~~A1.3~~

A1.4 Scaffolding shall be constructed and maintained in strict conformity with applicable laws and ordinances. ~~A1.4~~

A1.5 Work schedules shall provide for completion of work affecting supports, framework or lath of a suspended ceiling (such as loading) before plastering work is accomplished. ~~A1.5~~

A1.6 Surfaces and ~~lathing~~ accessories to receive plaster shall be examined before plastering is applied thereto. The proper authorities shall be notified and unsatisfactory conditions shall be corrected prior to the application of plaster. The plastering contractor shall use this portion of the construction specifications for acceptance or rejection of such surfaces. ~~A1.5.1~~

A1.6.1 Metal plaster bases, backing, attachment, and ~~lathing~~ accessories to receive plaster shall be examined to determine if the applicable requirements of Specification C1063 have been met unless otherwise required by the contract specifications. ~~A1.5.2~~

A1.6.2 ~~Lathing~~ Accessories ~~accessories~~ shall be installed prior to the application of plaster; therefore, their type, ~~location;~~ depth, ~~ground dimension;~~ and ~~orientation~~ location shall be included in the project contract documents. ~~Where~~

A1.6.3 ~~masonry or concrete surfaces vary in plane, plaster thickness required to produce level surfaces shall not be required to be uniform. A1.5.3~~ The construction specifier shall describe, in the proper section of the contract specifications, the physical characteristics of solid surface bases to receive plaster, including measures to promote bond. The plane tolerance shall be not more than $^1/_4$ in. ~~(6 mm)~~ in 10 ft ~~(3~~ (3.1 ~~m).~~ mm/m). The mortar joints shall be flush and not struck. Dissimilar ferrous-containing materials such as ties, reinforcing steel, and so forth, shall be cut back a minimum $^1/_8$ in. (3 mm) below the surface and treated with a corrosion-resistant coating. Dissimilar non-ferrous protuberances shall be permitted to be trimmed back even with the surface of the solid base. Masonry shall be solid at corners and where masonry changes thickness in a continuous construction. Form release compounds shall be compatible with plaster or be completely removed from surfaces to receive plaster.

A2 DESIGN CONSIDERATIONS

A2.1 Exterior plaster (stucco) is applied to outside surfaces of all types of structures to provide a durable, fire-resistant covering. Interior plaster is applied to inside surfaces that will be subjected to various exposures, such as abrasion, vibration, or to continuous or frequent moisture and wetting, or to freezing or thawing.

A2.1.1 Sufficient slope on faces of plastered surfaces shall be provided to prevent water, snow, or ice from accumulating or standing. Air-entrained portland cement plaster provides improved resistance to freeze/thaw deterioration. Resistance to rain penetration is improved where plaster has been adequately densified during application and properly cured. Plaster shall not, however, be considered to be "waterproof."

A2.1.2 The construction specifier shall describe, in the appropriate section of the contract specifications, the requirements for furnishing and application of flashing. Flashing shall be specified at openings, perimeters, and terminations to prevent water from getting behind plaster. Flashing shall be corrosion-resistant material. Aluminum flashing shall not be used. Flashing supplemented with sealant shall be permitted.~~ provided the flashing and sealant are designed in a manner that does not inhibit drainage.~~

A2.1.3 Sealing or caulking of V-grooves, exposed ends, and edges of plaster panels or exterior work to prevent entry of water shall be provided.

A2.1.4 To reduce spalling where interior plaster abuts openings, such as wood or metal door or window frames, or fascia boards, the edge of three-coat plaster shall be tooled through the second and finish coats to produce a continuous small V-joint of uniform depth and width. On two-coat work, the V-joint shall be tooled through the finish coat only.

A2.1.5 Provide in the appropriate project specification section that solid bases to receive plaster shall not be treated with bond breakers, parting compounds, form oil, or other material that will prevent or inhibit the bond of the plaster to the base.

A2.1.6 Maximum allowable deflection for vertical or horizontal framing for plaster, not including cladding, shall be L/360.

A2.2 *Provisions for Drainage Behind Exterior Plaster:*

A2.2.1 At the bottom of exterior ~~drainage~~ walls where the ~~drainage~~ wall ~~plane~~ is ~~interrupted~~ supported by a ~~floor,~~ floor ~~supporting structure,~~ or foundation, ~~or~~ a ~~when~~ drip ~~drainage~~ screed ~~wall~~ and ~~assemblies~~ throughwall ~~are~~ flashing ~~constructed~~ or ~~above~~ weep ~~barrier~~ holes ~~wall assemblies, a designated drainage screed, flashing,~~ or other effective means to drain away any water that may get behind the plaster shall be provided.

A2.2.2 Where vertical and horizontal exterior plaster surfaces meet, both surfaces shall be terminated with casing beads with the vertical surface extending at least $^1/_4$ in. (6 mm) below the intersecting horizontal plastered surface, thus providing a drip edge. The casing bead for the horizontal surface shall be terminated not less than $^1/_4$ in. ~~(6 mm)~~ from the back of the vertical surface to provide drainage.

A2.3 *Relief from Stresses:*

A2.3.1 For information on the requirements for control joints and perimeter relief, where a metal plaster base is installed; see the Installation Section of ~~Specifications~~ Specification C1063 ~~or~~. ~~C1787 as applicable.~~ Solid plaster bases are exempt from these criteria, except as stated in Specification C1063, subsection 7.11.4.3.

A2.3.1.1 ~~Clean~~ Control ~~cement~~ joints ~~plaster~~ shall ~~residue~~ be ~~from~~ cleaned ~~the~~ and ~~movement~~ clear ~~gaps~~ of ~~expansion~~ plaster ~~joints~~ within ~~and from~~ the ~~flexible~~ control ~~pleats~~ area ~~of~~ after ~~control~~ plaster ~~joints~~ application and before ~~cement~~ final plaster ~~hardens.~~ set.

A2.3.1.2 Prefabricated control joints and expansion joint members shall be installed prior to the application of plaster. Their type, location, ~~ground~~ depth, ~~dimension, orientation,~~ and method of installation shall be determined by the characteristics of the substrate and included in the project contract documents.

A2.3.1.3 A groove or cut in plaster only shall not be considered a control or expansion joint.

A2.3.2 Where plaster and metal plaster base continues across the face of a concrete column, or other structural member, ~~a~~ water-resistive ~~barrier~~ building paper or felt shall be placed between the metal plaster base and the structural member (paper or plastic-backed metal plaster base shall be permitted). Where the width of the structural member exceeds the approved span capability of the metal plaster base, self-furring metal plaster base shall be used and sparingly scatter nailed to bring ~~the~~ paper ~~plaster~~ and metal base to general plane.

A2.3.3 Where dissimilar base materials abut and are to receive a continuous coat of plaster: (*1*) a two-piece expansion joint, casing beads back-to-back, or premanufactured control-expansion joint member shall be installed; or (*2*) the juncture shall be covered with a 6-in. (152 mm) wide strip of galvanized, self-furring metal plaster base extending 3 in. (76 mm) on either side of the juncture; or (*3*) where one of the bases is metal plaster base, self-furring metal plaster base shall be extended 4 in. (102 mm) onto the abutting base.

A2.4 *Weather-Sensitive Materials*—Water-sensitive materials shall be stored off the ground or floor and under cover, avoiding contact with damp floor or wall surfaces. Temperature-sensitive materials shall be protected from freezing. Bulk materials shall be stored in the area of intended use and caution shall be exercised to prevent contamination and segregation of bulk materials prior to use.

A2.5 *Admixtures*—Admixtures shall be proportioned and mixed in accordance with the published directions of the admixture manufacturer.

A2.5.1 The quantity of admixtures required to impart the desired performance is generally very small in relation to the quantities of the other mix ingredients. Batch-to-batch quantities shall be measured accurately.

A2.5.2 Air-entraining agents cause air to be incorporated in the plaster in the form of minute bubbles, usually to improve frost or freeze-thaw resistance, or workability of the plaster during application. Air-entraining agents for portland cement-based plaster shall meet the requirements of Specification C260.

A2.6 *Design and Application of Ornamental Features*:

A2.6.1 The design and construction requirements of ornamental features that project beyond the surface of the cement plaster scratch and brown coat assembly (including quoins, bands, or other similar ornamentation) are to be described in the ~~contract~~ Contract ~~documents.~~ Documents. The ~~contract~~ Contract ~~documents~~ Documents shall provide details to indicate the location, nature, and extent of the ornamental feature. The ~~design~~ Design ~~authority~~ Authority shall be responsible for compliance with applicable building code(s) and prescribed design loads. The ~~design~~ Design ~~authority~~ Authority shall also consider fire ratings and combustibility requirements in the design and selection of the ornamental feature.

A2.6.2 Ornamental features with sky-facing top surfaces that are exposed to the elements shall include sufficient slope for drainage as required by A2.1.1 or as minimally acceptable to the finish coat manufacturer, whichever is more restrictive.

A2.6.3 Ornamental features shall be isolated from load-bearing members, penetrating elements, and wall openings (such as fenestrations) as required by Specification C1063 to avoid the transfer of structural loads and to provide separation from dissimilar materials.

A2.6.4 Ornamental features shall not obstruct the function of control joints or expansion joints. The ~~design~~ Design ~~authority~~ Authority shall provide details as to how to the ornamental feature shall interact with applicable joints.

A2.6.5 Application of Field-Coated Foam Core Ornamental Features—Field-finished ornamental features consist of foam plastic cores encapsulated with a polymer-modified cementitious base coat with an acrylic finish coat or other approved manufactured finish. The foam plastic cores are adhesively attached to the brown coat either before or after encapsulation in the field.

A2.6.5.1 Ornamental features shall be adhered to the plaster brown coat with an adhesive compatible with portland cement plaster and the ornamental core manufacturer. The ornamental feature shall be integrated with the plaster brown coat with consideration provided to crack control and moisture infiltration. The base coat of the material that encapsulates the core of the ornamental feature shall continue onto the surface of the plaster brown coat without interruption. Crack control and moisture penetration resistance of the ornamental feature shall be addressed in the ~~contract~~ Contract ~~documents~~ Documents for plaster thickness that is less than those values provided in Table 4.

A2.6.5.2 Cores of ornamental features shall be permitted to be fabricated of expanded polystyrene (EPS) conforming to Specification C578 Type I or II having a minimum density of 0.9 lb/ft^3 (14.4 kg/m^3). The thickness of the core shall be no less than ¾ in. (19 mm).

A2.6.5.3 Foam core ornamental features shall be permitted to be covered with a variety of materials. A polymer-modified, fabric reinforced cementitious base coat and an acrylic finish coat shall be an acceptable finish over the ornamental feature. The design authority shall give consideration to profile differences in the finish coat (such as variation in shade, color, and sheen) that may result at the transition of the polymer-modified and portland cement base coat materials.

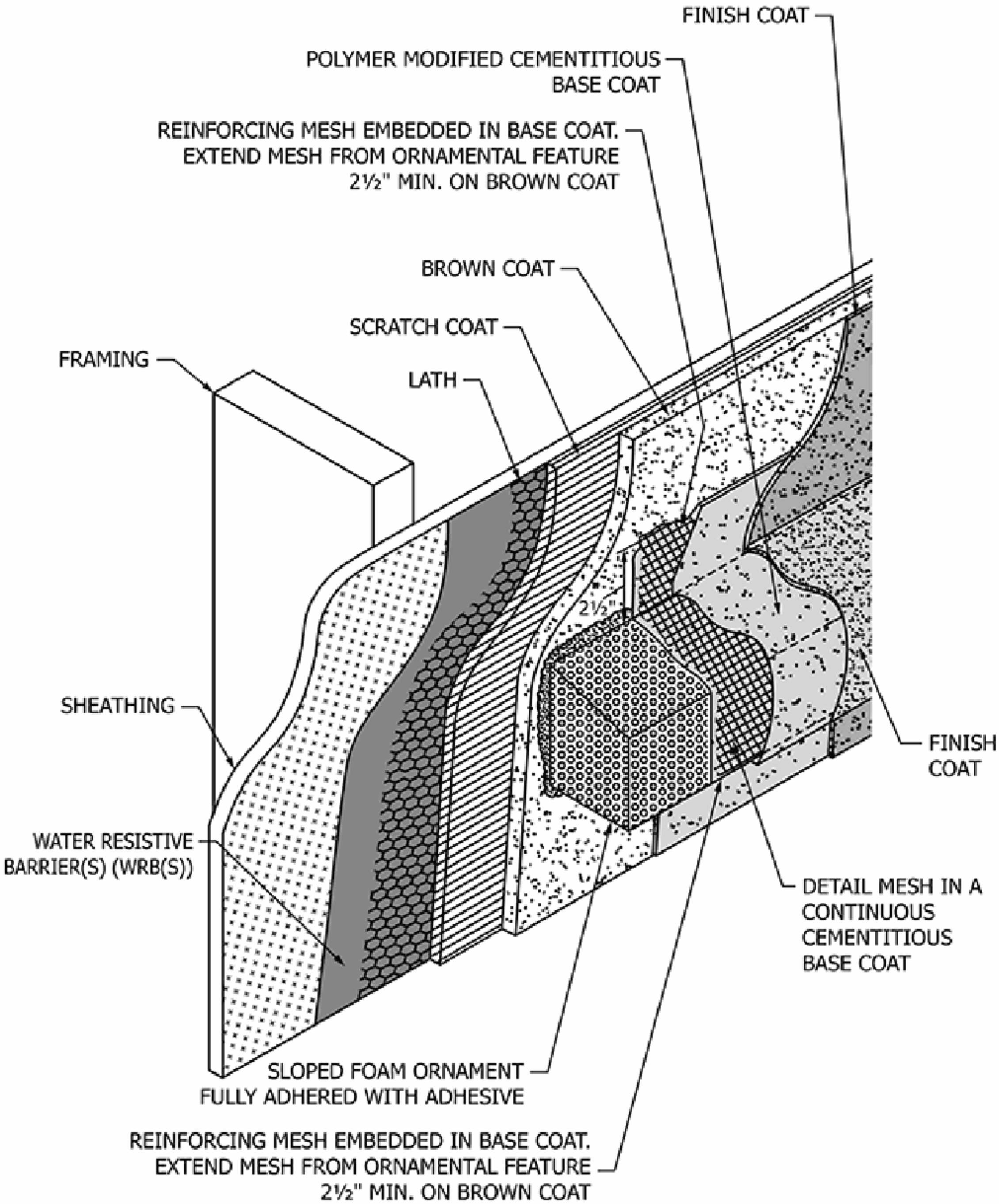
Nominal thickness for standard impact resistant base coats shall range from ~~1~~ 1/16~~/16~~ to ~~3~~ 3/32~~/32~~ in. ~~(2~~ (1.58 to ~~3~~ 2.38 mm) and be applied over nominal 4 oz/yd^2 (135.6 g/m^2) standard impact mesh. Thickness of impact-resistant base coats and nominal weight of impact-resistant mesh shall follow the manufacturer's installation instructions. The design authority shall give consideration to prevent impact damage to ornamental features.

Mesh shall be embedded in the base coat and extend a minimum of 2.5 in. ~~(64~~ (63.5 mm) beyond the ornamental feature. Where extension beyond the ornamental feature is not possible, backwrapping shall be provided.

A2.6.5.4 Application of the finish coat shall follow the manufacturer's installation instructions for the specific finish type. When cement-based finishes are applied, a bonding agent or admixture shall be used to insure proper adhesion to the polymer-modified base coat.

A2.6.5.5 A sample detail of an ornamental feature encapsulated with an exterior polymermodified cementitious base coat and detailing mesh is provided in Fig. A2.1. As depicted in the sample detail, the encapsulating material is continuous onto the surface of the plaster brown coat without interruption, providing a seamless transition between the ornamental feature and wall surface.

FIG. A2.1 Sample Detail of Ornamental Feature Consisting of Foam Plastic Core Encapsulated with Polymer Modified Cementitious Base Coat and Finish Coat



APPENDIX

(Nonmandatory Information)

X1 GENERAL INFORMATION

X1.1 *Additions*—Bonding compounds or agents may be pre-applied to a surface to receive plaster. In this usage it is not considered an admixture. Bonding compounds that are integrally mixed with plaster prior to its application are considered admixtures. Where exterior exposure and cyclic wetting are anticipated, the re-emulsification capability of the bonding material must be considered. Bonding agents are only as good as the material surface to which they are applied; therefore, form release materials must be removed from concrete or be compatible with the bonding material used. Bonding ~~agents,~~ agents in plaster mixes may increase the cohesive properties of the plaster. Bonding ~~agents,~~ agents ~~where used,~~ should meet the requirements of Specifications C631 ~~for interior plastering~~ or C932 ~~for~~. ~~exterior plastering.~~

X1.1.1 By the use of a suitable admixture or additive, it is possible to improve plaster's resistance to moisture movement. However, the use of the terms dampproofing or water proofing is misleading, and their use shall be discouraged.

X1.1.2 Natural or synthetic ~~fibers~~ fibers, $^1/_2$ to 2 in. (13 to 51 mm) in length and free of contaminates may be specified to ~~mitigate~~ improve resistance to cracking or to impart improved pumpability characteristics. The quantities per batch shall be in accordance with the ~~formation~~ published directions of ~~visible~~ the ~~cracking~~ fiber ~~during~~ manufacturer. ~~hydration.~~ No more than 2 lb (0.90 kg) of fiber should be used per cubic foot of cementitious material. Asbestos fibers should not be used. Alkaline-resistant glass fibers are recommended where glass fiber is used.

X1.1.3 Plasticizers containing hydrated lime putty, air-entraining agents, or approved fatteners to increase the workability of a portland cement plaster may be used. Plaster consistency and workability are affected by plasticizers that are beneficial in proper quantities from an economic standpoint, but in excess can be detrimental to the long-term performance of the plaster in place.

X1.1.4 Color material for integral mixing with plaster should not significantly alter the setting, strength development, or durability characteristics of the plaster. Natural or mineral pigments that are produced by physical processing of materials mined directly from the earth appear to offer the best long-term performance with respect to resistance to fading. Plaster color is determined by the natural color of the cementitious materials, aggregate, and any color pigment, and their proportions to each other. The use of white cement with the desired mineral oxide pigment color material may result in truer color.

X1.1.4.1 The uniformity of color cannot be guaranteed by the materials manufacturer of the component materials or by the applicating contractor. Color uniformity is affected by the uniformity of proportioning, thoroughness of mixing, cleanliness of equipment, application technique, and curing conditions and procedure, which are generally under the control of the applicator. Color uniformity is affected to an even greater degree by variations in thickness and differences in the suction of the base coat from one area or location to another, the type of finish selected, the migration of color pigments with moisture, and with job site climatic and environmental conditions. These factors are rarely under the control of the applicator.

X1.1.5 Corrective measures for conditions cited in ~~6.2~~ 5.2 include ~~sandblasting,~~ the ~~chipping,~~ installation ~~or~~ of ~~grinding~~ a ~~of~~ furred ~~the~~ or ~~solid~~ self-furring metal plaster ~~base,~~ base; application of a repair/build-out ~~mortar,~~ mortar; ~~installation~~ grinding/chipping of ~~a~~ the ~~self-furring~~ concrete ~~plaster~~ base; ~~base,~~ or combinations thereof. Because these measures may have structural or integrity consequences, they should be considered by all concerned parties with the ultimate selection left to the discretion of the design authority as defined by the Owner-Contractor Agreement.

X1.1.6 The ~~contract~~ "Project ~~documents~~ Documents" consist of many individual items but includes both the ~~specifications~~ Project Specifications and the ~~contract~~ Contract ~~drawings.~~ Drawings. It is the intent of this standard to have the type, location, depth, and orientation of control and expansion joints both stated in the ~~specifications~~ Project Specifications as well as shown and detailed on the ~~contract~~ Contract ~~drawings~~ Drawings where either or both of these documents exist for any particular project.

X1.2 *Finish Coat Categories* (applicable to both natural and colored finishes):

X1.2.1 Texture, as a description of surface appearance, is identified generally with the method and tools used to achieve the finish. Texture can be varied by the size and shape of the aggregate used, the equipment or tools employed, the consistency of the finish coat mix, the condition of the base to which it is applied, and by subsequent decorative or protective treatment.

X1.2.2 There are many factors that affect the ultimate appearance of textured and integrally colored plaster. A suitably sized sample panel should be submitted for approval by the architect and the owner. Once approved, the sample should be maintained on site for reference and comparison.

X1.2.3 With the almost limitless variations possible for finish appearance or texture, the same term may not have the same meaning to the specifier, the contractor, and the actual applicator. The specifier is cautioned to use an approved range of sample panels. To provide some guidance, the following categories are generally understood and recognized to imply a particular method of application technique or resulting finished appearance:

X1.2.4 *Smooth Trowel*—Hand- or machine-applied plaster floated as smooth as possible and then steel-troweled. Steel troweling should be delayed as long as possible and used only to eliminate uneven points and to force aggregate particles into the plaster surface. Excessive troweling should be avoided.

X1.2.5 *Float*—A plaster devoid of coarse aggregate applied in a thin coat completely covering the base coat, followed by a second coat that is floated to a true plane surface yielding a relatively smooth to fine-textured finish, depending on the size of aggregate and technique used. It is also known as sand finish.

X1.2.6 *Trowel-Textured (such as Spanish Fan, Trowel Sweep, English Cottage)*—A freshly applied plaster coat is given various textures, designs, or stippled effects by hand troweling. The effects achieved may be individualized and may be difficult to duplicate by different applicators.

X1.2.7 *Rough-Textured (such as Rough Cast, Wet Dash, Scottish Harl)*—Coarse aggregate is mixed intimately with the plaster and is then propelled against the base coat by trowel or by hand tool. The aggregate is largely unexposed and deep textured.

X1.2.8 *Exposed Aggregate (also known at Marblecrete)*—Varying sizes of natural or manufactured stone, gravel, shell, or ceramic aggregates are embedded by hand or machine propulsion into a freshly applied finish "bedding" coat. The size of the aggregate determines the thickness of the "bedding" coat. It is generally thicker than a conventional finish coat.

X1.2.9 *Spray-Textured*—A machine-applied plaster coat directed over a previously applied thin smooth coat of the same mix. The texture achieved depends on the consistency of the sprayed mixture, moisture content of the base to which it is applied, the angle and distance of the nozzle to the surface, and the pressure of the machine.

X1.2.10 *Brush-Finish*—A method of surfacing or resurfacing new or existing plaster. The plaster is applied with a brush to a thickness of not less than $^1/_{16}$ in. ~~(2~~ (1.6 mm). For an existing plaster surface the bond capability must be determined by test application or a bonding compound must be applied prior to the brush application.

X1.2.11 *Miscellaneous Types*—This finish coat category is somewhat similar to trowel-textured finishes, except that the freshly applied plaster is textured with a variety of instruments other than the trowel, such as swept with a broom or brush, corrugated by raking or combing, punched with pointed or blunt instrument, scored by aid of a straightedge into designs of simulated brick, block, stone, and so forth. A variation of texturing a finish coat involves waiting until it has partially set and then flattening by light troweling of the unevenly applied plaster or by simulating architectural terracotta.

X1.2.12 *Scraffitto*—A method of applying two or more successive coats of different colored plaster and then removing parts of the overlaid coats to reveal the underlaying coats, usually following a design or pattern. This is not generally considered a finish coat operation because of the number of thickness of coats.

X1.3 When specified as alternate for final coat, trowel- or plaster machine-applied textured acrylic finishes containing aggregate may be substituted for portland cement finish coats, provided brown coat is properly prepared and finish is applied according to the manufacturer's directions.

X1.4 *Staining of Plaster*—Staining and discoloration of plaster, caused by free water draining from one plane of plaster to another or from a dissimilar material onto a plaster surface, can be minimized by providing sufficient depth and angle for drip caps and the use of water-resistive surface coatings.

X1.4.1 Staining of plaster due to entrapment of moisture behind the plaster, can be avoided or minimized by providing an air space for ventilation between the back of the plaster and adjacent material. This type of staining may occur where insulation with or without vapor barrier, or other material containing asphaltic or coal tar derivatives, fireproofing salts, and so forth, can migrate with moisture movement to the finished plaster surface.

X1.4.2 Integrally colored plaster can be discolored or altered in shade if subjected to moisture, either from uncured base coats or external sources, such as rain, too soon after applications.

X1.5 *Installation Instructions:*

X1.5.1 Hand mixing should not be permitted, except as approved by the contract specifier.

X1.5.1.1 After all ingredients are in the mixer, mix the plaster for 3 to 5 min.

X1.5.1.2 The amount of water used in the plaster mix should be determined by the plasterer. Factors such as the suction of the base, or of the previous coat, water content of the aggregate, drying conditions, and finishing operations should be considered in determining water usage. Use of excessive water may result in dropouts, fall or slide off, excessive shrinkage, high porosity, and lower strength.

X1.5.2 Time Between Coats and Curing for Portland Cement-Based Plaster:

X1.5.2.1 The timing between coats will vary with climatic conditions and types of plaster base. Temperature and relative humidity extend or reduce the time between consecutive operations. Cold or wet weather lengthens and hot or dry weather shortens the time period. Moderate changes in temperature and relative humidity can be overcome by providing additional heating materials during cold weather and by reducing the absorption of the base by pre-wetting during hot or dry weather.

X1.5.2.2 In order to provide more intimate contact and bond between coats and to reduce rapid water loss, the second coat should be applied as soon as the first coat is sufficiently rigid to resist cracking, the pressures of the second coat application, and the leveling process.

X1.5.2.3 The amount of water and the timing for curing portland cement plaster will vary with the climatic conditions, the type of base, and use or nonuse of water-retentive admixtures.

X1.5.2.4 Some moisture must be retained in or added back to freshly applied portland cement-based plaster. If the relative humidity is relatively high (above 75 %), the frequency for rewetting a surface may be reduced. If it is hot, dry, and windy, the frequency of rewetting must be increased.

X1.5.2.5 Consider the physical characteristics of the structure as well as the previously mentioned conditions when selecting the method of curing. The method can be one or a combination of the following:

(1) Moist curing is accomplished by applying a fine fog spray of water as frequently as required, generally twice daily in the morning and evening. Care must be exercised to avoid erosion damage to portland cement-based plaster surfaces. Except for severe drying conditions, the wetting of finish coat should be avoided, that is, wet the base coat prior to application of the finish coat.

(2) Plastic film, when taped or weighted down around the perimeter of the plastered area, can provide a vapor barrier to retain the moisture between the membrane and plaster. Care must be exercised in placing the film: if too soon, the film may damage surface texture; if too late, the moisture may have already escaped.

(3) Canvas, cloth, or sheet material barriers can be erected to deflect sunlight and wind, both of which will reduce the rate of evaporation. If the humidity is very low, this option alone may not provide adequate protection.

X1.5.2.6 Application of Plaster Basecoats:

(1) Conventional, three-coat plaster is applied over a metal plaster base in two, nominal $^{3}/_{8}$ in. ~~(10 mm)~~ coats. The traditional application brings the plaster brown coat out to the lathing ~~accessory~~ accessories ~~grounds~~ which are ~~installed~~ set to approximately $^{3}/_{4}$ in. ~~(19~~ of ~~mm) from~~ the substrate. ~~Lathing~~ The lathing accessories that traditionally provide ~~cement~~ the plaster thickness ~~grounds~~ screed point include ~~weep screeds at~~ the ~~base of drainage wall assemblies,~~ casing ~~beads~~ beads, used to terminate the plaster into a dissimilar ~~materials,~~ material, control ~~joints~~ and expansion ~~joints,~~ joints ~~designated~~ installed ~~drainage~~ in ~~screeds~~ accordance with Specification C1063, corner transition trims, typically used at a vertical to horizontal ~~transitions,~~ transition, and ~~external~~ outside corner reinforcement (corner aids and corner beads).

(2) The interface of other exterior wall envelope systems, such as door and window frames, metal flashings and surrounds, drift joint framing, and other components often create build up that the lathing and plastering must cover. Further impacting this build-up are self-adhering flashing and multiple layers of water-resistive barriers used to enhance the ability of the exterior wall to provide a weather-resistive exterior wall envelope.

(3) In load-bearing wood framed and wood sheathed walls, build-up can occur from the wood and sheathing and any structural connection plates and bolts required to complete the structure.

(4) As a result of these factors that can impact the thickness of the plaster and are usually out of the control of the plastering contractor, references to plaster thickness use the term nominal to qualify the required thickness. The term nominal is intentionally ambiguous so as not to unnecessarily burden the plastering contractor with an expectation to provide a thickness of plaster that cannot reliably be achieved. Nominal is a term commonly associated with lumber that was many years ago actually a dimensional reference, but due to changes in the manufacturing of studs and timber, has become simply a name, and not an exact dimension.

X1.6 Design Considerations

X1.6.1 Provisions for Drainage Behind Exterior Plaster Base Systems:

X1.6.1.1 A barrier wall system where the plaster is applied directly to a solid substrate will not require any provisions for drainage to the exterior of the wall assembly.

X1.6.1.2 A drainage wall system where plaster is applied to a metal ~~or non metallic plaster~~ base shall include a water resistive barrier and a defined drainage plane, including provisions for moisture to escape to the exterior of the wall.

SUMMARY OF CHANGES

Committee C11 has identified the location of selected changes to this standard since the last issue (C926 ~~–18a)~~ 15) that may impact the use of this standard. (Approved ~~Aug.~~ July ~~1,~~ 15, ~~2018.)~~ 2015.)

(1) Revised ~~6.1,~~ subsections ~~7.3.4,~~ 5.2 ~~A1.5 A1.5.2, A2.2.1, A2.3.1.1, A2.3.1.2,~~ and ~~X1.5.2.6(1).~~ A1.6.3 ~~(2). Revised Notes 3 and 5.~~

Committee C11 has identified the location of selected changes to this standard since the last issue (C926 ~~–18)~~ 15) that may impact the use of this standard. (Approved ~~March~~ June 1, ~~2018.)~~ 2015.)

(1) ~~*Revised*~~ Added ~~A2.1.2.~~ Specification ~~Committee~~ C578 ~~C11 has identified the location of selected changes~~ to ~~this~~ Referenced ~~standard~~ Documents ~~since~~ subsection ~~the~~ 2.1 ~~last issue (C926 17) that may impact the use of this standard. (Approved Jan. 1, 2018.) (1) Revised X1.5.2.6. Committee C11 has identified the location of selected changes to this standard since the last issue (C926 16c) that may impact the use of this standard. (Approved Jan. 1, 2017.) (1) Revised X1.1 and X1.1.1~~.

(2) Added ~~X1.1.2~~ "back ~~.~~ wrap" ~~Committee~~ (~~C11~~ 3.2.5 ~~has~~) ~~identified~~ and ~~the~~ "polymer ~~location~~ modified ~~of~~ cementitious ~~selected~~ base ~~changes~~ coat" ~~to this standard since the last issue~~ (~~C926~~ 3.2.22) ~~16b) that may impact the use of this standard. (Approved Dec. 1, 2016.) (1) Removed previous Subsection A1.1. (2) Added "contract~~

~~documents"~~ to Terminology ~~(Subsection~~ Section. ~~3.3).~~

(3) ~~*Revised*~~ Added ~~1.1~~ subsections, **A2.6** ~~A1.5.2~~ ~~–~~, **A2.6.5.5** ~~A2.3.1.2,~~ and ~~X1.1.6~~ **Fig.** **A2.1** ~~Committee C11 has identified the location of selected changes to this standard since the last issue (C926-16a) that may impact the use of this standard. (Approved Sept. 1, 2016.) (1) Revised Subsection 7.3.1~~.

Committee C11 has identified the location of selected changes to this standard since the last issue (**C926** ~~–16)~~ 14a) that may impact the use of this standard. (Approved ~~March~~ Feb. 1, ~~2016.)~~ 2015.)

(1) ~~*Added Specification C1787 to 2.1. (2)*~~ Revised ~~6.1~~ **4.2.4**, ~~6.2.3~~ **4.2.5**, ~~7.4, A2.3.1, A2.3.2,~~ and ~~X1.6.1.2~~ **6.1.5**. ~~(3)~~

(2) ~~*Revised*~~ Renumbered ~~Note~~ **X1.4** ~~3~~ ~~–~~. **X1.4.2** ~~(4)~~ (formerly ~~Revised~~ X1.3.1 ~~A2.3.2~~ through~~:~~ X1.3.3).

Committee C11 has identified the location of selected changes to this standard since the last issue (**C926** ~~–15b~~ 14)~~e1)~~ that may impact the use of this standard. (Approved ~~Jan.~~ April ~~1,~~ 15, ~~2016.)~~ 2014.)

(1) Revised ~~A1.5.2~~ **5.2.3**~~, A2.2.1, and X1.1.5~~.

FOOTNOTES

(1) This specification is under the jurisdiction of ASTM Committee C11 on Gypsum and Related Building Materials and Systems and is the direct responsibility of Subcommittee C11.03 on Specifications for the Application of Gypsum and Other Products in Assemblies.

Current edition approved ~~Aug.~~ July ~~1,~~ 15, ~~2018.~~ 2015. Published ~~August~~ July ~~2018.~~ 2015. Originally approved in 1981. Last previous edition approved in ~~2018~~ 2015 as **C926** ~~–18a.~~ 15a. DOI: ~~10.1520/C0926-18B.~~ 10.1520/C0926-15b.

(2) For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

(3) Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

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Designation: C1063~~—–18b~~15a

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Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster [1]

This standard is issued under the fixed designation C1063; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

IN THIS STANDARD:

SUMMARY OF CHANGES

Footnotes

1 SCOPE *A Summary of Changes section appears at the end of this standard.

1.1 This specification covers the minimum ~~technical~~ requirements for lathing and furring for the application of exterior and interior portland ~~cement~~ cement-based ~~a hydraulic cement produced by pulverizing clinker consisting essentially of hydraulic calcium silicates, and usually containing one or more forms of calcium sulfate as an interground addition.Subcommittee: C11.91 Standard: C11-based~~ plaster, as in Specifications C841 or C926. ~~These requirements do not by default define a unit of work or assign responsibility for contractual purposes, which is the purview of a contract or contracts made between contracting entities.~~

1.2 Where a fire resistance rating is required ~~pertaining to a mandatory obligation imposed by a force outside this standard, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C840pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C926~~ for plastered assemblies and constructions, details of construction shall be in accordance with reports of fire tests of assemblies that have met the requirements of the fire rating imposed.

1.3 Where a specific degree of sound control is required ~~pertaining to a mandatory obligation imposed by a force outside this standard, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C840pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C926~~ for plastered assemblies and constructions, details of construction shall be in accordance with official reports of tests conducted in recognized testing laboratories in accordance with the applicable requirements of Test Method E90.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard. ~~1.5~~

2 ~~THIS~~ REFERENCED ~~INTERNATIONAL~~ DOCUMENTS ~~STANDARD~~

2.1 ~~was~~ ASTM ~~developed~~ Standards: ~~in~~ [2] ~~accordance~~

A641/A641M ~~with~~ Specification ~~internationally~~ for ~~recognized~~ Zinc–Coated ~~principles~~ (Galvanized) ~~on~~ Carbon ~~standardization~~ Steel ~~established~~ Wire ~~in~~

A653/A653M ~~the~~ Specification ~~Decision on Principles~~ for ~~the~~ Steel ~~Development~~ Sheet, ~~of~~ Zinc-Coated ~~International~~ (Galvanized) ~~Standards,~~ or ~~Guides~~ Zinc-Iron ~~and~~ Alloy-Coated ~~Recommendations~~ (Galvannealed) ~~issued~~ by the ~~World~~ Hot-Dip ~~Trade~~ Process ~~Organization~~

B69 ~~Technical~~ Specification ~~Barriers~~ for ~~to~~ Rolled ~~Trade~~ Zinc ~~(TBT)~~

B221 ~~Committee. 2 Referenced Documents 2.1 ASTM Standards:2 A653/A653M~~ Specification for ~~Steel~~ Aluminum ~~Sheet,~~ and ~~Zinc-Coated~~ Aluminum-Alloy ~~(Galvanized)~~ Extruded ~~or~~ Bars, ~~Zinc-Iron~~ Rods, ~~Alloy-Coated~~ Wire, ~~(Galvannealed)~~ Profiles, ~~by~~ and ~~the~~ Tubes ~~Hot-Dip Process~~

C11 Terminology Relating to Gypsum and Related Building Materials and Systems

C841 Specification for Installation of Interior Lathing and Furring

C847 Specification for Metal Lath

C926 Specification for Application of Portland Cement-Based Plaster

C933 Specification for Welded Wire Lath ~~C1032~~

C954 Specification for ~~Woven~~ Steel ~~Wire~~ Drill ~~Plaster~~ Screws ~~Base C1280 Specification~~ for the Application of ~~Exterior~~ Gypsum Panel Products ~~for~~ or ~~Use~~ Metal ~~as~~ Plaster ~~Sheathing~~ Bases ~~C1861~~ to ~~Specification~~ Steel ~~for~~ Studs ~~Lathing~~ from ~~and~~ 0.033 ~~Furring~~ in. ~~Accessories,~~ (0.84 ~~and~~ mm) ~~Fasteners,~~ to ~~for~~ 0.112 ~~Interior~~ in. ~~and~~ (2.84 ~~Exterior~~ mm) ~~Portland~~ in ~~Cement-Based~~ Thickness ~~Plaster~~

C1002 ~~E90~~ Specification ~~Test Method~~ for ~~Laboratory~~ Steel ~~Measurement~~ Self-Piercing ~~of~~ Tapping ~~Airborne~~ Screws ~~Sound~~ for ~~Transmission~~ Application ~~Loss~~ of ~~Building~~ Gypsum ~~Partitions~~ Panel ~~and~~ Products ~~Elements~~ or ~~2.2~~ Metal ~~US~~ Plaster ~~Department~~ Bases ~~of~~ to ~~Commerce~~ Wood ~~(DOC)~~ Studs ~~Standards~~ or ~~PS~~ Steel ~~1~~ Studs ~~Voluntary~~

C1032 ~~Product~~ Specification ~~Standard~~ for ~~PS~~ Woven ~~1,~~ Wire ~~Structural~~ Plaster ~~Plywood~~ Base ~~PS~~

D1784 ~~2~~ Specification ~~Voluntary~~ for ~~Product~~ Rigid ~~Standard~~ Poly(Vinyl ~~PS~~ Chloride) ~~2,~~ (PVC) ~~Performance~~ Compounds ~~Standard~~ and ~~for~~ Chlorinated ~~Wood-Based~~ Poly(Vinyl ~~Structural~~ Chloride) ~~Use~~ (CPVC) ~~Panels~~ Compounds ~~3~~

D4216 ~~Terminology~~ Specification ~~3.1~~ for ~~Definitions:~~ Rigid ~~3.1.1~~ Poly(Vinyl ~~For~~ Chloride) ~~definitions~~ (PVC) ~~relating~~ and ~~to~~ Related ~~ceilings~~ PVC and ~~walls,~~ Chlorinated ~~see~~ Poly(Vinyl ~~Terminology~~ Chloride) ~~C11~~ (CPVC)~~:~~ Building ~~3.1.2~~ Products ~~For~~ Compounds ~~definitions~~

E90 ~~relating~~ Test ~~to~~ Method ~~lathing accessories products fabricated~~ for ~~the~~ Laboratory ~~purpose~~ Measurement of ~~forming~~ Airborne ~~corners,~~ Sound ~~edges,~~ Transmission ~~control~~ Loss ~~joints,~~ of ~~or~~ Building ~~decorative~~ Partitions ~~effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims,~~ and ~~control~~ Elements ~~joints,~~

3 ~~SUCH~~ TERMINOLOGY ~~AS~~

3.1 ~~casing~~ *Definitions*—For ~~beads,~~ definitions ~~bull~~ relating ~~noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used~~ to ~~form~~ ceilings ~~corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516. furring accessories~~ and ~~fasteners,~~ walls, see ~~Specification~~ Terminology ~~C1861~~ C11.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 ~~building~~ *barrier* ~~*enclosure*~~ *wall,* ~~*system*~~ *n*—type of ~~building~~ wall ~~assemblies~~ system ~~and~~ that ~~materials~~ is ~~designed~~ intended ~~and~~ to ~~installed~~ block ~~in~~ or ~~such~~ interrupt ~~a~~ the ~~manner~~ movement ~~as~~ of water to ~~provide~~ the ~~a~~ interior. ~~barrier~~

3.2.2 ~~between~~ *building* ~~*different*~~ *enclosure,* ~~*environments.Subcommittee: C11.03 Standard: C1063,*~~ *n*~~—system~~—system of building assemblies and materials designed and installed in such a manner as to provide a barrier between different environments. ~~3.2.2~~

3.2.3 *control* ~~*joint*~~ *joint, n*—a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines. ~~Subcommittee:~~

3.2.4 ~~C11.03~~ *drainage* ~~*Standard:*~~ *plane,* ~~*C1063*~~ *n*~~a~~—surface ~~formed product used for designed or required separations~~ between ~~adjacent~~ the ~~surfaces~~ back of ~~gypsum~~ the ~~boards~~ cladding ~~or~~ and ~~gypsum~~ the ~~veneer~~ front ~~base.~~ of ~~Subcommittee:~~ the ~~C11.02~~ water ~~Standard:~~ resistive ~~C1047~~ barrier, which ~~n~~ resists ~~—a~~ liquid ~~joint~~ moisture ~~that~~ infiltration ~~accommodates~~ and ~~movement~~ provides ~~of~~ for ~~plaster~~ gravitational ~~shrinkage~~ flow ~~and~~ to ~~curing~~ a ~~the~~ collection ~~act~~ or ~~processes~~ exhaust ~~of~~ location. ~~producing~~

3.2.5 ~~a~~ *drainage* ~~*moisture*~~ *space,* ~~*environment*~~ *n* ~~*favorable*~~—volumetric ~~to~~ area ~~cement~~ that ~~hydration,~~ allows ~~resulting in~~ the ~~setting~~ gravitational ~~or~~ flow ~~hardening~~ of ~~the~~ liquid ~~plaster.~~ moisture ~~Subcommittee:~~ to ~~C11.03~~ a ~~Standard:~~ collection ~~C926~~ or ~~along~~ exhaust ~~predetermined,~~ location. ~~usually~~

3.2.6 ~~straight,~~ *drainage* ~~*lines.*~~ *wall,* ~~*3.2.3*~~ *n* ~~*expansion joint*~~—a joint wall ~~that~~ system ~~accommodates~~ in ~~movement~~ which ~~beyond~~ the ~~plaster~~ cladding ~~shrinkage~~ provides ~~and~~ a ~~curing.~~ substantial ~~Note~~ barrier ~~1—For~~ to ~~design~~ water ~~consideration~~ intrusion, ~~of control~~ and ~~expansion~~ which ~~joints,~~ also ~~see~~ incorporates ~~Annex A2.3.1.2 of Specification C926.Subcommittee: C11.03 Standard: C1063see control (expansion-contraction) joint.Subcommittee: C11.91 Standard: C11~~ a ~~structural~~ concealed ~~separation~~ water ~~between~~ resistive ~~building~~ barrier ~~elements~~ over ~~that~~ which ~~allows~~ drainage ~~independent~~ will ~~movement~~ occur. ~~without~~

3.2.7 ~~damage~~ *expansion* ~~*to*~~ *joint,* ~~*the assembly.Subcommittee: C11.05 Standard: C1516,*~~ *n*~~—a~~—a joint that accommodates movement beyond plaster shrinkage and curing. ~~the act or processes of producing a moisture environment favorable to cement hydration, resulting in the setting or hardening of the plaster.Subcommittee: C11.03 Standard: C926.~~

NOTE 1: For design consideration of control and expansion joints, see Annex A2.3.1.2 of Specification C926. ~~3.2.4~~

3.2.8 *framing* ~~*member*~~ *member, n*—studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel. ~~Subcommittee:~~

3.2.9 ~~C11.03~~ *hangers,* ~~*Standard: n*~~ ~~*C1063*~~—wire~~stud,~~ or ~~plate,~~ steel ~~track,~~ rods ~~joist,~~ or ~~furring,~~ straps ~~and~~ used ~~other~~ to support ~~to~~ main ~~which~~ runners ~~a~~ for ~~gypsum~~ suspended ~~panel~~ ceilings ~~product,~~ beneath floor or ~~metal~~ roof ~~plaster~~ constructions. ~~base~~

3.2.10 ~~is~~ *inserts,* ~~*attached.*~~ *n*~~*Subcommittee:*~~—devices ~~C11.91~~ embedded ~~Standard:~~ in ~~C11~~ concrete~~metal~~ structural ~~studs,~~ members ~~runners (track), and rigid furring channels designed~~ to ~~receive~~ provide ~~screw-attached~~ a ~~gypsum~~ loop ~~panel~~ or ~~products.~~ opening~~Subcommittee:~~ for ~~C11.03~~ attachment ~~Standard:~~ of ~~C754~~ hangers.~~that~~

3.2.11 ~~portion~~ *saddle* ~~*of*~~ *tie,* ~~*the*~~ *n*~~*-framing,*~~—~~see~~ ~~furring,~~ Figs. ~~blocking,~~ 1 and ~~so~~ 2 ~~forth,~~. ~~to~~

FIG. ~~which~~ 1 ~~the~~ Saddle ~~gypsum~~ Tie ~~base~~

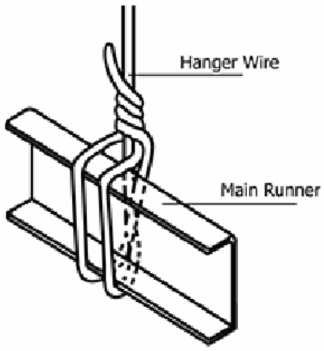
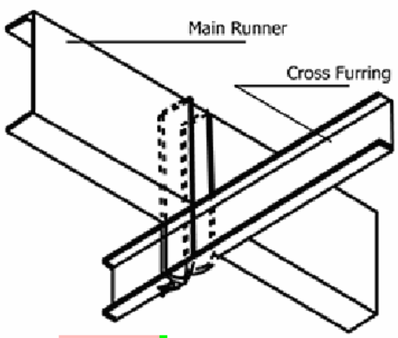


FIG. ~~is~~ 2 ~~attached.~~ Saddle ~~Unless~~ Tie ~~otherwise~~



3.2.12 ~~specified,~~ *self-furring,* ~~*the*~~ *adj* ~~*-surface*~~—a ~~to~~ metal ~~which~~ plaster ~~abutting~~ base ~~edges~~ manufactured ~~or~~ with ~~ends~~ evenly-spaced ~~are~~ indentations ~~attached~~ that ~~shall~~ hold ~~be~~ the ~~not~~ body ~~less~~ of ~~than~~ the ~~1~~ lath ~~1~~ approximately ~~2 in. (38 mm) wide for wood members, not less than~~ $^{1}/_{4}$ in. ~~(32~~ (6.4 mm) ~~wide~~ away ~~for~~ from ~~steel~~ solid ~~members,~~ surfaces ~~and~~ to ~~not~~ which ~~less~~ it ~~than~~ is ~~6~~ applied. ~~in.~~

3.2.13 ~~(152~~ *water* ~~*mm)*~~ *resistive* ~~*wide*~~ *barrier,* ~~*for*~~ *n* ~~*-gypsum*~~—a ~~studs.~~ material ~~For~~ that ~~internal~~ resists ~~corners or angles,~~ the ~~bearing~~ infiltration ~~surface~~ of ~~shall~~ liquid ~~be~~ moisture ~~not~~ through ~~less~~ the ~~than~~ building ~~3~~ enclosure system. ~~4~~

3.2.14 ~~in.~~ *water* ~~*(19*~~ *resistive* ~~*mm).*~~ *barrier*~~*Subcommittee:*~~ *system,* ~~*C11.03*~~ *n* ~~*Standard:*~~—a ~~C844~~ combination ~~studs,~~ of ~~headers,~~ water ~~bracing,~~ resistive ~~and~~ barrier ~~blocking~~ assemblies that ~~serve~~ resist ~~to receive~~ the ~~gypsum~~ infiltration ~~panel~~ of ~~product.~~ liquid~~Subcommittee:~~ moisture ~~C11.03~~ through ~~Standard:~~ the ~~C1280~~ building~~studs,~~ enclosure ~~joist,~~ system. ~~runners (tracks), bridging, bracing,~~ and ~~related~~ facilitates ~~accessories~~ its ~~manufactured~~ gravitational ~~or~~ flow ~~supplied~~ to ~~in~~ a ~~wood~~ collection or ~~hot~~ drainage ~~or~~ location. ~~cold~~

4 ~~FORMED~~ DELIVERY ~~STEEL.~~ OF ~~SUBCOMMITTEE:~~ MATERIALS ~~C11.05~~

4.1 ~~Standard:~~ All ~~C1516~~ materials ~~see~~ shall ~~Specification~~ be ~~C1063.~~ delivered ~~Subcommittee:~~ in ~~C11.03~~ the ~~Standard:~~ original ~~C1787~~ packages, ~~,~~ containers, ~~n~~ or ~~—studs,~~ bundles ~~joist,~~ bearing ~~runners~~ the ~~(track),~~ brand-name ~~bridging, bracing,~~ and ~~related~~ manufacturer's ~~accessories~~ (or ~~products~~ supplier's) ~~fabricated~~ identification. ~~for~~

5 ~~THE~~ STORAGE ~~PURPOSE~~ OF ~~FORMING~~ MATERIALS ~~CORNERS,~~

5.1 ~~edges,~~ All ~~control~~ materials ~~joints,~~ shall ~~or~~ be ~~decorative~~ kept ~~effects.~~ dry.~~Subcommittee:~~ Materials ~~C11.91~~ shall ~~Standard:~~ be ~~C11~~ stacked~~cornerbeads,~~ off ~~edge~~ the ~~trims,~~ ground, ~~and~~ supported ~~control~~ on ~~joints,~~ a ~~such~~ level ~~as~~ platform, ~~casing~~ and ~~beads,~~ protected ~~bull~~ from ~~noses,~~ the weather and ~~stops.~~ surface~~Subcommittee:~~ contamination. ~~C11.02~~

5.2 ~~Standard:~~ Materials ~~C1047~~ shall~~preformed~~ be ~~metal,~~ neatly ~~fiberglass~~ stacked ~~or~~ with ~~plastic~~ care ~~members~~ taken ~~used~~ to ~~form~~ avoid ~~corners,~~ damage to edges, ~~control~~ ends, ~~joints,~~ or ~~decorative~~ surfaces. ~~effects.~~

5.3~~Subcommittee:~~ Paper ~~C11.05~~ backed ~~Standard:~~ metal ~~C1516~~ plaster ~~manufactured~~ bases ~~or~~ shall ~~supplied~~ be ~~in~~ handled ~~wood~~ carefully ~~or~~ in ~~light~~ delivery, ~~gauge~~ storage, ~~steel.~~ and ~~3.2.5~~ erection ~~hangers~~ to ~~wires~~ prevent ~~or~~ puncturing ~~steel rods~~ or ~~straps~~ removal ~~used~~ of ~~to~~ paper. ~~support~~

6 ~~MAIN~~ MATERIALS ~~RUNNERS~~

6.1 ~~for~~ Metal ~~suspended~~ Plaster ~~ceilings~~ Bases: ~~beneath~~

6.1.1 ~~floor~~ *Expanded* ~~*or*~~ *Metal* ~~*roof*~~ *Lath*—Specification ~~constructions.~~ C847~~Subcommittee: C11.03 Standard: C1063~~, ~~n~~ galvanized. ~~—wires~~

6.1.2 ~~or~~ *Wire* ~~*steel*~~ *Laths:* ~~*rods*~~

6.1.2.1 ~~or~~ *Welded* ~~*straps*~~ *Wire* ~~*used*~~ *Lath*—Specification ~~to~~ C933 ~~support.~~ ~~main~~

6.1.2.2 ~~runners~~ *Woven* ~~*the*~~ *Wire* ~~*members*~~ *Lath*—Specification ~~that~~ C1032 ~~are.~~ ~~attached~~

6.1.2.3 ~~to~~ *Paper* ~~*or*~~ *Backed* ~~*suspended*~~ *Plaster* ~~*from*~~ *Bases*—Specification ~~the~~ C847 ~~construction.~~ ~~above~~

6.2 ~~for~~ Accessories: ~~the~~

6.2.1 ~~support~~ *General*—All ~~of~~ accessories ~~cross~~ shall ~~furring.~~ have~~Subcommittee:~~ perforated ~~C11.03~~ or ~~Standard:~~ expanded ~~C841~~ flanges ~~for suspended ceilings beneath floor~~ or ~~roof~~ clips ~~constructions.~~ shaped ~~3.2.6~~ to ~~inserts,~~ permit ~~n~~ complete— ~~devices~~ embedment ~~embedded~~ in ~~concrete~~ the ~~framing~~ plaster, ~~members~~ to provide ~~a~~ means ~~loop~~ for ~~or~~ accurate ~~opening~~ alignment, ~~for~~ and to secure attachment of ~~hangers~~ the ~~wires~~ accessory ~~or~~ to ~~steel~~ the ~~rods~~ underlying ~~or~~ surface. ~~straps~~ Accessories ~~used~~ shall be designed to ~~support~~ receive ~~main~~ application ~~runners~~ of ~~for~~ the ~~suspended~~ specified ~~ceilings~~ plaster ~~beneath~~ thickness. ~~floor~~

6.2.2 ~~or~~ Accessories ~~roof~~ shall ~~constructions.~~ be~~Subcommittee:~~ fabricated ~~C11.03~~ from ~~Standard:~~ Zinc ~~C1063~~ Alloy ~~.~~ (99 ~~3.2.7~~ % ~~saddle~~ pure ~~tie~~ zinc), ~~see~~ galvanized ~~Figs.~~ (zinc-coated) ~~1~~ steel, ~~and~~ rigid ~~2.~~ PVC~~Subcommittee:~~ or ~~C11.03~~ CPVC ~~Standard:~~ plastic, ~~C1063~~ or ~~,~~ anodized ~~n~~ aluminum ~~—see~~ alloy ~~Figs.~~ (see ~~1~~ Specification ~~and~~ B221 ~~2~~). ~~.~~ (See ~~FIG.~~ Table 1 ~~Saddle~~ for ~~Tie~~ minimum ~~FIG.~~ allowable ~~2~~ thicknesses.) ~~Saddle~~

TABLE ~~Tie~~ 1 ~~3.2.8~~ Minimum ~~self-furring~~ Thickness ~~a~~ of ~~metal~~ Accessories ~~plaster~~

Accessory ~~base~~	Base ~~manufactured~~ Material, ~~with~~ in. ~~evenly spaced~~ (mm) ~~indentations~~		
	Steel ~~that~~	Zinc ~~hold~~ Alloy ~~the~~	P.V.C. ~~body~~
Corner ~~of~~ Beads ~~the~~	0.0172 ~~lath~~ (0.44) ~~approximately~~	0.0207 ~~1~~ (0.53)	0.035~~4~~ (0.89) ~~in.~~
Casing ~~(6~~ Beads ~~mm)~~	0.0172 ~~away~~ (0.44) ~~from~~	0.0207 ~~solid~~ (0.53) ~~surfaces~~	0.035 ~~to~~ (0.89) ~~which~~
Weep ~~it~~ Screeds ~~is~~	0.0172 ~~installed.~~ (0.44)~~Subcommittee:~~	0.0207 ~~C11.03~~ (0.53) ~~Standard:~~	0.050 ~~C1063~~ (1.27) ~~,~~
Control ~~adj~~ Joints ~~—a~~	0.0172 ~~metal~~ (0.44) ~~plaster~~	0.018 ~~base~~ (0.46) ~~manufactured~~	0.050 ~~with~~ (1.27) ~~evenly spaced~~

NOTE ~~INDENTATIONS~~ 2: ~~that~~ The ~~hold~~ selection ~~the body~~ of ~~the~~ an ~~lath~~ appropriate ~~see~~ type ~~gypsum~~ of ~~lath.~~ material~~Subcommittee:~~ for ~~C11.91~~ accessories ~~Standard:~~ shall ~~C11~~ be ~~approximately~~ determined ~~1~~ by ~~/~~ applicable ~~4~~ surrounding ~~in.~~ climatic ~~(6~~ and ~~mm)~~ environmental ~~away~~ conditions ~~from~~ specific ~~solid surfaces~~ to ~~which~~ the ~~it~~ project ~~is~~ location, ~~installed.~~ such ~~3.2.9~~ as ~~water~~ salt ~~resistive~~ air, ~~barrier~~ industrial ~~a~~ pollution, ~~material~~ high ~~that~~ moisture, ~~resists~~ or ~~the~~ humidity. ~~infiltration~~

6.2.3 of *Steel*—Specification liquid A653/A653M moisture and through shall the have building a enclosure G60 system. coating.Subcommittee:

6.2.4 C11.03 *PVC* *Standard:* *Plastic*—Specification C1063 D1784; or n D4216—a. material

6.2.5 that *Zinc* resists *Alloy*—Specification the B69 infiltration, of 99 liquid % moisture pure through zinc. the

6.2.6 building Thickness enclosure system of building base assemblies material and shall materials be designed as and shown installed in such Table a 1 manner. as

6.2.7 to *Cornerite*—1.75 provide lb/yd a[2 barrier] (0.059 between kg/m different[2 environments.]),Subcommittee: galvanized C11.03 expanded Standard: metal C1063 lath, system. 1.7 4 lb/yd Delivery[2 and] (0.057 Storage kg/m of[2 Materials]) 4.1 galvanized Delivery woven of or Materials: welded 4.1.1 wire All fabric materials of shall 0.0410 be delivered in. the (1.04 original mm) packages, wire. containers; When or shaped bundles for bearing angle the reinforcing, brand-name it and shall manufacturer's have (or outstanding supplier's) flanges identification. (legs) 4.2 Storage of Materials: not 4.2.1 less All than materials 2 shall in. be (51 kept mm). dry.

6.3 Materials Channels—Shall shall be stacked cold-formed off from the steel ground with the minimum element 33 of 000 a psi lathing (228 accessory MPa) that yield provides strength an and edge, 0.0538 end, in. or (1.37 termination mm) for minimum a bare cement steel plaster thickness. panel Channel area, shall with have a ground protective dimension coating conforming to assist Specification in A653/A653M cement–G60, plaster or thickness have control.Subcommittee: C11.02 Standard: C1861, supported on a level protective platform, coating and with protected an from equivalent the corrosion weather resistance and for surface exterior contamination. applications, 4.2.2 or Materials shall be neatly coated stacked with care a taken rust to inhibitive avoid paint, damage for to interior edges, applications, ends and the shall end have perpendicular to the paper-bound following edge minimum or weights long in edge. poundsSubcommittee: per C11.01 1000 Standard: linear C473 ft, (kg/m). or

Sizes, surfaces. in. 4.2.3 (mm) Paper	Weight, backed lb/1000 metal ft plaster (kg/m) bases	Flange expanded Width, metal in. lath. (mm) sheet
3 metal/4 lath. welded (19) or	277 woven (0.412) wire	1 lath./2 Subcommittee: C11.03 (13) Standard:
1 C841 1 shall/2 be handled (38) carefully	414 in (0.616) delivery,	1 storage/2 and erection (13) to
2 prevent (51) puncturing	506 or (0.753) removal	1 of/2 paper 5 (13) Materials
2 5.1 1 Metallic/2 materials including (64) lathing,	597 lathing (0.888) accessories	1 products/2 fabricated for (13) the

NOTE PURPOSE 3 of Channels forming used corners, in edges, areas control subject joints, to or corrosive decorative action effects. ofSubcommittee: salt C11.01 air Standard: shall C11 be cornerbeads, hot-dipped edge galvanized, trims, G60 and coating control

6.3.1 joints, *External* such *Corner* as *Reinforcement*—Expanded casing lath, beads, welded bull wire, noses, or and woven stops. wireSubcommittee: mesh C11.02 bent Standard: to C1047 approximately preformed 90 metal, ° fiberglass or plastic members used to form reinforce corners, portland edges, cement control stucco joints, at or external decorative corners. effects. ThisSubcommittee: accessory C11.05 Standard: C1516, furring, furring accessories, and fasteners shall be selected fully for embedded compatibility in to the minimize stucco. galvanic

6.3.2 corrosion *Weep* between *Screed*—Accessory adjacent used metallic to materials terminate installed portland in the cement plaster based see stucco gypsum at plaster, the gypsum bottom neat of plaster. exteriorSubcommittee: framed C11.91 walls. Standard: This C11 accessoryportland shall cement-based have cementitious a mixture sloped, (see solid, stucco). orSubcommittee: perforated, C11.03 ground, Standard: or C926 screed cladding flange assembly. to 5.2 facilitate Metal the Plaster removal Bases: of 5.2.1 moisture Expanded from Metal the Lath—Specification wall C847 cavity, and galvanized. a 5.2.2 vertical Wire attachment Laths: flange 5.2.2.1 not Welded less Wire than Lath—Specification 3 C933 1/2 5.2.2.2 Woven in. Wire (89 Lath—Specification mm) C1032 long.

6.4 5.2.2.3 Wire—As Paper specified Backed in Plaster Specification Bases—Specification A641/A641M C847 with, a 5.3 Class Lathing I Accessories, zinc-coated Furring (galvanized), Accessories soft-temper and steel. Fasteners: Wire 5.3.1 diameters Lathing (uncoated) Accessories, specified Furring herein Accessories correspond and with Fasteners—Specification United C1861 States. Steel 5.3.2 Wire The Gauge selection numbers of as an follows: appropriate

Wire type Gauge of (US material Steel for Wire lathing Gauge) accessories	Diameter products (in.) fabricated	mm for

No. ~~the~~ 20 ~~purpose~~	0.0348 ~~of~~	.88 ~~forming~~
No. ~~corners,~~ 19 ~~edges,~~	0.0410 ~~control~~	1.04 ~~joints,~~
No. ~~or~~ 18 ~~decorative~~	0.0475 ~~effects.~~	1.21 ~~Subcommittee:~~
No. ~~C11.91~~ 17 ~~Standard:~~	0.0540 ~~C11~~	1.37 ~~cornerbeads,~~
No. ~~edge~~ 16 ~~trims,~~	0.0625 ~~and~~	1.59 ~~control~~
No. ~~joints,~~ 14 ~~such~~	0.0800 ~~as~~	2.03 ~~casing~~
No. ~~beads,~~ 13 ~~bull~~	0.0915 ~~noses,~~	2.32 ~~and~~
No. ~~stops.~~ 12 ~~Subcommittee:~~	0.1055 ~~C11.02~~	2.68 ~~Standard:~~
No. ~~C1047~~ 11 ~~preformed~~	0.1205 ~~metal,~~	3.06 ~~fiberglass~~
No. ~~or~~ 10 ~~plastic~~	0.1350 ~~members~~	3.43 ~~used~~
No. ~~to~~ 9 ~~form~~	0.1483 ~~corners,~~	3.77 ~~edges,~~
No. ~~control~~ 8 ~~joints,~~	0.1620 ~~or~~	4.12 ~~decorative~~

6.5 ~~effects.~~ Rod ~~Subcommittee:~~ and ~~C11.05~~ Strap ~~Standard:~~ Hangers—Mild ~~C1516~~ steel, ~~shall~~ zinc ~~be~~ or ~~based~~ cadmium ~~upon~~ plated, ~~applicable~~ or ~~surrounding~~ protected ~~climatic~~ with ~~and~~ ~~a environmental~~ rust-inhibiting ~~conditions~~ paint. ~~specific~~

6.6 ~~to~~ Clips—Form ~~the~~ from ~~project~~ steel ~~location,~~ wire, ~~such~~ Specification ~~as~~ A641/A641M ~~salt~~ zinc-coated ~~air,~~ (galvanized), ~~industrial~~ Specification ~~pollution,~~ A641/A641M ~~high moisture,~~ or ~~humidity.~~ steel ~~6~~ sheet, ~~Requirements~~ Specification ~~for~~ A653/A653M ~~Substrates,~~ ~~to~~ depending ~~Receive~~ on ~~Metal~~ use ~~Lathing~~ and ~~Furring~~ manufacturer's ~~6.1~~ requirements. ~~Framed,~~

6.7 ~~or~~ Fasteners: ~~Framed~~

6.7.1 ~~and~~ *Nails*—For ~~Sheathed~~ attaching ~~Substrates:~~ metal ~~6.1.1~~ plaster ~~Framing~~ bases ~~member~~ to ~~deflection~~ wood ~~shall~~ supports, ~~not~~ 0.1205-in. ~~exceed~~ 11 ~~L/360~~ gauge ~~(0.33~~ (3.06 ~~in.~~ mm) ~~in~~ diameter, ~~10~~ 7/16 ~~6.1.2~~ Plywood -in. ~~and~~ (11.1 ~~oriented~~ mm) ~~strand~~ head, ~~board~~ barbed, ~~sheathing~~ galvanized ~~panels~~ roofing ~~shall~~ nails ~~be marked in accordance with DOC PS1~~ or ~~DOC~~ galvanized ~~PS~~ common ~~2~~ nails.

6.7.1 ~~6.1.3~~ Nails ~~Plywood~~ for ~~and~~ attaching ~~oriented~~ metal ~~strand~~ plaster ~~board~~ bases ~~sheathing~~ to ~~panels~~ solid substrates shall be ~~installed~~ not ~~with~~ less ~~1~~ than $^3/_{8}$ in. ~~(3~~ (19 mm) ~~minimum panel edge the paper-bound edge, or~~ long. ~~edge,~~

6.7.2 ~~as~~ Screws ~~manufactured.~~ for ~~Subcommittee:~~ attaching ~~C11.01~~ metal ~~Standard:~~ plaster ~~C473~~ base ~~the bound edge as manufactured.Subcommittee: C11.01 Standard: C1177/C1177M, C1178/C1178M, C1396/C1396M gaps, and panel edges~~ shall be ~~offset~~ fabricated ~~4~~ in ~~(10~~ accordance ~~cm)~~ with ~~minimum~~ either ~~from~~ Specification ~~wall~~ C954 ~~opening~~ or ~~reentrant~~ C1002 ~~corners. 6.1.4 Wood framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007, plywood~~ and ~~oriented strand board sheathing panels~~ shall have a ~~moisture~~ 7 ~~content~~ / ~~not~~ 16 ~~to~~ in. ~~exceed~~ (11.1 ~~19~~ mm) ~~%~~ diameter ~~immediately~~ pan ~~before~~ wafer ~~plastering.~~ head ~~6.1.5~~ and ~~Exterior~~ a ~~gypsum~~ 0.120 ~~sheathing~~ in. ~~a~~ (3.0 ~~gypsum~~ mm) ~~board~~ diameter ~~used~~ shank. ~~as~~ Screws ~~a~~ used ~~backing~~ for ~~exterior~~ attachment ~~surface~~ to ~~materials;~~ metal ~~manufactured~~ framing ~~with~~ members ~~water-repellant~~ shall ~~paper and may~~ be ~~manufactured~~ self-drilling ~~with~~ and ~~a~~ self-tapping. ~~water-resistant~~ Screws ~~core.~~ used ~~Subcommittee:~~ for ~~C11.91~~ attachment ~~Standard:~~ to ~~C11~~ wood ~~panels~~ framing members shall be ~~installed~~ sharp-point. ~~in compliance with Specification C1280.~~

7 INSTALLATION

7.1 ~~Workmanship—Metal~~ Workmanship—Metal ~~lathing,~~ furring ~~lathing accessories, furring,~~ and ~~furring~~ lathing ~~accessories~~ shall be erected so that the finished ~~cement~~ plaster surfaces are true to line (allowable tolerance of $^1/_4$ in. ~~(6~~ (6.4 mm) in 10 ft ~~(3~~ (3.05 m)), level, plumb, square, or curved as required to receive the specified ~~pertaining to a mandatory requirement of this standard or a referenced requirement (see 3.2.17).Subcommittee: C11.03 Standard: C840pertaining to a mandatory requirement of this specification or a referenced requirement.Subcommittee: C11.03 Standard: C1280 cement~~ plaster ~~see gypsum plaster, gypsum neat plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926~~ thickness.

7.2 Hangers and Inserts:

7.2.1 **Hangers shall be of ample length and shall conform to the requirements of** Table~~1~~ 2**, both as to size and maximum~~cement plaster panel~~ area to be supported, except as modified in this section.**

TABLE ~~1~~ 2 Allowable Support or Hanger Wire Spacing ft-in. (mm) and Cold-Rolled Channel~~Furring~~ Main Runner Spans, ft-in. (mm)~~1—7~~1–10

NOTE 1: 1 in. = 25.4 mm; 1 ft^2 = 0.093 m^2

Member Size, in. (mm)	Member Weight, lb/1000 ft (kg/m)	Span Condition~~6,7~~9,10	Uniform Load = 12 psf (0.479 kPa)				
			Member Spacing, in. (mm)				
			24 (610)	36 (914)	48 (1220)	60 (1520)	72 (1830)
			Allowable Hanger Wire or Support Spacing, ft-in. (mm)				
$1^1/_2$	414	Single	3-6 (1070)	3-1 (940)	2-9 (840)	2-9 (790)	2-5 (740)~~(38)~~
(38.1)	(0.615)	2 or More	4-11 (1500)	4-2 (1270)	3-7 (1090)	3-2 (970)	2-11 (890)
2	506	Single	3-9 (1140)	3-3 (990)	3-0 (910)	2-9 (840)	2-8 (810)~~(51)~~
(50.8)	(0.753)	2 or More	5-2 (1570)	4-6 (1370)	4-1 (1240)	3-10 (1170)	3-7 (1090)
$2^1/_2$	597	Single	3-11 (1190)	3-5 (1040)	3-2 (970)	2-11 (890)	2-9 (840)~~(64)~~
(63.5)	(0.888)	2 or More	5-5 (1650)	4-9 (1450)	4-4 (1320)	4.0 (1220)	3-10 (1170)

Member Size, in. (mm)	Member Weight, lb/1000 ft (kg/m)	Span Condition~~6,7~~9,10	Uniform Load = 15 psf (0.287 kPa)				
			Member Spacing, in. (mm)				
			24 (610)	36 (914)	48 (1220)	60 (1520)	72 (1830)
$1^1/_2$	414	Single	3-3 (990)	2-10 (860)	2-7 (790)	2-4 (710)	2-2 (660)~~(38)~~
(38.1)	(0.616)	2 or More	4-6 (1370)	3-8 (1120)	3-2 (970)	2-10 (860)	2-7 (790)
2	506	Single	3-6 (1070)	3-1 (940)	2-10 (880)	2-7 (790)	2-5 (740)~~(51)~~
(50.8)	(0.753)	2 or More	4-10 (1470)	4-3 (1300)	3-10 (1170)	3-6 (1070)	3-3 (990)
$2^1/_2$	597	Single	3-8 (1120)	3-3 (990)	2-11 (890)	2-9 (840)	2-7 (790)~~(64)~~
(63.5)	(0.888)	2 or More	5-0 (1520)	4-5 (1350)	4-0 (1220)	3.9 (1140)	3-6 (1070)

Allowable Spans Notes:

1~~Spans~~ Bare~~based~~ metal~~on~~ thickness~~upper flange~~ of cold-rolled main runners~~the~~ shall~~members~~ be~~that~~ not~~are~~ less~~attached~~ than~~to~~ 0.0538~~or~~ in. ~~suspended~~ (1.367~~from~~ mm).~~the~~

2~~construction~~ Inside~~above~~ corner~~for~~ radii~~the~~ shall~~support~~ not~~of~~ be~~cross~~ greater~~furring.~~ than~~Subcommittee:~~ 1~~C11.03~~/~~Standard:~~8~~C841~~ in. (3.19 mm).

3 Spans based on upper flange of main runners laterally unbraced.~~2~~

4 Maximum deflection limited to 1/360 of the span length.~~3~~

5~~Uniform~~ Steel~~load~~ yield~~12~~ stress,~~psf~~ Fy,~~(dry density)~~ shall be~~used~~ not~~for~~ less~~portland~~ than~~cement~~ 33~~plaster~~ 000~~a~~ psi~~plaster~~ (228~~mix~~ MPa). ~~in~~

6~~which~~ Uniform~~portland~~ load~~cement~~ 12~~or~~ psf~~combinations~~ (dry~~of~~ density)~~portland~~ shall~~and~~ be~~masonry~~ used~~cements~~ for~~or~~ portland cement~~and~~ plaster~~lime are the principal cementitious materials mixed with aggregate.Subcommittee: C11.91 Standard: C11~~ ceilings with plaster thicknesses up to $^7/_8$ in. (22 mm) and 15 psf shall be used for ceilings with plaster~~see gypsum plaster, gypsum neat plaster.Subcommittee: C11.01 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926~~ thicknesses over $^7/_8$ in. (22 mm) and not more than $1^1/_4$ in. (32 mm).~~4~~

7~~"2~~ "2 or~~More"~~ More" spans refers to two or more continuous, equal spans.~~5~~

8 For the ~~"2~~ "2 or ~~More"~~ More" span condition, listed spans represent the center-to-center distance between adjacent ~~framing~~ supports. ~~members 9 studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007. 6~~ These tables are designed for dead loads. Specific conditions such as exterior installations in high wind areas require ~~to mandate by a force outside this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C1280~~ additional engineering. ~~7~~

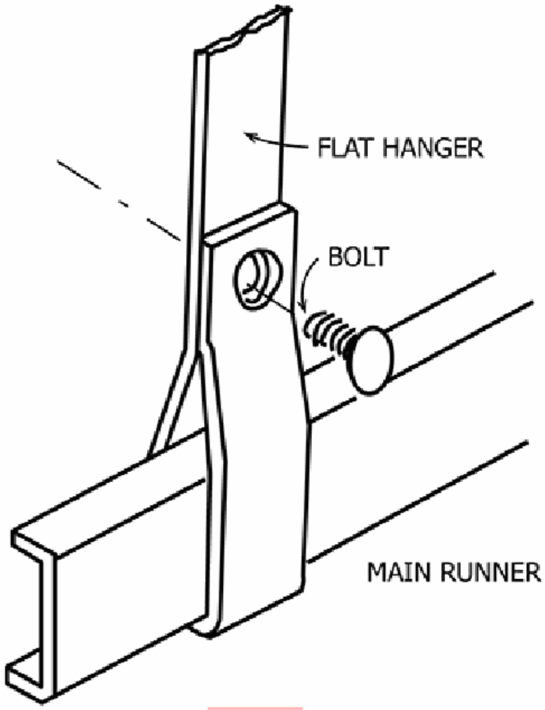
10 Where uplift resistance is required ~~pertaining to a mandatory obligation imposed by a force outside this standard, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C840pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C926~~ for suspended ceilings to resist negative forces, the architect or engineer of record shall select the method to be used. ~~TABLE~~

7.2.2 ~~2~~ When ~~Spans~~ 1 ~~and~~ by ~~Spacing of Cold-Rolled Channel Cross-Furring MembersA, B, C Design Load, 12 psf (575 Pa) Allowable Span, Main Runners or Supports Ft-in. (mm) Member Depth Spacing, in. (mm) Simple Span Two or More SpansD, E $^{3}/4$ (19) 13.5 (343) 2-9 (840) 3-5 (1040)~~$_{16}$ ~~(406)~~-in. ~~2-7~~ (25 ~~(790)~~ by ~~3-3~~ 4.8 ~~(990)~~ mm) ~~19~~ flat ~~(483)~~ inserts ~~2-7 (740) 3-0 (910) 24 (610) 2-3 (690) 2-10 (860) 11/2 (38) 13.5 (343) 4-6 (1370) 5-8 (1730) 16 (406) 4-3 (1300) 5-5 (1650) 19 (483) 4-0 (1220) 5-1 (1550) 24 (610) 3-8 (1120) 4-9 (1450)(A) Spans based on upper flange of cross-furring laterally unbraced.(B) Maximum deflection limited to 1/360 th of span length unbraced.(C) Tabulated spans apply only to cross-furring with webs oriented vertically.(D) "Two or more" spans refers to two or more continuous, equal spans.(E) For the "two or more" span conditions, listed spans represent the center-to-center distance between adjacent framing members studs joist, runners (tracks), bridging~~ and ~~bracing and related accessories.Subcommittee: C11.03 Standard: C1007. TABLE 3 Types and Weights of Metal Plaster Bases and Corresponding Maximum Permissible Spacing of Wall and Ceiling Framing Members or Furring Type of Metal Plaster Base Minimum Weight of Metal Plaster Base, lb/yd2 (kg/m2) Specific Installation Requirements and Maximum Permissible Spacing of Wall and Ceiling Framing Members or Furring, Center to Center, in. (mm) Walls Ceilings 24 (610) 16 (406) 24 (610) 16 (406) 12 (305) Expanded Sheet Metal 2.5 (1.4) Permitted only for self-furred lath on sheathed wall framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 or solid wall bases Permitted Not Permitted Not Permitted Permitted 3.4 (1.8) Permitted Flat Rib 2.75 (1.5) Not Permitted Permitted only for unsheathed wall framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 3/8 in. Rib 3.4 (1.8) Not Permitted Permitted 4.0 (2.1) Welded Wire 1.14 (0.618) Not Permitted Permitted Not Permitted 1.95 (1.058) Permitted Permitted Woven Wire 1.4 (0.76) Permitted only for wood wall framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007, wood furring preparing a wall or ceiling with framing or furring members to provide a level surface or airspace.Subcommittee: C11.03 Standard: C754spacer strips fastened to a wall, ceiling, or planar element that create an even surface for the application of metal plaster bases or gypsum lath.Subcommittee: C11.03 Standard: C841spacer elements added to a building structure to facilitate fastening of gypsum panel products.Subcommittee: C11.03 Standard: C1546 Permitted Permitted only for wood and concrete ceiling framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 Not Permitted Permitted only for steel ceiling framing members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007 7.2.2 When strap~~ hangers are used, $^{7}/_{16}$-in. ~~(11~~ (11.1 mm) diameter holes shall be provided on the center line at the ~~upper~~ lower end of the ~~strap~~ insert ~~hanger~~ and ~~to~~ upper ~~permit~~ end ~~the attachment~~ of the ~~strap~~ hanger ~~The~~ to ~~edge~~ permit the ~~paper-bound~~ attachment ~~edge,~~ of ~~or~~ the ~~long~~ hanger ~~edge,~~ to ~~as manufactured.Subcommittee: C11.01 Standard: C473~~ the ~~bound~~ insert. The edge ~~as manufactured.Subcommittee: C11.01 Standard: C1177/C1177M, C1178/C1178M, C1396/C1396M~~ of the holes in both the ~~strap~~ inserts and the hangers shall be not less than $^{3}/_{8}$ in. ~~(10~~ (9.5 mm) from the ends. ~~the end perpendicular to the paper-bound edge or long edge.Subcommittee: C11.01 Standard: C473.~~

7.2.3 In concrete, ~~rod or strap~~ hangers shall be attached to inserts ~~devices~~ embedded in ~~concrete framing members to provide a loop or opening for attachment of hangers.Subcommittee: C11.03 Standard: C1063 embedded in~~ the concrete, or to other attachment devices designed for this purpose, and able to develop full strength of the hanger.

7.2.4 ~~Strap~~ Flat, steel hangers shall be bolted to 1 by $^{3}/_{16}$-in. (25 by 4.8 mm) inserts with ~~machine~~ $^{3}/_{8}$-in. (9.5 mm) diameter round-head stove bolts. (See Fig. 3.)

FIG. 3 Flat ~~(Strap)~~ Hanger Attached to ~~Cold-rolled Channel Furring~~ Main Runner Using ~~Machine~~ Round-head Stove Bolt



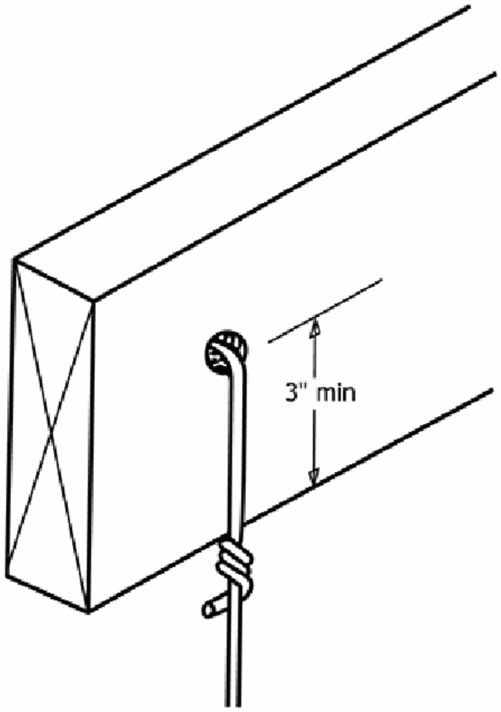
7.2.5 The nuts of the ~~machine~~ bolts shall be drawn up tight.

NOTE ~~2:~~ 4: Hangers required ~~pertaining~~ to ~~a mandatory obligation imposed by a force outside this standard, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C840pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C926 to~~ withstand upward wind pressures shall be of a type to resist compression. Struts of formed channels shall be permitted.

7.3 Installation of Hangers for Suspended Ceilings Under Wood ~~Constructions—Hangers~~ Constructions—Hangers shall be attached to ~~framing~~ supports ~~members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ by any of the following methods:

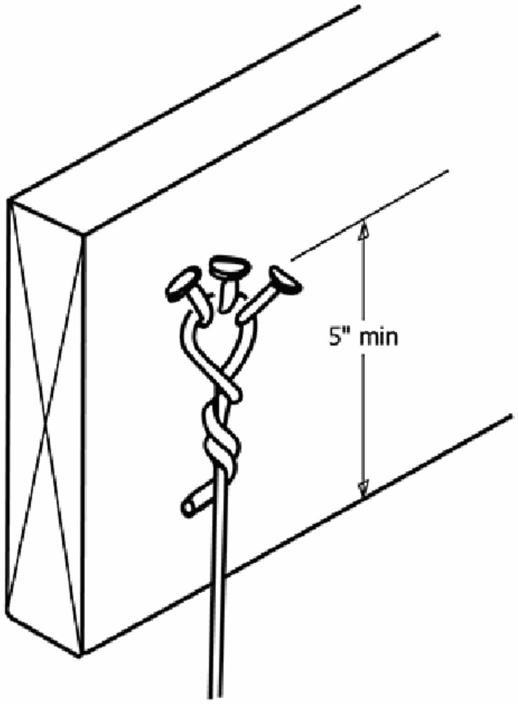
7.3.1 A hole shall be drilled through the wood ~~framing~~ member ~~studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be~~ not less than ~~112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than~~ 34 in. ~~(19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787 not less than 3 in.~~ (76 mm) above the bottom, with the upper end of the wire hanger passed through the hole and twisted three times around itself. (See Fig. 4.)

FIG. 4 Hanger Attached to ~~Framing~~ Support ~~Member~~ Through Drilled Hole



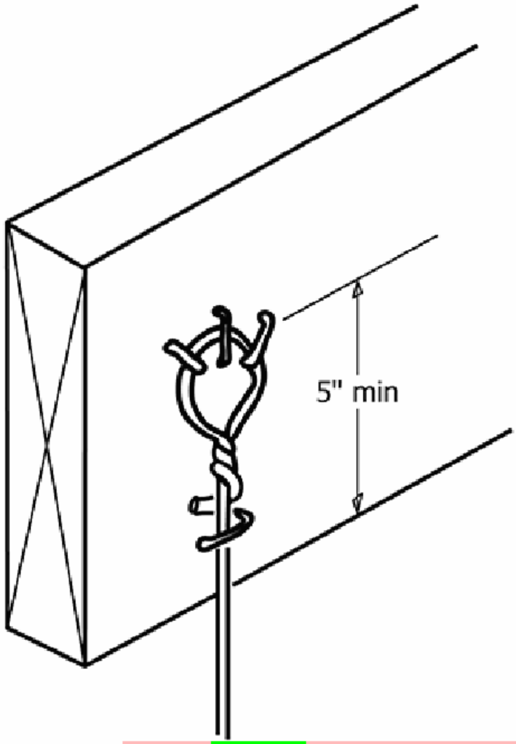
7.3.2 Three 12d nails shall be driven, on a downward slant, into the sides of the wood ~~framing~~ member ~~studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787~~ with not less than $1^1/_4$ in. ~~(32~~ (31.8 mm) penetration and not less than 5 in. (127 mm) from the bottom edges, and not more than 36 in. (914 mm) on the center with the upper end of the wire hanger wrapped around the nails and twisted three times around itself. (See Fig. 5.)

FIG. 5 Hanger Attached to ~~Framing~~ Support ~~Member~~ Using Nails



7.3.3 A loop shall be formed in the upper end of the wire hanger and secured to the wood ~~framing~~ member ~~studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787~~ by four $1^1/_2$-in. ~~(38~~ (38.1 mm), not less than 9 gauge, 0.1483-in. (3.77 mm) diameter wire staples driven horizontally or on a downward slant into the sides of the wood ~~framing~~ members, three near the upper end of the loop and the fourth to fasten the loose end. (See Fig. 6.)

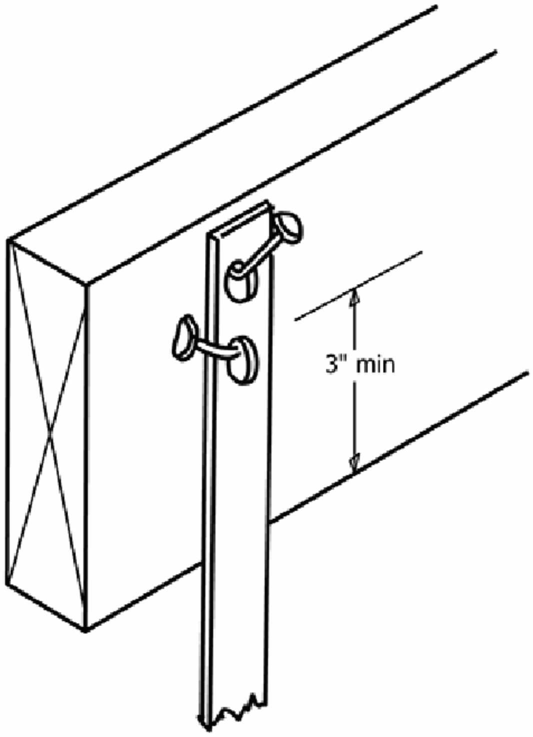
FIG. 6 Hanger Attached to ~~Framing~~ Support ~~Member~~ Using Staples



7.3.4 Where ~~framing~~ supports ~~members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ for flooring are thicker than $1^1/_2$ in. ~~(38~~ (38.1 mm) and are spaced more than 4 ft (1.2 m) on center, $1^1/_2$ in. (38.1 mm) No. 1/0 (0.3065 in.) (7.78 mm) eye screws (or equivalent), spaced not more than 3 ft ~~(914~~ (0.9 ~~mm)~~ m) on centers shall be screwed into the flooring ~~framing~~ supports ~~members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ with the upper end of the wire hanger inserted through the eye screws and twisted three times around itself.

7.3.5 Two holes shall be drilled in the upper end of the flat hangers and nailed to the sides of the wood ~~framing~~ members with 12d nails driven through the holes and clinched. Nails shall be not less than 3 in. (76 mm) above the bottom edge of the framing member. ~~studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787.~~ (See Fig. 7.)

FIG. 7 Flat ~~(Strap)~~ Hanger Attached to ~~Framing~~ Support ~~Member~~ Using Nails



7.4 Attachment of Hangers to ~~Cold-rolled Channel Furring~~ Main Runners:

7.4.1 Wire hangers shall be saddle-tied to ~~cold-rolled~~ the ~~channel furring main~~ runners. ~~the members that are attached to or suspended from the construction above for the support of cross furring.Subcommittee: C11.03 Standard: C841.~~ (See Fig. 1.)

7.4.2 Smooth or threaded rod hangers shall be fastened to ~~cold-rolled~~ the ~~channel furring main~~ runners ~~the members that are attached to or suspended from the construction above for the support of cross furring.Subcommittee: C11.03 Standard: C841~~ with special attachments appropriate to the design.

7.4.3 The lower ends of ~~strap~~ flat hangers shall be bolted to ~~cold-rolled~~ the ~~channel furring~~ main ~~runners~~ runners, ~~the members that are attached to~~ or ~~suspended from the construction above for the support of cross furring.Subcommittee: C11.03 Standard: C841, or~~ bent tightly around the ~~cold-rolled channel furring main~~ runners and carried up and above the ~~cold-rolled channel furring main~~ runners ~~the~~ and ~~members~~ bolted ~~that are attached~~ to ~~or suspended from~~ the ~~construction~~ main ~~above~~ part ~~for~~ of the ~~support~~ hanger. ~~of~~ Bolts ~~cross~~ shall ~~furring.~~ be~~Subcommittee:~~ 3~~C11.03~~/~~Standard:~~8~~C841~~-in. ~~and~~ (9.5 ~~bolted~~ mm) ~~to~~ diameter, ~~the~~ round-head ~~main~~ stove ~~part~~ bolts. ~~of the hanger.~~ (See Fig. 3.)

7.5 Installation of ~~Cold-rolled Channel Furring~~ Main Runners:

7.5.1 Minimum sizes and maximum spans and spacings of ~~cold-rolled channel furring~~ main runners for the various spans between hangers or other ~~framing~~ supports ~~members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ shall be in accordance with the requirements of Table ~~1~~ 2.

7.5.2 A clearance of not less than 1 in. (25 mm) shall be maintained between the ends of the ~~cold-rolled channel furring~~ main runners ~~the members that are attached to or suspended from the construction above for the support of cross furring.Subcommittee: C11.03 Standard: C841~~ and the abutting masonry or the concrete walls, partitions, and columns. Where special conditions require that ~~cold-rolled channel furring~~ main runners let into abutting masonry or concrete construction, within such constructions maintain a clearance of not less than 1 in. (25 mm) from the ends and not less than $^{1}/_{4}$ in. ~~(6~~ (6.4 mm) from the tops and sides of the ~~cold-rolled channel furring main~~ runners. ~~the members that are attached to or suspended from the construction above for the support of cross furring.Subcommittee: C11.03 Standard: C841.~~

7.5.3 A ~~cold-rolled channel furring~~ main runner shall be located within 6 in. (152 mm) of the paralleling walls to support the ends of the ~~cold-rolled channel~~ cross furring. ~~furring member attached perpendicular to main runners or framing members.Subcommittee: C11.03 Standard: C754furring members that are attached at right angles to the underside of the main~~

~~runners or construction above for support of the lath.Subcommittee: C11.03 Standard: C841.~~ The ends of ~~cold-rolled channel furring~~ main runners shall be supported by hangers located not more than 6 in. (152 mm) from the ends. ~~the end perpendicular to the paper-bound edge or long edge.Subcommittee: C11.01 Standard: C473.~~

7.5.4 Where ~~cold-rolled channel furring~~ main runners are spliced, the ends shall be overlapped not less than 12 in. (305 mm) with flanges of ~~cold-rolled~~ channels ~~channel furring main runners~~ interlocked and securely tied near each end of the splice, with double loops of 0.0625 in. (1.59 mm) or double loops of twin strands of 0.0475-in. (1.21 mm) galvanized wire. However, when the splice occurs at an expansion joint or control ~~joint~~ joint, ~~a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047;~~ the ~~cold-rolled~~ channel ~~furring preparing a wall or ceiling with framing or furring members to provide a level surface or airspace.Subcommittee: C11.03 Standard: C754spacer strips fastened to a wall, ceiling, or planar element that create an even surface for the application of metal plaster bases or gypsum lath.Subcommittee: C11.03 Standard: C841spacer elements added to a building structure to facilitate fastening of gypsum panel products.Subcommittee: C11.03 Standard: C1546~~ shall be nested and loosely tied to hold together but still allow movement.

7.5.5 Hanger wires shall hang straight down. If an obstacle prevents this, a trapeze type device shall be used to allow hanger wires to hang straight.

7.6 Installation of ~~Cold-rolled Channel~~ Cross Furring:

7.6.1 Minimum size and maximum spans and spacings of various types of ~~cold-rolled channel~~ cross furring for various spans between ~~cold-rolled channel furring~~ main runners and ~~framing~~ supports ~~members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ shall conform to the requirements of Table 2.

7.6.2 ~~Cold-rolled~~ Cross ~~channel cross~~ furring ~~furring member attached perpendicular to main runners or framing members.Subcommittee: C11.03 Standard: C754furring members that are attached at right angles to the underside of the main runners or construction above for support of the lath.Subcommittee: C11.03 Standard: C841~~ shall be saddle-tied to ~~cold-rolled channel furring~~ main runners with 0.0625-in. 16 gauge (1.59 mm) galvanized wire, or a double strand of 0.0475-in. 18 gauge (1.21 mm) galvanized wire or with special galvanized clips, or equivalent attachments. (See Fig. 2.)

7.6.3 Where ~~cold-rolled channel~~ cross furring ~~furring member attached perpendicular to main runners or framing~~ members~~Subcommittee: C11.03 Standard: C754furring members that~~ are ~~attached at right angles to the underside of the main runners or construction above for support of the lath.Subcommittee: C11.03 Standard: C841 members are~~ spliced, the ends shall be overlapped not less than 8 in. (203 mm), with flanges of ~~cold-rolled~~ channels ~~channel cross furring furring member attached perpendicular to main runners or framing members.Subcommittee: C11.03 Standard: C754furring members that are attached at right angles to the underside of the main runners or construction above for support of the lath.Subcommittee: C11.03 Standard: C841~~ interlocked, and securely tied near each end of the splice with double loops of 0.0625-in. (1.59 mm) 16 gauge galvanized wire or twin strands of 0.0475-in. 18 gauge (1.21 mm) galvanized wire.

7.6.4 ~~Cold-rolled~~ Cross ~~channel cross~~ furring ~~furring member attached perpendicular to main runners or framing members.Subcommittee: C11.03 Standard: C754furring members that are attached at right angles to the underside of the main runners or construction above for support of the lath.Subcommittee: C11.03 Standard: C841~~ shall not come into contact with abutting masonry or reinforced concrete walls or partitions, except, where special conditions require that ~~cold-rolled channel~~ cross furring be let into abutting masonry or concrete construction, the applicable provisions of 7.5.2 shall apply.

7.6.5 ~~Cold-rolled~~ Main ~~channel furring main~~ runners and ~~cold-rolled channel~~ cross ~~furring~~ runners shall be interrupted at expansion joints or control joints. However when the splice occurs at an expansion joint or control ~~joint~~ joint, ~~a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047;~~ the ~~cold-rolled~~ channel ~~furring preparing a wall or ceiling with framing or furring members to provide a level surface or airspace.Subcommittee: C11.03 Standard: C754spacer strips fastened to a wall, ceiling, or planar element that create an even surface for the application of metal plaster bases or gypsum lath.Subcommittee: C11.03 Standard: C841spacer elements added to a building structure to facilitate fastening of gypsum panel products.Subcommittee: C11.03 Standard: C1546~~ shall be nested and loosely tied to hold together but still allow movement.

7.7 Metal Furring for Walls:

7.7.1 Attachments for furring ~~accessories~~ shall ~~products~~ be ~~fabricated~~ concrete ~~for~~ nails ~~the~~ driven ~~purpose~~ securely ~~of~~ into ~~forming~~ concrete ~~corners, edges, control joints,~~ or ~~decorative~~ into ~~effects.~~ masonry~~Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control~~ joints, ~~such~~ short ~~as~~ pieces ~~casing~~ of ~~beads,~~ ^{3}~~bull~~/ ~~noses,~~$_4$ ~~and~~ -in. ~~stops.~~ (19.1~~Subcommittee:~~ mm) ~~C11.02~~ channels ~~Standard: C1047preformed metal, fiberglass or plastic members~~ used ~~to~~ as ~~form~~ anchors ~~corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516 shall be concrete nails~~ driven ~~securely~~ into ~~concrete or into~~ masonry joints, ~~power-actuated fasteners,~~ or other devices specifically designed as spacer elements, spaced horizontally not more than 2 ft ~~(610~~ (0.6 ~~mm)~~ m) on centers. They shall be spaced vertically in accordance with horizontal stiffener spacing so that they project from the face ~~the surface designed to be left exposed to view or to receive decoration or additional finishes.Subcommittee: C11.91 Standard: C11the coated surface.Subcommittee: C11.01 Standard: C1178/C1178M~~ of the wall in order for ties to be made.

7.7.2 Horizontal stiffeners shall be not less than $^{3}/_{4}$ in. ~~(19~~ (19.5 mm) cold-rolled ~~channel~~ channels, ~~furring,~~ spaced not to exceed 54 in. (1372 mm) on centers vertically, with the lower and upper ~~cold-rolled~~ channels ~~channel furring~~ not more than 6 in. (152 mm) from the ends of vertical ~~framing~~ members ~~studs joist, runners (tracks), bridging~~ and ~~bracing and related accessories.Subcommittee: C11.03 Standard: C1007 and~~ not less than $^{1}/_{4}$ in. ~~(6~~ (6.4 mm) clear from the wall face, securely tied to attachments with three loops of galvanized, soft-annealed wire, or equivalent devices. Approved furring ~~preparing a wall or ceiling with framing or furring members to provide a level surface or airspace.Subcommittee: C11.03 Standard: C754spacer strips fastened to a wall, ceiling, or planar element that create an even surface for the application of metal plaster bases or gypsum lath.Subcommittee: C11.03 Standard: C841spacer elements added to a building structure to facilitate fastening of gypsum panel products.Subcommittee: C11.03 Standard: C1546~~ is not prohibited from use in this application.

7.7.3 Vertical ~~framing~~ members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ shall be not less than $^{3}/_{4}$ in. ~~(19~~ (19.5 mm) cold-rolled ~~channel~~ channels ~~furring~~ in accordance with the requirements of Table 3. Vertical ~~framing~~ members shall be saddle-tied to horizontal stiffeners with three loops of 0.0475-in. (1.21 mm) galvanized soft-annealed wire, or equivalent devices, at each crossing, and securely anchored to the floor and ceiling constructions. Where ~~cold-rolled~~ furring ~~channel~~ is ~~furring~~ not ~~preparing~~ in ~~a~~ contact ~~wall~~ with ~~or~~ the ~~ceiling~~ wall, ~~with~~ channel ~~framing~~ braces ~~or~~ shall ~~furring~~ be ~~members~~ installed ~~to~~ between ~~provide~~ horizontal ~~a~~ stiffeners ~~level~~ and ~~surface~~ the ~~or~~ wall, ~~airspace.~~ spaced~~Subcommittee:~~ horizontally ~~C11.03~~ not ~~Standard:~~ more ~~C754~~ than~~spacer~~ 2 ~~strips~~ ft ~~fastened~~ (600 ~~to~~ mm) ~~a~~ on ~~wall,~~ centers. ~~ceiling,~~

TABLE ~~or~~ 3 ~~planar~~ Types ~~element~~ and ~~that~~ Weights ~~create~~ of ~~an~~ Metal ~~even~~ Plaster ~~surface~~ Bases ~~for~~ and ~~the~~ Corresponding ~~application~~ Maximum Permissible Spacing of ~~metal~~ Supports ~~plaster~~

Type ~~bases~~ of ~~or~~ Metal ~~gypsum~~ Plaster ~~lath.~~ Base~~Subcommittee:~~	Minimum ~~C11.03~~ Weight ~~Standard:~~ of ~~C841~~ Metal~~spacer~~ Plaster ~~elements~~ Base ~~added~~ lb/yd^{2} ~~to a building structure~~ (kg/m^{2}) ~~to~~	Maximum ~~facilitate~~ Permissible ~~fastening~~ Spacing of ~~gypsum~~ Supports ~~panel~~ Center ~~products.~~ to~~Subcommittee:~~ Center, ~~C11.03~~ in. ~~Standard:~~ (mm) ~~C1546~~				
		Walls ~~is~~ (Partitions) ~~not~~			Ceilings ~~in~~	
		Wood ~~contact~~ Studs ~~with~~ or ~~the~~ Furring ~~wall,~~	Solid ~~cold-rolled~~ Partitions ~~channel furring~~ A	Steel ~~preparing~~ Studs ~~a~~ or ~~wall~~ Furring	Wood or ~~ceiling~~ Concrete ~~with~~	Metal ~~framing~~
U.S. ~~or~~ Nominal ~~furring~~ Weights: ~~members~~						
Diamond ~~to~~ Mesh ~~provide~~ B ~~a~~	2.5 ~~level~~ (1.4) ~~surface~~	16 ~~or~~ (406) ~~airspace.~~ C~~Subcommittee:~~	16 ~~C11.03~~ (406) ~~Standard:~~	16 ~~C754~~ (406) ~~spacer strips~~ C	12 ~~fastened~~ (305) ~~to~~	12 ~~a~~ (305) ~~wall,~~
	3.4 ~~ceiling,~~ (1.8) ~~or~~	16 ~~planar~~ (406) ~~element that~~ C	16 ~~create~~ (406) ~~an~~	16 ~~even~~ (406) ~~surface~~ C ~~for~~	16 ~~the~~ (406) ~~application~~	16 ~~of~~ (406) ~~metal~~
Flat ~~plaster~~ Rib ~~bases~~	2.75 ~~or~~ (1.5) ~~gypsum~~	16 ~~lath.~~ (406)~~Subcommittee:~~	16 ~~C11.03~~ (406) ~~Standard:~~	16 ~~C841~~ (406)~~spacer~~	16 ~~elements~~ (406) ~~added~~	16 ~~to~~ (406) ~~a~~
	3.4 ~~building~~ (1.8) ~~structure~~	19 ~~to~~ (482) ~~facilitate~~	24 ~~fastening~~ (610) ~~of~~	19 ~~gypsum~~ (482) ~~panel~~	19 ~~products.~~ (482)~~Subcommittee:~~	19 ~~C11.03~~ (482) ~~Standard:~~

		of			or	
Flat ~~C1546~~ Rib ~~braces~~ (large ~~shall~~ opening) ~~be~~	1.8 ~~installed~~ (0.95) ~~between~~	24 ~~horizontal~~ (610) ~~stiffeners~~	24 ~~and~~ (610) ~~the~~	24 ~~wall,~~ (610) ~~spaced~~	16 ~~horizontally~~ (406) ~~not~~	16 ~~more~~ (406) ~~than~~
3 ~~2~~/~~ft~~8 (610 in. ~~mm)~~ Rib ~~on~~	3.4 ~~centers.~~ (1.8) ~~7.7.4~~	24 ~~Where~~ (610) ~~the~~	N/A ~~water~~ D ~~resistive~~	24 ~~barrier~~ (610) ~~a~~	24 ~~material~~ (610) ~~that~~	24 ~~resists~~ (610) ~~the~~
	4.0 ~~infiltration~~ (2.1) ~~of~~	24 ~~liquid~~ (610) ~~moisture~~	N/A ~~through~~	24 ~~the~~ (610) ~~building~~	24 ~~enclosure~~ (610) ~~system.~~	24 ~~Subcommittee:~~ (610) ~~C11.03~~
3 ~~Standard:~~/~~C1063~~4 ~~has~~ in. ~~been~~ Rib ~~damaged~~	5.4 ~~during~~ (2.9) ~~installation~~	24 ~~of~~ (610) ~~attachments,~~	N/A ~~the~~	24 ~~water~~ (610) ~~resistive~~	36 ~~barrier~~ (914) ~~shall~~	36 ~~be~~ (914) ~~repaired~~
Welded ~~with~~ Wire ~~the~~ B ~~same~~	1.14 ~~or~~ (0.62) ~~an~~	16 ~~alternative~~ (406) ~~material,~~	16 ~~compatible~~ (406) ~~with~~	16 ~~the~~ (406) ~~water~~	16 ~~resistive~~ (406) ~~barrier~~	16 ~~a~~ (406) ~~material~~
	1.95 ~~that~~ (1.1) ~~resists~~	24 ~~the~~ (610) ~~infiltration~~	24 ~~of~~ (610) ~~liquid~~	24 ~~moisture~~ (610) ~~through~~	24 ~~the~~ (610) ~~building~~	24 ~~enclosure~~ (610) ~~system.~~
Woven ~~Subcommittee:~~ Wire ~~C11.03~~ B ~~Standard:~~	1.4 ~~C1063~~ (0.6) ~~;~~	24 ~~before~~ (610) ~~proceeding~~	16 ~~with~~ (406) ~~the~~	16 ~~installation~~ (406) ~~of~~	24 ~~the~~ (610) ~~furring~~	16 ~~preparing~~ (406) ~~a~~
Canadian ~~wall~~ Nominal ~~or~~ Weights: ~~ceiling~~						
Diamond ~~with~~ Mesh ~~framing~~ B ~~or~~	2.5 ~~furring~~ (1.4) ~~members~~	16 ~~to~~ (406) ~~provide~~	12 ~~a~~ (305) ~~level~~	12 ~~surface~~ (305) ~~or~~	12 ~~airspace.~~ (305) ~~Subcommittee:~~	12 ~~C11.03~~ (305) ~~Standard:~~
	3.0 ~~C754~~ (1.6) ~~spacer~~	16 ~~strips~~ (406) ~~fastened~~	12 ~~to~~ (305) ~~a~~	12 ~~wall,~~ (305) ~~ceiling,~~	12 ~~or~~ (305) ~~planar~~	12 ~~element~~ (305) ~~that~~
	3.4 ~~create~~ (1.8) ~~an~~	16 ~~even~~ (406) ~~surface~~	16 ~~for~~ (406) ~~the~~	16 ~~application~~ (406) ~~of~~	16 ~~metal~~ (406) ~~plaster~~	16 ~~bases~~ (406) ~~or~~
Flat ~~gypsum~~ Rib ~~lath.~~	2.5 ~~Subcommittee:~~ (1.4) ~~C11.03~~	16 ~~Standard:~~ (406) ~~C841~~	12 ~~spacer~~ (305) ~~elements~~	12 ~~added~~ (305) ~~to~~	12 ~~a~~ (305) ~~building~~	12 ~~structure~~ (305) ~~to~~
	3.0 ~~facilitate~~ (1.6) ~~fastening~~	16 ~~of~~ (406) ~~gypsum~~	16 ~~panel~~ (406) ~~products.~~	16 ~~Subcommittee:~~ (406) ~~C11.03~~	16 ~~Standard:~~ (406) ~~C1546~~	13 1 ~~7.8~~/~~Z-furring~~ 2 ~~used~~ (343) ~~to~~
3 ~~support~~/~~lathing~~8 ~~and~~ in. ~~lathing~~ Rib ~~accessories~~	3.0 ~~and~~ (1.6) ~~its~~	19 ~~fasteners~~ (482) ~~for~~	N/A ~~fastening~~	16 ~~to~~ (406) ~~framing~~	16 ~~members~~ (406) ~~studs~~	16 ~~joist,~~ (406) ~~runners~~
	3.5 ~~(tracks),~~ (1.9) ~~bridging~~	24 ~~and~~ (610) ~~bracing~~	N/A ~~and~~	19 ~~related~~ (482) ~~accessories.~~	19 ~~Subcommittee:~~ (482) ~~C11.03~~	19 ~~Standard:~~ (482) ~~C1007~~
	4.0 ~~or~~ (2.1) ~~solid~~	24 ~~bases,~~ (610)	N/A	24 (610)	24 (610)	24 (610)

(A) Where plywood is used for sheathing, ~~a customized~~ minimum ~~furring~~ of ~~preparing~~ 1 ~~a~~/~~wall~~8 ~~or~~ in. ~~ceiling~~ (3.2 ~~with~~ mm) ~~framing~~ separation ~~or~~ shall ~~furring~~ be ~~members~~ provided ~~to~~ between ~~provide~~ adjoining ~~a~~ sheets ~~level~~ to ~~surface~~ allow ~~or~~ for ~~airspace.~~ expansion ~~Subcommittee:~~

(B) ~~C11.03~~ Metal ~~Standard:~~ plaster ~~C754~~ bases ~~spacer~~ shall ~~strips~~ be ~~fastened~~ furred ~~to~~ away ~~a~~ from ~~wall,~~ vertica ~~ceiling,~~ supports or ~~planar~~ solid ~~element~~ surfaces ~~that~~ at ~~create~~ least ~~an~~ 1 ~~even~~/~~surface~~4 ~~for~~ in. ~~the~~ Self-furring ~~application~~ lath ~~of~~ meets ~~metal~~ furring ~~plaster~~ requirements; ~~bases~~ except ~~or~~ furring

~~gypsum~~ of ~~lath.~~ expanded~~Subcommittee:~~ metal ~~C11.03~~ lath ~~Standard:~~ is ~~C841~~ not~~spacer~~ required ~~elements~~ on ~~added~~ supports ~~to~~ having a ~~building~~ bearing ~~structure~~ surface ~~to~~ of ~~facilitate~~ 1 ~~fastening~~ 5 ~~of~~/ ~~gypsum~~ 8 ~~pane~~ in. ~~products.~~ or~~Subcommittee:~~ less. ~~C11.03~~

(C) ~~Standard:~~ These ~~C1546~~ spacings ~~system~~ are ~~which~~ based ~~shall~~ on ~~be~~ unsheathed ~~engineered.~~ walls. ~~7.9~~ Where ~~Lapping~~ self-furring ~~of~~ lath ~~Metal~~ is ~~Plaster~~ placed ~~Bases:~~ over ~~7.9.1~~ sheathing ~~Side~~ or ~~laps~~ a ~~of~~ solid ~~metal~~ surface, ~~plaster~~ the ~~bases~~ permissible ~~expanded~~ spacing ~~metal~~ of ~~lath,~~ supports ~~sheet~~ shall ~~metal~~ be ~~lath,~~ no ~~welded~~ more ~~or~~ than ~~woven~~ 24 ~~wire~~ in. ~~lath.~~ (610~~Subcommittee:~~ mm). ~~C11.03~~

(D) ~~Standard:~~ Not ~~C841~~ applicable ~~shall~~

~~7.7.4~~ be Where ~~secured~~ the ~~to~~ water ~~framing~~ resistive ~~members.~~ barrier ~~They~~ has ~~shall~~ been ~~be~~ damaged ~~tied~~ during ~~between~~ installation ~~framing~~ of ~~members~~ attachments, ~~studs~~ the ~~joist,~~ water ~~runners~~ resistive ~~(tracks),~~ barrier ~~bridging~~ shall ~~and~~ be ~~bracing~~ repaired ~~and~~ with ~~related~~ the ~~accessories.~~ same~~Subcommittee:~~ or ~~C11.03~~ an ~~Standard:~~ alternative ~~C1007~~ material, compatible with ~~0.0475-in.~~ the ~~(1.21~~ water ~~mm)~~ resistive ~~wire~~ barrier, ~~at~~ before ~~intervals~~ proceeding ~~not~~ with ~~more~~ the ~~than~~ installation ~~9~~ of ~~in.~~ the ~~(229~~ furring. ~~mm).~~

TABLE ~~7.9.2~~ 4 ~~Side~~ Spans ~~laps~~ and Spacing of ~~expanded~~ Cold-Rolled ~~metal~~ Channel ~~lath~~ Cross-Furring ~~shall~~ Members ~~be~~ A ~~lapped,~~ ~~2~~ B ~~in.~~ ~~(50~~ C ~~mm),~~ ~~nominal~~ D ~~and,~~ ~~not~~ E ~~less,~~ ~~than~~ F ~~1~~

Design ~~/~~ Load, ~~2~~ 12 ~~in.~~ psf ~~(13~~ (575 ~~mm).~~ Pa) ~~Side~~		Allowable ~~laps~~ Span, ~~of~~ Main ~~rib~~ Runners ~~lath~~ or ~~shall~~ Supports ~~be~~ Ft-in. ~~lapped~~ (mm) ~~2~~	
Member Depth	Spacing, in. ~~(50~~ (mm) ~~mm)~~	Simple ~~nominal~~ Span ~~and~~	Two ~~not~~ or ~~less~~ More ~~than~~ Spans ~~1 in.~~ G ~~/ 2~~ H
3 ~~(13~~/ ~~mm),~~ 4 ~~or~~ (19) ~~nest~~	13.5 ~~the~~ (343) ~~edge~~	2-9 ~~ribs.~~ (840) ~~End~~	3-5 ~~laps~~ (1040) ~~of~~
	16 ~~expanded~~ (406) ~~metal~~	2-7 ~~lath~~ (790) ~~and~~	3-3 ~~rib~~ (990) ~~metal~~
	19 ~~lath~~ (483) ~~2~~	2-7 ~~in.~~ (740) ~~(50~~	3-0 ~~mm)~~ (910) ~~nominal~~
	24 ~~and~~ (610) ~~not~~	2-3 ~~less~~ (690) ~~than~~	2-10 (860)
1 ~~in.~~ 1 ~~(25~~/ ~~mm),~~ 2 ~~Wire~~ (38) ~~lath~~	13.5 ~~shall~~ (343) ~~be~~	4-6 ~~lapped~~ (1370) ~~minimum~~	5-8 ~~one~~ (1730) ~~mesh~~
	16 ~~at~~ (406) ~~the~~	4-3 ~~sides~~ (1300) ~~and~~	5-5 ~~ends.~~ (1650) ~~Where~~
	19 ~~end~~ (483) ~~laps~~	4-0 ~~occur~~ (1220) ~~between~~	5-1 ~~the~~ (1550) ~~framing~~
	24 ~~members,~~ (610) ~~the~~	3-8 ~~ends~~ (1120) ~~of~~	4-9 ~~the~~ (1450) ~~sheets~~

(A) ~~of~~ Bare ~~all~~ metal ~~plaster~~ thickness ~~bases~~ of ~~expanded~~ cold-rolled ~~metal~~ members ~~lath,~~ shall ~~sheet~~ not ~~metal~~ be ~~lath,~~ less ~~welded~~ than ~~or~~ 0.0538 ~~woven~~ in. ~~wire~~ (1.367 ~~lath.~~ mm). ~~Subcommittee:~~

(B) ~~C11.03~~ Inside ~~Standard:~~ corner ~~C841~~ radii shall not be ~~laced~~ greater ~~or~~ than ~~wire~~ 1 ~~tied~~/ ~~with~~ 8 ~~0.0475-in.~~ in. ~~(1.21~~ (3.17 mm). ~~wire.~~

(C) ~~7.9.3~~ Spans ~~Where~~ based ~~metal~~ on ~~plaster~~ upper ~~base~~ flange ~~with~~ of ~~an~~ cross-furring ~~attached~~ laterally ~~water~~ unbraced. ~~resistive~~

(D) ~~barrier~~ Maximum ~~a~~ deflection ~~material~~ limited ~~that~~ to ~~resists~~ 1 ~~the~~/ ~~infiltration~~ 360 th of ~~liquid~~ span ~~moisture~~ length ~~through~~ unbraced. ~~the~~

(E) ~~building~~ Steel ~~enclosure~~ yield ~~system.~~ stress~~Subcommittee:~~ *Fy*, ~~C11.03~~ shall ~~Standard:~~ not ~~C1063~~ be ~~is~~ less ~~installed,~~ than ~~the~~ 33 ~~vertical~~ 000 ~~and~~ psi ~~horizontal~~ (228 ~~lap~~ MPa). ~~joints~~

(F) ~~shall~~ Tabulated ~~be~~ spans ~~water~~ apply ~~resistive~~ only ~~barrier~~ to ~~on~~ cross-furring ~~water~~ with ~~resistive~~ webs ~~barrier~~ oriented ~~a~~ vertically. ~~material~~

(G) ~~that~~ "Two ~~resists~~ or ~~the~~ more" ~~infiltration~~ spans ~~of~~ refers ~~liquid~~ to ~~moisture~~ two ~~through~~ or ~~the~~ more ~~building~~ continuous, ~~enclosure~~ equal ~~system.~~ spans.~~Subcommittee:~~

(H) ~~C11.03~~ For ~~Standard:~~ the ~~C1063~~ "two ~~and~~ or ~~metal~~ more" ~~plaster~~ span ~~base~~ conditions, ~~expanded~~ listed ~~metal~~ spans ~~lath,~~ represent ~~or~~ the ~~welded~~ center-to-center ~~or~~ distance ~~woven~~ between ~~wire~~ adjacent ~~lath.~~ supports.~~Subcommittee:~~

7.8 ~~C11.03~~ Lapping ~~Standard:~~ of ~~C926~~ Metal ~~on~~ Plaster ~~metal~~ Bases: ~~plaster~~

~~7.8.1~~ base Side ~~expanded~~ laps of metal ~~lath,~~ plaster ~~or~~ bases ~~welded~~ shall ~~or~~ be ~~woven~~ secured ~~wire~~ to ~~lath.~~ framing~~Subcommittee:~~ members. ~~C11.03~~ They ~~Standard:~~ shall ~~C926~~ be: tied ~~7.9.3.1~~ between ~~Where~~ supports ~~metal~~ with ~~plaster~~ 0.0475-in. ~~base~~ (1.21 ~~with~~ mm) ~~an~~ wire ~~attached~~ at ~~water~~ intervals ~~resistive~~ not ~~barrier~~ more ~~a~~ than ~~material~~ 9 ~~that~~ in. ~~resists~~ (229 ~~the~~ mm). ~~infiltration~~

~~7.8.2~~ ~~of~~ Metal ~~liquid~~ lath ~~moisture~~ shall ~~through~~ be ~~the~~ lapped ~~building~~ 1 ~~enclosure~~/ ~~system.~~ 2~~Subcommittee:~~ in. ~~C11.03~~ minimum ~~Standard:~~ (12.7 ~~C1063~~ mm) ~~is~~ at ~~installed,~~ the sides, or nest the ~~water~~ edge ~~resistive~~ ribs. ~~barrier~~ Wire lath shall be lapped ~~not~~ minimum ~~less~~ one ~~than~~ mesh ~~2~~ at ~~in.~~ the ~~(51~~ sides ~~mm).~~ and ~~shall~~ the ~~be~~ ends. ~~lapped~~ Lap ~~not~~ metal ~~less~~ lath ~~than~~ minimum ~~2~~

1 in. ~~(51~~ (25 mm) ~~On~~ at ~~walls,~~ ends. ~~the~~ Where ~~water~~ end ~~resistive~~ laps ~~barrier~~ occur ~~a~~ between ~~material~~ the ~~that~~ framing ~~resists~~ members, the ~~infiltration~~ ends of ~~liquid~~ the ~~moisture~~ sheets ~~through~~ of ~~the~~ all ~~building~~ metal ~~enclosure~~ plaster ~~system.~~ bases~~Subcommittee:~~ shall ~~C11.03~~ be ~~Standard:~~ laced ~~C1063~~ or ~~shall~~ wire ~~be~~ tied ~~lapped~~ with ~~so~~ 0.0475-in. ~~water~~ (1.21 ~~will~~ mm) ~~flow~~ galvanized, ~~to~~ annealed steel wire.

7.8.3 Where metal plaster base with backing is used, the ~~exterior.~~ vertical ~~Except~~ and ~~for~~ horizontal ~~weep~~ lap ~~screeds,~~ joints ~~designated~~ shall ~~drainage~~ be ~~screeds,~~ backing on backing and ~~drainage~~ metal ~~flashings,~~ on ~~the~~ metal. ~~water~~

7.8.3.1 ~~resistive~~ Backing ~~barrier~~ shall ~~a~~ be ~~material~~ lapped ~~that~~ not ~~resists~~ less than 2 in. (50 mm). On walls, the ~~infiltration~~ backing ~~of~~ shall ~~liquid~~ be ~~moisture~~ lapped ~~through~~ so water will flow to the ~~building~~ exterior. ~~enclosure~~ Except ~~system.~~ for~~Subcommittee:~~ weep ~~C11.03~~ screeds ~~Standard:~~ (as ~~C1063~~ described in 7.11.5), backing shall not be placed between ~~metal~~ plaster base (lath) and ~~lath~~ flanges ~~accessory~~ of ~~attachment~~ accessories. ~~flanges.~~ Metal ~~plaster~~ lath ~~base~~ to ~~lath accessory key attachment~~ flange contact shall be required to ensure that ~~the~~ flanges ~~metal~~ are ~~plaster~~ mechanically ~~base~~ locked ~~expanded~~ together. ~~metal~~

7.9 ~~lath,~~ **Spacing** ~~or~~ **of** ~~welded~~ **Attachments** ~~or~~ **for** ~~woven~~ **Metal** ~~wire~~ **Plaster** ~~lath.~~ **Bases—Attachments**~~Subcommittee:~~ for ~~C11.03~~ securing ~~Standard:~~ metal ~~C926~~ plaster ~~and~~ bases ~~lath~~ to ~~accessory~~ framing ~~key~~ members ~~the~~ shall ~~grip~~ be ~~or~~ spaced ~~mechanical~~ not ~~bond~~ more ~~of~~ than ~~one~~ 7 ~~coat~~ in. ~~of~~ (178 ~~plaster~~ mm) ~~to~~ apart ~~another~~ for ~~coat,~~ diamond ~~or~~ mesh ~~to~~ and ~~a~~ flat ~~substrate.~~ rib~~Subcommittee:~~ laths ~~C11.91~~ and ~~Standard:~~ at ~~C11~~ each ~~attachment~~ rib ~~flanges~~ for ~~are~~ ^{3}~~mechanically~~/ ~~locked~~$_8$ ~~together.~~ in. (9.5 mm) rib lath.

7.10 ~~Installation~~ **Application of Metal Plaster Bases:**

7.10.1 General:

7.10.1.1 Metal plaster bases shall be furred away from vertical ~~framing~~ supports ~~members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ or solid surfaces at least $^1/_4$ in. ~~(6 mm).~~ Self furring lath meets furring requirements; except, furring of expanded metal lath is not required on ~~framing~~ supports ~~members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ having a bearing surface of $1^5/_8$ in. ~~(41 mm)~~ or less.

7.10.1.2 The spacing of framing members for the type and weight of metal plaster base ~~expanded metal lath, or welded or woven wire lath.Subcommittee: C11.03 Standard: C926~~ shall conform to the requirements of Table 3. Metal plaster bases shall be attached to framing members at not more than 7 in. (178 mm) on center, along framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ except for $^3/_8$-in. ~~(10~~ (9.5 mm) rib metal lath that shall be attached at each rib. Attachment penetrations between the framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ shall be avoided.

7.10.1.3 Lath shall be ~~installed~~ applied with the long dimension at right angles to the ~~framing~~ supports, ~~members studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007,~~ unless otherwise specified. ~~pertaining to a mandatory requirement of this standard or a referenced requirement (see 3.2.17).Subcommittee: C11.03 Standard: C840pertaining to a mandatory requirement of this specification or a referenced requirement.Subcommittee: C11.03 Standard: C1280.~~

7.10.1.4 Ends of adjoining plaster bases shall be staggered.

7.10.1.5 Lath shall not be continuous through control joints, but shall be stopped and tied at each side.

7.10.1.6 Where furred or suspended ceilings butt into or are penetrated by columns, walls, beams, or other elements, the edges and ends of the ceiling lath shall be terminated at the horizontal internal ~~corners~~ angles with a casing ~~bead~~ bead, ~~lathing accessory,~~ control ~~joint~~ joint, ~~a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed~~ or ~~required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessory, or~~ similar device designed to keep the edges and ends of the ceiling lath and plaster free of the adjoining vertically oriented, or penetrating elements. ~~Internal~~ Cornerite ~~corner reinforcement lathing accessories~~ shall not be used at these locations. A clearance of not less than $^3/_8$ in. ~~(10~~ (9.5 mm) shall be maintained between the ~~casing~~ bead ~~lathing accessory, control joint a joint that accommodates movement of plaster shrinkage~~ and ~~curing~~ all ~~along~~ such ~~predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessory, or similar device and penetrating~~ elements.

7.10.1.7 Where load bearing walls or partitions butt into structural walls, columns, or floor or roof slabs, the sides or ends of the wall or partition lath shall be terminated at the internal ~~corners~~ angles with a casing ~~bead~~ bead, ~~lathing accessory,~~ expansion joint ~~lathing~~ or ~~accessory,~~ control ~~joint~~ joint, ~~a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed~~ or ~~required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessory, or~~ similar device designed to keep the sides and ends of the wall or partition lath free of the adjoining elements. ~~Internal~~ Cornerite ~~corner reinforcement lathing accessories products fabricated for the purpose of forming corners, edges, control joints, or decorative effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints, such as casing beads, bull noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516~~ shall not be used at these internal ~~corners.~~ angles. A clearance of not less than $^3/_8$ in. ~~(10~~ (9.5 mm) shall be maintained from all abutting walls, columns, or other vertical elements.

7.10.2 Attachments for Metal Plaster Bases to Wood Framing Members:

7.10.2.1 Lath shall be attached to framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ with attachments spaced not more than 7 in. (178 mm) on center along framing members. Attachment penetrations between the framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ shall be avoided.

7.10.2.2 Diamond-mesh expanded metal lath, flat-rib expanded metal lath, and wire lath shall be attached to horizontal wood framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ with $1^1/_2$-in. ~~(38~~ (38.1 mm) roofing nails driven flush with the plaster base and attached to vertical wood framing members with 6d common nails, or 1-in. (25 mm) roofing nails driven to a penetration of not less than $^3/_4$ in. ~~(19~~ (19.1 mm), or 1-in. (25 mm) wire staples driven flush with the plaster base. Staples shall have crowns not less than $^3/_4$ in. (19.05 mm) and shall engage not less than three strands of diamond mesh and flat rib expanded metal lath or not less than two strands of wire lath and penetrate the wood framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ not less than $^3/_4$ in. ~~(19~~ (19.05 mm). When metal lath is ~~installed~~ applied over sheathing, use fasteners that will penetrate the ~~framing~~ structural members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ not less than $^3/_4$ in. (19 mm).

7.10.2.3 Expanded $^3/_8$ in. ~~(10~~ (9.5 mm) rib lath shall be attached to horizontal and vertical wood framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ with nails or staples to provide not less than $1^3/_4$-in. ~~(44~~ (44.5 mm) penetration into horizontal wood framing ~~members~~ members, ~~studs~~ and ~~joist,~~ 3 ~~runners~~/ ~~(tracks),~~ 4 ~~bridging~~-in. ~~and~~ (19.1 ~~bracing~~ mm) ~~and~~ penetration ~~related~~ into ~~accessories.~~ vertical ~~Subcommittee:~~ wood ~~C11.03~~ framing ~~Standard:~~ members. ~~C1007.~~

7.10.2.4 Common nails shall be bent over to engage not less than three strands of diamond mesh and flat rib expanded metal lath ~~see gypsum lath.Subcommittee: C11.91 Standard: C11~~ or not less than two strands of wire lath, or be bent over a rib when rib lath ~~see gypsum lath.Subcommittee: C11.91 Standard: C11~~ is installed.

7.10.2.5 Screws used to attach metal plaster base ~~expanded metal lath, or welded or woven wire lath.Subcommittee: C11.03 Standard: C926~~ to horizontal and vertical wood framing members shall penetrate not less than $^5/_8$ in. ~~(16~~ (15.9 mm) into the member when the lath ~~see gypsum lath.Subcommittee: C11.91 Standard: C11~~ is installed. For expanded metal ~~lath~~ lath, ~~see gypsum lath.Subcommittee: C11.91 Standard: C11,~~ the screw shall engage not less than three strands of lath. For wire laths, screws shall engage not less than two strands of diamond mesh and flat rib expanded metal lath ~~see gypsum lath.Subcommittee: C11.91 Standard: C11~~ or not less than two strands of wire lath. ~~see gypsum lath.Subcommittee: C11.91 Standard: C11.~~ When installing expanded metal rib lath, the screw shall pass through, but not deform, the rib. When installing wire rib ~~lath~~ lath, ~~see gypsum lath.Subcommittee: C11.91 Standard: C11,~~ the screw may deform the rib.

7.10.3 Attachments for Metal Plaster Bases to Metal Framing Members:

7.10.3.1 Except as described in 7.10.3.2, all metal plaster bases shall be securely attached to metal framing members ~~studs joist, runners (tracks), bridging and bracing and related accessories.Subcommittee: C11.03 Standard: C1007~~ with 0.0475-in. 18 gauge (1.21 mm) wire ties, clips, or by other means of attachment which afford carrying strength and resistance to corrosion equal to or superior to that of the wire.

7.10.3.2 Rib metal lath shall be attached to open-web steel joists by single ties of galvanized, annealed steel wire, not less than 0.0475 in. (1.21 mm), with the ends ~~the end perpendicular to the paper-bound edge or long edge.Subcommittee: C11.01 Standard: C473~~ of each tie twisted together $1^1/_2$ times.

7.10.3.3 Screws used to attach metal plaster base to metal framing members shall project not less than $^3/_8$ in. ~~(10~~ (9.5 mm) through the metal framing member ~~studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787~~ when the lath is installed and for expanded metal laths shall engage not less than three strands of lath. ~~see gypsum lath.Subcommittee: C11.91 Standard: C11.~~ For wire laths, screws shall engage not less than two strands of diamond mesh and flat rib expanded metal lath ~~see gypsum lath.Subcommittee: C11.91 Standard: C11~~ or not less than two strands of wire lath. When installing expanded metal rib ~~lath~~ lath, ~~see gypsum lath.Subcommittee: C11.91 Standard: C11,~~ the screw shall pass through, but not deform, the rib. When installing wire rib ~~lath~~ lath, ~~see gypsum lath.Subcommittee: C11.91 Standard: C11,~~ the screw may deform the rib.

***7.10.4** Attachments for Metal Plaster Bases to Concrete* ~~*Joists—Rib*~~ *Joists—*Rib metal lath shall be attached to concrete joists by loops of 0.0800-in. (2.03 mm) galvanized, annealed steel wire, with the ends ~~the end perpendicular to the paper-bound edge or long edge.Subcommittee: C11.01 Standard: C473~~ of each loop twisted together.

7.10.5 Metal plaster bases shall be attached to masonry or concrete with power or powder actuated fasteners, or a combination of power or powder actuated fasteners and hardened concrete stub nails. One power or powder actuated fastener shall be located at each corner and one at the mid point of the long dimension adjacent to the edge of the metal plaster base ~~expanded metal lath, or welded or woven wire lath.Subcommittee: C11.03 Standard: C926~~ sheet. The balance of the sheet shall be fastened with power or powder actuated fasteners, or hardened concrete stub nails. The fasteners shall be installed in rows not more than 16 in. (406 mm) on center and spaced vertically along each row not more 7 in. (178 mm) on center. ~~Power-actuated~~ All fasteners ~~and~~ shall ~~concrete~~ be ~~stub~~ corrosion ~~nails~~ resistant and shall be ~~be~~ not less than $^3/_4$ in. (19 mm) long, with heads not less than $^3/_8$ in. ~~(10~~ (9.5 mm) wide. ~~Where the head diameter of the power actuated fastener or concrete stub nail is smaller than 3/8-in. (10 mm), fastener nails, screws, or staples used for the application of the gypsum base or backing board.Subcommittee: C11.03 Standard: C844nails, staples, or screws used for application of the gypsum panel product.Subcommittee: C11.03 Standard: C1280a nail, screw, staple or power actuated fastener.Subcommittee: C11.02 Standard: C1861 shall use a 7/8-in. (22 mm) diameter minimum corrosion resistant metal washer, which shall be perforated when washer diameter exceeds 1 in. (25 mm).~~

7.11 ~~**Installation**~~ **Application** of ~~**Lathing**~~ **Accessories:**

7.11.1 ~~Lathing~~ *General—*All ~~Accessory~~ metal ~~General Requirements—The type, location, ground dimension, and orientation of lathing~~ accessories shall be ~~indicated~~ installed in ~~the contract documents a series of several individual items that generally include drawings and specifications. Either or both of these documents may exist for any particular project.Subcommittee: C11.03 Standard: C926. 7.11.2 Install lathing accessories products fabricated for the purpose of forming corners, edges, control joints, or decorative effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints,~~ such ~~as casing beads, bull noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516 before cement plaster application to facilitate lathing installation, cement plaster see gypsum plaster, gypsum neat plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926 application, and functionality of the completed stucco~~ a ~~portland~~ manner ~~cement-aggregate~~ than ~~plaster mix designed for use on exterior surfaces. See portland cement plaster.Subcommittee: C11.91 Standard: C11portland cement-based plaster used on exterior locations.Subcommittee: C11.03 Standard: C926 cladding assembly. 7.11.3 Lathing Accessory Attachment Requirements: 7.11.3.1 Attach lathing accessory attachment~~ flanges ~~to substrate to ensure proper alignment during application of cement plaster. Secure lathing accessory attachment flanges at 7 in. (178 mm) maximum intervals along framing members studs joist,~~

~~runners (tracks), bridging~~ and ~~bracing~~ clips ~~and~~ provided ~~related accessories.Subcommittee: C11.03 Standard: C1007. 7.11.3.2 Install lathing accessories products fabricated~~ for ~~the~~ their ~~purpose of forming corners, edges, control joints, or decorative effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints, such as casing beads, bull noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516 with key~~ attachment ~~flanges~~ are ~~to~~ completely ~~embed~~ embedded ~~the flanges~~ in ~~cement~~ the plaster. ~~see~~

7.11.1.1 ~~gypsum~~ Accessories ~~plaster,~~ shall ~~gypsum~~ be ~~neat~~ attached ~~plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926. 7.11.3.3 Alternatively for solid plaster base substrates, adhere lathing accessory key attachment flanges directly~~ to ~~solid~~ substrate ~~plaster bases with adhesive applied~~ in ~~nominal 1 in. (25 mm) dabs at intervals in accordance with 7.11.3.1 or in a semi-continuous bead between the solid plaster base and the solid portion of the key attachment flange the attachment flange element of a lathing accessory that is full of holes or is expanded sheet metal that provides a means for accurate alignment, facilitates complete embedment of the key attachment flange and adjacent lath by cement plaster, and is used to attach the lathing accessory.Subcommittee: C11.02 Standard: C1861. 7.11.4 Lathing Accessory Water Management Requirements: 7.11.4.1 Where a defined drainage space is provided over the water-resistive barrier under lath and cement plaster, the ground dimension of lathing accessories with solid attachment flanges installed behind the water resistive barrier a material that resists the infiltration of liquid moisture through the building enclosure system.Subcommittee: C11.03 Standard: C1063 and defined drainage space to facilitate drainage,~~ such ~~as weep screeds, designated drainage screeds, expansion joints and drainage flashings, shall accommodate the defined drainage space dimension and specified cement plaster see gypsum plaster, gypsum neat plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926 thickness. 7.11.4.2 Install the water-resistive barrier and lathing to entirely cover the vertical solid attachment flange the solid attachment flange element of~~ a ~~lathing~~ manner ~~or furring accessory that provides a means for accurate alignment, facilitates drainage where drainage is required by integration of the solid attachment flange with the water-resistive barrier, and which has no holes except for optional fastener holes used to fasten the lathing accessory.Subcommittee: C11.02 Standard: C1861 of lathing accessories with a drainage function and drainage flashings such~~ as ~~weep screeds, designated drai nage screeds, expansion joints, and drainage flashings. Terminate lathing within 1/2 in. (13 mm) nominal above the lathing accessory drainage surface the sloped or non-sloped, perforated or non-perforated surface element of a lathing accessory that facilitates a drainage function, by directing water from behind the stucco cladding~~ to ~~the~~ ensure ~~exterior~~ proper ~~of~~ alignment ~~the~~ during ~~stucco~~ application ~~cladding.Subcommittee: C11.02 Standard: C1861. 7.11.4.3 At intersections~~ of ~~lathing~~ plaster. ~~accessories~~ Flanges ~~products fabricated for the purpose~~ of ~~forming corners, edges, control joints, or decorative effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints, such as casing beads, bull noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516 exposed at the cement plaster cladding finished surface, install the vertical lathing accessory continuously through the intersection unless the horizontally intersecting lathing accessory performs an expansion or drainage function, or both. Where vertical lathing~~ accessories ~~terminate above a drainage screed synonymous with ground.Subcommittee: C11.02 Standard: C1861 lathing accessory or drainage flashing, the intersection~~ shall be ~~kept~~ secured ~~free of sealant or other materials that will impede drainage. 7.11.4.4 Lathing accessories products fabricated for the purpose of forming corners, edges, control joints, or decorative effects.Subcommittee: C11.91 Standard: C11cornerbeads, edge trims, and control joints, such as casing beads, bull noses, and stops.Subcommittee: C11.02 Standard: C1047preformed metal, fiberglass or plastic members used to form corners, edges, control joints, or decorative effects.Subcommittee: C11.05 Standard: C1516 installed over the water-resistive barrier shall not impede drainage. 7.11.5 Foundation Weep Screed—install a weep screed lathing accessory~~ at ~~the bottom of steel or wood framed exterior walls. Locate the bottom edge of the weep screed lathing accessory~~ not ~~less~~ more than ~~1~~ 7 in. ~~(25~~ (178 mm) ~~below~~ intervals ~~the~~ along ~~joint~~ supports. ~~formed~~

7.11.2 ~~by~~ *Corner* ~~the~~ *Beads*—Corner ~~foundation~~ beads ~~and~~ shall ~~framing.~~ be ~~Locate~~ installed ~~the weep screed lathing accessory ground the element of a lathing accessory that provides an edge, end, or termination for a cement plaster panel area, with a ground dimension~~ to ~~assist~~ protect ~~in~~ all ~~cement~~ external ~~plaster~~ corners ~~thickness control.Subcommittee: C11.02 Standard: C1861 a of 4 in. (102 mm) minimum above raw earth or 2 in. (51 mm) above paved surfaces. 7.11.6 Designated Drainage Screed—Install a designated drainage screed lathing accessory at locations indicated in the contract documents a series of several individual items that generally include drawings~~ and ~~specifications. Either or both of these documents may exist for any particular project.Subcommittee: C11.03 Standard: C926 and follow specified requirements in the contract documents a series of several individual items that generally include drawings and specifications. Either or both of these documents may exist for any particular project.Subcommittee: C11.03 Standard: C926. 7.11.7 Casing Bead—Install a casing bead lathing accessory or other suitable means, at locations~~ to ~~separate~~ establish ~~cement~~ grounds. ~~plaster~~

7.11.2.1 ~~see~~ External ~~gypsum plaster, gypsum neat plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious mixture (see stucco).Subcommittee: C11.03 Standard: C926 from dissimilar materials, penetrating elements, load bearing members in screw application of gypsum board, studs, runners (track), hat furring channels, main beams, and cross furring members of grid suspension systems or other items manufactured in accordance with this specification.Subcommittee: C11.02 Standard: C645studs, runners, tracks, bracing, bridging, accessories, or other items manufactured in accordance with this specification.Subcommittee: C11.02 Standard: C955 and to avoid transfer of structural loads. 7.11.8 Internal~~ Corner ~~Reinforcement—Install~~ Reinforcement—External ~~an internal~~ corner reinforcement ~~lathing~~ shall ~~accessory~~ be ~~at internal cement plaster corner locations except where lathing is~~ installed ~~continuously~~ to ~~through~~ reinforce ~~the~~ all ~~internal~~ external ~~corner,~~ corners ~~or~~ where ~~an~~ corner ~~expansion~~ bead ~~joint~~ is ~~lathing~~ not ~~accessory or control joint a joint that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product~~ used. ~~for~~ Where ~~designed~~ no ~~or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessory is installed at the internal corner location. 7.11.9 External Corner Reinforcement—Install an~~ external corner reinforcement ~~lathing~~ or ~~accessory at external cement plaster~~ corner ~~locations.~~ bead ~~Alternatively, where no external corner reinforcement lathing accessory~~ is ~~used~~ used, ~~on~~ lath ~~framed, and framed and sheathed construction, lathing~~ shall be furred ~~away~~ out ~~from the substrate~~ and ~~installed~~ carried ~~continuously~~ around ~~external~~ corners ~~for~~ not ~~a~~ less ~~minimum~~ than ~~distance of~~ one ~~framing member studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other~~ support ~~to~~ on ~~which~~ frame ~~a~~ construction. ~~gypsum~~

7.11.3 ~~panel~~ Casing ~~product,~~ Beads—Non-load-bearing ~~or~~ members ~~metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached~~ shall be ~~not~~ isolated ~~less~~ from ~~than~~ load-bearing ~~112 in. (38 mm) wide for wood~~ members, ~~not less than 114 in. (32 mm) wide for steel members,~~ and ~~not~~ all ~~less~~ penetrating ~~than~~ elements, ~~6~~ with ~~in.~~ casing ~~(152~~ beads ~~mm) wide for gypsum studs. For internal corners~~ or ~~angles,~~ other ~~the~~ suitable ~~bearing~~ means, ~~surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve~~ to ~~receive~~ avoid ~~the~~ transfer ~~gypsum~~ of ~~panel~~ structural ~~product.~~ loads, ~~Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing,~~ and ~~related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787 beyond the corner. 7.11.10 Expansion Joint—Install an expansion joint lathing accessory at an expansion joint location in the building, the substrate surface~~ to ~~which~~ separate ~~the~~ from ~~DEFS~~ dissimilar ~~is~~ materials. ~~applied.~~

7.11.4 ~~Subcommittee: C11.05 Standard: C1516, or its components. 7.11.11~~ Control ~~Joints—Install~~ Joints ~~control~~ (General)—Control ~~joint~~ joints ~~a~~ shall ~~joint~~ be ~~that~~ formed ~~accommodates~~ by ~~movement~~ using ~~of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063~~ a ~~formed~~ single ~~product~~ prefabricated ~~used~~ member, ~~for designed~~ or ~~required~~ fabricated ~~separations~~ by ~~between~~ installing ~~adjacent~~ casing ~~surfaces~~ beads ~~of~~ back ~~gypsum~~ to ~~boards~~ back ~~or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessories in conformance~~ with ~~7.10.1.5. 7.11.11.1 Form control joints by attaching~~ a ~~prefabricated~~ flexible ~~control~~ barrier ~~joint~~ membrane ~~a~~ behind ~~joint~~ the ~~that accommodates movement of plaster shrinkage and curing along predetermined, usually straight, lines.Subcommittee: C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessory, or alternatively by attaching a pair of~~ casing beads. ~~with~~ The ~~key attachment flanges, back to back, with a~~ separation spacing shall be not less than $^1/_8$ in. ~~(3~~ (3.2 mm) or as required ~~pertaining to a mandatory obligation imposed~~ by ~~a force outside this standard, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C840pertaining to a mandatory obligation imposed by a force outside of this specification, such as a building code, project specification, contract, or purchase order.Subcommittee: C11.03 Standard: C926 by~~ the anticipated thermal exposure ~~range~~ range, and ~~a flexible barrier membrane behind the casing beads. Wall or partition height door frames~~ shall be ~~considered~~ in ~~as~~ conformance ~~control~~ with ~~joints.~~ 7.10.1.5 ~~7.11.11.2. Install~~

7.11.4.1 ~~control~~ Control ~~joint~~ Joints—Control ~~a~~ (expansion ~~joint that accommodates movement of plaster shrinkage~~ and ~~curing~~ contraction) ~~along~~ joints ~~predetermined,~~ shall ~~usually~~ be ~~straight,~~ installed ~~lines.~~ in ~~Subcommittee:~~ walls ~~C11.03 Standard: C1063a formed product used for designed or required separations between adjacent surfaces of gypsum boards or gypsum veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessories at locations~~ to delineate ~~cement~~ areas ~~plaster~~ not ~~see~~ more ~~gypsum~~ than ~~plaster, gypsum neat plaster.Subcommittee: C11.91 Standard: C11portland cement-based cementitious~~

~~mixture (see stucco).Subcommittee: C11.03 Standard: C926 panel areas of~~ 144 ft^2 ~~(13~~ (13.4 m^2) ~~maximum~~ and ~~for~~ to ~~walls~~ delineate ~~and~~ areas not more than 100 ft^2 ~~(9~~ (9.30 m^2) ~~maximum~~ for all horizontal ~~installations,~~ applications, that is, ceilings, curves, or angle type structures. ~~7.11.11.3~~

7.11.4.2 ~~Install~~ The ~~control~~ distance ~~joint~~ between ~~a~~ control ~~joint~~ joints ~~that~~ shall ~~accommodates~~ not ~~movement~~ exceed ~~of~~ 18 ~~plaster~~ ft ~~shrinkage~~ (5.5 ~~and~~ m) ~~curing~~ in ~~along~~ either ~~predetermined,~~ direction ~~usually~~ or ~~straight, lines.Subcommittee: C11.03 Standard: C1063~~ a ~~formed~~ length-to-width ~~product~~ ratio ~~used for designed or required separations between adjacent surfaces~~ of ~~gypsum~~ 2 ~~boards~~[1] ~~or~~ / ~~gypsum~~ ~~2 veneer base.Subcommittee: C11.02 Standard: C1047 lathing accessories at locations~~ to ~~delineate~~ 1. ~~cement~~ A ~~plaster~~ control ~~see~~ joint ~~gypsum~~ shall ~~plaster,~~ be ~~gypsum~~ installed ~~neat~~ where ~~plaster.~~ the~~Subcommittee:~~ ceiling ~~C11.91~~ framing ~~Standard:~~ or ~~C11~~ furring~~portland~~ changes ~~cement-based~~ direction. ~~cementitious~~

7.11.4.3 ~~mixture~~ An ~~(see~~ expansion ~~stucco).~~ joint~~Subcommittee:~~ shall ~~C11.03~~ be ~~Standard:~~ installed ~~C926~~ where ~~panel~~ an ~~areas~~ expansion ~~of~~ joint ~~18~~ occurs ~~ft~~ in ~~(5~~ the ~~m)~~ base ~~maximum~~ exterior ~~dimension,~~ wall. ~~in~~

7.11.4.4 ~~either~~ Wall ~~direction,~~ or ~~a~~ partition ~~maximum~~ height ~~length-to-width~~ door ~~ratio~~ frames ~~of~~ shall ~~2~~ be ~~1~~ considered ~~/ as2 to 1. 7.11.11.4 Install a~~ control ~~joint~~ joints. ~~a~~

7.11.5 ~~joint~~ ***Foundation*** ~~*that*~~ ***Weep*** ~~*accommodates*~~ ***Screed***—Foundation ~~movement~~ weep ~~of~~ screed ~~plaster~~ shall ~~shrinkage~~ be ~~and~~ installed ~~curing~~ at ~~along~~ the ~~predetermined;~~ bottom ~~usually~~ of ~~straight,~~ all ~~lines.~~ steel~~Subcommittee:~~ or ~~C11.03~~ wood ~~Standard:~~ framed ~~C1063~~ exterior~~a~~ walls ~~formed~~ to ~~product~~ receive ~~used~~ lath ~~for~~ and ~~designed~~ plaster. ~~or~~ Place ~~required~~ the ~~separations~~ bottom ~~between~~ edge ~~adjacent surfaces~~ of ~~gypsum~~ the ~~boards~~ foundation ~~or~~ weep ~~gypsum~~ screed ~~veneer~~ not ~~base.~~ less~~Subcommittee:~~ than ~~C11.02~~ 1 ~~Standard:~~ in. ~~C1047~~ (25 ~~lathing~~ mm) ~~accessory~~ below ~~at locations where~~ the ~~ceiling~~ joint ~~framing~~ formed ~~or~~ by ~~furring~~ the ~~preparing~~ foundation ~~a~~ and ~~wall or ceiling with~~ framing. ~~or~~ The ~~furring~~ nose ~~members~~ of ~~to~~ the ~~provide~~ screed ~~a~~ shall ~~level~~ be ~~surface~~ placed ~~or~~ not ~~airspace.~~ less~~Subcommittee:~~ than ~~C11.03~~ 4 ~~Standard:~~ in. ~~C754~~ (102~~spacer~~ mm) ~~strips~~ above ~~fastened~~ raw ~~to~~ earth ~~a wall, ceiling,~~ or ~~planar~~ 2 ~~element~~ in. ~~that~~ (51 ~~create~~ mm) ~~an~~ above ~~even~~ paved ~~surface~~ surfaces. ~~for~~ The ~~the~~ weather ~~application~~ resistive ~~of~~ barrier ~~metal~~ and ~~plaster bases or gypsum~~ lath~~Subcommittee:~~ shall ~~C11.03~~ entirely ~~Standard:~~ cover ~~C841~~ the~~spacer~~ vertical ~~elements~~ attachment ~~added~~ flange ~~to~~ and ~~a~~ terminate ~~building~~ at ~~structure~~ the ~~to~~ top ~~facilitate~~ edge ~~fastening~~ of ~~gypsum~~ the ~~panel~~ nose ~~products.~~ or~~Subcommittee:~~ ground ~~C11.03~~ flange. ~~Standard: C1546 changes direction.~~

8 KEYWORDS

8.1 ceiling; expansion control joints; lath; plaster; screed; suspended ceiling; walls

ANNEX

(Mandatory Information)

A1 GENERAL INFORMATION

A1.1 All wood-based sheathing shall be installed with a minimum $^1/_8$-in. ~~(3~~ (3.2 mm) ~~minimum~~ gap around all panel edges and between openings for doors and windows.

NOTE A1.1: This $^1/_8$-in. ~~(3~~ (3.2 mm) gap is intended to accommodate expansion. Linear expansion that is not accommodated by an expansion gap can cause stress on the stucco ~~a portland cement aggregate plaster mix designed for use on exterior surfaces. See portland cement plaster.Subcommittee: C11.91 Standard: C11portland cement-based plaster used on exterior locations.Subcommittee: C11.03 Standard: C926~~ membrane resulting in stucco cracks.

~~APPENDIX~~

A1.2 ~~(Nonmandatory~~ *Expansion* ~~*Information)*~~ *Joints* ~~X1.1~~ shall ~~The~~ be ~~nominal~~ used ~~lap values specified pertaining~~ to ~~a~~ accommodate ~~mandatory~~ some ~~requirement~~ degree of ~~this~~ movement ~~standard or a referenced requirement (see 3.2.17).Subcommittee: C11.03 Standard: C840pertaining to a mandatory requirement of this specification or a referenced requirement.Subcommittee: C11.03 Standard: C1280~~ in ~~7.9.2 do not represent a maximum threshold value. Experience has shown that excessive lapping of expanded metal lath can inhibit proper embedment of~~ the ~~plaster in the underlying layer of lath which, in turn, can result in attendant corrosion and cracking of the~~ stucco ~~a~~ membrane ~~portland~~ caused ~~cement-aggregate~~ by ~~plaster~~ movement ~~mix designed for use on exterior surfaces. See portland cement plaster.Subcommittee: C11.91 Standard: C11portland cement-based plaster used on exterior locations.Subcommittee: C11.03 Standard: C926 finishes. The nominal value provided in~~

~~7.9.2 has been shown to perform successfully; lath see gypsum lath.Subcommittee: C11.91 Standard: C11 laps greater than this value may also perform successfully, but represent a heightened risk~~ of ~~embedment and cracking problems. SUMMARY OF CHANGES Committee C11 has identified~~ the ~~location~~ building ~~of~~ or ~~selected~~ its ~~changes~~ components to ~~this~~ minimize ~~standard~~ damage ~~since the last issue (C1063 — 18a) that may impact the use of this standard. (Approved April 1, 2018.) (1) Revised 7.9.2. (2) Added new Appendix X1. Committee C11 has identified the location of selected changes~~ to ~~this standard since~~ the ~~last~~ stucco ~~issue (C1063 — 18) that may impact the use of this standard. (Approved April 1, 2018.) (1) Removed A0641_A0641M, B0069, B0221, C0954, C1002, D1784,~~ and ~~D4216~~ water ~~from~~ resistive ~~list~~ barrier ~~of~~

A1.3 ~~referenced~~ *Control* ~~*documents*~~ *Joints* ~~(Section~~ shall ~~2).~~ be ~~(2)~~ installed ~~Added~~ to ~~Specifications~~ minimize ~~C1280~~ stress ~~and~~ due ~~C1861~~ to ~~list~~ stucco ~~of~~ curing ~~referenced documents (Section 2). (3) Added new 3.1.2~~ and ~~renumbered~~ drying ~~subsequent~~ shrinkage ~~sections accordingly. (4) Removed previous 6.3 — 6.3.2 with new 6 — 6.3.2. (5) Removed previous 6.3.4 — 6.8.3. (6) Revised 7.1, 7.2.1 — 7.2.5, 7.3.4, 7.4 — 7.5.4, 7.6 — 7.6.2, 7.7.1 — 7.7.3. (7) Added new 7.8~~ and ~~renumbered~~ minor ~~subsequent~~ movement, ~~sections~~ along ~~accordingly.~~ predetermined, ~~(8)~~ usually ~~Revised~~ straight ~~7.9.2,~~ lines ~~7.10.1.6, 7.10.1.7, 7.10.2.3, 7.10.3.2, 7.10.4,~~ and ~~7.10.5.~~ as ~~(9)~~ a ~~Removed~~ screed ~~previous~~ to ~~7.11~~ aid ~~–~~ in ~~7.11.5~~ stucco ~~and~~ thickness ~~replaced~~ control. ~~with~~

SUMMARY ~~NEW~~ OF ~~7.11~~ CHANGES ~~— 7.11.11.4. (10) SWITCHED PREVIOUS TABLES 2 AND 3 (AND UPDATED IN-TEXT TABLE REFERENCES ACCORDINGLY). (11) REVISED TABLE 3 AND TITLE OF FIG. 3. (12) REMOVED PREVIOUS A1.2 AND A1.3.~~

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 — ~~17b)~~ 15) that may impact the use of this standard. (Approved ~~Jan.~~ Aug. 1, ~~2018.)~~ 2015.)

(1) Revised ~~7.8.3,~~ definition ~~7.8.3.1, 7.10.4.1. (2) Replaced previous Table 3 with new Table 3. (3) Added new 2.2. (4) Added new Section 6, renumbered other sections accordingly. (5) Updated titles~~ of ~~Sections~~ “water ~~4~~ resistive ~~and~~ barrier ~~5.~~ system” ~~Committee~~ (formerly ~~C11~~ “water ~~has~~ barrier ~~identified~~ system”) ~~the~~ in ~~location~~ Terminology ~~of~~ (Section ~~selected~~ 3 ~~changes~~). ~~to this standard since the last issue (C1063 — 17a) that may impact the use of this standard. (Approved Dec. 1, 2017.) (1) Revised 7.9.2.3 and 7.10.4.1. (2) Combined previous Sections 4 and 5, added new Section 6, and renumbered subsequent sections accordingly.~~

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 — ~~17a)~~ 14d) that may impact the use of this standard. (Approved June 1, ~~2017.)~~ 2015.)

(1) ~~*Added*~~ Definition ~~new~~ for ~~7.10.1.3.~~ “drainage ~~Committee~~ plane” ~~C11 has identified the location of selected changes to this standard since the last issue~~ (~~C1063~~3.2.4 ~~—~~) ~~16c)~~ was ~~that~~ revised. ~~may impact the use of this standard. (Approved April 1, 2017.) (1) Removed previous 3.2.1, 3.2.4 — 3.2.6, , 3.2.14, 7.9, and renumbered subsequent sections accordingly.~~

(2) ~~*Replaced the terms "member" and "support" with " framing member studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in. (38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787" throughout. (3) Replaced the term "support" with " framing member studs, joist, runners (track), bridging, bracing, and related accessories manufactured or supplied in wood or light gauge steel.Subcommittee: C11.03 Standard: C1063stud, plate, track, joist, furring, and other support to which a gypsum panel product, or metal plaster base is attached.Subcommittee: C11.91 Standard: C11metal studs, runners (track), and rigid furring channels designed to receive screw-attached gypsum panel products.Subcommittee: C11.03 Standard: C754that portion of the framing, furring, blocking, and so forth, to which the gypsum base is attached. Unless otherwise specified, the surface to which abutting edges or ends are attached shall be not less than 112 in.*~~

~~*(38 mm) wide for wood members, not less than 114 in. (32 mm) wide for steel members, and not less than 6 in. (152 mm) wide for gypsum studs. For internal corners or angles, the bearing surface shall be not less than 34 in. (19 mm).Subcommittee: C11.03 Standard: C844studs, headers, bracing, and blocking that serve to receive the gypsum panel product.Subcommittee: C11.03 Standard: C1280studs, joist, runners (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or hot or cold formed steel.Subcommittee: C11.05 Standard: C1516see Specification C1063.Subcommittee: C11.03 Standard: C1787". (4) Replaced the terms "application" and "applied" with "installation" and "installed" throughout. (5) Removed previous Note 2 and placed its contents in new 5.3.3. (6)*~~ Revised ~~7.10.1.4~~ 7.10.2.2 ~~and~~, ~~7.9.2.2.~~ 7.10.2.4 ~~(7)~~, ~~Added~~ 7.10.2.5 ~~new~~, ~~5.1~~ and ~~renumbered~~ 7.10.3.3 ~~subsequent~~. ~~sections accordingly. (8) Added new 5.8.3.~~

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063~~—~~ –~~16b)~~ 14c) that may impact the use of this standard. (Approved ~~Sept.~~ Aug. 15, ~~2016.)~~ 2014.)

(1) Revised ~~5.3.2~~ subsection ~~and~~ 7.10.1.7 ~~7.10.1.~~.

Committee C11 has identified the location of selected changes to this standard since the last issue (C1063~~—~~ –~~16a)~~ 14b) that may impact the use of this standard. (Approved ~~Sept.~~ June 1, ~~2016.)~~ 2014.)

(1) ~~*Corrected*~~ Definition ~~table~~ for ~~reference~~ water ~~in~~ resistive ~~7.6.1.~~ barrier ~~(2)~~ was ~~Added~~ revised. ~~7.10.1.4. Committee C11 has identified the location of selected changes to this standard since the last issue (C1063 — 16) that may impact the use of this standard. (Approved March 1, 2016.) (1) Revised 1.1.~~

(2) ~~*Revised*~~ Revisions ~~7.10.1.2.~~ were ~~Committee~~ made ~~C11~~ in ~~has~~ 7.7.4, ~~identified~~ 7.8.3.1, ~~the location of selected changes to this standard since the last issue (C1063 — 15a) that may impact the use of this standard. (Approved Jan. 1, 2016.) (1) Revised 3.2.6~~ and ~~7.9.2.2.~~ A1.2.

Committee C11 has identified the location of selected changes to this ~~standard~~ specification since the last issue (C1063~~—~~ –~~15)~~ 14a) that may impact the use of this ~~standard.~~ specification. (Approved ~~Aug.~~ April 1, ~~2015.)~~ 2014.)

(1) ~~*Revised*~~ Addition ~~definition~~ of ~~"~~ the ~~water~~ exception ~~resistive~~ in ~~barrier~~ 7.8.3.1 ~~a~~ for ~~material~~ backing ~~that~~ to ~~resists~~ be ~~the~~ placed ~~infiltration~~ outboard of ~~liquid moisture through~~ the ~~building~~ weep ~~enclosure~~ screed ~~system.~~ flange~~Subcommittee:~~ to ~~C11.03~~ be ~~Standard:~~ consistent ~~C1063~~ with ~~system"~~ 7.11.5 ~~(formerly~~. ~~"water barrier system") in Terminology (Section 3).~~

FOOTNOTES

(1) This specification is under the jurisdiction of ASTM Committee C11 on Gypsum and Related Building Materials and Systems and is the direct responsibility of Subcommittee C11.03 on Specifications for the Application of Gypsum and Other Products in Assemblies.

Current edition approved ~~June~~ Aug. 1, ~~2010.~~ 2015. Published ~~July~~ September ~~2010.~~ 2015. Originally approved in 1986. Last previous edition approved in ~~2010~~ 2015 as **C1063~~—~~** –~~18a.~~ 15. DOI: ~~10.1520/C1063-18B.~~ 10.1520/C1063-15A.

(2) For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

S7821

Date Submitted	12/10/2018	**Section**	704	**Proponent**	T Stafford
Chapter	7	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Approved as Submitted
Commission Action Pending Review

Comments

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

Related Modifications

Summary of Modification

A new stand alone section is proposed for soffits with new language addressing other common materials and a new prescriptive option for wood structural panel soffits.

Rationale

The purpose of this code change proposal is to improve the high wind performance of soffits by clarifying FBCR installation requirements for the most common types of manufactured soffits and by providing a prescriptive alternative for wood structural panel soffits that comply with design wind pressures specified in the Florida Building Code and ASCE 7. See uploaded support file for additional rationale and justification.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

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

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

No impact to building and property owners relative to cost of compliance with the code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to cost of compliance with the code.

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

No impact to small business relative to cost of compliance with the code.

Requirements

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

This proposal clarifies wind requirements for soffits which should result in improved performance wand reduced water infiltration during design wind events.

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

This proposal strengthens the code by clarifying the wind requirements for soffits which should result in improved performance wand reduced water infiltration during design wind events.

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

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

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

2nd Comment Period

7821-A2

Proponent T Stafford **Submitted** 5/20/2019 **Attachments** Yes

Rationale

This public comment intends to add some additional clarity to Mod#7821. While the original modification was Approved as Submitted, a TAC member commented that depiction of the attachment of the soffit panels at the wall was a bit problematic with the way the fasteners were shown "inside" the J-channel. The new figures depict a more realistic attachment. Additionally, a new single span soffit panel figure has also been added as this is the most common type of soffit installation. This public comment does not change the basic intent of the original modification but does provide additional clarity.

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 the 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 public comment is a clarification of the code.

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

This public comment improves the code by clarifying the intent.

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

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

Does not degrade the effectiveness of the code

This public comment does not degrade the effectiveness of the code.

Revise Section R704.2.1 of the original modification as follows:

R704.2.1 Vinyl soffit panels. Vinyl soffit panels shall be installed using fasteners specified by the manufacturer and shall be fastened at both ends to a supporting component such as a nailing strip, fascia or subfascia component in accordance with Figure R704.2.1. Where the unsupported span of soffit panels is greater than 12 inches, intermediate nailing strips shall be provided in accordance with Figure R704.2.2 unless a larger span is permitted in accordance with the manufacturer's product approval specification. Vinyl soffit panels shall be installed in accordance with the manufacturer's product approval specification and limitations of use. Fascia covers shall be installed in accordance with the manufacturer's product approval specification and limitations of use.

Replace Figure R704.2.1 in the original modification with new Figures R704.2.1 and R704.2.2:

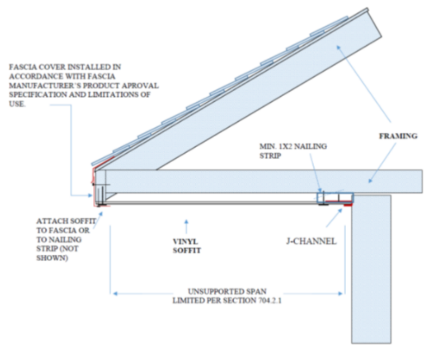


FIGURE R704.2.1

TYPICAL SINGLE SPAN VINYL SOFFIT PANEL SUPPORT

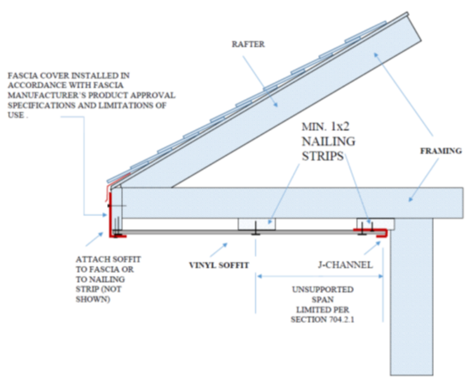


FIGURE R704.2.2

TYPICAL MULTI-SPAN VINYL SOFFIT PANEL SUPPORT

Revise as follows:

R703.1.2.1 Wind resistance of soffits. Soffits and their attachments shall comply with Section R704. ~~be capable of resisting wind loads specified in Tables R301.2(2) and R301.2(3) for walls using an effective wind area of 10 square feet.~~

Delete without substitution:

~~**R703.11.1.4 Vinyl soffit panels.** Soffit panels shall be individually fastened to a supporting component such as a nailing strip, fascia or subfascia component or as specified by the manufacturer's instructions.~~

Add new Section as follows:

SECTION R704

SOFFITS

R704.1 Wind resistance of soffits. Soffits and their attachments shall be capable of resisting wind loads specified in Tables R301.2(2) and R301.2(3) for walls using an effective wind area of 10 square feet.

R704.2 Soffit installation. Soffit installation shall comply with Section R704.2.1, Section R704.2.2, Section R704.2.3, Section R704.2.4.

R704.2.1 Vinyl soffit panels. Vinyl soffit panels shall be installed using fasteners specified by the manufacturer and shall be fastened at both ends to a supporting component such as a nailing strip, fascia or subfascia component. Where the unsupported span of soffit panels is greater than 12 inches, intermediate nailing strips shall be provided in accordance with Figure R704.2 unless a larger span is permitted in accordance with the manufacturer's product approval specification. Vinyl soffit panels shall be installed in accordance with the manufacturer's product approval specification and limitations of use. Fascia covers shall be installed in accordance with the manufacturer's product approval specification and limitations of use.

Figure R704.2 Typical vinyl soffit panel support

R704.2.2 Fiber-cement soffit panels. Fiber-cement soffit panels shall be a minimum of 1/4 inch thick and shall comply with the requirements of ASTM C1186, Type A, minimum Grade II or ISO 8336, Category A, minimum Class 2. Panel joints shall occur over framing or over wood structural panel sheathing. Soffit panels shall be installed with spans and fasteners in accordance with the manufacturer's product approval specification and limitations of use.

R704.2.3 Hardboard soffit panels. Where the design wind pressure is 30 psf or less, soffit panels shall be a minimum of 7/16 inch in thickness and shall be fastened to framing or nailing strips with 2 ½ " x 0.113" siding nails spaced not more than 6 inches on center at panel edges and 12 inches on center at intermediate supports. Where the design wind pressure is greater than 30 psf, hardboard soffit panels shall be installed in accordance with the manufacturer's product approval specification and limitations of use.

R704.2.4 Wood structural panel soffit prescriptive alternative. Wood structural panel soffit panels are permitted to be installed in accordance with Table R704.2.4.

Table 704.2.4

Installation Requirements for Wood Structural Panel, Closed Soffit[b,c,d,e,f]

Maximum Design Pressure (- or + psf)	Minimum Panel Span Rating	Minimum Panel Performance Category	Nail Type and Size (inch)	Fastener[a] Spacing along Edges and Intermediate Supports (inch)	
				Galvanized Steel	Stainless Steel
30	24/0	3/8	6d box (2 x 0.099 x 0.266 head diameter)	6[f]	4
40	24/0	3/8	6d box (2 x 0.099 x 0.266 head diameter)	6	4
50	24/0	3/8	6d box (2 x 0.099 x 0.266 head diameter)	4	4
			8d common (2½ x 0.131 x 0.281 head diameter)	6	6
60	24/0	3/8	6d box (2 x 0.099 x 0.266 head diameter)	4	3
			8d common (2½ x 0.131 x 0.281 head diameter)	6	4
70	24/16	7/16	8d common (2½ x 0.131 x 0.281 head diameter)	4	4
			10d box (3 x 0.128 x 0.312 head diameter)	6	4
80	24/16	7/16	8d common (2½ x 0.131 x 0.281 head diameter)	4	4
			10d box (3 x 0.128 x 0.312 head diameter)	6	4
90	32/16	15/32	8d common (2½ x 0.131 x 0.281 head diameter)	4	3
			10d common (3 x 0.148 x 0.312 head diameter)	6	4

a. Fasteners shall comply with Sections R703.3.2 and R703.3.3.

-

b. Maximum spacing of soffit framing members shall not exceed 24 inches.

c. Wood structural panels shall be of an exterior exposure grade.

d. Wood structural panels shall be installed with strength axis perpendicular to supports with a minimum of two continuous spans.

e. Wood structural panels shall be attached to soffit framing members with specific gravity of at least 0.42. Framing members shall be minimum 2x3 nominal with the larger dimension in the cross section aligning with the length of fasteners to provide sufficient embedment depths.

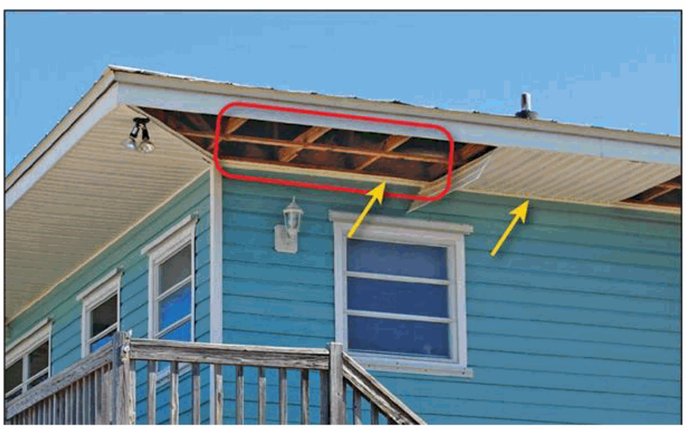
f. Spacing at intermediate supports is permitted to be 12 inches on center.

Reasons Statement: The purpose of this code change proposal is to improve the high wind performance of soffits by clarifying FBCR installation requirements for the most common types of manufactured soffits and by providing prescriptive alternative wood structural panel soffits that comply with design wind pressures specified in the Florida Building Code and ASCE 7.

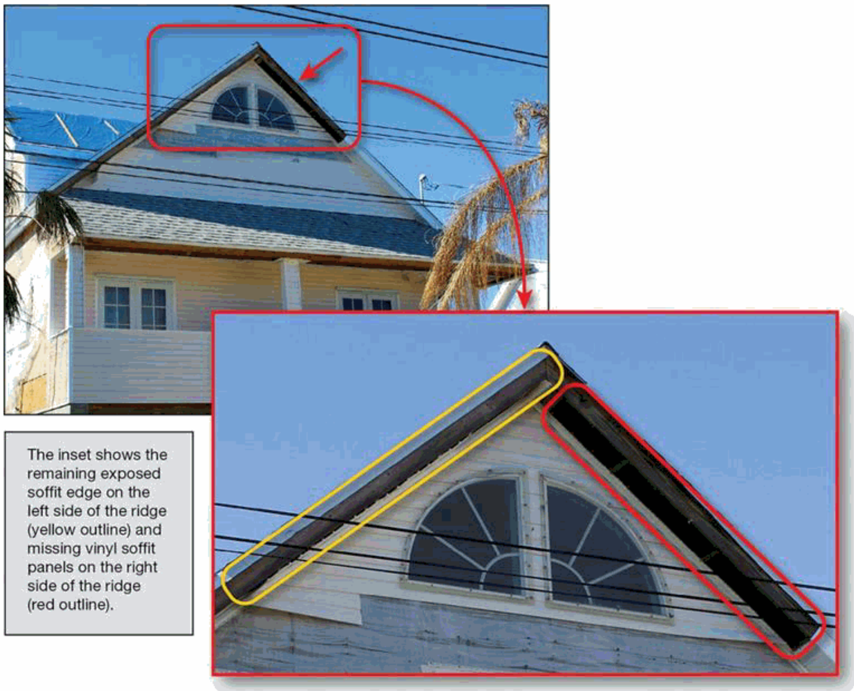
As part of the response to Hurricane Irma in Florida, the Federal Insurance and Mitigation Administration (FIMA) deployed a Mitigation Assessment Team (MAT) composed of national and regional building science experts to assess the damage in Florida. The primary purpose of a MAT is to improve the natural hazard resistance of buildings by evaluating the key causes of building damage, failure, and success, and developing strategic recommendations for improving short-term recovery and long-term disaster resilience to future natural hazard events. The following MAT-related information will be included in the FEMA MAT Report: Hurricane Irma in Florida which is anticipated to be published in December 2018. Links to download the free report will be shared with FBC TAC members and Commission members for reference upon publication.

The MAT observed building envelope damage on both older and newer residential construction, and soffits were among the most frequently observed damaged envelope components. Based on estimated wind speeds at the sites visited ranging from 104 to 120 mph, failure occurred to soffit components at wind speeds well below design wind speeds for these areas. The MAT observed both vinyl and metal soffit loss, but vinyl soffit panels were the most common product observed, particularly in the Florida Keys where vinyl soffit damage was widespread.

In many cases, inadequate support and attachment at the ends of the soffit panel led to failure of the soffit. The Sugarloaf Key house shown below (MAT Report Figure 4-19) lost its vinyl soffit in several areas. The red oval shows where the soffit panel was stripped from the assembly's J-channel, which remains attached along the exterior wall (yellow arrows). The soffit appears to have been fastened to only a single nailing strip across the midpoint of the framing above. Section 704.2.1 (including Figure 704.2) of the proposal has been included to clarify that vinyl soffit panel are required to be fastened at each end and the unsupported span cannot exceed 12 inches unless permitted by the manufacturer's product approval.



In some cases, vinyl soffit failure appeared to have been associated with fascia cover loss as shown in the image below from Little Torch Key (MAT Report Figure 4-18). Loss of the fascia cover likely increases wind pressures on vinyl soffit where the edges of the soffit are exposed.



The inset shows the remaining exposed soffit edge on the left side of the ridge (yellow outline) and missing vinyl soffit panels on the right side of the ridge (red outline).

MAT observations described above along with other examples detailed in the MAT Report, led to the following conclusions and recommendations:

Conclusion FL-10: The MAT observed evidence of inadequate resistance to wind pressures and improper installation of soffits on residential buildings. Widespread loss of soffits was observed in residential construction, and wind-driven rain infiltrated some areas where soffits were displaced or lost.
Recommendation FL-10a: Designers, contractors, and inspectors should place more emphasis on proper soffit installation to limit wind-driven rain. Proper soffit installation should be emphasized by designers, contractors, and inspectors in order to limit wind-driven rain from entering building envelopes and damaging building interiors. Florida Recovery Advisory 2, Hurricane Irma in Florida, *Soffit Installation in Florida* (2018), provides soffit installation guidance and resources to meet or exceed minimum provisions of the FBC.

In addition to the MAT Report, FEMA also develops Recovery Advisories to address immediate short-term rebuilding needs. Based on MAT observations of widespread soffit loss and concern expressed by local officials over the lack of FBCR provisions to address the issue, FEMA developed Recovery Advisory 2 in May of 2018. One of the key issues identified in the Recovery Advisory: Need for clarification on how to meet the 6th Edition (2017) FBCR soffit installation criteria. While the Recovery Advisory includes guidance to provide clarification on 6th edition FBCR compliant soffit installation, adding further clarification to the FBCR through approval of this code change proposal will provide a much more effective approach to ensuring improved wind performance of soffits going forward.

Cost Impact: The code change proposal will not increase the cost of construction because it only clarifies the existing requirement for soffit installation.

S7945

Date Submitted 12/11/2018
Chapter 7
Section 703.16
Affects HVHZ No
Proponent Ann Russo8
Attachments No
TAC Recommendation Approved as Submitted
Commission Action Pending Review

Comments

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

Related Modifications

RB309-16

Summary of Modification

This proposal updates the table values to a consistent rounding approach by rounding the values down to the nearest 0.05" to address actual thicknesses of foam sheathing materials that often vary from nominal dimensions such as 0.5", 1", 1.5", 2", 3", and 4".

Rationale

This proposal updates the table values to a consistent rounding approach by rounding the values down to the nearest 0.05" to address actual thicknesses of foam sheathing materials that often vary from nominal dimensions such as 0.5", 1", 1.5", 2", 3", and 4" as used in the existing table & 18 psf cladding weight category was added.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal adds an additional option (18 psf cladding weight) and does not increase cost.

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

This proposal adds an additional option (18 psf cladding weight) and does not increase cost.

Impact to industry relative to the cost of compliance with code

This proposal adds an additional option (18 psf cladding weight) and does not increase cost.

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

This proposal adds an additional option (18 psf cladding weight) and does not increase cost.

Requirements

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

This proposal adds an additional option (18 psf cladding weight) and does not effect the enforcement of the code.

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

This proposal adds an additional option (18 psf cladding weight) and provides an additional option to the table.

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

This proposal adds an additional option (18 psf cladding weight) and provides an additional option to the table and does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal adds an additional option (18 psf cladding weight) and provides an additional option to the table and does not degrade the effectiveness of the code.

2nd Comment Period

S7945-G1

Proponent Borrone Jeanette **Submitted** 5/21/2019 **Attachments** No

Comment:

I agree with the proposed revision.

Section: R703.16.1, R703.16.2

Revise as follows:

TABLE R703.16.1

CLADDING MINIMUM FASTENING REQUIREMENTS FOR DIRECT ATTACHMENT OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[a]

CLADDING FASTENER THROUGH FOAM SHEATHING INTO:	CLADDING FASTENER TYPE AND MINIMUM SIZE[b]	CLADDING FASTENER VERTICAL SPACING (inches)	MAXIMUM THICKNESS OF FOAM SHEATHING[c] (inches) — 16? o.c. Fastener Horizontal Spacing — Cladding Weight: 3 psf	16? o.c. — 11 psf	16? o.c. — 18 psf	16? o.c. — 25 psf	24" o.c. Fastener Horizontal Spacing — Cladding Weight: 3 psf	24" o.c. — 11 psf	24" o.c. — 18 psf	24" o.c. — 25 psf
Steel Framing (minimum penetration of steel thickness + 3 threads)	No. 8 screw into 33 mil steel or thicker	6	3.00	2.95~~3~~	2.20	1.45	3.00	2.35	1.25	DR
		8	3.00	2.55	1.60	0.60~~5~~	3.00	1.80~~5~~	DR	DR
		12	3.00	1.80~~5~~	DR	DR	3.00	0.65~~75~~	DR	DR
	No. 10 screw into 33 mil steel	6	4.00	3.50	2.70	1.95~~2~~	4.00	2.90~~3~~	1.70	0.55
		8	4.00	3.10	2.05	1.00	4.00	2.25	0.70	DR
		12	4.00	2.25	0.70	DR	3.70	1.05	DR	DR
	No. 10 screw into 43 mil steel or thicker	6	4.00	4.00	4.00	3.60	4.00	4.00	3.45	2.70
		8	4.00	4.00	3.70	3.00~~2~~	4.00	3.85	2.80	1.80~~5~~
		12	4.00	3.85	2.80	1.80~~5~~	4.00	3.05	1.50	DR

For SI: 1 inch = 25.4 mm, 1 mil = 0.0254 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa. DR = Design required.

o.c. = on center

a. Steel framing shall be minimum 33 ksi steel for 33 mil and 43 mil steel, and 50 ksi steel for 54 mil steel orthicker.

b. Screws shall comply with the requirements of ASTM C1513.

c. Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C 578 or ASTM C1289.

TABLE R703.16.2

FURRING MINIMUM FASTENING REQUIREMENTS FOR APPLICATION OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[a]

FURRING MATERIAL	FRAMING MEMBER	FASTENER TYPE AND MINIMUM SIZE[b]	MINIMUM PENETRATION INTO WALL FRAMING (inches)	FASTENER SPACING IN FURRING (inches)	MAXIMUM THICKNESS OF FOAM SHEATHING[d] (inches)							
					16? o.c. Furringe				24? o.c. Furringe			
					Cladding Weight:				Cladding Weight:			
					3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 PSF	25 psf
Minimum 33 mil Steel Furring or Minimum 1 × Wood Furring[c]	33 mil Steel Stud	No. 8 screw	Steel thickness + 3 threads	12	3.00	1.80~~5~~	DR	DR	3.00	0.65	DR	DR
				16	3.00	1.00	DR	DR	2.85	DR	DR	DR
				24	2.85	DR	DR	DR	2.20	DR	DR	DR
		No. 10 screw	Steel thickness + 3 threads	12	4.00	2.25	0.70	DR	3.704	1.05	DR	DR
				16	3.85 4	1.45	DR	DR	3.40	DR	DR	DR
				24	3.40	DR	DR	DR	2.70	DR	DR	DR
	43 mil or thicker SteelStud	No. 8 Screw	Steel thickness + 3 threads	12	3.00	1.80~~5~~	DR	DR	3.00	0.65	DR	DR
				16	3.00	1.00	DR	DR	2.85	DR	DR	DR
				24	2.85	DR	DR	DR	2.20	DR	DR	DR
		No. 10 screw	Steel thickness + 3 threads	12	4.00	3.85	2.80	1.80~~5~~	4.00	3.05	1.50	DR
				16	4.00	3.30	1.95	0.60~~5~~	4.00	2.25	DR	DR
				24	4.00	2.25	DR	DR	4.00	0.65	DR	DR

For SI: 1 inch = 25.4 mm, 1 mil = 0.0254 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa. DR = Design required.

o.c. = on center

Wood furring shall be Spruce-pine-fir or any softwood species with a specific gravity of 0.42 or greater. Steel furring shall be minimum 33 ksi steel. Steel studs shall be minimum 33 ksi steel for 33mil and 43 mil thickness, and 50 ksi steel for 54 mil steel or thicker.

Screws shall comply with the requirements of ASTM C1513.

c. Where the required cladding fastener penetration into wood material exceeds $^{3}/_{4}$ inch and is not more than $1^{1}/_{2}$ inches, a minimum 2-inch nominal wood furring or an approved design shall beused.

d. Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C 578 or ASTM C1289.

Furring shall be spaced not more than 24 inches (610 mm) on center, in a vertical or horizontal orientation. In a vertical orientation, furring shall be located over wall studs and attached with the required fastener spacing. In a horizontal orientation, the indicated 8-inch and 12-inch fastener spacing in furring shall be achieved by use of two fasteners into studs at 16 inches and 24 inches on center,respectively

S8150

Date Submitted	12/14/2018	**Section**	802.2	**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** **Yes**

Related Modifications

Summary of Modification

This proposal is intended to clarify the limits for using the prescriptive (non-high) wind criteria that's been carried forward in the FBCR from the IRC.

Rationale

This proposal is intended to clarify the applicability of the prescriptive criteria in the FBCR for wood, masonry, concrete and steel buildings. Since the first edition, the FBCR has limited the use of the prescriptive criteria that has been carried forward from the IRC. With the adoption of ASCE 7-10 in the 2010 FBCR, the prescriptive provisions have not been permitted to be used in any area of Florida. Recent editions of the FBCR have simply deleted this criteria. During the last cycle, language was added to specifically address the limits but was not as comprehensive as in previous editions. This proposal simply provides additional clarification.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

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

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

No impact to building and property owners relative to cost of compliance with the code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to cost of compliance with the code.

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

No impact to small business relative to cost of compliance with the code.

Requirements

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

This proposal clarifies requirements for wind design of buildings within the scope of the FBCR.

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

This proposal improves the code by clarifying the wind design requirements of buildings within the scope of the FBCR.

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

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

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

2nd Comment Period

8150-A1

Proponent T Stafford **Submitted** 5/22/2019 **Attachments** Yes

Rationale

This public comment is being submitted at the request of several members of the Structural TAC during the first meetings to address proposed code changes to the FBC. The original modification simply added language clarifying the provisions of Section R802 were not permitted to be used in Florida, similar to language that was included in previous editions of the code. Since the provisions of Section R802 cannot be used in the State of Florida, the Structural TAC requested a public comment be submitted deleting these requirements. This modification does just that. It's a cleaner approach that removes construction requirements that are not acceptable for the design wind speeds in Florida in addition to removing snow requirements that also do not apply 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

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 the 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 public comment simply provides further clarification of the intent of the code.

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

This public comment improves the code by providing further clarification of the intent.

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

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

Does not degrade the effectiveness of the code

This public comment does not degrade the effectiveness of the code.

Revise the original modification as follows:

R802.2 Design and construction. ~~Where the ultimate design wind speed, V_{ult}, equals or exceeds 115 mph, w~~Wood roof framing shall be in accordance with Section R301.2.1.1 or ANSI AWC NDS. ~~Where ultimate design wind speed, V_{ult}, is less than 115 mphwood roof framing shall be in accordance with the provisions of this section.~~

~~**R802.2.1 Framing details.** 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).~~

Further revise Section R802.3 as follows:

Delete Sections R802.3, R802.4, R802.5, and R802.6 including all subsections, tables and figures. Show sections, tables and figures as "Reserved" to maintain section numbering.

Further revise as follows:

Delete Sections R802.8, R802.8.1 and R802.9 and show as "Reserved."

Delete Section R802.11 including all subsections, tables and figures. Show sections, tables and figures as "Reserved" to maintain section numbering.

R802.2 Design and construction. Where the ultimate design wind speed, V_{ult}, equals or exceeds 115 mph, wood roof framing shall be in accordance with Section R301.2.1.1 or ANSI AWC NDS. Where ultimate design wind speed, V_{ult}, is less than 115 mphwood roof framing shall be in accordance with the provisions of this section.

R802.2.1 Framing details **~~Design and construction~~.** The framing details required in Section R802 apply to roofs having a minimum slope of three units vertical in 12 units horizontal (25-percent slope) or greater. Roof-ceilings shall be designed and constructed in accordance with the provisions of this chapter and Figures R606.11(1), R606.11(2) and R606.11(3) or in accordance with AWC NDS. Components of roof-ceilings shall be fastened in accordance with Table R602.3(1).

S7967

Date Submitted	12/14/2018	**Section** 905		**Proponent**	Andy Williams
Chapter	9	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Approved as Submitted				
Commission Action	Pending Review				

Comments

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

Related Modifications

R301.2.1

Summary of Modification

Addition of Wind Resistance testing ASTM D3161 to measure metal roof shingle wind resistance performance

Rationale

This proposal recognizes wind resistance of metal roof shingles as a separate item, R905.4.4.1. These items are not the same as asphalt shingles, R905.2.4.1. Showing compliance with the FRC wind resistance requirements is necessary for proper evaluation. UL580, UL1897, and FM4474, currently recognized in the FBC for “Other roof systems,” including metal panel systems, are added as options for metal shingles. TAS 107, which directly states its appropriateness for metal shingles, is added with ASTM equivalent D3161. UL has provided metal shingle wind classifications for many years and currently has D3161-related listings in the Online Certifications Directory.

D3161, created for asphalt shingles, was expanded in 2013 to include other discontinuous, air permeable, steep slope roofing products. This includes metal shingles (specifically identified in Section 1.3). UL was a proponent of the D3161 scope change showing support of D3161 to demonstrate wind resistance.

This proposal removes problems for metal shingle use by clarifying options to show compliance with the wind resistance code requirements. Included are uplift resistance methods used in the FBC for many years (UL1897, UL580, FM4474), and accepted methods of fan-induced wind simulations (TAS 107, ASTM D3161) that are used for other discontinuous, air-permeable roof covers (asphalt shingles) and building integrated PV shingles. The fan-induced options provide alternatives for evaluation of air permeable metal shingles in a non-air-permeable manner via the uplift resistance methods, which unfairly represents the products.

Table R905.4.4.1 is added to establish recognition of metal shingles qualified via D3161. Classifications are equivalent to those for asphalt shingles (Table R905.2.6.1). Like asphalt, metal shingles qualified via D3161 must to bear a label and classification (Table R905.4.4.1).

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal should have no additional impact on enforcement of the code

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

This proposal should have no additional cost impact for compliance with the code

Impact to industry relative to the cost of compliance with code

This proposal should have no additional cost impact for compliance with the code

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

This proposal should have no additional cost impact for compliance with the code

Requirements

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

This proposal should provide realistic performance information to better ensure safety through code compliance.

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

This proposal provides more accurate performance information on this type of roofing system.

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

This proposal provides more accurate performance information on this type of roofing system.

Does not degrade the effectiveness of the code

This proposal provides more accurate performance information on this type of roofing system.

2nd Comment Period

7967-A2

Proponent Andy Williams **Submitted** 4/19/2019 **Attachments** Yes

Rationale

The only modification is within the table and a change in reference in the first column. The wrong tables 1609A, B, C or ASCE-7 were called out and it should have been table R301.2(4) or ASCE-7

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change to the original proposed modification

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

No change to the original proposed modification

Impact to industry relative to the cost of compliance with code

No change to the original proposed modification

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

This proposal should have no additional cost impact for compliance with the code

Requirements

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

No change to the original proposed modification

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

No change to the original proposed modification

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

No change to the original proposed modification

Does not degrade the effectiveness of the code

No change to the original proposed modification

Add new text as follows:

R905.4.4.1 Wind Resistance of Metal roof shingles. Metal roof shingles applied to a solid or closely fitted deck shall be tested in accordance with ASTM D3161, FM 4474, UL 580, UL 1897, or TAS 107. Metal roof shingles tested in accordance with ASTM D3161 shall meet the classification requirements of Table R905.2.4.1 for the appropriate maximum basic wind speed and the metal shingle packaging shall bear a label to indicate compliance with ASTM D3161 and the required classification in Table R905.4.4.1.

Add new table as follows:

TABLE R905.4.4.1

CLASSIFICATION OF METAL ROOF SHINGLES TESTED IN ACCORDANCE WITH ASTM D3161

MAXIMUM BASIC WIND SPEED FROM FIGURE ~~1609A, B, C or ASCE-7~~ R301.2(4) or ASCE-7	V_{asd}	ASTM D3161
110	85	D or F
116	90	D or F
129	100	D or F
142	110	F
155	120	F
168	130	F
181	140	F
194	150	F

Modify existing text as follows

R301.2.1Wind design criteria.

Buildings and portions thereof shall be constructed in accordance with the wind provisions of this code using the ultimate design wind speed in Table R301.2(1) as determined from Figure R301.2(4). Where different construction methods and structural materials are used for various portions of a building, the applicable requirements of this section for each portion shall apply. Where not otherwise specified, the wind loads listed in Table R301.2(2) adjusted for height and exposure using Table R301.2(3) shall be used to determine design load performance requirements for wall coverings, curtain walls, roof coverings, exterior windows, skylights, and exterior doors (other than garage doors). Where loads for garage doors are not otherwise specified, the loads listed in Table R301.2(4) adjusted for height and exposure using Table R301.2(3) shall be used to determine design load performance requirements. Asphalt shingles shall be designed for wind speeds in accordance with Section R905.2.4. Metal roof shingles shall be designed for wind speeds in accordance with Section R905.4.4. A continuous load path shall be provided to transmit the applicable uplift forces from the roof assembly to the foundation.

Add new text as follows

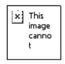
R905.4.4.1

R905.4.4.1 Wind Resistance of Metal roof shingles. Metal roof shingles applied to a solid or closely fitted deck shall be tested in accordance with ASTM D3161, FM 4474, UL 580, UL 1897 or TAS 107. Metal roof shingles tested in accordance with ASTM D3161 shall meet the classification requirements of Table R905.2.4.1 for the appropriate maximum basic wind speed and the metal shingle packaging shall bear a label to indicate compliance with ASTM D3161 and the required classification in Table R905.4.4.1.

Add new table as follows:

TABLE R905.4.4.1

CLASSIFICATION OF METAL ROOF SHINGLES TESTED IN ACCORDANCE WITH ASTM D3161



Modify existing text as follows

R301.2.1Wind design criteria.

Buildings and portions thereof shall be constructed in accordance with the wind provisions of this code using the ultimate design wind speed in Table R301.2(1) as determined from Figure R301.2(4). Where different construction methods and structural materials are used for various portions of a building, the applicable requirements of this section for each portion shall apply. Where not otherwise specified, the wind loads listed in Table R301.2(2) adjusted for height and exposure using Table R301.2(3) shall be used to determine design load performance requirements for wall coverings, curtain walls, roof coverings, exterior windows, skylights, and exterior doors (other than garage doors). Where loads for garage doors are not otherwise specified, the loads listed in Table R301.2(4) adjusted for height and exposure using Table R301.2(3) shall be used to determine design load performance requirements. Asphalt shingles shall be designed for wind speeds in accordance with Section R905.2.4. Metal roof shingles shall be designed for wind speeds in accordance with Section R905.4.4. A continuous load path shall be provided to transmit the applicable uplift forces from the roof assembly to the foundation.

S7991

Date Submitted	12/12/2018	**Section**	46	**Proponent**	Bonnie Manley
Chapter	46	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Approved as Submitted
Commission Action Pending Review

Comments

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

Related Modifications

7856, 7857, 7858, 7989

Summary of Modification

This proposal is one in a series adopting the latest generation of AISI standards for cold-formed steel.

Rationale

This proposal is one in a series adopting the latest generation of AISI standards for cold-formed steel. This particular proposal focuses on Chapter 46 by updating references to the AISI suite of standards, including the addition of one new cold-formed steel standard -- AISI S240 – now referenced in Chapter 7. All AISI standards are published and available for a free download at: www.aisistandards.org.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

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

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

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

No change in cost is anticipated.

Requirements

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

Yes, it does.

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

Yes, it does.

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

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

2nd Comment Period

7991-A1

Proponent Bonnie Manley **Submitted** 5/16/2019 **Attachments** Yes

Rationale

This proposal was approved as submitted; however, in order to fully coordinate with ASCE 7-16, we recommend adopting the 2019 edition of AISI S230, which is now available for free from www.steel.org. A coordinating comment has been submitted for the FBC -- Proposal S7458.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

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

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

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

No change in cost is anticipated.

Requirements

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

Yes, it does.

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

Yes, it does.

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

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

1st Comment Period History

S7991-G1

Proponent Jaime Gascon **Submitted** 1/22/2019 **Attachments** No

Comment:

This standards update does impact the HVHZ. Needs correlation as to the sections in the code that reference the new standard added; ANSI S240-15.

AISI S100-16—~~12~~ *North American Specification for the Design of Cold-formed Steel Structural Members*, 2016~~2012~~

~~AISI S200—12 North American Standard for Cold-formed Steel Framing—General Provisions 2012~~

AISI S220-15—~~11~~ *North American Standard for Cold-formed Steel Framing—Nonstructural Members*, 2015~~2011~~

AISI S230-19—~~07/S3-12 (2012)~~ *Standard for Cold-formed Steel Framing—Prescriptive Method for One- and Two-family Dwellings*, 2019~~2007 with Supplement 3, dated 2012 (Reaffirmed 2012)~~

AISI S240—15, *North American Standard for Cold-Formed Steel Structural Framing*, 2015

AISI S100-16~~—12~~ *North American Specification for the Design of Cold-formed Steel Structural Members*, 2016~~2012~~

~~AISI S200—12 North American Standard for Cold-formed Steel Framing—General Provisions 2012~~

AISI S220-15~~—11~~ *North American Standard for Cold-formed Steel Framing—Nonstructural Members*, 2015~~2011~~

AISI S230-15~~—07/S3-12 (2012)~~ *Standard for Cold-formed Steel Framing—Prescriptive Method for One- and Two-family Dwellings*, 2015~~2007 with Supplement 3, dated 2012 (Reaffirmed 2012)~~

AISI S240—15, *North American Standard for Cold-Formed Steel Structural Framing*, 2015

S8285

19

Date Submitted	12/15/2018	**Section**	1	**Proponent**	Chadwick Collins
Chapter	TAS 131	**Affects HVHZ**	Yes	**Attachments**	Yes

TAC Recommendation	Approved as Submitted
Commission Action	Pending Review

Comments

General Comments **Yes** **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.

2nd Comment Period

S8285-G1

Proponent Michael Goolsby **Submitted** 5/23/2019 **Attachments** No

Comment:

The intention was for Mod 8285 to be withdrawn as it conflicts with Modification 7307.

For this reason Mod 8285 should be withdrawn or be assigned a "no affirmative recommendation".

See attached file.

TESTING APPLICATION STANDARD (TAS)131-95
STANDARD REQUIREMENTS FOR UNREINFORCED THERMOPLASTIC OLEFIN
ELASTOMER BASED SHEET USED IN SINGLE-PLY ROOF ~~MEMBRANE~~ SYSTEMS

1. Scope:

1.1 This Protocol covers unreinforced ~~and reinforced~~ thermoplastic olefin elastomer sheet made from blends of polypropylene and ethylene-propylene rubber (TPO), intended for use as a roof membrane exposed to the weather.

1.2 The test and property limits are used to characterize the membrane and are minimum values. In-place roof system design criteria, such as fire resistance, field seaming strength, material compatibility, and up-lift resistance, in situ shrinkage, among others, are factors which must be considered but are beyond the scope of this specification.

1.3 The following precautionary caveat pertains to the test methods portion only, Section 8, of this specification: This Standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1.4 All testing shall be conducted by an approved testing agency, and all test reports shall be signed by an authorized signer of the testing/listing agency. Manufacturing location of tested products shall be verified by the testing laboratory and be included in the report.

2. Referenced Documents:

2.1 ASTM Standards

D412 Test Method for Rubber Properties in Tension

D471 Test Method for Rubber Property - Effect of Liquids

D573 Test method for Rubber-Deterioration in an Air Oven

D624 Test Method for Rubber Property - Tear Resistance

D751 Method of Testing Coated Fabrics

D816 Methods of Testing Rubber Cements

D1149 Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber (Flat Specimens)

D1204 Test Method for Linear Dimensional Changes of Non-rigid Thermoplastic Sheeting or Film at Elevated Temperature

D1822 Tensile Impact Testing

D2137 Test Method for Rubber Property - Brittleness Point of Flexible Polymers and Coated Fabrics

E 96 Water Vapor Permeability, Method BW

E380 Excerpts from Use of the International System of Units (SI) (The Modernized Metric System)

G 154 Standard Practice for Operating Fluorescent Light Apparatus for UV-Condensation (QUV) Exposure of Nonmetallic Material

G 155 Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials

2.2 The Florida Building Code, Building

2.3 Application Standards

TAS 114 Test Procedures for Roof System Assemblies in the High Velocity Hurricane Zone Jurisdiction

3. Terminology & Units:

3.1 Definitions - For definitions of terms used in this Protocol, refer to Chapter 2 and Section 1513 of the Florida Building Code, Building and/or the RCI Glossary of Terms. Definitions from the Florida Building Code, Building shall take precedence.

3.2 Units - For conversion of U.S. customary units to SI units, refer to ASTM E380.

4. Limitations and Precautions:

4.1 This Protocol may involve hazardous materials, operations and equipment. This Protocol does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

5. Classification:

5.1 Types are used to identify the principal polymer component of the sheet.

5.1.1 Ethylene-Propylene based elastomer (TPO)

~~5.2 Grades indicate the mass percentage of the polymer (TPO) in relation to the total sheet:~~

~~5.2.1 Grade 1 - Greater than 95%.~~

~~5.2.2 Grade 2 - 50 to 95%.~~

~~5.3 Class describes sheet construction.~~

~~5.3.1 Class U - Unreinforced.~~

~~5.3.2 Class SR - Reinforced, internally or externally.~~

6. Materials and Manufacture:

6.1 The sheet shall be formulated from the appropriate polymers and other compounding ingredients. The principal polymer used in the sheet shall be one of those listed in Section 5.1.1 ~~in accordance with the percentages listed in Sections 5.2.1 and 5.2.2.~~

6.2 The sheet shall be capable of being bonded to itself for making watertight field splices and repairs, and the supplier or fabricator shall recommend suitable bonding methods and materials.

7. Physical Properties:

7.1 The test shall conform to the physical requirements prescribed in Table 1 of this Protocol.

8. Dimensions and Permissible Variations:

8.1 The width and length of the sheet shall be as published and tested for physical property values. The sheet width shall be as tested for system performance in compliance with TAS 114.

8.1.1 The width and length tolerance shall be + 3%, - 0%.

8.2 The published sheet thickness tolerance shall be +15%, -10% of the specified thickness, but in no case shall the thickness be less than the minimum listed Table 1 of this Protocol.

Remove this table and footnotes

~~TABLE 1~~

~~PHYSICAL REQUIREMENTS FOR TPO ELASTOMER SHEETS~~

~~Physical Property~~	~~Grade 1 or 2 Class SR~~	~~Grade 1 or 2 Class U~~ Unreinforced
~~Thickness (over scrim) in. (mm)~~	~~min. 0.015 (0.385)~~	~~NA~~
~~Thickness (overall) in. (mm)~~	~~min. 0.039 (1.0)~~	~~min. 0.039 (1.0)~~
~~Tensile Strength psi (MPa)~~	~~NA~~	~~min. 1740 (12.0)~~
~~Breaking Strength lbf (kN)~~	~~min. 225 (1.0)~~	~~NA~~
~~Elongation (ultimate) %~~	~~NA~~	~~min. 500~~
~~Elongation (at break) %~~	~~min. 15[1]~~	~~NA~~
~~Tensile set %~~	~~NA~~	~~max. 10~~
~~Tear Resistance lbf/in (kN/m)~~		~~min. 340 (60)~~
~~Tearing Strength lbf (N)~~	~~min. 55 (245)~~	~~NA~~
~~Brittleness Point °F(°C)~~	~~max. -49 (-45)~~	~~max. -30 (-34)~~
~~Ozone Resistance no cracks~~	~~pass~~	~~pass~~
~~After Heat Aging (A.H.A.)~~		
~~Tensile Strength A.H.A. psi (MPa)~~	~~NA~~	~~min. 1740 (120)~~
~~Breaking Strength A.H.A. lbf (kN)~~	~~min. 225 (1.0)~~	~~NA~~
~~Elongation (ultimate) A.H.A. %~~	~~NA~~	~~min. 500~~
~~Elongation (at break) A.H.A. %~~	~~min. 15[1]~~	~~NA~~
~~Tear Resistance A.H.A. lbf/in. (kN/m)~~	~~NA~~	~~min. 340 (60)~~
~~Linear Dimensional Change A.H.A %~~ ~~Weight Change A.H.A %~~	~~max. ± 2~~	~~max. ± 2~~ ~~max. ± 2~~
~~Water Absorption mass %~~	~~max. ± 4[2]~~	~~max. ± 2~~
~~Factory Seam Strength lbf/in. (kN/m)~~	~~min. 51 (9) or Sheet Failure~~	~~min. 51 (9) or Sheet Failure~~
~~Weather Resistance no cracks or crazing~~	~~pass~~	~~pass~~
~~After Accelerated Weathering-A.A.W.~~		
~~Tensile Strength A.A.W. psi (MPa)~~	~~report~~	~~min. 1450 (10.0)~~
~~Elongation (ultimate) A.A.W. %~~	~~report~~	~~min. 200 %~~
~~PRFSE A.A.W. %~~	~~report~~	~~30.00~~
~~Static Puncture Resistance~~	~~report~~	~~report~~
~~Dynamic Puncture Resistance~~	~~report~~	~~report~~
~~Tensile Impact ft•lb/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
Tensile set %	max. 10
Tear Resistance lbf/in (kN/m)	min. 340 (60)
Brittleness Point °F(°C)	max. -30 (-34)
Ozone Resistance no cracks	pass
After Heat Aging-(A.H.A.)	
Tensile Strength-A.H.A. psi (MPa)	min. 1740 (120)
Elongation (ultimate)-A.H.A. %	min. 500
Tear Resistance -A.H.A. lbf/in. (kN/m)	min. 340 (60)
Linear Dimensional Change -A.H.A % Weight Change -A.H.A %	max. ± 2 max. ± 2
Water Absorption mass %	max. ± 2
Factory Seam Strength lbf/in. (kN/m)	min. 51 (9) or Sheet Failure
Weather Resistance no cracks or crazing	pass
After Accelerated Weathering-A.A.W.	
Tensile Strength-A.A.W. psi (MPa)	min. 1450 (10.0)
Elongation (ultimate)-A.A.W. %	min. 200 %
PRFSE-A.A.W. %	30.00
Static Puncture Resistance	report
Dynamic Puncture Resistance	report
Tensile Impact ft•lb/in^2 (kJ/m^2)	min. 21 (44)

9. Workmanship, Finish, and Appearance:

9.1 The sheet, including factory seams, if present, shall be water tight and free of pinholes, particles of foreign matter, undisbursed raw material, or other manufacturing defects that might affect serviceability. Excessive irregularities on the sheet surface shall not be acceptable (or portion thereof), then its rejection should be negotiated between supplier and buyer.

9.2 Edges of the sheets shall be straight and flat so that they may be seamed to one another without fishmouthing.

10. Test Methods: **(Need to be Re-numbered)**

~~10.1 Thickness (over scrim) - Appendix A of this Protocol.~~

~~10.2 Dimensions - Test Method D 751~~

~~10.2.1 Testing shall be conducted after permitting the sheet to relax at 73°F (23°C) for 1 hour.~~

10.~~3~~1 Thickness (overall) - Test Methods D 412 for Class U Sheet and D 751 for Class SR Sheet.

10.~~4~~2 Tensile Strength - Test Method D 412, Die C for Class U Sheet.

~~10.5 Breaking Strength - Test Method D 751, Grab Method for Class SR Sheet.~~

10.~~6~~3 Elongation (ultimate) - Test Method D 412, Die C for Class U Sheet.

~~10.7 Elongation (at break) - Test Method D 751, Grab method for Class SR Sheet.~~

10.~~8~~4 Tensile Set - Test Method D 412, Method A, Die C, 50% elongation for Class U Sheet.

10.~~9~~5 Tear Resistance - Test Method D 624, Die C for Class U Sheet.

~~10.10 Tearing Strength - Test Method D 751, Procedure B for Class SR Sheet.~~

10.~~11~~6 Brittleness Point - Test Method D 746 or D 2137.

10.~~12~~7 Ozone Resistance - Test Method D 1149.

10.~~12~~7.1 Inspect at 7x magnification on specimens exposed to 1 x 10-5 psi (100 MPa) ozone in air at 100°F (38°C). For Class U Sheet, wrap around 3" (76.2 mm) mandrel for 166 hour exposure. For Class SR Sheets, use Procedure B.

10.~~13~~8 Heat Aging - Test Method D 573.

10.~~13~~8.1 Age sheet specimens at 240°F (115°C) for 670 hours.

10.~~14~~9 Linear Dimensional Change - Test Method D 471.

10.~~14~~9.1 Conduct test at 158°F (70°C) for 166 hours.

10.~~15~~10 Water Absorption - Test Method D 471.

10.~~15~~10.1 Conduct test at 158°F (70°C) for 166 hours.

10.1~~6~~1 Factory Seam Strength - Test Method D 816, Method B.

10.1~~6~~1.1 Modify procedure by cutting a 1 in. (25.4 mm) wide by 12 in. (304.8 mm) long sample across the lap seam. Place in jaws approximately 2 in. (50.8 mm) from edges of the overlap area and test at 2 in. per minute (50.8 mm/min.) claim for rehearing.

10.1~~7~~2 Weather Resistance - Practice G 155

10.1~~7~~2.1 Xenon-Arc shall be operated to the following conditions:
Filter Type: borosilicate inner and outer
Exposure: 0.35 W/m2 at 340 nm
Cycle: 690 min light, 30 min. light and water spray Black Panel
Temperature: 80 ± 3°C
Relative Humidity: 50 ± 5%
Spray Water: deionized
Specimen Rotation: every 250 hours
Exposure Time: 4000 hours

10.1~~7~~2.2 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~~

10.1~~9~~3 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.

S8286

Date Submitted	12/15/2018	**Section**	1	**Proponent**	Chadwick Collins
Chapter	TAS 131	**Affects HVHZ**	Yes	**Attachments**	Yes

TAC Recommendation Approved as Submitted
Commission Action Pending Review

Comments

General Comments Yes   **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.

2nd Comment Period

S8286-G1

Proponent Michael Goolsby   **Submitted** 5/23/2019   **Attachments** No

Comment:

The intention was for Mod 8286 to be withdrawn as it conflicts with Modification 7307.

For this reason Mod 8286 should be withdrawn or be assigned a "no affirmative recommendation".

See attached file.

~~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: 92**

Total Mods for report: 112

Sub Code: Building

S7381

21

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

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

G9-16 Part I

Summary of Modification

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

Rationale

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

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

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

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

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

Impact to industry relative to the cost of compliance with code

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

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

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

Requirements

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

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

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

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

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

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

Does not degrade the effectiveness of the code

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

2nd Comment Period

S7381-G3

Proponent Jennifer Privateer **Submitted** 5/23/2019 **Attachments** No

Comment:

I agree

2nd Comment Period

S7381-G4

Proponent	Harold Barrineau	**Submitted**	5/25/2019	**Attachments**	No

Comment:

I agree with this modification

2nd Comment Period

S7381-G5

Proponent	Harold Barrineau	**Submitted**	5/26/2019	**Attachments**	No

Comment:

I agree with this modification.

1st Comment Period History

S7381-G1

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

Comment:

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

1st Comment Period History

S7381-G2

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

Comment:

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

FBCB SECTION 202

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

FENESTRATION. Products classified as either vertical fenestration or skylights.

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

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

S7498

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

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes **Alternate Language** No

Related Modifications

Summary of Modification

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

Rationale

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

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

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

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

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

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

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

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

Impact to industry relative to the cost of compliance with code

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

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

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

Requirements

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

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

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

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

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

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

Does not degrade the effectiveness of the code

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

2nd Comment Period

S7498-G1

Proponent Borrone Jeanette **Submitted** 5/21/2019 **Attachments** No

Comment:

I agree with the proposed revision.

2nd Comment Period

S7498-G2

Proponent Ann Russo5 **Submitted** 5/24/2019 **Attachments** No

Comment:

The modification was submitted to better align the current definition of fenestration as well as add the proper definition for vertical applications. This brings out the differences as well as coordinates better with requirements under other Chapters of the Code, decreasing possible confusion and misuse of systems.

2nd Comment Period

S7498-G3

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

Revise as follows:

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

Add new definition as follows:

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

S7502

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

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes **Alternate Language** No

Related Modifications

Summary of Modification

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

Rationale

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

Fiscal Impact Statement

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

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

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

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

Requirements

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

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

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

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

2nd Comment Period

S7502-G1

Proponent Borrone Jeanette **Submitted** 5/21/2019 **Attachments** No

Comment:
I agree with the proposed revision.

2nd Comment Period

S7502-G2

Proponent Jennifer Privateer **Submitted** 5/24/2019 **Attachments** No

Comment:
I agree as proposed

2nd Comment Period

S7502-G3

Proponent	Ann Russo5	**Submitted**	5/24/2019	**Attachments**	No

Comment:

The proposed modification clearly defines common systems proposed in construction and it better coordinates with definitions under the Energy Code which have specific requirements based on the defined system. Lack of clarity can cause issues which may impact adherence to both IBC and Energy Code requirements

2nd Comment Period

S7502-G4

Proponent	Harold Barrineau	**Submitted**	5/25/2019	**Attachments**	No

Comment:

I agree with this modification

Delete:

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

Add:

FENESTRATION. Products classified as either vertical fenestration or skylights.

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

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

S7520

Date Submitted	12/5/2018	**Section**	202	**Proponent**	Ann Russo5
Chapter	2	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

Summary of Modification

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

Rationale

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

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

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

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

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

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

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

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

Impact to industry relative to the cost of compliance with code

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

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

None foreseen

Requirements

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

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

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

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

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

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

Does not degrade the effectiveness of the code

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

2nd Comment Period

S7520-G1

Proponent Borrone Jeanette **Submitted** 5/21/2019 **Attachments** No

Comment:

I agree with the proposed revision.

2nd Comment Period

S7520-G2

Proponent	Ann Russo5	Submitted	5/24/2019	Attachments	No

Comment:

The modification was submitted to better align definitions to the products used as well as coordinate with the Energy requirements of the sister Code. Lack of a better definition could lead to occurances where an approved system/product under IBC is not in conformance to the Energy Code as the key definition does not match

Revise as follows:

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

Add new definition as follows:

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

S7535

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

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes **Alternate Language** No

Related Modifications

Summary of Modification

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

Rationale

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

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

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

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

No impact on costs expected

Impact to industry relative to the cost of compliance with code

None

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

None

Requirements

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

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

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

Improves Code by better defining moisture testing of barriers

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

Does not as it provides a recognized test standard protocol

Does not degrade the effectiveness of the code

No, does not

2nd Comment Period

S7535-G1

Proponent Borrone Jeanette **Submitted** 5/21/2019 **Attachments** No

Comment:

I agree with the proposed revision.

2nd Comment Period

S7535-G2

Proponent Ann Russo5 **Submitted** 5/24/2019 **Attachments** No

Comment:

The modification was submitted so that the proper standard and option for the evaluation of a system as being in accordance to the requirements of weathertightness could be documented. The ASTM updates key standards and also defines the applicability of the various options to best illustrate the required performance criteria they achieve. The proper citation for use in review should be clearly listed for reference.

2nd Comment Period

S7535-G3

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

Revise as follows:

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

Class I: 0.1 perm or less.

Class II: 0.1 < perm = 1.0 perm.

Class III: 1.0 < perm = 10 perm.

S7606

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

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

Summary of Modification

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

Rationale

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

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None, but clarifies usage and application

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

None

Impact to industry relative to the cost of compliance with code

None

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

None

Requirements

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

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

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

Improves by focusing on attributes of product

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

Does not

Does not degrade the effectiveness of the code

Does not

Alternate Language

2nd Comment Period

7606-A1

Proponent Joseph Belcher **Submitted** 5/25/2019 **Attachments** Yes

Rationale

This change was approved as submitted for the 2021 IBC and IRC (G12-18). There is no reason for different terms or definitions in the two volumes of the code for the same product or material. Relying on only Procedure A is inaccurate and misleading. The existing code language limits the use of newer materials and systems such as “smart” materials that can be “tuned” to address moisture control issues in different climate zones. The existing definition applied to asphalt felts and Type D coated papers and dates back over a half a century. For Type D papers the original Federal Specification UUP-147 was issued in 1948. The technical rationale for this change can be found in the uploaded file.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact on the enforcement of the code.

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

The code change proposal will not increase or decrease the cost of construction. This adds a test procedure that is more appropriate for some products.

Impact to industry relative to the cost of compliance with code

The code change proposal will not increase or decrease the cost of construction. This adds a test procedure that is more appropriate for some products.

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

The change positively impacts the public welfare by eliminating inaccuracies and adopting another test procedure allowing the use of state-of-the-art materials currently not permitted.

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

The change improves and strengthens the code by eliminating inaccuracies and adopting another test procedure allowing the use of state-of-the-art materials currently not permitted.

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.

2nd Comment Period

S7606-G1

Proponent Ann Russo5 **Submitted** 5/24/2019 **Attachments** No

Comment:

The modification was submitted to clarify the proper ASTN standard and option as well as to clarify that weathertightness is not just limited to membranes, but is a function of building products and systems employed in the structure, and this is then defined to a standard for comparison between possible options of products and systems. It removes the focus and places the review on the effect to the overall structure

2nd Comment Period

S7606-G2

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

FBC-B

202

VAPOR PERMEABLE ~~MEMBRANE~~. The property of having a moisture vapor permeance rating of 5 perms (2.9 × 10^{10} kg/Pa x s x m^2) or greater ~~,~~ when tested in accordance with ~~the desiccant method~~ using Procedure A <u>or Procedure B</u> of ASTM E96. A vapor permeable material permits the passage of moisture vapor.

FBC-R

R202

VAPOR PERMEABLE. The property of having a moisture vapor permeance rating of 5 perms (2.9 × 10^{10} kg/Pa x s x m^2) or greater ~~,~~ when tested in accordance with ~~the desiccant method~~ using Procedure A <u>or Procedure B</u> of ASTM E96. A vapor permeable material permits the passage of moisture vapor.

Revise as follows:

VAPOR PERMEABLE ~~MEMBRANE~~. The property of having a moisture vapor permeance rating of 5 perms (2.9×10^{-10} kg/Pa $\times$ s $\times$ m^2) or greater, when tested in accordance with the desiccant method using Procedure A of ASTM E 96. A vapor permeable material permits the passage of moisture vapor..

Insight

It's All Relative

Magic and Mystery of the Water Molecule

An edited version of this Insight first appeared in the ASHRAE Journal.

By Joseph W. Lstiburek, Ph.D., P.Eng., Fellow ASHRAE

It is just shocking, just shocking that some molecules have a positive electrical charge and a negative electrical charge. Water is a molecule with one oxygen and two hydrogen atoms held together with a covalent bond at an angle of 104.5 degrees (**Figure 1**) resulting in a permanent dipole (**Figure 2**). The polar nature of the water molecule causes magic and mystery to happen with its interaction with other materials.

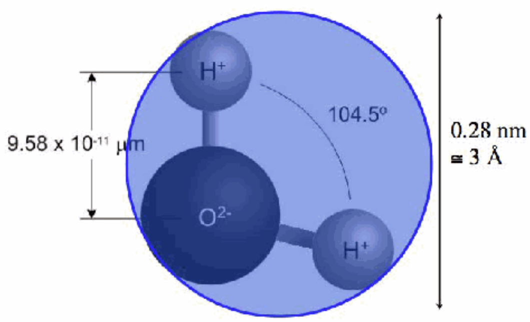


Figure 1: The Water Molecule – A permanent dipole.

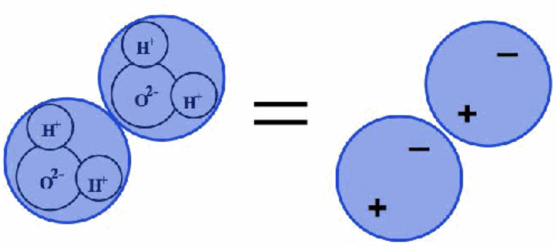


Figure 2: Sticky Stuff – Because it is a polar molecule water likes to stick to itself and to other things.

Water likes to stick to itself and stick to other things…it sure is sticky. Hydrogen bonding, among other forces, causes the water molecule to cling to other molecules resulting in adsorption. This has consequences. Many materials "can capture water molecules from the air and localize them on their surfaces…such water is said to be in the adsorbed state"[1].

Adsorbed water is kind of like a 4th state of matter (**Figure 3**). Apologies to the physicists for what comes next…a breach of protocol for sure. Here goes. Adsorbed water is not quite a liquid. But it is a liquid…sort of. It has weird properties. It sticks to surfaces in "monolayers" (**Figure 4**). The number of monolayers is directly related to relative humidity. Let me explain why this is weird. Relative humidity is not absolute humidity or vapor pressure. The sheer number of water molecules in the air adjacent a surface is not as important as the relative amount of water molecules in the air adjacent the surface compared to the total amount of molecules that can be in the air adjacent the surface. This is nuts….but it is so.

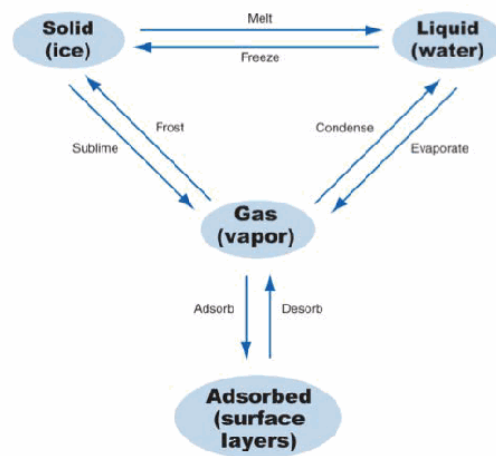


Figure 3: Four "Phases" of Water – Adsorbed water is not quite a liquid. But is sort of like a liquid. This is adapted from Kumaran, 2002.

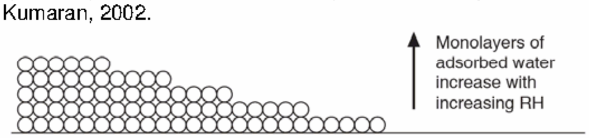


Figure 4: Monolayers of Water – The number of monolayers is directly related to relative humidity. Note that surfaces are never "flat" as shown…

1 These words come from Kumar Kumaran, a legend from the National Research Council of Canada.

More weird coming. No more than 5 monolayers of water molecules can stick to a surface[2]. Don't know why. Find the ghost of Edward Teller[3] and ask him. The first monolayer of water is really, really stuck to the surface. The second monolayer not so much because it has to stick "through" the first monolayer. The third has to stick "through" two monolayers and so on. Until you get to the fifth monolayer which is pretty weak. This is the basis of multilayer sorption – the BET theory – named after Brunauer, Emmet and Teller – the guys who came up with it.

This adsorbed water layer tends to move along a surface following a concentration gradient….from more to less…more 2nd Law stuff (**Figure 5**). The process is called surface diffusion. Think about this for a minute. The molecules of water flow along the surface according to the concentration gradient…. but they don't get to the surface necessarily because of a concentration gradient. Yup, weird. They change their behavior once they get to where they are going.

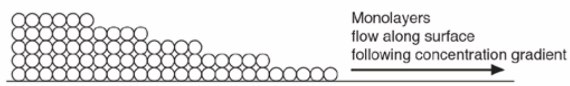


Figure 5: Surface Diffusion – Adsorbed water moves along a surface following a concentration gradient. Note that reality does not have such clean straight surfaces….

Most of our building materials are porous in nature. This of course is obvious. What is also obvious is that the pores are not all of uniform size. Some pores are big. Some are small. Some are in between. Yes, this is obvious as well. As the relative humidity goes up the number of monolayers of adsorbed water go up. Yes, we just covered that. This means that the small pores get filled up before the large pores get filled up (**Figure 6**). This is also obvious. What comes next is not. Just as the small pores get filled the pore opening "sees" a depression…. a curvature. We call this curved surface a "meniscus" …after the Greek meaning "crescent-shaped" moon. Now we need help from Lord Kelvin. The Kelvin equation shows that a reduction in vapor pressure over a curved meniscus results in capillary condensation. Wow. The practical implications are huge. This means we can get condensation on porous surfaces at relative humidities less than 100 percent. The condensation occurs in the pores. Did I mention huge?

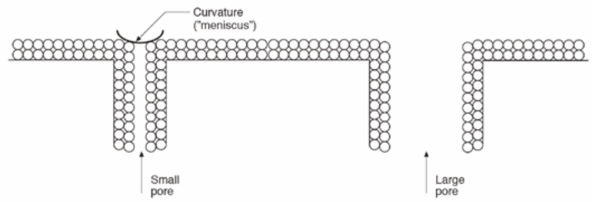


Figure 6: Capillary Condensation – Small pores get filled before large pores. A reduction in vapor pressure over a curved surface results in capillary condensation. Thank Lord Kelvin for this. Once again that the real world is not as "crisp" and "clean" as drawn.

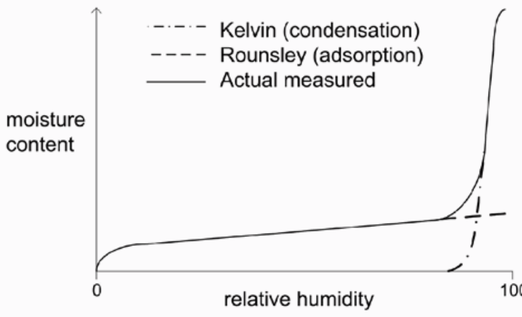
Let's say you are a microbiologist and you are studying mold and you know that mold needs liquid phase water to do its thing…. how do you explain that mold happens on paper faced surfaces at 80 percent relative humidity? Ah, easy, thanks to Lord Kelvin and capillary condensation. At 80 percent relative humidity you get liquid phase water in the pores of the paper faced gypsum due to capillary condensation (**Photograph 1**).

Photograph 1: Capillary Condensation and Mold - We can get condensation on porous surfaces at relative humidities less than 100 percent. The condensation occurs in the pores. Mold needs liquid phase water to do its thing yet mold happens on paper faced surfaces at 80 percent relative humidity. Thanks to Lord Kelvin and capillary condensation at 80 percent relative humidity you get liquid phase water in the pores of the paper faced gypsum due to capillary condensation.

2 Not strictly true anymore…. with modern tech toys some folks have found clusters up to 20 monolayers thick. And note that surfaces are never "flat" as drawn in Figures 4, 5 and 6.

3 Hungarian physicist…. real big dog in physics…his doctoral advisor was Werner Heisenberg. Wow. Heisenberg the uncertainty principle guy. Awarded the Nobel Prize for "the creation of quantum mechanics". Teller the student should have also got one for the BET theory.

The affinity of a material for water vapor is described by a sorption curve. More formally the moisture content of a material in equilibrium with most air is referred to as a sorption isotherm. Today, we have pretty good theory to go with measurements. The most widely accepted adsorption theory today is BET (after Brunauer, Emmet and Teller) as improved by Rounsley (1961) with a dose of Lord Kelvin (**Figure 7**).

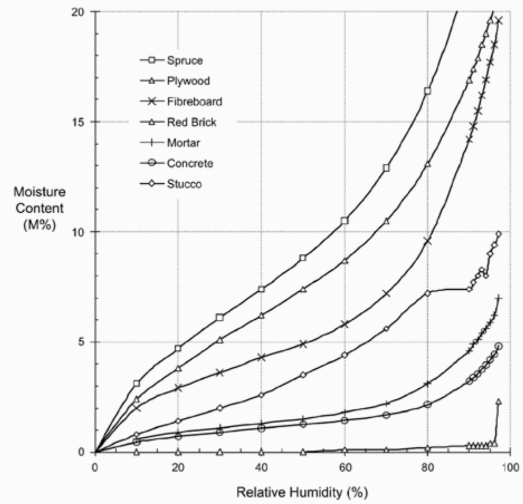


Typical predicted sorption isotherm according to Kelvin equation and modified BET theory
From Straube & Burnett, 2005

Figure 7: Adsorption Theory - The most widely accepted adsorption theory today is BET (after Brunauer, Emmet and Teller) as improved by Rounsley (1961) with a dose of Lord Kelvin.

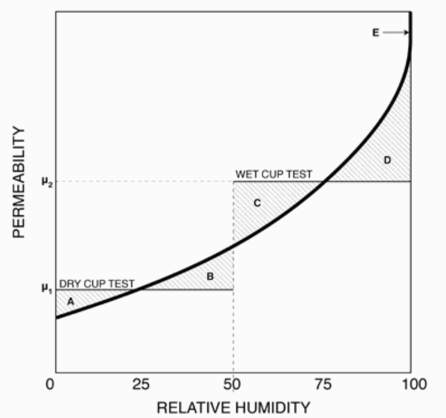
Figure 8 shows sorption isotherms for common building materials – courtesy of Kumaran by way of Straube and Burnett (2005). Notice that the horizontal axis is relative humidity and the vertical access is moisture content. So why should we care? If we replace the vertical axis with vapor transmission in permeability we get pretty much the same shape of curve. For many materials as relative humidity goes up so does vapor transmission. There is a dramatic change in vapor permeability with relative humidity due to adsorbate transport, capillary transport and liquid transport. This is huge, huge, huge and huge. We can do "magic" things with building materials and assemblies with these properties.

We measure these properties using what youngsters today refer to as old technology: "dry cup", "wet cup" and "inverted wet cup" tests (**Figure 9**).[4] We have two legends to thank for the tests: Frank Joy and Grant Wilson. More than a half a century has gone by and they still set the "standard".



Sorption isotherm for several building materials [Kumaran 2002]
From Straube & Burnett, 2005

Figure 8: Sorption Isotherms - Common building materials sorption isotherms– courtesy of Kumaran by way of Straube and Burnett (2005).



A - Single-layer of absorbed molecules
B - Multiple layers of absorbed molecules
C - Interconnected layers (internal capillary condensation)
D - Free water in pores, capillary suction
E - Supersaturated regime

Relationship between Dry Cup and Wet Cup
Adapted from Joy & Wilson, 1963

Figure 9: Dry Cup vs Wet Cup - The zones described as A, B, C, D and E in Figure 9 represent the moisture transport processes involved. As relative humidity goes up the material goes from single layer adsorbate transport to multiple layer adsorbate transport to internal capillary condensation to free water capillary suction and finally to supersaturated flow.

4 ASTM E96 -16 Standard Test Methods for Water Vapor Transmission of Materials. Test Method A is the "desiccant" or "dry cup" approach. Test Method B is the "water" or "wet cup" approach. Test Method C is the "inverted water" or "inverted wet cup" approach.

For a dry cup test you place the material you want to "test" over a "cup" that has a desiccant in it. The material is sealed with wax to the edge of the cup. The cup is placed in an environmental chamber maintained at room temperature and 50 percent relative humidity. So, one side of the material – the "cup side" - "sees" 0 percent relative humidity and the top side "sees" 50 percent relative humidity. Water molecules migrate from the environmental chamber through the material into the cup and are absorbed by the desiccant. The cup gains weight over time and this increase in weight over time determines the "dry cup" vapor permeability of the material.

For a wet cup test the desiccant is replaced with liquid water. The "cup side" of the material now "sees" 100 percent relative humidity and the top side – the environmental chamber side "sees" the same 50 percent relative humidity as before. The water molecules now move in the opposite direction and the cup loses weight over time and this determines the "wet cup" vapor permeability of the material.

For the inverted wet cup test turn the wet cup upside down – "invert" it. Now we have liquid water on the "cup side" of the material in direct contact with the material.

Pretty neat, eh? The zones described as A, B, C, D and E in **Figure 9** represent the moisture transport processes involved. As relative humidity goes up the material goes from single layer adsorbate transport to multiple layer adsorbate transport to internal capillary condensation to free water capillary suction and finally to supersaturated flow.

On to the magic part. Check out the "asphalt coated kraft paper" in **Photograph 2** on the interior side of a fiberglass batt cavity insulation and look at **Figure 10** that graphs the permeance of interior wall assembly linings vs relative humidity. The kraft facing has a "dry cup" value of 1 perm and a "wet cup" value of 15 perms. In most of the United States and Canada buildings in the winter have low interior relative humidites – around 25 percent and high interior relative humidites during the summer – 60 percent and higher. The kraft facing works much like a "valve" …. closed in the winter and open in the summer. It reduces wetting from the interior during the winter but allows inward drying during the summer. In an air conditioned building it is a bad idea to have an interior vapor barrier. The kraft facing is not an interior vapor barrier during cooling periods as its valve is open. During the winter the kraft facing is a vapor retarder throttling the outward flow of vapor from the interior. Awesome. That is why we call kraft facing a "first generation smart vapor control layer". How about that, more than a half century old "smart" membrane.

Photograph 2: Magic Valve – The asphalt coated kraft facing on the interior side of fiberglass batt cavity insulation changes its vapor transmission according to relative humidity.

Today we have extremely "smart" vapor control layers – second generation smart control layers". To understand their significance and therefor underlying performance both dry cup and wet cup properties need to be appreciated. And in some cases inverted wet cup properties. Dry cup by itself does not tell the story. The "inflection points[5]" for the sorption curves of these layers are "engineered" to provide control that otherwise would not be possible. In this case "inflection points" translates into "valve" opening and closing. "Smart vapor barriers" on the interior are truly smart. In many cases insulating the interior of mass walls would not be possible without this type of technology.

Let's go look at **Figure 11** the vapor permeance of materials on the exterior of wall assemblies. For many years folks have been obsessing over the ability of assemblies to dry to the exterior. Look at the shape of the curves for the traditional materials: impregnated felt and asphalt saturated kraft (ASK). Notice how the bend upward past 50 percent relative humidity. Valves again, eh? Hard to knock the old materials. They were pretty darn "smart". Trouble was they tended to blow off and hard to put up…. but what made them "better" than most appreciated was their wet cup properties. Again, dry cup by itself does not tell the story.

[5] Where the curve bends upwards….

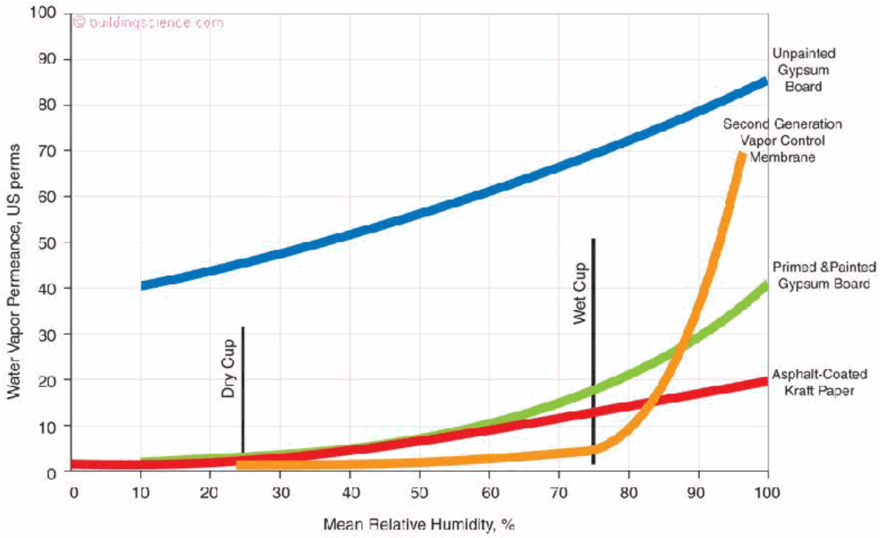


Figure 10: Permeance of Interior Wall Linings - The kraft facing has a "dry cup" value of 1 perm and a "wet cup" value of 15 perms. In most of the United States and Canada buildings in the winter have low interior relative humidites – around 25 percent and high interior relative humidites during the summer – 60 percent and higher. The kraft facing works much like a "valve"….closed in the winter and open in the summer.

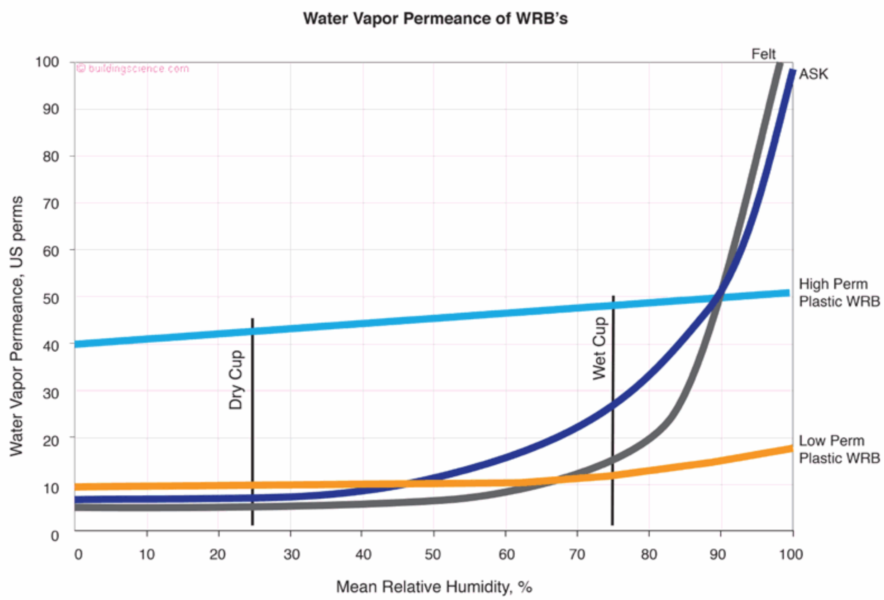


Figure 11: Permeance of Exterior Wall Layers - Look at the shape of the curves for the traditional materials: impregnated felt and asphalt saturated kraft (ASK). Notice how the bend upward past 50 percent relative humidity. Hard to knock the old materials. They were pretty darn "smart".

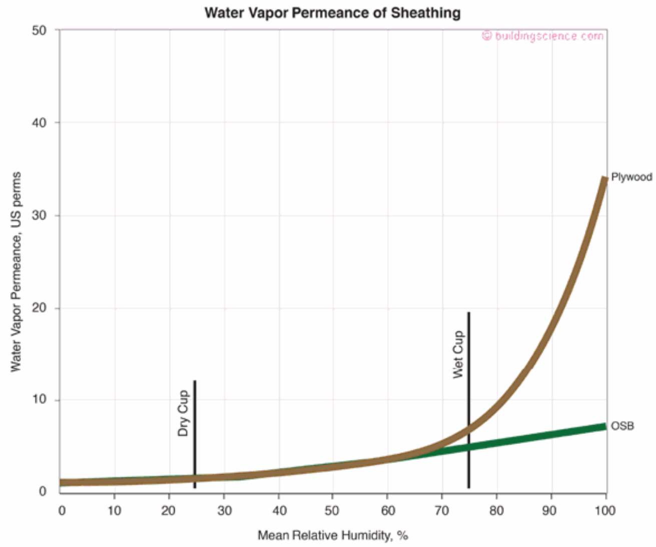


Figure 12: Vapor Transmission of Plywood and Oriented Strand Board (OSB) - What makes them work is the wet cup performance not the dry cup performance. Lots of walls would be rotting if they stayed at their dry cup value regardless of the relative humidity and their respective moisture content

On to **Figure 12** – the vapor transmission of plywood and oriented strand board (OSB). What makes them work is the wet cup performance not the dry cup performance. Lots of walls would be rotting if they stayed at their dry cup value regardless of the relative humidity and their respective moisture contents.

When we start looking at composite materials and assemblies such as OSB covered with fluid applied water resistive barriers (WRB's) (**Photograph 3**) or gypsum board or OSB with integral water resistive barriers (**Photograph 4**) all three characteristics need to be considered: dry cup, wet cup and inverted wet cup. The shape of the curve matters. Where the inflection point occurs matters. The direction of vapor and water flow matters.

Joy and Wilson were ahead of their time. Materials and assemblies have finally caught up. Relative humidity matters to materials more than most of us appreciated. Magic and mysterious stuff.

Photograph 3: Fluid Applied Membranes - Composite materials and assembly performance such as OSB covered with fluid applied water resistive barriers (WRB's) can be understood by looking at the full sorption curve. It can be argued that the wet cup properties are more significant to performance than the dry cup properties.

Photograph 4: Integral Water Resistive Barriers - It can be argued that the wet cup properties are more significant to performance than the dry cup properties with respect to exterior wall layers.

References

Joy, F. A., and Wilson, A. G. Standardization of the dish method for measuring water vapor transmission. Vol 4. Proceedings, International Symposium on Humidity and Moisture. Washington, 1963. Chapter 31, pp. 259-70 (NRCC 8838)

Kumaran, M. K. Fundamentals of transport and storage of moisture in building materials and components. Moisture Control in Buildings, ASTM: MNL18 – 2nd, Chapter 1, West Conshohocken, PA, 2009

Rounsley, R. R. Multimolecular adsorption equation. Journal of the American Chemical Society, Volume 7, No 2, pp. 308-311, 1961.

Straube, J. F., and Burnett, E. F. P. Building Science for Building Enclosures. Building Science Press Inc., Westford, MA. 2005 (ISBN: 0-9755127-4-9)

S8249

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 **Yes** **Alternate Language** **No**

Related Modifications

Summary of Modification

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

Rationale

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

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

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

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

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

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

Impact to industry relative to the cost of compliance with code

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

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

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

Requirements

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

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

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

Improves the code with more accurate definition.

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

Does not discriminate against materials.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

2nd Comment Period

S8249-G1

Proponent John Woestman **Submitted** 5/22/2019 **Attachments** No

Comment:

We ask the TAC to reconsider this proposal.
The definition of Vapor Retarder Class includes the requirement to test according to ASTM E96. Within ASTM E96, there's Procedure A and there's Procedure B. The vapor retarder classes included in this current FBC definition (Class I, Class II, and Class III) are pertinent only to Procedure A of ASTM E96.
Hence, this proposal to revise the definition to specify Procedure A.

2nd Comment Period

S8249-G2

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

Revise as follows:

SECTION 202 DEFINITIONS

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

Class I: 0.1 perm or less.

Class II: 0.1 < perm = 1.0 perm.

Class III: 1.0 < perm = 10 perm.

S7982

Date Submitted 12/14/2018	**Section** 1626	**Proponent** Amanda Hickman
Chapter 16	**Affects HVHZ** Yes	**Attachments** No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

Summary of Modification

This modification revises and adds language to Section 1626 of the Florida Building Code.

Rationale

AMCA 540 - Test Method for Louvers Impacted by Wind Borne Debris has been referenced in Florida's Building Code since 2010. This standard is the appropriate standard for properly testing louvers for impact. As such it is critical that it also be recognized in the High Velocity Hurricane Zone (HVHZ) section of Florida's code. The current 2013 edition which is already referenced in the 7th edition of the Florida Code includes cycling requirements that make it even more robust. This modification seeks to add AMCA 540 standard to the HVHZ section of the code as an alternative to the comparative TAS 201 protocol.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

There will be little impact to enforcement, as this modification will only provide another test standard for impact testing of louvers in the HVHZ zone.

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

This modification could decrease the cost to building owners as this will streamline the louver impact testing and could decrease the cost of the products in some cases.

Impact to industry relative to the cost of compliance with code

This modification will decrease the cost to the industry as this will streamline the louver impact testing.

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

This modification could decrease the cost to small business as this will streamline the louver impact testing and could decrease the cost of the products in some cases.

Requirements

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

This modification will recognize an impact standard that is more stringent for testing louvers than the current protocol, thereby promoting the health, safety and welfare of the general public.

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

This modification will recognize an impact standard that is more stringent for testing louvers than the current protocol, thereby strengthening the code.

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

This modification does not discriminate against any products or methods or systems of construction, as it only provide another test standard for impact testing of louvers in the HVHZ zone.

Does not degrade the effectiveness of the code

This modification does not degrade the effectiveness of the code, as it only provide another test standard for impact testing of louvers in the HVHZ zone.

2nd Comment Period

7982-A2

Proponent Amanda Hickman **Submitted** 5/23/2019 **Attachments** Yes

Rationale

Per the TAC's comments the phrase "or an approved impact-resistance standard" has been removed from the proposed language.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

There will be little impact to enforcement, as this modification will only provide another test standard for impact testing of louvers in the HVHZ zone.

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

This modification could decrease the cost to building owners as this will streamline the louver impact testing and could decrease the cost of the products in some cases.

Impact to industry relative to the cost of compliance with code

This modification will decrease the cost to the industry as this will streamline the louver impact testing.

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

This modification could decrease the cost to small business as this will streamline the louver impact testing and could decrease the cost of the products in some cases.

Requirements

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

This modification will recognize an impact standard that is more stringent for testing louvers than the current protocol, thereby promoting the health, safety and welfare of the general public.

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

This modification will recognize an impact standard that is more stringent for testing louvers than the current protocol, thereby strengthening the code.

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

This modification does not discriminate against any products or methods or systems of construction, as it only provide another test standard for impact testing of louvers in the HVHZ zone.

Does not degrade the effectiveness of the code

This modification does not degrade the effectiveness of the code, as it only provide another test standard for impact testing of louvers in the HVHZ zone.

Replace original modification language with the following:

1626.1

All parts or systems of a building or structure envelope such as, but not limited, to exterior walls, roof, outside doors, skylights, glazing and glass block shall meet impact test criteria or be protected with an external protection device that meets the impact test criteria. Test procedures to determine resistance to wind-borne debris of wall cladding, outside doors, skylights, glazing, glass block, shutters and any other external protection devices shall be performed in accordance with this section.

Exception: The following structures or portion of structures shall not be required to meet the provisions of this section:

a.Roof assemblies for screen rooms, porches, canopies, etc., attached to a building that do not breach the exterior wall or building envelope and have no enclosed sides other than screen.
b.Soffits, soffit vents and ridge vents. Size and location of such vents shall be detailed by the designer and shall not compromise the integrity of the diaphragm boundary.
c.Vents in a garage with four or fewer cars. Size and location of such vents shall be detailed by the designer and shall not exceed the minimum required area by more than 25 percent.
d.Exterior wall or roof openings for wall- or roof-mounted HVAC equipment.
e.Openings for roof-mounted personnel access roof hatches.
f.Storage sheds that are not designed for human habitation and that have a floor area of 720 square feet (67 m^2) or less are not required to comply with the mandatory windborne debris impact standards of this code.
g.Louvers as long as they properly considered ASCE 7 in the design of the building <u>and that meet the requirements of Section 1626.5</u>.
h.Buildings and structures for marinas, cabanas, swimming pools, and greenhouses.
i.Exterior balconies or porches under existing roofs or decks enclosed with screen or removable vinyl and acrylic panels complying with Section 1622.1 or 1622.2 shall not be required to be protected and openings in the wall separating the unit from the balcony or porch shall not be required to be protected unless required by other provisions of this code.

<u>**1626.5 Louvers.**</u>

<u>Louvers protecting intake and exhaust ventilation ducts not assumed to be open that are located within 30 feet (9144 mm) of grade shall meet the requirements of AMCA 540 or shall be protected by an impact-resistant cover complying with the large missile test of TAS 201, TAS 202, TAS 203. Louvers required to be open for life safety purposes such as providing a breathable atmosphere shall meet the requirements of AMCA 540. Open and closed louvers shall also comply with uniform air pressure testing per TAS 202 protocol and cyclical wind pressure loading per TAS 203 protocol. This test shall be applicable to the construction unit of each louver type and material. A minimum of two test specimens made up of hidden (Architectural joints) and visible mullioned assembliesshall be utilized in verification of all specimen assembly conditions.</u>

Revise and add language as follows:

1626.1
All parts or systems of a building or structure envelope such as, but not limited, to exterior walls, roof, outside doors, skylights, glazing and glass block shall meet impact test criteria or be protected with an external protection device that meets the impact test criteria. Test procedures to determine resistance to wind-borne debris of wall cladding, outside doors, skylights, glazing, glass block, shutters and any other external protection devices shall be performed in accordance with this section.

Exception: The following structures or portion of structures shall not be required to meet the provisions of this section:

a.Roof assemblies for screen rooms, porches, canopies, etc., attached to a building that do not breach the exterior wall or building envelope and have no enclosed sides other than screen.
b.Soffits, soffit vents and ridge vents. Size and location of such vents shall be detailed by the designer and shall not compromise the integrity of the diaphragm boundary.
c.Vents in a garage with four or fewer cars. Size and location of such vents shall be detailed by the designer and shall not exceed the minimum required area by more than 25 percent.
d.Exterior wall or roof openings for wall- or roof-mounted HVAC equipment.
e.Openings for roof-mounted personnel access roof hatches.
f.Storage sheds that are not designed for human habitation and that have a floor area of 720 square feet (67 m^2) or less are not required to comply with the mandatory windborne debris impact standards of this code.
g.Louvers as long as they properly considered ASCE 7 in the design of the building <u>and that meet the requirements of Section 1626.5</u>.
h.Buildings and structures for marinas, cabanas, swimming pools, and greenhouses.
i.Exterior balconies or porches under existing roofs or decks enclosed with screen or removable vinyl and acrylic panels complying with Section 1622.1 or 1622.2 shall not be required to be protected and openings in the wall separating the unit from the balcony or porch shall not be required to be protected unless required by other provisions of this code.

<u>**1626.5 Louvers.**</u>
<u>Louvers protecting intake and exhaust ventilation ducts not assumed to be open that are located within 30 feet (9144 mm) of grade shall meet the requirements of AMCA 540 or shall be protected by an impact-resistant cover complying with the large missile test of TAS 201, TAS 202, TAS 203 or an approved impact-resistance standard. Louvers required to be open for life safety purposes such as providing a breathable atmosphere shall meet the requirements of AMCA 540. Open and closed louvers shall also comply with uniform air pressure testing per TAS 202 protocol and cyclical wind pressure loading per TAS 203 protocol. This test shall be applicable to the construction unit of each louver type and material. A minimum of two test specimens made up of hidden (Architectural joints) and visible mullioned assembliesshall be utilized in verification of all specimen assembly conditions.</u>

S8057

Date Submitted	12/13/2018	**Section**	1708.1	**Proponent**	Ann Russo4
Chapter	17	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes **Alternate Language** No

Related Modifications

1708.2
1708.3 1708.3.1 1708.3.2

Summary of Modification

This is an editorial tune-up of the in-situ load tests. The first change deletes a superfluous phrase. The second change (deletion of 1708.2) is intended to eliminate a duplicative provision. The third change (addition of the word "material" in two locations)

Rationale

This is an editorial tune-up of the in-situ load tests. As an editorial change, this proposal is intended to clarify and make the load test requirements more concise. It should have no measurable impact on the cost of construction.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity as this is already a code requirement

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

No impact to building and property owners as this is already a code requirement

Impact to industry relative to the cost of compliance with code

No impact to industry as this is already a code requirement

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

No impact to small businesses as this is already a code requirement

Requirements

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

Improves the health, safety, and welfare of the general public by cleaning up wording that could cause confusion

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

Improves the code by clarifying and making the load test requirements more concise

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

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities, this is a current code requirement that does not limit materials, products, methods, or systems of construction

Does not degrade the effectiveness of the code

It make the effectiveness of the code better by clarifying and making the load test requirements more concise

2nd Comment Period

S8057-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

Revise as follows:

1708.1 General. Whenever there is a reasonable doubt as to the stability or load-bearing capacity of a completed building, structure or portion thereof for the expected loads, an engineering assessment shall be required. The engineering assessment shall involve either a structural analysis or an in-situ load test, or both. The structural analysis shall be based on actual material properties and other as-built conditions that affect stability or load-bearing capacity, and shall be conducted in accordance with the applicable design standard. ~~If the structural assessment determines that the load-bearing capacity is less than that required by the code,~~ The in-situ load tests shall be conducted in accordance with Section 1708.2. If the building, structure or portion thereof is found to have inadequate stability or load-bearing capacity for the expected loads, modifications to ensure structural adequacy or the removal of the inadequate construction shall be required.

~~**1708.2 Test standards.** Structural components and assemblies shall be tested in accordance with the appropriate referenced standards. In the absence of a standard that contains an applicable load test procedure, the test procedure shall be developed by a *registered design professional* and *approved*. The test procedure shall simulate loads and conditions of application that the completed structure or portion thereof will be subjected to in normal use.~~

~~**1708.3**~~ **1708.2 In-situ load tests.** In-situ load tests shall be conducted in accordance with Section ~~1708.3.1~~ 1708.2.1 or ~~1708.3.2~~ 1708.2.2 and shall be supervised by a *registered design professional*. The test shall simulate the applicable loading conditions specified in Chapter 16 as necessary to address the concerns regarding structural stability of the building, structure or portion thereof.

~~**1708.3.1**~~ **1708.2.1 Load test procedure specified.** Where a referenced material standard contains an applicable load test procedure and acceptance criteria, the test procedure and acceptance criteria in the standard shall apply. In the absence of specific load factors and acceptance criteria in Section ~~1708.3.2~~ 1708.2.2 shall apply.

~~**1708.3.2**~~ **1708.2.2 Load test procedure not specified.** In the absence of applicable load test procedures contained within a a material standard referenced by this code or acceptance criteria for a specific material or method of construction, such *existing structure* shall be subjected to ~~a~~ an *approved* test procedure developed by a *registered design professional* that simulates applicable loading and deformation conditions. For components that are not a part of the seismic force-resisting system, at a minimum the test load shall be equal to the specified factored design loads. For materials such as wood that have strengths that are dependent on load duration, the test load shall be adjusted to account for the difference in load duration of the test compared to the expected duration of the design loads being considered. For statically loaded components, the test load shall be left in place for a period of 24 hours. For components that carry dynamic loads(e.g.,machine supports or fall arrest anchors),the load shall be left in place for a period consistent with the component's actual function. The structure shall be considered to have successfully met the test requirements where the following criteria are satisfied:

1. Under the design load, the deflection shall not exceed the limitations specified in Section1604.3. within 24 hours after removal of the test load, the structure shall have recovered not less than 75.2 percent of the maximum deflection.
2. During the immediately after the test, the structure shall not show evidence of failure

S7391

Date Submitted	11/21/2018	**Section**	1803.3	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

Summary of Modification

Add settlement to evaluation list

Rationale

Adding clarification that settlement should be considered.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

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

None

Impact to industry relative to the cost of compliance with code

None

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

None

Requirements

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

Building settlement analysis promotes greater structural safety.

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

Clarifies that any soil condition that causes settlement should be analyzed, not just whether or not the soil is "compressible".

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

Does not discriminate

Does not degrade the effectiveness of the code

Does not affect the effectiveness.

2nd Comment Period

S7391-G1

Proponent Hill Kevin **Submitted** 5/14/2019 **Attachments** No

Comment:

This is a minor text addition, but I feel it is important to clarify that settlement should be evaluated (settlement is not always the same as compressibility).

Soil classification shall be based on observation and any necessary tests of the materials disclosed by borings, test pits or other subsurface exploration made in appropriate locations. Additional studies shall be made as necessary to evaluate slope stability, soil strength, position and adequacy of load-bearing soils, the effect of moisture variation on soil-bearing capacity, compressibility (settlement), liquefaction and expansiveness.

S7392

Date Submitted	11/21/2018	**Section**	1803.6	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

Summary of Modification

Adding highly organic and total settlement to foundation recommendations for reporting.

Rationale

Highly organic soils and total settlement should be also considered when providing geotechnical recommendations for foundations. You can have 6 inches of total settlement with only 1/2 inch of differential settlement then total settlement can be more important than differential. This can be the case for poor, but uniform, soil conditions.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

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

None

Impact to industry relative to the cost of compliance with code

None

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

None

Requirements

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

Increase safety for foundation stability in that geotechnical reports should also consider poor soil conditions such as highly organic soils and also consider total settlement which can cause more substantial problems than differential settlement.

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

Strengthens code by adding additional considerations for geotechnical report.

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

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

2nd Comment Period

S7392-G1

Proponent Hill Kevin **Submitted** 5/14/2019 **Attachments** No

Comment:

It is important to ensure that total settlement and mitigation of highly organic soils (when present) are included in the geotechnical report.

1803.6 Reporting.

Where geotechnical investigations are required, a written report of the investigations shall be submitted to the *building official* by the permit applicant at the time of permit application. This geotechnical report shall include, but need not be limited to, the following information:

1. 1.A plot showing the location of the soil investigations.
2. 2.A complete record of the soil boring and penetration test logs and soil samples.
3. 3.A record of the soil profile.
4. 4.Elevation of the water table, if encountered.
5. 5.Recommendations for foundation type and design criteria, including but not limited to: bearing capacity of natural or compacted soil; provisions to mitigate the effects of expansive<u> or highly organic</u> soils; mitigation of the effects of liquefaction, <u>total and </u>differential settlement and varying soil strength; and the effects of adjacent loads.
6. 6.Expected total and differential settlement.
7. 7.Deep foundation information in accordance with Section 1803.5.5.
8. 8.Special design and construction provisions for foundations of structures founded on expansive soils, as necessary.
9. 9.Compacted fill material properties and testing in accordance with Section 1803.5.8.
10. 10.Controlled low-strength material properties and testing in accordance with Section 1803.5.9.

Designation: D2974 – 14

Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils[1]

This standard is issued under the fixed designation D2974; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 These test methods cover the measurement of moisture content, ash content, and organic matter in peats and other organic soils, such as organic clays, silts, and mucks. Test Method D2216 provides an alternative method for determining moisture content in mineral soils and rock.

1.1.1 *Test Method A*—Moisture is determined by drying peat or organic sample at 110 ± 5°C.

1.1.2 *Test Method B*—Alternative moisture method which removes the total moisture in two steps: (*1*) evaporation of moisture at room temperature, (*2*) subsequent oven drying of air dried sample at 110 ± 5°C. This method is used when the peat is to be used as fuel.

1.1.3 *Test Method C*—Ash content of a peat or organic soil sample, for general purposes, is determined by igniting oven dried sample from moisture content determination in a furnace at 440 ± 40°C.

1.1.4 *Test Method D*—Ash content of a peat or organic soil sample, for materials used for fuel, is determined by igniting oven dried sample from moisture content determination in a furnace at 750 ± 38°C.

1.2 Test Method A should be used for general classification, except for use of the peat as a fuel. Test Method B should be used when peats are being evaluated for use as a fuel

1.3 The values stated in SI units are to be regarded as the standard. No other units of measurement are included in this standard.

1.4 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026.

1.4.1 The procedures used to specify how data are collected/recorded or calculated in this standard are regarded as the industry standard. In addition, they are representative of the significant digits that generally should be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user's objectives; and it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations. It is beyone the scope of this standard to consider significant digits used in analysis methods for engineering design.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

D2944 Practice of Sampling Processed Peat Materials

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing

D6026 Practice for Using Significant Digits in Geotechnical Data

E145 Specification for Gravity-Convection and Forced-Ventilation Ovens

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of common technical terms in this standard, refer to Terminology D653.

4. Summary of Test Methods

4.1 *Test Method A*—Moisture is determined by drying a peat or organic soil sample at 110 ± 5°C. The moisture content is expressed as a percent of the oven dry mass.

[1] These test methods are under the jurisdiction of ASTM Committee D18 on Soil and Rock and are the direct responsibility of Subcommittee D18.22 on Soil as a Medium for Plant Growth.

Current edition approved Nov. 1, 2014. Published November 2014. Originally approved in 1971. Last previous edition approved in 2013 as D2974 – 13. DOI: 10.1520/D2974-14.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard**

4.2 *Test Method B*—This is an alternative moisture method which removes the total moisture in two steps: (*1*) evaporation of moisture in air at room temperature (air-drying), and (*2*) the subsequent oven drying of the air-dried sample at 110 ± 5°C. This method is used when the peat is to be used as fuel. The moisture content is expressed as both a percent of the oven dry mass and of the as received mass.

4.3 *Test Methods C and D*—Ash content of a peat or organic soil sample is determined by igniting the oven-dried sample from the moisture content determination in a furnace at 440 ± 40°C (Test Method C) or 750 ± 38°C (Test Method D). The substance remaining after ignition is the ash. The ash content is expressed as a percentage of the mass of the oven-dried sample.

4.4 Organic matter is determined by subtracting percent ash content from one hundred.

5. Significance and Use

5.1 This test method can be used to determine the moisture content, ash content, and percent organic matter in soil.

5.2 The percent organic matter is important in the following: (*1*) classifying peat or other organic soil, (*2*) geotechnical and general classification purposes, and (*3*) when peats are being evaluated as a fuel.

NOTE 1—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Oven,* meeting the requirements of E145 and capable of being regulated to a constant temperature of 110 ± 5°C.

6.2 The temperature of 110 ± 5°C is quite critical for organic soils. The oven should be checked for "hot spots" to avoid possible ignition of the specimen.

6.3 *Furnace,* capable of producing constant temperatures of 440 ± 40°C and 750 ± 38°C.

6.4 *Balance or Scale,* a balance or scale for determining the mass of the soil having a minimum capacity of 500 g and meeting the requirements of Guide D4753 for a balance or scale of 0.01 g readability.

6.5 *Rubber Sheet, Oil Cloth,* or other non-absorbent material.

6.6 *Evaporating Dishes,* of high silica or porcelain of not less than 100-mL capacity.

6.7 *Aluminum Foil,* heavy-duty.

6.8 *Porcelain Pan, Spoons,* and equipment of the like.

6.9 *Desiccator.*

7. Sampling and Test Specimens

7.1 Place a representative field sample on a rubber sheet, oil cloth, or equivalent material and mix thoroughly.

7.2 Reduce the sample to the quantity required for a test specimen by quartering.

7.3 Place the test specimen and the remaining sample in separate waterproof containers.

7.4 Work rapidly to prevent moisture loss or perform the operation in a room with a high humidity.

8. Procedure

8.1 *Moisture Content Determination:*

8.1.1 *Test Method A:*

8.1.1.1 Record to the nearest 0.01 g the mass of a high silica or porcelain evaporating dish fitted with a heavy-duty aluminum foil cover. The dish shall have a capacity of not less than 100 mL.

8.1.1.2 Following the instruction in Section 7 above, place a test specimen of at least 50 g in the container described in 8.1.1.1. Crush soft lumps with a spoon or spatula. The thickness of peat in the container should not exceed 3 cm.

8.1.1.3 Record the mass to the nearest 0.01 g.

8.1.1.4 Dry uncovered for at least 16 h at 110 ± 5°C or until there is less than 0.1 % change in mass of the sample per hour. Remove from the oven, cover tightly, cool in a desiccator, and record the mass to the nearest 0.01 g keeping exposure to the room atmosphere to a minimum.

8.1.2 *Calculations for Test Method A:*

8.1.2.1 Calculate the moisture content as follows:

$$\text{Moisture Content, \%} = [(A - B) \times 100]/B \quad (1)$$

where:

A = mass of the as-received test specimen, g, and
B = mass of the oven-dried specimen, g.

(*1*) This calculation is used for general purposes (except when the peat is to be used as a fuel) and the result should be referred to as the moisture content as a percentage of oven-dried mass.

8.1.3 *Test Method B:*

8.1.3.1 This test method should be used if the peat is to be used as a fuel.

8.1.3.2 Following the instructions in Section 7, select a 100 to 300 g representative test specimen. Determine the mass of this test specimen to the nearest 0.01 g and spread it evenly on a large flat pan. Crush soft lumps with a spoon or spatula and let the sample come to moisture equilibrium with room air. This will require at least 24 h. Stir occasionally during the normal workday to maintain maximum air exposure of the entire sample. Continue drying until there is less than 0.1% change in mass per hour, then calculate the moisture removed during air drying as a percentage of the as-received mass.

8.1.3.3 After thoroughly mixing the air-dried sample, obtain 50 g of material and record to the nearest 0.01 g.

8.1.3.4 Place the sample in a container as described in 8.1.1 and proceed as in Test Method A.

8.1.4 *Calculations for Test Method B:*

8.1.4.1 Calculate the moisture content as follows:

$$\text{Moisture Content for Air-Dried Sample, \%} = ((A_D - B) \times 100)/B \quad (2)$$

where:

A_D = mass of the air-dried sample, g, and
B = mass of the oven-dried sample, g.

(1) This calculation gives moisture content of the air dried sample as a percentage of oven-dried mass.

8.2 *Ash Content Determination:*

8.2.1 *Test Method C:*

8.2.1.1 Determine the mass of a covered high-silica or porcelain dish to the nearest 0.01 g.

8.2.1.2 Place a part or all of the oven-dried test specimen from a moisture determination in the dish and determine the mass of the dish and specimen to the nearest 0.01 g.

8.2.1.3 Remove the cover and place the dish in a furnace. Gradually bring the temperature in the furnace to 440 ± 40°C and hold until the specimen is completely ashed (no change of mass occurs after at least 1 hr period of heating).

8.2.1.4 Cool in a desiccator, and determine the mass to the nearest 0.01 g keeping the exposure to the room atmosphere to a minimum.

8.2.1.5 This test method should be used for general classification purposes, except the use of peat for fuel.

8.2.2 *Test Method D:*

8.2.2.1 Determine the mass of a covered high-silica or porcelain dish to the nearest 0.01 g.

8.2.2.2 Place a part of the oven-dried test specimen from a moisture determination in the dish and determine the mass of the dish and specimen to the nearest 0.01 g.

8.2.2.3 Remove the cover and place the dish in a furnace. Gradually bring the temperature in the furnace to 750 ± 38°C and hold until the specimen is completely ashed (no change in mass of the sample after further drying periods in excess of 1 h).

8.2.2.4 Cool in a desiccator, and determine the mass to the nearest 0.01 g keeping the exposure to the room atmosphere to a minimum.

8.2.2.5 This test method should be used when peats are being evaluated for use as a fuel.

8.2.3 *Calculation for Test Methods C and D:*

8.2.3.1 Calculate the ash content as follows:

$$\text{Ash Content, } \% = (C \times 100)/B \quad (3)$$

where:

C = mass of ash, g, and
B = oven-dried test specimen, g.

8.3 *Organic Matter Determination:*

8.3.1 *Calculation:*

8.3.1.1 Determine the amount of organic matter to the nearest 0.1 % by difference, as follows:

$$\text{Organic matter, } \% = 100.0 - D \quad (4)$$

where:

D = ash content, % (nearest 0.1 %).

9. Report: Test Data Sheet(s)/Form(s)

9.1 The methodology used to specify how data are recorded on the test data sheet(s)/form(s), as follows, is covered in 1.4.

9.2 Record as a minimum the following general information (data):

9.2.1 Sample/specimen identifying information, such as Project No., Boring No., Sample No., Depth, and alike.

9.2.2 Any special selection and preparation process, such as removal of gravel or other materials.

9.2.3 Technician name or initials, method used and date.

9.3 Record as a minimum the following test specimen data:

9.3.1 Results for organic matter and ash content, to the nearest 0.1 %.

9.3.2 Furnace temperature used for ash content determinations.

9.3.3 Express results for moisture content as a percentage of oven-dried mass as follows:

9.3.3.1 Below 100 % to the nearest 1 %.

9.3.3.2 Between 100 % and 500 % to the nearest 5 %.

9.3.3.3 Between 500 % and 1000 % to the nearest 10 %.

9.3.3.4 Above 1000 % to the nearest 20 %.

10. Precision and Bias

10.1 *Precision*—Test data on precision is not presented due to the nature of the soil materials tested by this test method. It is either not feasible or too costly at this time to have ten or more laboratories participate in a round-robin testing program.

10.1.1 The Subcommittee D18.22 is seeking any data from the users of this test method that might be used to make a limited statement on precision.

10.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

11. Keywords

11.1 ash content; moisture content; organic soil; peat; percent organic matter

SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (D2974 – 13) that may impact the use of this standard. (Approved November 1, 2014)

(1) Changes made throughout to clarify the uses of the different test methods contained in this standard.

(2) Reference to D2944 was added for sampling methodology.

S7396

Date Submitted	11/21/2018	**Section**	1803.5.3	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments No | **Alternate Language** Yes

Related Modifications

Summary of Modification

Adding highly organic soil to be tested (in addition to expansive soils) and defines highly organic soil.

Rationale

Highly organic soils have at least as much chance of causing settlement-related distress to a building than expansive soils and testing should be required when present.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Building Official can now require testing based on highly organic soils if present.

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

None

Impact to industry relative to the cost of compliance with code

Rarely when testing may not have been required, geotechnical testing would be required for highly organic soils. Typically, these would be tested anyway, but this change would require it. Very little if any additional cost.

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

None

Requirements

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

Increases safety of structure by ensuring that buildings are not constructed over highly organic soils without testing.

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

Strengthens code by ensuring that buildings are not constructed over highly organic soils without testing.

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

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

Alternate Language

2nd Comment Period

7396-A1

Proponent Hill Kevin **Submitted** 5/14/2019 **Attachments** Yes

Rationale

Corrected a missed text addition "or highly organic" in the first sentence. It is important to allow the Building Official to require soil tests where organic soils are known to exist. Building on organic soils is one of the most common causes of settlement damage for structures and it should be prevented whenever possible.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Allows Building Official to require testing if organics are present.

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

May require testing when constructing in wetland or other organic soil areas.

Impact to industry relative to the cost of compliance with code

Very little impact, but on certain structures constructed on organic soils, testing would be required if testing was not already planned.

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

None

Requirements

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

Improves safety by requiring testing when organic soils are present to help minimize chance of structure settlement.

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

Strengthens code by requiring testing when organic soils are present.

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

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

1803.5.3 Expansive or highly organic soil.

In areas likely to have expansive or highly organic soil, the building official shall require soil tests to determine where such soils do exist. Soils meeting all four of the following provisions shall be considered expansive, except that tests to show compliance with Items 1, 2 and 3 shall not be required if the test prescribed in Item 4 is conducted:

1. Plasticity index (PI) of 15 or greater, determined in accordance with ASTM D4318.

2. More than 10 percent of the soil particles pass a No. 200 sieve (75 µm), determined in accordance with ASTM D422.

3. More than 10 percent of the soil particles are less than 5 micrometers in size, determined in accordance with ASTM D422.

4. Expansion index greater than 20, determined in accordance with ASTM D4829.

Soils shall be considered highly organic if the Organic Content by weight, determined in accordance with ASTM D2974, is greater than 8 percent and the total thickness of organic layer(s) is greater than 12 inches.

1803.5.3 Expansive or highly organic soil.

In areas likely to have expansive soil, the *building official* shall require soil tests to determine where such soils do exist.

Soils meeting all four of the following provisions shall be considered expansive, except that tests to show compliance with Items 1, 2 and 3 shall not be required if the test prescribed in Item 4 is conducted:

1. 1.Plasticity index (PI) of 15 or greater, determined in accordance with ASTM D4318.
2. 2.More than 10 percent of the soil particles pass a No. 200 sieve (75 μm), determined in accordance with ASTM D422.
3. 3.More than 10 percent of the soil particles are less than 5 micrometers in size, determined in accordance with ASTM D422.
4. 4.Expansion index greater than 20, determined in accordance with ASTM D4829.

Soils shall be considered highly organic if the Organic Content by weight, determined in accordance with ASTM D2974, is greater than 8 percent and the total thickness of organic layer(s) is greater than 12 inches.

Designation: D2974 – 14

Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils[1]

This standard is issued under the fixed designation D2974; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 These test methods cover the measurement of moisture content, ash content, and organic matter in peats and other organic soils, such as organic clays, silts, and mucks. Test Method D2216 provides an alternative method for determining moisture content in mineral soils and rock.

1.1.1 *Test Method A*—Moisture is determined by drying peat or organic sample at 110 ± 5°C.

1.1.2 *Test Method B*—Alternative moisture method which removes the total moisture in two steps: (*1*) evaporation of moisture at room temperature, (*2*) subsequent oven drying of air dried sample at 110 ± 5°C. This method is used when the peat is to be used as fuel.

1.1.3 *Test Method C*—Ash content of a peat or organic soil sample, for general purposes, is determined by igniting oven dried sample from moisture content determination in a furnace at 440 ± 40°C.

1.1.4 *Test Method D*—Ash content of a peat or organic soil sample, for materials used for fuel, is determined by igniting oven dried sample from moisture content determination in a furnace at 750 ± 38°C.

1.2 Test Method A should be used for general classification, except for use of the peat as a fuel. Test Method B should be used when peats are being evaluated for use as a fuel

1.3 The values stated in SI units are to be regarded as the standard. No other units of measurement are included in this standard.

1.4 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026.

1.4.1 The procedures used to specify how data are collected/recorded or calculated in this standard are regarded as the industry standard. In addition, they are representative of the significant digits that generally should be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user's objectives; and it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations. It is beyone the scope of this standard to consider significant digits used in analysis methods for engineering design.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

D2944 Practice of Sampling Processed Peat Materials

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing

D6026 Practice for Using Significant Digits in Geotechnical Data

E145 Specification for Gravity-Convection and Forced-Ventilation Ovens

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of common technical terms in this standard, refer to Terminology D653.

4. Summary of Test Methods

4.1 *Test Method A*—Moisture is determined by drying a peat or organic soil sample at 110 ± 5°C. The moisture content is expressed as a percent of the oven dry mass.

[1] These test methods are under the jurisdiction of ASTM Committee D18 on Soil and Rock and are the direct responsibility of Subcommittee D18.22 on Soil as a Medium for Plant Growth.

Current edition approved Nov. 1, 2014. Published November 2014. Originally approved in 1971. Last previous edition approved in 2013 as D2974 – 13. DOI: 10.1520/D2974-14.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard**

4.2 *Test Method B*—This is an alternative moisture method which removes the total moisture in two steps: (*1*) evaporation of moisture in air at room temperature (air-drying), and (*2*) the subsequent oven drying of the air-dried sample at 110 ± 5°C. This method is used when the peat is to be used as fuel. The moisture content is expressed as both a percent of the oven dry mass and of the as received mass.

4.3 *Test Methods C and D*—Ash content of a peat or organic soil sample is determined by igniting the oven-dried sample from the moisture content determination in a furnace at 440 ± 40°C (Test Method C) or 750 ± 38°C (Test Method D). The substance remaining after ignition is the ash. The ash content is expressed as a percentage of the mass of the oven-dried sample.

4.4 Organic matter is determined by subtracting percent ash content from one hundred.

5. Significance and Use

5.1 This test method can be used to determine the moisture content, ash content, and percent organic matter in soil.

5.2 The percent organic matter is important in the following: (*1*) classifying peat or other organic soil, (*2*) geotechnical and general classification purposes, and (*3*) when peats are being evaluated as a fuel.

NOTE 1—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Oven*, meeting the requirements of E145 and capable of being regulated to a constant temperature of 110 ± 5°C.

6.2 The temperature of 110 ± 5°C is quite critical for organic soils. The oven should be checked for "hot spots" to avoid possible ignition of the specimen.

6.3 *Furnace*, capable of producing constant temperatures of 440 ± 40°C and 750 ± 38°C.

6.4 *Balance or Scale*, a balance or scale for determining the mass of the soil having a minimum capacity of 500 g and meeting the requirements of Guide D4753 for a balance or scale of 0.01 g readability.

6.5 *Rubber Sheet, Oil Cloth*, or other non-absorbent material.

6.6 *Evaporating Dishes*, of high silica or porcelain of not less than 100-mL capacity.

6.7 *Aluminum Foil*, heavy-duty.

6.8 *Porcelain Pan, Spoons*, and equipment of the like.

6.9 *Desiccator.*

7. Sampling and Test Specimens

7.1 Place a representative field sample on a rubber sheet, oil cloth, or equivalent material and mix thoroughly.

7.2 Reduce the sample to the quantity required for a test specimen by quartering.

7.3 Place the test specimen and the remaining sample in separate waterproof containers.

7.4 Work rapidly to prevent moisture loss or perform the operation in a room with a high humidity.

8. Procedure

8.1 *Moisture Content Determination:*

8.1.1 *Test Method A:*

8.1.1.1 Record to the nearest 0.01 g the mass of a high silica or porcelain evaporating dish fitted with a heavy-duty aluminum foil cover. The dish shall have a capacity of not less than 100 mL.

8.1.1.2 Following the instruction in Section 7 above, place a test specimen of at least 50 g in the container described in 8.1.1.1. Crush soft lumps with a spoon or spatula. The thickness of peat in the container should not exceed 3 cm.

8.1.1.3 Record the mass to the nearest 0.01 g.

8.1.1.4 Dry uncovered for at least 16 h at 110 ± 5°C or until there is less than 0.1 % change in mass of the sample per hour. Remove from the oven, cover tightly, cool in a desiccator, and record the mass to the nearest 0.01 g keeping exposure to the room atmosphere to a minimum.

8.1.2 *Calculations for Test Method A:*

8.1.2.1 Calculate the moisture content as follows:

$$\text{Moisture Content, \%} = [(A - B) \times 100]/B \tag{1}$$

where:

A = mass of the as-received test specimen, g, and
B = mass of the oven-dried specimen, g.

(*1*) This calculation is used for general purposes (except when the peat is to be used as a fuel) and the result should be referred to as the moisture content as a percentage of oven-dried mass.

8.1.3 *Test Method B:*

8.1.3.1 This test method should be used if the peat is to be used as a fuel.

8.1.3.2 Following the instructions in Section 7, select a 100 to 300 g representative test specimen. Determine the mass of this test specimen to the nearest 0.01 g and spread it evenly on a large flat pan. Crush soft lumps with a spoon or spatula and let the sample come to moisture equilibrium with room air. This will require at least 24 h. Stir occasionally during the normal workday to maintain maximum air exposure of the entire sample. Continue drying until there is less than 0.1% change in mass per hour, then calculate the moisture removed during air drying as a percentage of the as-received mass.

8.1.3.3 After thoroughly mixing the air-dried sample, obtain 50 g of material and record to the nearest 0.01 g.

8.1.3.4 Place the sample in a container as described in 8.1.1 and proceed as in Test Method A.

8.1.4 *Calculations for Test Method B:*

8.1.4.1 Calculate the moisture content as follows:

$$\text{Moisture Content for Air-Dried Sample, \%} = ((A_D - B) \times 100)/B \tag{2}$$

where:

A_D = mass of the air-dried sample, g, and
B = mass of the oven-dried sample, g.

(1) This calculation gives moisture content of the air dried sample as a percentage of oven-dried mass.

8.2 *Ash Content Determination:*

8.2.1 *Test Method C:*

8.2.1.1 Determine the mass of a covered high-silica or porcelain dish to the nearest 0.01 g.

8.2.1.2 Place a part or all of the oven-dried test specimen from a moisture determination in the dish and determine the mass of the dish and specimen to the nearest 0.01 g.

8.2.1.3 Remove the cover and place the dish in a furnace. Gradually bring the temperature in the furnace to 440 ± 40°C and hold until the specimen is completely ashed (no change of mass occurs after at least 1 hr period of heating).

8.2.1.4 Cool in a desiccator, and determine the mass to the nearest 0.01 g keeping the exposure to the room atmosphere to a minimum.

8.2.1.5 This test method should be used for general classification purposes, except the use of peat for fuel.

8.2.2 *Test Method D:*

8.2.2.1 Determine the mass of a covered high-silica or porcelain dish to the nearest 0.01 g.

8.2.2.2 Place a part of the oven-dried test specimen from a moisture determination in the dish and determine the mass of the dish and specimen to the nearest 0.01 g.

8.2.2.3 Remove the cover and place the dish in a furnace. Gradually bring the temperature in the furnace to 750 ± 38°C and hold until the specimen is completely ashed (no change in mass of the sample after further drying periods in excess of 1 h).

8.2.2.4 Cool in a desiccator, and determine the mass to the nearest 0.01 g keeping the exposure to the room atmosphere to a minimum.

8.2.2.5 This test method should be used when peats are being evaluated for use as a fuel.

8.2.3 *Calculation for Test Methods C and D:*

8.2.3.1 Calculate the ash content as follows:

$$\text{Ash Content, \%} = (C \times 100)/B \quad (3)$$

where:

C = mass of ash, g, and
B = oven-dried test specimen, g.

8.3 *Organic Matter Determination:*

8.3.1 *Calculation:*

8.3.1.1 Determine the amount of organic matter to the nearest 0.1 % by difference, as follows:

$$\text{Organic matter, \%} = 100.0 - D \quad (4)$$

where:

D = ash content, % (nearest 0.1 %).

9. Report: Test Data Sheet(s)/Form(s)

9.1 The methodology used to specify how data are recorded on the test data sheet(s)/form(s), as follows, is covered in 1.4.

9.2 Record as a minimum the following general information (data):

9.2.1 Sample/specimen identifying information, such as Project No., Boring No., Sample No., Depth, and alike.

9.2.2 Any special selection and preparation process, such as removal of gravel or other materials.

9.2.3 Technician name or initials, method used and date.

9.3 Record as a minimum the following test specimen data:

9.3.1 Results for organic matter and ash content, to the nearest 0.1 %.

9.3.2 Furnace temperature used for ash content determinations.

9.3.3 Express results for moisture content as a percentage of oven-dried mass as follows:

9.3.3.1 Below 100 % to the nearest 1 %.

9.3.3.2 Between 100 % and 500 % to the nearest 5 %.

9.3.3.3 Between 500 % and 1000 % to the nearest 10 %.

9.3.3.4 Above 1000 % to the nearest 20 %.

10. Precision and Bias

10.1 *Precision*—Test data on precision is not presented due to the nature of the soil materials tested by this test method. It is either not feasible or too costly at this time to have ten or more laboratories participate in a round-robin testing program.

10.1.1 The Subcommittee D18.22 is seeking any data from the users of this test method that might be used to make a limited statement on precision.

10.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

11. Keywords

11.1 ash content; moisture content; organic soil; peat; percent organic matter

SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (D2974 – 13) that may impact the use of this standard. (Approved November 1, 2014)

(1) Changes made throughout to clarify the uses of the different test methods contained in this standard.

(2) Reference to D2944 was added for sampling methodology.

S7397

Date Submitted	11/21/2018	**Section**	1804.6	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

Summary of Modification

Increasing minimum existing in-place soil density from 90 to 95 percent to not require an approved report.

Rationale

The existing text was not clear as to what soil (fill or native) had to meet the existing density requirements. Also, 90% of maximum dry density is too low for support of structures and is never recommended by geotechnical engineers. 95% is typically the minimum recommended for structures (often 98% is used).

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

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

None

Impact to industry relative to the cost of compliance with code

None

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

None

Requirements

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

Should improve minimum soil compaction beneath structures without an approved report. Increases safety.

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

Strengthens the code by requiring a higher soil compaction without an approved report. Existing requirement was too low and is not up to the level recommended by geotechnical engineers.

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

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

2nd Comment Period

S7397-G1

Proponent Hill Kevin **Submitted** 5/14/2019 **Attachments** No

Comment:

It is important that both fill and in-situ (native) soils be compacted to at least 95 percent of maximum dry density for structures. In Florida, I have never seen a geotechnical report by any company recommend less than 95% compaction for any structure and 98% is commonly used. 95% should be the minimum, not 90%.

1804.6 Compacted fill material.

Where shallow foundations will bear on compacted fill material, the compacted fill shall comply with the provisions of an *approved* geotechnical report, as set forth in Section 1803.

Exception: Compacted fill material 12 inches (305 mm) in depth or less need not comply with an *approved* report, provided the in-place dry density of existing native soils and new fill to a depth of at least 12 inches below footing or slab to be supported is not less than ~~90~~95 percent of the maximum dry density at optimum moisture content determined in accordance with ASTM D1557.

S7398

Date Submitted	11/21/2018	**Section**	1806.2	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

Summary of Modification

Lower the presumptive bearing capacity for sandy soils from 2000psf to 1500psf. Florida soils, often with shallow water table, often do not meet 2000psf allowable bearing capacity with sufficient safety factor and a case can be made that there is no safety factor at all in certain circumstances.

Rationale

2000psf presumptive bearing pressure for sands and clayey sands is too high and does not allow adequate safety factor against bearing failure under a number of conditions. A primary example is when the water table is shallow. If the minimum footing width of 12 inches is used with the water table at the bottom of the footing and 12 inches of embedment, there litterally is no safety factor against failure. 1500psf is more commonly used for sandy soils in Florida for allowable bearing capacity but in some conditions that still may be too high depending on the water table depth. Typically a safety factor of 3 is used for bearing failure but 2 may be acceptable. Regardless, 2000psf is too high to assume without testing, particularly for an architect or contractor who does not understand what causes bearing failure. This is a Florida-specific condition.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

More projects may require a geotechnical report if presumptive bearing values are used or if the designer needs a higher bearing value than the presumptive values for sandy soils. Those already testing to verify the presumptive bearing value will require no additional work.

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

Some projects may require a report where they may not have been required to do so previously. This could add a fee to the overall project cost. Additional report cost may range from $1000 to a few thousand dollars depending on what testing needs to be completed.

Impact to industry relative to the cost of compliance with code

Some projects may require a report where they may not have been required to do so previously. This could add a fee to the overall project cost. Additional report cost may range from $1000 to a few thousand dollars depending on what testing needs to be completed.

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

No impact anticipated for typical projects.

Requirements

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

Safety factor against soil bearing failure is increased which increases public safety. Under certain conditions, the current code has no safety factor and needed to be updated.

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

Strengthens the code by providing a lower presumptive bearing pressure for sandy soils.

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

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

2nd Comment Period

S7398-G1

Proponent Hill Kevin **Submitted** 5/14/2019 **Attachments** No

Comment:

This Mod is extremely important. In-Situ Florida sands are very loose to loose and are not competent for building without proper compaction. Furthermore, for narrow footings, the calculated allowable bearing pressures are much lower than for wider footings. Allowable bearing pressure is a function of both footing width and footing embedment (depth below final grade). It is also a function of water table depth. For a shallow water table, the allowable bearing is reduced even further. We can calculate combinations of footing sizes that are allowable under the current code that have no safety factor at all against bearing failure. Assuming a certain value has a lot of risk if footings are narrow. 2,000 is too low for common narrow continuous strip footings, particularly for those 18-inches in width or less and we strongly recommend 1,500 be used for a presumptive value for sandy soils without a geotechnical report to provide a more precise value for a particular case.

1806.2 Presumptive load-bearing values.

The load-bearing values used in design for supporting soils near the surface shall not exceed the values specified in Table 1806.2 unless data to substantiate the use of higher values are submitted and *approved*. Where the *building official* has reason to doubt the classification, strength or compressibility of the soil, the requirements of Section 1803.5.2 shall be satisfied.

Presumptive load-bearing values shall apply to materials with similar physical characteristics and dispositions when proper preparation and compaction efforts are applied (e.g. stripped, proof-rolled and compacted to at least 95% of modified Proctor maximum dry density). Mud, organic silt, organic clays, peat, unprepared in-situ soil or unprepared fill shall not be assumed to have a presumptive load-bearing capacity unless data to substantiate the use of such a value are submitted. Additionally, for foundation widths of 18 inches or narrower, if the seasonal high water level is within 12 inches of the bottom of the foundation (or higher), an approved geotechnical report shall be required to provide the allowable bearing pressure for those particular foundations.

Exception: A presumptive load-bearing capacity shall be permitted to be used where the *building official* deems the load-bearing capacity of mud, organic silt or unprepared fill is adequate for the support of lightweight or temporary structures.

TABLE 1806.2

PRESUMPTIVE LOAD-BEARING VALUES

CLASS OF MATERIALS	VERTICAL FOUNDATIONPRESSURE (psf)	LATERAL BEARINGPRESSURE(psf/ft below natural grade)	LATERAL SLIDING RESISTANCE	
			Coefficient of friction[a]	Cohesion (psf)[b]
1. Crystalline bedrock	12,000	1,200	0.70	—
2. Sedimentary and foliated rock	4,000	400	0.35	—
3. Sandy gravel and/or gravel (GW and GP)	3,000	200	0.35	—
4. ~~Sand, silty sand, clayey sand,~~ ~~s~~Silty gravel and clayey gravel (~~SW, SP, SM, SC,~~ GM and GC)	2,000	150	0.25	—
5. Sand, silty sand and clayey sand (SW, SP, SM, SC)	1,500	100	0.25	—
~~5~~6. Clay, sandy clay, silty clay, clayey silt, silt and sandy silt (CL, ML, MH	1,500	100	—	130

and CH)				

For SI: 1 pound per square foot = 0.0479kPa, 1 pound per square foot per foot = 0.157 kPa/m.

1. a.Coefficient to be multiplied by the dead load.
2. b.Cohesion value to be multiplied by the contact area, as limited by Section 1806.3.2.

S7399

Date Submitted	11/21/2018	**Section**	1808.2	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

Summary of Modification

Adding requirements for design of foundations to include allowance for total settlement (not just differential settlement) and organic soils.

Rationale

Both total and differential settlement are important for the structure, not just differential. Foundations can be severely affected by highly organic soils, not just expansive soils. Construction over highly organic soils is never recommended without proper foundation design and settlement analysis to account for such conditions.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

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

None

Impact to industry relative to the cost of compliance with code

None

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

None

Requirements

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

Improves public safety/welfare by ensuring that structures built where highly organic soils are located are properly constructed to resist settlement-related damages.

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

Improves the code to cover more types of settlement that may (and often do) occur in Florida.

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

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

2nd Comment Period

S7399-G1

Proponent Hill Kevin **Submitted** 5/14/2019 **Attachments** No

Comment:

It is very important that settlement (both total and differential) is analyzed during foundation design. Foundations rarely fail in bearing and settlement is the most common form of foundation failure. The presence of organic soils is one of the most common causes of settlement-related damage to structures.

1808.2 Design for capacity and settlement.

Foundations shall be so designed that the allowable bearing capacity of the soil is not exceeded, and that total and differential settlement ~~is~~are minimized. Foundations in areas with expansive or highly organic soils shall be designed in accordance with the provisions of Section 1808.6. Foundations in areas with highly organic soils or buried debris below any portion of the foundation or floor slab areas shall require a settlement analysis as well as satisfy the requirements of Section 1806 unless the organic soil or debris is removed in accordance with Section 1808.6.3 and replaced with clean compacted fill in accordance with Section 1804.

S7401

Date Submitted	11/21/2018	**Section**	1808.6	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

Summary of Modification

Adds highly organic soils to expansive soils requiring special attention during foundation design.

Rationale

Highly organic soils should be included with expansive soils for needing additional attention during foundation design. Both are problematic soil conditions that can cause foundation movement.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

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

None

Impact to industry relative to the cost of compliance with code

None

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

None

Requirements

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

Improved public safety/welfare by requiring design of foundations to account for highly organic soils if present.

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

Strengthens the code by requiring special attention for highly organic soils, if present, during foundation design.

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

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

2nd Comment Period

S7401-G1

Proponent Hill Kevin **Submitted** 5/14/2019 **Attachments** No

Comment:

This is a minor addition to include highly organic soils to have the same design and removal requirements as expansive soils.

1808.6 Design for expansive or highly organic soils.

Foundations for buildings and structures founded on expansive or highly organic soils shall be designed in accordance with Section 1808.6.1 or 1808.6.2.

Exception: Foundation design need not comply with Section 1808.6.1 or 1808.6.2 where one of the following conditions is satisfied:

1. 1.The expansive or highly organic soil is removed in accordance with Section 1808.6.3.
2. 2.The *building official* approves stabilization of the soil in accordance with Section 1808.6.4.

S7402

Date Submitted	11/21/2018	**Section**	1808.6.1	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

7401

Summary of Modification

Adding consideration for highly organic soils to foundation design.

Rationale

Highly organic soils are some of the most common causes of settlement of structures in Florida. They should have the same consideration in the FBC as expansive soils. This condition is more prevalent in Florida than many parts of the world.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

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

None

Impact to industry relative to the cost of compliance with code

None

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

None

Requirements

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

Improves public safety/welfare by requiring foundations to account for highly organic soils when present.

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

Strengthens the code by accounting for highly organic soil conditions which can cause foundation movement.

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

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

2nd Comment Period

S7402-G1

Proponent Hill Kevin **Submitted** 5/14/2019 **Attachments** No

Comment:

It is very important that foundations be designed to resist settlement due to organics, if present.

1808.6.1 Foundations.

Foundations placed on or within the active zone of expansive or highly organic soils shall be designed to resist differential volume changes and to prevent structural damage to the supported structure. Foundations placed above, on, or within the zone of influence of highly organic soils shall be designed to resist differential and total settlement in consideration of both the immediate compressibility and long-term degradation/decay of organics over time. Deflection and racking of the supported structure shall be limited to that which will not interfere with the usability and serviceability of the structure.

Foundations placed below where volume change occurs or below expansive soil shall comply with the following provisions:

1. 1.Foundations extending into or penetrating expansive soils shall be designed to prevent uplift of the supported structure.
2. 2.Foundations penetrating expansive soils shall be designed to resist forces exerted on the foundation due to soil volume changes or shall be isolated from the expansive soil.

S7403

Date Submitted	11/21/2018	**Section**	1808.6.2	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

7401, 7402

Summary of Modification

Adds highly organic soils to expansive soils already in the code.

Rationale

Highly organic soils cause many of the same soil conditions that expansive soils create and both should be considered during design.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

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

None

Impact to industry relative to the cost of compliance with code

None

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

None

Requirements

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

Increases safety/welfare by requiring foundations to consider highly organic soils.

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

Strengthens the code with additional requirement for highly organic soils.

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

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

2nd Comment Period

S7403-G1

Proponent Hill Kevin **Submitted** 5/14/2019 **Attachments** No

Comment:

Simple addition of highly organic soils to the expansive soil requirements for slabs-on-grade.

1808.6.2 Slab-on-ground foundations.

Moments, shears and deflections for use in designing slab-on-ground, mat or raft foundations on expansive or highly organic soils shall be determined in accordance with *WRI/CRSI Design of Slab-on-Ground Foundations* or *PTI DC 10.5.* Using the moments, shears and deflections determined above, nonprestressed slabs-on-ground, mat or raft foundations on expansive soils shall be designed in accordance with *WRI/CRSI Design of Slab-on-Ground Foundations* and post-tensioned slab-on-ground, mat or raft foundations on expansive soils shall be designed in accordance with *PTI DC 10.5*. It shall be permitted to analyze and design such slabs by other methods that account for soil-structure interaction, the deformed shape of the soil support, the plate or stiffened plate action of the slab as well as both center lift and edge lift conditions. Such alternative methods shall be rational and the basis for all aspects and parameters of the method shall be available for peer review.

S7404

Date Submitted	11/21/2018	**Section**	1808.6.3	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

7401, 7402, 7403

Summary of Modification

Adds removal of highly organic soils to the expansive soils of this section. Both soil types have similar needs for removal.

Rationale

Adds highly organic soil removal to expansive soil removal already in the code. Also defines when enough organic soil has been removed as it may be impossible to remove 100% of organics from soil.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

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

None

Impact to industry relative to the cost of compliance with code

None

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

None

Requirements

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

Improves safety by ensuring proper removal of organic soils.

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

Improves the code by adding organic soil removal and also defining how much organic soil needs to be removed.

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

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

2nd Comment Period

S7404-G1

Proponent Hill Kevin **Submitted** 5/14/2019 **Attachments** No

Comment:

This is important for use with other suggested mods regarding organic soils to add removal of organic soils. This includes a suggested definition for "complete removal" of organics.

1808.6.3 Removal of expansive <u>or highly organic </u>soil.

Where expansive soil is removed in lieu of designing foundations in accordance with Section 1808.6.1 or 1808.6.2, the soil shall be removed to a depth sufficient to ensure a constant moisture content in the remaining soil. Fill material shall not contain expansive <u>or highly organic </u>soils and shall comply with Section 1804.5 or 1804.6. <u>Removal of highly organic soil shall be considered complete when the total thickness of all organic layers remaining in the soil is no more than 12 inches thick and organic content of the remaining soil is less than 8 percent by weight. If highly organic soil is to be treated rather than removed, an approved geotechnical report shall be required that includes design of such treatment and recommendations for construction.</u>

Exception: Expansive soil need not be removed to the depth of constant moisture, provided the confining pressure in the expansive soil created by the fill and supported structure exceeds the swell pressure.

Date Submitted	11/21/2018	**Section**	1808.6.4	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

7401, 7402, 7403

Summary of Modification

Adds clarification that soil stabilization plans must be designed by a PE. Also adds acceptance of underpinning in lieu of removal as acceptable technique for expansive and organic soil mitigation which also must be designed by a PE.

Rationale

Adds clarification that soil stabilization plans must be designed by a PE. Also adds acceptance of underpinning in lieu of removal as acceptable technique for expansive and organic soil mitigation which also must be designed by a PE.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

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

None

Impact to industry relative to the cost of compliance with code

None

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

None

Requirements

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

Improves public safety/welfare by requiring stabilization plans to be designed by a PE.

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

Provides clarification to the code.

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

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

2nd Comment Period

S7405-G1

Proponent Hill Kevin **Submitted** 5/14/2019 **Attachments** No

Comment:

This is important to add clarification for requirements for foundation stabilization programs.

1808.6.4 Stabilization.

All soil stabilization plans for foundations should be designed by a registered professional engineer based on site specific soil data collected. Where the active zone of expansive soils is stabilized in lieu of designing foundations in accordance with Section 1808.6.1 or 1808.6.2, the soil shall be stabilized by chemical, dewatering, presaturation or equivalent techniques. The use of properly designed bypass underpinning in lieu of complete removal is an acceptable technique for both expansive and highly organic soils and should also be designed by a registered professional engineer. Additional considerations for floor slab support may also be required based on the engineer's stabilization design.

S7406

Date Submitted	11/21/2018	**Section**	1809.2	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

Summary of Modification

Clarifies the types of soils that foundations may be built upon. Primarily removes "undisturbed" soil as being allowed. Undisturbed soil in Florida is typically too loose to properly support a foundation.

Rationale

Undisturbed soil is Florida is typically very loose to loose sand and is definitely not competent enough for supporting structures. The current code is a carry-over from the IBC and does not properly apply to Florida soils and should be changed. All in-situ soils below foundations should require compacting.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This is a change from current code that allows constructing on undisturbed soil. Enforcement of this code will require some attention to new building plans for permits as default text used on plans may now incorrectly reference undisturbed soil.

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

There should be no impact other than updating text on future plans.

Impact to industry relative to the cost of compliance with code

There should be no impact other than updating text on future plans.

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

None

Requirements

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

Helps protect public safety/welfare by requiring that all buildings be constructed on compacted soil.

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

Improves the code by eliminating allowance of building on undisturbed (uncompacted) soil which can cause settlement if left uncompacted.

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

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

2nd Comment Period

S7406-G1

Proponent Hill Kevin **Submitted** 5/14/2019 **Attachments** No

Comment:

This mod is extremely important for Florida soils. Florida in-situ soils are most often very loose to loose and NOT competent for foundation support without compaction. The current code is a copy of the IBC language that allows construction on "undisturbed" soil without compaction. This should no longer be allowed. A geotechnical engineer in Florida would never suggest that a foundation be constructed on uncompacted soil.

1809.2 Supporting soils.

Shallow foundations shall be built on ~~undisturbed~~ compacted in-situ soil, compacted fill material or controlled low-strength material (CLSM). Compacted fill material shall be placed in accordance with Section 1804.5. CLSM shall be placed in accordance with Section 1804.6. Undisturbed soil shall not be considered suitable for supporting shallow foundations or slabs-on-grade without compaction unless an approved geotechnical report to recommend otherwise has been completed.

S7407

Date Submitted	11/21/2018	**Section**	1809.4	**Proponent**	Hill Kevin
Chapter	18	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

1809.2

Summary of Modification

Require footing depth 12" below final grade rather than 12" below undisturbed ground surface. Coincides with Mod 7406 to remove "undisturbed soil" from the Code as it doesn't apply to Florida soils.

Rationale

Similar to Mod 7406 where "undisturbed" soil (intending to mean "competent soil") does not properly apply to Florida's very loose to loose sandy soil conditions. Most geotechnical reports reference foundation embedment relative to final grade; thus the change is needed.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

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

None. This may actually allow shallower footing depths in certain cases, which could slightly reduce costs.

Impact to industry relative to the cost of compliance with code

None. This may actually allow shallower footing depths in certain cases, which could slightly reduce costs.

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

None

Requirements

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

Improves safety (slightly) by clarifying the code language.

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

Clarifies the code language.

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

Does not discriminate

Does not degrade the effectiveness of the code

Does not significantly change the code, but clarifies the language specific to Florida soils.

2nd Comment Period

S7407-G1

Proponent Hill Kevin **Submitted** 5/14/2019 **Attachments** No

Comment:

Similar to mod 7406, undisturbed soil should not be used as a reference for Florida structures. For proper allowable bearing pressure, foundations should be at least 12 inches below final grade. Reference to depth below undisturbed soil is irrelevant. The current code may require a foundation to be excessively deep and this proposed mod may allow some foundations to be constructed shallower, thus saving cost. Foundations that are too deep sometimes risk excavation beyond the compacted soil layer from the vibratory roller.

1809.4 Depth and width of footings.

The minimum depth of footings below the ~~undisturbed ground surface~~ final grade shall be 12 inches (305 mm). Where applicable, the requirements of Section 1809.5 shall also be satisfied. The minimum width of footings shall be 12 inches (305 mm).

S8141

Date Submitted	12/14/2018	**Section**	1810.3.3.1.4	**Proponent**	Dale Biggers
Chapter	18	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	No Affirmative Recommendation				
Commission Action	Pending Review				

Comments

General Comments Yes **Alternate Language** No

Related Modifications

Summary of Modification

The only change is a modification of wording for clarification. There is no change to the substance of the paragraph. This modification has been incorporated into IBC 2018.

Rationale

This clarifies the terminology by using the more common term " shaft ". The phrase " a maximum of " is redundant.

This modification has been incorporated into IBC 2018.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

There is no impact.

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

There is no impact.

Impact to industry relative to the cost of compliance with code

There is no impact.

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

There is no inpact.

Requirements

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

Yes, it clarifies the code.

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

Yes, this clarifies the code.

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

This does not discriminate.

Does not degrade the effectiveness of the code

This does not degrade the code.

2nd Comment Period

S8141-G1

Proponent Gregory Young **Submitted** 5/15/2019 **Attachments** No

Comment:

I support the proposed modification.

2nd Comment Period

S8141-G2

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

1810.3.3.1.4 Allowable ~~frictional~~ shaft resistance.

The assumed ~~frictional~~ shaft resistance developed by any uncased cast-in-place deep foundation element shall not exceed one-sixth of the bearing value of the soil material at minimum depth as set forth in Table 1806.2, up to ~~a maximum of~~ 500 psf (24 kPa), unless a greater value is allowed by the *building official* on the basis of a geotechnical investigation as specified in Section 1803 or a greater value is substantiated by a load test in accordance with Section 1810.3.3.1.2. ~~Frictional~~ Shaft resistance and end-bearing resistance shall not be assumed to act simultaneously unless determined by a geotechnical investigation in accordance with Section 1803.

S7277

Date Submitted	12/13/2018	**Section**	2201	**Proponent**	Bonnie Manley
Chapter	22	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

8072

Summary of Modification

This clarifies the relationship between the main body of Chapter 22 and the HVHZ provisions of Chapter 22.

Rationale

The HVHZ provisions of Chapter 22 shouldn't have to duplicate requirements that are provided in the base chapter in sections such as 2210, 2211, and 2212. Instead, the focus of the HVHZ sections should be on provisions that are critical for these areas of Florida.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

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

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

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

No change in cost is anticipated.

Requirements

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

Yes, it does.

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

Yes, it does.

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

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

2nd Comment Period

S7277-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

2201.1 Scope.

The provisions of this chapter govern the quality, design, fabrication and erection of steel used structurally in buildings or structures.

~~Exception:~~ Buildings and structures located within the high-velocity hurricane zone shall comply with the additional provisions of Sections ~~2204 through 2209 and~~ 2214 through 2224.

S7455

Date Submitted	11/26/2018	**Section**	2211	**Proponent**	Bonnie Manley
Chapter	22	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

7452, 7454, S299-16 (Structural, Structural, Chart #1), 7458

Summary of Modification

This proposal is one in a series adopting the latest generation of AISI standards for cold-formed steel.

Rationale

Please see attached file for details.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

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

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

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

No change in cost is anticipated.

Requirements

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

Yes, it does.

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

Yes, it does.

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

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

Alternate Language

2nd Comment Period

7455-A3

Proponent Bonnie Manley **Submitted** 5/16/2019 **Attachments** Yes

Rationale

This comment merges the original proposed changes (S7455) with the minor modification that was included in (S7455-A2). It represents the complete set of changes recommended for Section 2211.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

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

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

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

No change in cost is anticipated.

Requirements

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

Yes, it does.

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

Yes, it does.

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

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

Alternate Language

1st Comment Period History

7455-A2

Proponent Bonnie Manley **Submitted** 1/7/2019 **Attachments** Yes

Rationale

A correction is needed in Section 2211.1. AISI S220 is for nonstructural cold-formed steel framing and is adopted in Section 2211.2. It's reference here is a mistake.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

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

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

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

No change in cost is anticipated.

Requirements

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

Yes, it does.

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

Yes, it does.

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

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

2nd Comment Period

S7455-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with the alternate language of this modification.

2211.1 ~~General.~~Structural framing.

~~The~~For cold-formed steel light-frame construction, the design and installation of the following structural framing systems, including their members and ~~nonstructural members utilized in cold-formed steel light-frame construction where the specified minimum base steel thickness is not greater than 0.1180 inches (2.997 mm)~~connections, shall be in accordance with AISI S240 ~~S200~~ and Sections 2211.1.1~~2211.2~~ through 2211.1.3~~2211.7, or AISI S220~~, as applicable:~~.~~

1. Floor and roof systems,

2. Structural walls,

3. Shear walls, strap braced walls and diaphragms to resist in-plane lateral loads, and

4. Trusses.

2211.1.1 Seismic requirements for cold-formed steel structural systems. The design of cold-formed steel light frame construction to resist seismic forces shall be in accordance with the provisions of Section 2211.1.1.1 or 2211.1.1.2, as applicable.

2211.1.1.1 Seismic Design Categories B and C. Where a response modification coefficient, R, in accordance with ASCE 7, Table 12.2-1 is used for the design of cold-formed steel light frame construction assigned to Seismic Design Category B or C, the seismic force-resisting system shall be designed and detailed in accordance with the requirements of AISI S400.

Exception: The response modification coefficient, R, designated for "Steel systems not specifically detailed for seismic resistance, excluding cantilever column systems" in ASCE 7 Table 12.2-1 shall be permitted for systems designed and detailed in accordance with AISI S240 and need not be designed and detailed in accordance with AISI S400.

2211.1.1.2 Seismic Design Categories D through F. In cold-formed steel light frame construction assigned to Seismic Design Category D, E, or F, the seismic force-resisting system shall be designed and detailed in accordance with AISI S400.

2211.1.2~~2211.7~~Prescriptive framing. Detached one- and two-family *dwellings*and*townhouses*, less than or equal to three*stories above grade plane*, shall be permitted to be constructed in accordance withAISI S230subject to the limitations therein.

~~**2211.2 Header design.**~~

~~Headers, including box and back-to-back headers, and double and single L-headers shall be designed in accordance with AISI S212 or AISI S100.~~

2211.1.3~~2211.3~~ Truss design.

Cold-formed steel trusses shall comply with the additional provisions of Sections 2211.1.3.1 through 2211.1.3.3.~~be designed in accordance with AISI S214, Sections 2211.3.1 through 2211.3.4 and accepted engineering practice.~~

2211.1.3.1~~2211.3.1~~ Truss design drawings. The truss design drawings shall conform to the requirements of Section I1 of AISI S202 ~~B2.3 of AISI S214~~ and shall be provided with the shipment of trusses delivered to the job site. The truss design drawings shall include the details of permanent individual truss member restraint/bracing in accordance with Section I1.6 of AISI S202~~B6(a) or B 6(c) of AISI S214~~where these methods are utilized to provide restraint/bracing.

~~**2211.3.2 Deferred submittals.** AISI S214 Section B4.2 shall be deleted.~~

2211.1.3.2~~2211.3.3~~ Trusses spanning 60 feet or greater. The owner or the owner's authorized agent shall contract with a *registered design professional* for the design of the temporary installation restraint/bracing and the permanent individual truss member restraint/bracing for trusses with clear spans 60 feet (18 288 mm) or greater.

2211.1.3.3~~2211.3.4~~ Truss quality assurance. Reserved.

2211.2 Nonstructural Members. For cold-formed steel light frame construction, the design and installation of nonstructural members and connections shall be in accordance with AISI S220.

~~**2211.4 Sructural wall stud design.** Structural wall studs shall be designed in accordance with either AISI S211 or AISI S100.~~

~~**2211.5 Floor and roof system design.** Framing for floor and roof systems in buildings shall be designed in accordance with either AISI S210 or AISI S100.~~

~~**2211.6 Lateral design.** Light-frame shear walls, diagonal strap bracing that is part of a structural wall and diaphragms used to resist wind, seismic and other in-plane lateral loads shall be designed in accordance with AISI S213.~~

Further modify Section 2211.1:

2211.1 Structural framing.

For cold-formed steel light-frame construction, the design and installation of the following structural framing systems, including their members and connections, shall be in accordance with AISI S240 and Sections 2211.1.1 through 2211.1.3, ~~or AISI S220,~~ as applicable:

1. Floor and roof systems,

2. Structural walls,

3. Shear walls, strap braced walls and diaphragms to resist in-plane lateral loads, and

4. Trusses.

2211.1 ~~General.~~Structural framing.

~~The~~For cold-formed steel light-frame construction, the design and installation of the following structural framing systems, including their members and ~~nonstructural members utilized in cold-formed steel light-frame construction where the specified minimum base steel thickness is not greater than 0.1180 inches (2.997 mm)~~connections, shall be in accordance with AISI S240 ~~S200~~ and Sections 2211.1.1~~2211.2~~ through 2211.1.3~~2211.7~~, or AISI S220, as applicable:~~.~~

1. Floor and roof systems,

2. Structural walls,

3. Shear walls, strap braced walls and diaphragms to resist in-plane lateral loads, and

4. Trusses.

2211.1.1 Seismic requirements for cold-formed steel structural systems. The design of cold-formed steel light frame construction to resist seismic forces shall be in accordance with the provisions of Section 2211.1.1.1 or 2211.1.1.2, as applicable.

2211.1.1.1 Seismic Design Categories B and C. Where a response modification coefficient, R, in accordance with ASCE 7, Table 12.2-1 is used for the design of cold-formed steel light frame construction assigned to Seismic Design Category B or C, the seismic force-resisting system shall be designed and detailed in accordance with the requirements of AISI S400.

Exception: The response modification coefficient, R, designated for "Steel systems not specifically detailed for seismic resistance, excluding cantilever column systems" in ASCE 7 Table 12.2-1 shall be permitted for systems designed and detailed in accordance with AISI S240 and need not be designed and detailed in accordance with AISI S400.

2211.1.1.2 Seismic Design Categories D through F. In cold-formed steel light frame construction assigned to Seismic Design Category D, E, or F, the seismic force-resisting system shall be designed and detailed in accordance with AISI S400.

2211.1.2~~2211.7~~Prescriptive framing. Detached one- and two-family *dwellings*and*townhouses*, less than or equal to three*stories above grade plane*, shall be permitted to be constructed in accordance withAISI S230subject to the limitations therein.

~~2211.2 Header design.~~

~~Headers, including box and back-to-back headers, and double and single L-headers shall be designed in accordance with AISI S212 or AISI S100.~~

2211.1.3~~2211.3~~ Truss design.

Cold-formed steel trusses shall comply with the additional provisions of Sections 2211.1.3.1 through 2211.1.3.3.~~be designed in accordance with AISI S214, Sections 2211.3.1 through 2211.3.4 and accepted engineering practice.~~

2211.1.3.1~~2211.3.1~~ Truss design drawings. The truss design drawings shall conform to the requirements of Section I1 of AISI S202 ~~B2.3 of AISI S214~~ and shall be provided with the shipment of trusses delivered to the job site. The truss design drawings shall include the details of permanent individual truss member restraint/bracing in accordance with Section I1.6 of AISI S202~~B6(a) or B 6(c) of AISI S214~~where these methods are utilized to provide restraint/bracing.

~~2211.3.2 Deferred submittals. AISI S214 Section B4.2 shall be deleted.~~

2211.1.3.2~~2211.3.3~~ Trusses spanning 60 feet or greater. The owner or the owner's authorized agent shall contract with a *registered design professional* for the design of the temporary installation restraint/bracing and the permanent individual truss member restraint/bracing for trusses with clear spans 60 feet (18 288 mm) or greater.

2211.1.3.3~~2211.3.4~~ Truss quality assurance. Reserved.

2211.2 Nonstructural Members. For cold-formed steel light frame construction, the design and installation of nonstructural members and connections shall be in accordance with AISI S220.

~~2211.4 Sructural wall stud design. Structural wall studs shall be designed in accordance with either AISI S211 or AISI S100.~~

~~2211.5 Floor and roof system design. Framing for floor and roof systems in buildings shall be designed in accordance with either AISI S210 or AISI S100.~~

~~**2211.6 Lateral design. Light-frame shear walls, diagonal strap bracing that is part of a structural wall and diaphragms used to resist wind, seismic and other in-plane lateral loads shall be designed in accordance with AISI S213.**~~

This proposal is one in a series adopting the latest generation of AISI standards for cold-formed steel. This particular proposal focuses on Chapter 22 by incorporating references to three new cold-formed steel standards -- AISI S240, AISI S400, and AISI S202. All three standards are published and available for a free download at: www.aisistandards.org.

AISI S240, *North American Standard for Cold-Formed Steel Structural Framing*, addresses requirements for construction with cold-formed steel structural framing that are common to prescriptive and engineered light frame construction. This comprehensive standard was formed by merging the following AISI standards:

1. AISI S200, *North American Standard for Cold-Formed Steel Framing-General Provisions*
2. AISI S210, *North American Standard for Cold-Formed Steel Framing–Floor and Roof System Design*
3. AISI S211, *North American Standard for Cold-Formed Steel Framing–Wall Stud Design*
4. AISI S212, *North American Standard for Cold-Formed Steel Framing–Header Design*
5. AISI S213, *North American Standard for Cold-Formed Steel Framing– Lateral Design*
6. AISI S214, *North American Standard for Cold-Formed Steel Framing–Truss Design*

Consequently, AISI S240 supersedes all previous editions of the above mentioned individual AISI standards.

AISI S400, *North American Standard for Seismic Design of Cold-Formed Steel Structural Systems*, addresses the design and construction of cold-formed steel structural members and connections used in the seismic force-resisting systems in buildings and other structures. This first edition primarily represents a merging of the requirements from AISI S110, *Standard for Seismic Design of Cold- Formed Steel Structural Systems – Special Bolted Moment Frame*, 2007 with Supplement No. 1-09, and the 2016 seismic portions of AISI S213, 2007 with Supplement No. 1-09. The layout and many of the seismic design requirements are drawn from ANSI/AISC 341-10, *Seismic Provisions for Structural Steel Buildings*, which is developed by the American Institute of Steel Construction (AISC). AISI S400 supersedes AISI S110 and the seismic design provisions of AISI S213 and is intended to be applied in conjunction with both AISI S100 and AISI S240, as applicable.

AISI S202, *Code of Standard Practice for Cold-formed Steel Structural Framing,* is intended to service as a state-of-the-art mandatory document for establishing contractual relationships between various parties in a construction project where coldformed steel structural materials, components and assemblies are used. While it is not specifically intended to be a direct reference in the building code, portions of AISI S202 are recommended for adoption in this proposal to establish the minimum requirements for cold-formed steel truss design drawings.

Modifications specific to Chapter 22 include the following:

- Section 2211: Requirements for cold-formed steel light-frame construction are now split into two major subsections – structural provisions are located in Section 2211.1 and nonstructural provisions are located in Section 2211.2.
- Section 2211.1: Reference to AISI S240 is made for the general design of cold-formed steel structural framing systems.
- Section 2211.1.1: Reference to AISI S400 is made for the design of cold-formed steel seismic force-resisting systems. Since the relationship between AISI S240 and AISI S400 is similar to that between AISC 360 and AISC 341, the charging language in IBC Section 2211.1.1 has been modified to parallel the language in Section 2205.2 for structural steel. It adopts AISI S400 and exempts seismic force-resisting systems only where the seismic design category is B or C and the seismic response modification coefficient, R, equals 3. This is done to recognize that ASCE 7, Table 12.2-1, Line H exempts steel systems from seismic detailing requirements as long as they are designed in accordance with AISI S240.
- Section 2211.1.2: No substantive changes are proposed for prescriptive framing.
- Section 2211.1.3: Requirements for cold-formed steel trusses are updated and streamlined to reflect changes in AISI S240. Additionally, in the process of merging the old AISI S214 into the new AISI S240, requirements for truss design drawings were relocated to AISI S202. Consequently, a direct pointer was added to Section 2211.1.3.1.

S8072

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

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes

Alternate Language No

Related Modifications

7277

Summary of Modification

Clarifies application of requirements in Chapter 22.

Rationale

The purpose of this proposal is to clarify the relationship between the HVHZ requirements and the base chapter requirements. It also makes editorial modifications to the sentence on CFS so that it more closely parallels the sentence on structural steel.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

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

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

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

No change in cost is anticipated.

Requirements

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

Yes, it does.

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

Yes, it does.

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

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

2nd Comment Period

S8072-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

2214.2

The design, fabrication and erection of iron and steel for buildings and other structures shall be as set forth in this chapter. The additional requirements set forth in Sections 2215 through 2221 herein, inclusive, apply to structural steel for buildings and other structures located in high-velocity hurricane zones. The additional requirements set forth in Sections 2222 and 2223, herein, inclusive, apply to cold-formed members of sheet or strip steel and cold-formed steel light frame construction located in high-velocity hurricane zones.

S7460

Date Submitted	11/27/2018	**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 **Yes** **Alternate Language** **No**

Related Modifications

Same as change between 2015 IBC-B and 2018 IBC-B

Summary of Modification

This proposal makes it clear that a concrete slab on grade can be used in conjunction with conventional light-frame construction and that the 40 psf live load limit for floors would not apply. The modification places a practical limit of 125 psf for the slab on grade live load.

Rationale

FBC section 2308.2.3 will now show the exception to the requirement in Risk Category I and II

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities

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

No impact to building and property owners

Impact to industry relative to the cost of compliance with code

No impact to industry

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

No impact

Requirements

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

Yes

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

strengthens and clarifies

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

Does not discriminate against materials, product, methods, or systems of construction

Does not degrade the effectiveness of the code

Clarifies and increases the effectiveness of the code

2nd Comment Period

S7460-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

2308.2.3 Allowable Loads

Exception: live loads for concrete slab-on ground floors in Risk Category I and II occupancies are not limited.

Date Submitted	12/14/2018	**Section**	2308.4.1.1	**Proponent**	Paul Coats
Chapter	23	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

Summary of Modification

Replacement table for T2308.4.1.1(1) Header and Girder Spans for Exterior Bearing Walls

Rationale

This modification was approved by the ICC committee and membership and appears in the 2018 edition of the International Residential Code. The update of Table 2308.4.1.1(1) Header and Girder Spans for Exterior Bearing Walls is proposed. Updated spans address use of Southern Pine No. 2 in lieu of Southern Pine No. 1. Footnote "f" is added to clarify that header spans are based on laterally braced assumption such as when the header is raised. For dropped headers consisting of 2x8, 2x10, or 2x12 sizes that are not laterally braced, a factor of 0.7 can be applied to determine the spans or alternatively the header or girder can be designed to include any adjustment for potential buckling. Laterally braced (raised) and not laterally braced (dropped) header conditions and building widths for which header spans are tabulated represent the same conditions used to develop header span tables in the Wood Frame Construction Manual (WFCM).

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Code officials will need to become familiar with the use of the new table and footnotes.

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

Increased cost may be associated with reduced spans that result from the unbraced header condition and application of footnote f. Due to certain new options in the table, in some circumstances it may reduce the cost of construction.

Impact to industry relative to the cost of compliance with code

Increased cost may be associated with reduced spans that result from the unbraced header condition and application of footnote f. Due to certain new options in the table, in some circumstances it may reduce the cost of construction.

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

Increased cost may be associated with reduced spans that result from the unbraced header condition and application of footnote f. Due to certain new options in the table, in some circumstances it may reduce the cost of construction.

Requirements

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

Maintains correct header sizing for safety and serviceability.

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

Strengthens the code.

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

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

2nd Comment Period

8258-A1

Proponent Paul Coats **Submitted** 5/25/2019 **Attachments** Yes

Rationale

The provisions of Section 2308 are not applicable in Florida because of the wind limitation in 2308.2.4, which is set at 115 mph. The TAC expressed a desire to remove the provisions entirely.

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

Increased cost may be associated with reduced spans that result from the unbraced header condition and application of footnote f. Due to certain new options in the table, in some circumstances it may reduce the cost of construction.

Requirements

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

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

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

2nd Comment Period

S8258-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

Delete Section 2308 and all subsections without substitution:

SECTION 2308
CONVENTIONAL LIGHT-FRAME CONSTRUCTION

<u>RESERVED</u>

Completely delete the current Table 2308.4.1.1(1) and replace with a new table:

~~TABLE 2308.4.1.1(1)~~

~~HEADER AND GIRDER SPANSa, b FOR EXTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine and Spruce-Pine-Firb and required number of jack studs)~~

TABLE 2308.4.1.1(1)

HEADER AND GIRDER SPANS[a,b] FOR EXTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir and required number of jack studs)

See uploaded support file for contents of new Table 2308.4.1.1(1)

Revise as follows:

~~2308.4.1.1~~ (1)

~~HEADER AND GIRDER SPANS[a, b] FOR EXTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine and Spruce-Pine-Fir[b] and required number of jack studs)~~

~~GIRDERS AND HEADERS SUPPORTING~~	~~SIZE~~	~~GROUND SNOW LOAD (psf)[e]~~											
		~~30~~						~~50~~					
		~~Building width[c] (feet)~~											
		~~20~~		~~28~~		~~36~~		~~20~~		~~28~~		~~36~~	
		~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~
~~Roof and ceiling~~	~~2-2 × 4~~	~~3-6~~	~~1~~	~~3-2~~	~~1~~	~~2-10~~	~~1~~	~~3-2~~	~~1~~	~~2-9~~	~~1~~	~~2-6~~	~~1~~
	~~2-2 × 6~~	~~5-5~~	~~1~~	~~4-8~~	~~1~~	~~4-2~~	~~1~~	~~4-8~~	~~1~~	~~4-1~~	~~1~~	~~3-8~~	~~2~~
	~~2-2 × 8~~	~~6-10~~	~~1~~	~~5-11~~	~~2~~	~~5-4~~	~~2~~	~~5-11~~	~~2~~	~~5-2~~	~~2~~	~~4-7~~	~~2~~
	~~2-2 × 10~~	~~8-5~~	~~2~~	~~7-3~~	~~2~~	~~6-6~~	~~2~~	~~7-3~~	~~2~~	~~6-3~~	~~2~~	~~5-7~~	~~2~~
	~~2-2 × 12~~	~~9-9~~	~~2~~	~~8-5~~	~~2~~	~~7-6~~	~~2~~	~~8-5~~	~~2~~	~~7-3~~	~~2~~	~~6-6~~	~~2~~
	~~3-2 × 8~~	~~8-4~~	~~1~~	~~7-5~~	~~1~~	~~6-8~~	~~1~~	~~7-5~~	~~1~~	~~6-5~~	~~2~~	~~5-9~~	~~2~~
	~~3-2 × 10~~	~~10-6~~	~~1~~	~~9-1~~	~~2~~	~~8-2~~	~~2~~	~~9-1~~	~~2~~	~~7-10~~	~~2~~	~~7-0~~	~~2~~
	~~3-2 × 12~~	~~12-2~~	~~2~~	~~10-7~~	~~2~~	~~9-5~~	~~2~~	~~10-7~~	~~2~~	~~9-2~~	~~2~~	~~8-2~~	~~2~~
	~~4-2 × 8~~	~~9-2~~	~~1~~	~~8-4~~	~~1~~	~~7-8~~	~~1~~	~~8-4~~	~~1~~	~~7-5~~	~~1~~	~~6-8~~	~~1~~
	~~4-2 × 10~~	~~11-8~~	~~1~~	~~10-6~~	~~1~~	~~9-5~~	~~2~~	~~10-6~~	~~1~~	~~9-1~~	~~2~~	~~8-2~~	~~2~~
	~~4-2 × 12~~	~~14-1~~	~~1~~	~~12-2~~	~~2~~	~~10-11~~	~~2~~	~~12-2~~	~~2~~	~~10-7~~	~~2~~	~~9-5~~	~~2~~
~~Roof, ceiling and one center bearing floor~~	~~2-2 × 4~~	~~3-1~~	~~1~~	~~2-9~~	~~1~~	~~2-5~~	~~1~~	~~2-9~~	~~1~~	~~2-5~~	~~1~~	~~2-2~~	~~1~~
	~~2-2 × 6~~	~~4-6~~	~~1~~	~~4-0~~	~~1~~	~~3-7~~	~~2~~	~~4-1~~	~~1~~	~~3-7~~	~~2~~	~~3-3~~	~~2~~
	~~2-2 × 8~~	~~5-9~~	~~2~~	~~5-0~~	~~2~~	~~4-6~~	~~2~~	~~5-2~~	~~2~~	~~4-6~~	~~2~~	~~4-1~~	~~2~~
	~~2-2 × 10~~	~~7-0~~	~~2~~	~~6-2~~	~~2~~	~~5-6~~	~~2~~	~~6-4~~	~~2~~	~~5-6~~	~~2~~	~~5-0~~	~~2~~
	~~2-2 × 12~~	~~8-1~~	~~2~~	~~7-1~~	~~2~~	~~6-5~~	~~2~~	~~7-4~~	~~2~~	~~6-5~~	~~2~~	~~5-9~~	~~3~~
	~~3-2 × 8~~	~~7-2~~	~~1~~	~~6-3~~	~~2~~	~~5-8~~	~~2~~	~~6-5~~	~~2~~	~~5-8~~	~~2~~	~~5-1~~	~~2~~

	~~3 2 × 10~~	~~8 9~~	~~2~~	~~7 8~~	~~2~~	~~6 11~~	~~2~~	~~7 11~~	~~2~~	~~6 11~~	~~2~~	~~6 3~~	~~2~~
	~~3 2 × 12~~	~~10 2~~	~~2~~	~~8 11~~	~~2~~	~~8 0~~	~~2~~	~~9 2~~	~~2~~	~~8 0~~	~~2~~	~~7 3~~	~~2~~
	~~4 2 × 8~~	~~8 1~~	~~1~~	~~7 3~~	~~1~~	~~6 7~~	~~1~~	~~7 5~~	~~1~~	~~6 6~~	~~1~~	~~5 11~~	~~2~~
	~~4 2 × 10~~	~~10 1~~	~~1~~	~~8 10~~	~~2~~	~~8 0~~	~~2~~	~~9 1~~	~~2~~	~~8 0~~	~~2~~	~~7 2~~	~~2~~
	~~4 2 × 12~~	~~11 9~~	~~2~~	~~10 3~~	~~2~~	~~9 3~~	~~2~~	~~10 7~~	~~2~~	~~9 3~~	~~2~~	~~8 4~~	~~2~~
~~Roof , ceiling and one clear span floor~~	~~2 2 × 4~~	~~2 8~~	~~1~~	~~2 4~~	~~1~~	~~2 1~~	~~1~~	~~2 7~~	~~1~~	~~2 3~~	~~1~~	~~2 0~~	~~1~~
	~~2 2 × 6~~	~~3 11~~	~~1~~	~~3 5~~	~~2~~	~~3 0~~	~~2~~	~~3 10~~	~~2~~	~~3 4~~	~~2~~	~~3 0~~	~~2~~
	~~2 2 × 8~~	~~5 0~~	~~2~~	~~4 4~~	~~2~~	~~3 10~~	~~2~~	~~4 10~~	~~2~~	~~4 2~~	~~2~~	~~3 9~~	~~2~~
	~~2 2 × 10~~	~~6 1~~	~~2~~	~~5 3~~	~~2~~	~~4 8~~	~~2~~	~~5 11~~	~~2~~	~~5 1~~	~~2~~	~~4 7~~	~~3~~
	~~2 2 × 12~~	~~7 1~~	~~2~~	~~6 1~~	~~3~~	~~5 5~~	~~3~~	~~6 10~~	~~2~~	~~5 11~~	~~3~~	~~5 4~~	~~3~~
	~~3 2 × 8~~	~~6 3~~	~~2~~	~~5 5~~	~~2~~	~~4 10~~	~~2~~	~~6 1~~	~~2~~	~~5 3~~	~~2~~	~~4 8~~	~~2~~
	~~3 2 × 10~~	~~7 7~~	~~2~~	~~6 7~~	~~2~~	~~5 11~~	~~2~~	~~7 5~~	~~2~~	~~6 5~~	~~2~~	~~5 9~~	~~2~~
	~~3 2 × 12~~	~~8 10~~	~~2~~	~~7 8~~	~~2~~	~~6 10~~	~~2~~	~~8 7~~	~~2~~	~~7 5~~	~~2~~	~~6 8~~	~~2~~
	~~4 2 × 8~~	~~7 2~~	~~1~~	~~6 3~~	~~2~~	~~5 7~~	~~2~~	~~7 0~~	~~1~~	~~6 1~~	~~2~~	~~5 5~~	~~2~~
	~~4 2 × 10~~	~~8 9~~	~~2~~	~~7 7~~	~~2~~	~~6 10~~	~~2~~	~~8 7~~	~~2~~	~~7 5~~	~~2~~	~~6 7~~	~~2~~
	~~4 2 × 12~~	~~10 2~~	~~2~~	~~8 10~~	~~2~~	~~7 11~~	~~2~~	~~9 11~~	~~2~~	~~8 7~~	~~2~~	~~7 8~~	~~2~~
~~Roof , ceiling and two center bearing floors~~	~~2 2 × 4~~	~~2 7~~	~~1~~	~~2 3~~	~~1~~	~~2 0~~	~~1~~	~~2 6~~	~~1~~	~~2 2~~	~~1~~	~~1 11~~	~~1~~
	~~2 2 × 6~~	~~3 9~~	~~2~~	~~3 3~~	~~2~~	~~2 11~~	~~2~~	~~3 8~~	~~2~~	~~3 2~~	~~2~~	~~2 10~~	~~2~~
	~~2 2 × 8~~	~~4 9~~	~~2~~	~~4 2~~	~~2~~	~~3 9~~	~~2~~	~~4 7~~	~~2~~	~~4 0~~	~~2~~	~~3 8~~	~~2~~
	~~2 2 × 10~~	~~5 9~~	~~2~~	~~5 1~~	~~2~~	~~4 7~~	~~3~~	~~5 8~~	~~2~~	~~4 11~~	~~2~~	~~4 5~~	~~3~~
	~~2 2 × 12~~	~~6 8~~	~~2~~	~~5 10~~	~~3~~	~~5 3~~	~~3~~	~~6 6~~	~~2~~	~~5 9~~	~~3~~	~~5 2~~	~~3~~
	~~3 2 × 8~~	~~5 11~~	~~2~~	~~5 2~~	~~2~~	~~4 8~~	~~2~~	~~5 9~~	~~2~~	~~5 1~~	~~2~~	~~4 7~~	~~2~~
	~~3 2 × 10~~	~~7 3~~	~~2~~	~~6 4~~	~~2~~	~~5 8~~	~~2~~	~~7 1~~	~~2~~	~~6 2~~	~~2~~	~~5 7~~	~~2~~
	~~3 2 × 12~~	~~8 5~~	~~2~~	~~7 4~~	~~2~~	~~6 7~~	~~2~~	~~8 2~~	~~2~~	~~7 2~~	~~2~~	~~6 5~~	~~3~~
	~~4 2 × 8~~	~~6 10~~	~~1~~	~~6 0~~	~~2~~	~~5 5~~	~~2~~	~~6 8~~	~~1~~	~~5 10~~	~~2~~	~~5 3~~	~~2~~
	~~4 2 × 10~~	~~8 4~~	~~2~~	~~7 4~~	~~2~~	~~6 7~~	~~2~~	~~8 2~~	~~2~~	~~7 2~~	~~2~~	~~6 5~~	~~2~~
	~~4 2 × 12~~	~~9 8~~	~~2~~	~~8 6~~	~~2~~	~~7 8~~	~~2~~	~~9 5~~	~~2~~	~~8 3~~	~~2~~	~~7 5~~	~~2~~
~~Roof , ceiling, and two clear span floors~~	~~2 2 × 4~~	~~2 1~~	~~1~~	~~1 8~~	~~1~~	~~1 6~~	~~2~~	~~2 0~~	~~1~~	~~1 8~~	~~1~~	~~1 5~~	~~2~~
	~~2 2 × 6~~	~~3 1~~	~~2~~	~~2 8~~	~~2~~	~~2 4~~	~~2~~	~~3 0~~	~~2~~	~~2 7~~	~~2~~	~~2 3~~	~~2~~
	~~2 2 × 8~~	~~3 10~~	~~2~~	~~3 4~~	~~2~~	~~3 0~~	~~3~~	~~3 10~~	~~2~~	~~3 4~~	~~2~~	~~2 11~~	~~3~~

~~GIRDERS AND HEADERS SUPPORTING~~	~~SIZE~~	~~GROUND SNOW LOAD (psf)~~[e]											
		~~30~~						~~50~~					
		~~Building width~~[c] ~~(feet)~~											
		~~20~~		~~28~~		~~36~~		~~20~~		~~28~~		~~36~~	
		~~Span~~	~~NJ~~[d]	~~Span~~	~~NJ~~[d]	~~Span~~	~~NJ~~[d]	~~Span~~	~~NJ~~[d]	~~Span~~	~~NJ~~[d]	~~Span~~	~~NJ~~[d]
~~Roof, ceiling, and two clear span floors~~	~~2-2 × 10~~	~~4-9~~	~~2~~	~~4-1~~	~~3~~	~~3-8~~	~~3~~	~~4-8~~	~~2~~	~~4-0~~	~~3~~	~~3-7~~	~~3~~
	~~2-2 × 12~~	~~5-6~~	~~3~~	~~4-9~~	~~3~~	~~4-3~~	~~3~~	~~5-5~~	~~3~~	~~4-8~~	~~3~~	~~4-2~~	~~3~~
	~~3-2 × 8~~	~~4-10~~	~~2~~	~~4-2~~	~~2~~	~~3-9~~	~~2~~	~~4-9~~	~~2~~	~~4-1~~	~~2~~	~~3-8~~	~~2~~
	~~3-2 × 10~~	~~5-11~~	~~2~~	~~5-1~~	~~2~~	~~4-7~~	~~3~~	~~5-10~~	~~2~~	~~5-0~~	~~2~~	~~4-6~~	~~3~~
	~~3-2 × 12~~	~~6-10~~	~~2~~	~~5-11~~	~~3~~	~~5-4~~	~~3~~	~~6-9~~	~~2~~	~~5-10~~	~~3~~	~~5-3~~	~~3~~
	~~4-2 × 8~~	~~5-7~~	~~2~~	~~4-10~~	~~2~~	~~4-4~~	~~2~~	~~5-6~~	~~2~~	~~4-9~~	~~2~~	~~4-3~~	~~2~~
	~~4-2 × 10~~	~~6-10~~	~~2~~	~~5-11~~	~~2~~	~~5-3~~	~~2~~	~~6-9~~	~~2~~	~~5-10~~	~~2~~	~~5-2~~	~~2~~
	~~4-2 × 12~~	~~7-11~~	~~2~~	~~6-10~~	~~2~~	~~6-2~~	~~3~~	~~7-9~~	~~2~~	~~6-9~~	~~2~~	~~6-0~~	~~3~~

~~For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.~~

~~a. Spans are given in feet and inches.~~

~~b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir and Spruce-Pine-Fir. No. 1 or better grade lumber shall be used for Southern Pine.~~

~~c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.~~

~~d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.~~

~~e. Use 30 psf ground snow load for cases in which ground snow load is less than 30 psf and the roof live load is equal to or less than 20 psf.~~

TABLE 2308.4.1.1(1)

HEADER AND GIRDER SPANS[a,b] FOR EXTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir and required number of jack studs)

GIRDERS AND HEADERS SUPPORTING	SIZE	GROUND SNOW LOAD (psf)[e]																	
		30						50						70					
		Building width[c] (feet)																	
		12		24		36		12		24		36		12		24		36	
		Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]
Roof and ceiling	1-2x6	4 - 0	1	3 - 1	2	2 - 7	2	3 - 5	1	2 - 8	2	2 - 3	2	3 - 0	2	2 - 4	2	2 - 0	2
	1-2x8	5 - 1	2	3 - 11	2	3 - 3	2	4 - 4	2	3 - 4	2	2 - 10	2	3 - 10	2	3 - 0	2	2 - 6	3
	1-2x10	6 - 0	2	4 - 8	2	3 - 11	2	5 - 2	2	4 - 0	2	3 - 4	3	4 - 7	2	3 - 6	3	3 - 0	3
	1-	7 - 1	2	5 - 5	2	4 - 7	3	6 - 1	2	4 - 8	3	3 - 11	3	5 - 5	2	4 - 2	3	3 - 6	3

	2x12																		
	2-2x4	4 - 0	1	3 - 1	1	2 - 7	1	3 - 5	1	2 - 7	1	2 - 2	1	3 - 0	1	2 - 4	1	2 - 0	1
	2-2x6	6 - 0	1	4 - 7	1	3 - 10	1	5 - 1	1	3 - 11	1	3 - 3	2	4 - 6	1	3 - 6	2	2 - 11	2
	2-2x8	7 - 7	1	5 - 9	1	4 - 10	2	6 - 5	1	5 - 0	2	4 - 2	2	5 - 9	1	4 - 5	2	3 - 9	2
	2-2x10	9 - 0	1	6 - 10	2	5 - 9	2	7 - 8	2	5 - 11	2	4 - 11	2	6 - 9	2	5 - 3	2	4 - 5	2
	2-2x12	10 - 7	2	8 - 1	2	6 - 10	2	9 - 0	2	6 - 11	2	5 - 10	2	8 - 0	2	6 - 2	2	5 - 2	3
	3-2x8	9 - 5	1	7 - 3	1	6 - 1	1	8 - 1	1	6 - 3	1	5 - 3	2	7 - 2	1	5 - 6	2	4 - 8	2
	3-2x10	11 - 3	1	8 - 7	1	7 - 3	2	9 - 7	1	7 - 4	2	6 - 2	2	8 - 6	1	6 - 7	2	5 - 6	2
	3-2x12	13 - 2	1	10 - 1	2	8 - 6	2	11 - 3	2	8 - 8	2	7 - 4	2	10 - 0	2	7 - 9	2	6 - 6	2
	4-2x8	10 - 11	1	8 - 4	1	7 - 0	1	9 - 4	1	7 - 2	1	6 - 0	1	8 - 3	1	6 - 4	1	5 - 4	2
	4-2x10	12 - 11	1	9 - 11	1	8 - 4	1	11 - 1	1	8 - 6	1	7 - 2	2	9 - 10	1	7 - 7	2	6 - 4	2
	4-2x12	15 - 3	1	11 - 8	1	9 - 10	2	13 - 0	1	10 - 0	2	8 - 5	2	11 - 7	1	8 - 11	2	7 - 6	2
Roof, ceiling and one center-bearing floor	1-2x6	3 - 3	1	2 - 7	2	2 - 2	2	3 - 0	2	2 - 4	2	2 - 0	2	2 - 9	2	2 - 2	2	1 - 10	2
	1-2x8	4 - 1	2	3 - 3	2	2 - 9	2	3 - 9	2	3 - 0	2	2 - 6	3	3 - 6	2	2 - 9	2	2 - 4	3
	1-2x10	4 - 11	2	3 - 10	2	3 - 3	3	4 - 6	2	3 - 6	3	3 - 0	3	4 - 1	2	3 - 3	3	2 - 9	3
	1-2x12	5 - 9	2	4 - 6	3	3 - 10	3	5 - 3	2	4 - 2	3	3 - 6	3	4 - 10	3	3 - 10	3	3 - 3	4
	2-2x4	3 - 3	1	2 - 6	1	2 - 2	1	3 - 0	1	2 - 4	1	2 - 0	1	2 - 8	1	2 - 2	1	1 - 10	1
	2-2x6	4 - 10	1	3 - 9	1	3 - 3	2	4 - 5	1	3 - 6	2	3 - 0	2	4 - 1	1	3 - 3	2	2 - 9	2
	2-2x8	6 - 1	1	4 - 10	2	4 - 1	2	5 - 7	2	4 - 5	2	3 - 9	2	5 - 2	2	4 - 1	2	3 - 6	2
	2-2x10	7 - 3	2	5 - 8	2	4 - 10	2	6 - 8	2	5 - 3	2	4 - 5	2	6 - 1	2	4 - 10	2	4 - 1	2
	2-2x12	8 - 6	2	6 - 8	2	5 - 8	2	7 - 10	2	6 - 2	2	5 - 3	3	7 - 2	2	5 - 8	2	4 - 10	3
	3-2x8	7 - 8	1	6 - 0	1	5 - 1	2	7 - 0	1	5 - 6	2	4 - 8	2	6 - 5	1	5 - 1	2	4 - 4	2

	3-2x10	9 - 1	1	7 - 2	2	6 - 1	2	8 - 4	1	6 - 7	2	5 - 7	2	7 - 8	2	6 - 1	2	5 - 2	2
	3-2x12	10 - 8	2	8 - 5	2	7 - 2	2	9 - 10	2	7 - 8	2	6 - 7	2	9 - 0	2	7 - 1	2	6 - 1	2
	4-2x8	8 - 10	1	6 - 11	1	5 - 11	1	8 - 1	1	6 - 4	1	5 - 5	2	7 - 5	1	5 - 11	1	5 - 0	2
	4-2x10	10 - 6	1	8 - 3	2	7 - 0	2	9 - 8	1	7 - 7	2	6 - 5	2	8 - 10	1	7 - 0	2	6 - 0	2
	4-2x12	12 - 4	1	9 - 8	2	8 - 3	2	11 - 4	2	8 - 11	2	7 - 7	2	10 - 4	2	8 - 3	2	7 - 0	2
Roof, ceiling and one clear span floor	1-2x6	2 - 11	2	2 - 3	2	1 - 11	2	2 - 9	2	2 - 1	2	1 - 9	2	2 - 7	2	2 - 0	2	1 - 8	2
	1-2x8	3 - 9	2	2 - 10	2	2 - 5	3	3 - 6	2	2 - 8	2	2 - 3	3	3 - 3	2	2 - 6	3	2 - 2	3
	1-2x10	4 - 5	2	3 - 5	3	2 - 10	3	4 - 2	2	3 - 2	3	2 - 8	3	3 - 11	2	3 - 0	3	2 - 6	3
	1-2x12	5 - 2	2	4 - 0	3	3 - 4	3	4 - 10	3	3 - 9	3	3 - 2	4	4 - 7	3	3 - 6	3	3 - 0	4
	2-2x4	2 - 11	1	2 - 3	1	1 - 10	1	2 - 9	1	2 - 1	1	1 - 9	1	2 - 7	1	2 - 0	1	1 - 8	1
	2-2x6	4 - 4	1	3 - 4	2	2 - 10	2	4 - 1	1	3 - 2	2	2 - 8	2	3 - 10	1	3 - 0	2	2 - 6	2
	2-2x8	5 - 6	2	4 - 3	2	3 - 7	2	5 - 2	2	4 - 0	2	3 - 4	2	4 - 10	2	3 - 9	2	3 - 2	2
	2-2x10	6 - 7	2	5 - 0	2	4 - 2	2	6 - 1	2	4 - 9	2	4 - 0	2	5 - 9	2	4 - 5	2	3 - 9	3
	2-2x12	7 - 9	2	5 - 11	2	4 - 11	3	7 - 2	2	5 - 7	2	4 - 8	3	6 - 9	2	5 - 3	3	4 - 5	3
	3-2x8	6 - 11	1	5 - 3	2	4 - 5	2	6 - 5	1	5 - 0	2	4 - 2	2	6 - 1	1	4 - 8	2	4 - 0	2
	3-2x10	8 - 3	2	6 - 3	2	5 - 3	2	7 - 8	2	5 - 11	2	5 - 0	2	7 - 3	2	5 - 7	2	4 - 8	2
	3-2x12	9 - 8	2	7 - 5	2	6 - 2	2	9 - 0	2	7 - 0	2	5 - 10	2	8 - 6	2	6 - 7	2	5 - 6	3
	4-2x8	8 - 0	1	6 - 1	1	5 - 1	2	7 - 5	1	5 - 9	2	4 - 10	2	7 - 0	1	5 - 5	2	4 - 7	2
	4-2x10	9 - 6	1	7 - 3	2	6 - 1	2	8 - 10	1	6 - 10	2	5 - 9	2	8 - 4	1	6 - 5	2	5 - 5	2
	4-2x12	11 - 2	2	8 - 6	2	7 - 2	2	10 - 5	2	8 - 0	2	6 - 9	2	9 - 10	2	7 - 7	2	6 - 5	2
Roof, ceiling and two center-	1-2x6	2 - 8	2	2 - 1	2	1 - 10	2	2 - 7	2	2 - 0	2	1 - 9	2	2 - 5	2	1 - 11	2	1 - 8	2

bearing floors	1-2x8	3 - 5	2	2 - 8	2	2 - 4	3	3 - 3	2	2 - 7	2	2 - 2	3	3 - 1	2	2 - 5	3	2 - 1	3
	1-2x10	4 - 0	2	3 - 2	3	2 - 9	3	3 - 10	2	3 - 1	3	2 - 7	3	3 - 8	2	2 - 11	3	2 - 5	3
	1-2x12	4 - 9	3	3 - 9	3	3 - 2	4	4 - 6	3	3 - 7	3	3 - 1	4	4 - 3	3	3 - 5	3	2 - 11	4
	2-2x4	2 - 8	1	2 - 1	1	1 - 9	1	2 - 6	1	2 - 0	1	1 - 8	1	2 - 5	1	1 - 11	1	1 - 7	1
	2-2x6	4 - 0	1	3 - 2	2	2 - 8	2	3 - 9	1	3 - 0	2	2 - 7	2	3 - 7	1	2 - 10	2	2 - 5	2
	2-2x8	5 - 0	2	4 - 0	2	3 - 5	2	4 - 10	2	3 - 10	2	3 - 3	2	4 - 7	2	3 - 7	2	3 - 1	2
	2-2x10	6 - 0	2	4 - 9	2	4 - 0	2	5 - 8	2	4 - 6	2	3 - 10	3	5 - 5	2	4 - 3	2	3 - 8	3
	2-2x12	7 - 0	2	5 - 7	2	4 - 9	3	6 - 8	2	5 - 4	3	4 - 6	3	6 - 4	2	5 - 0	3	4 - 3	3
	3-2x8	6 - 4	1	5 - 0	2	4 - 3	2	6 - 0	1	4 - 9	2	4 - 1	2	5 - 8	2	4 - 6	2	3 - 10	2
	3-2x10	7 - 6	2	5 - 11	2	5 - 1	2	7 - 1	2	5 - 8	2	4 - 10	2	6 - 9	2	5 - 4	2	4 - 7	2
	3-2x12	8 - 10	2	7 - 0	2	5 - 11	2	8 - 5	2	6 - 8	2	5 - 8	3	8 - 0	2	6 - 4	2	5 - 4	3
	4-2x8	7 - 3	1	5 - 9	1	4 - 11	2	6 - 11	1	5 - 6	2	4 - 8	2	6 - 7	1	5 - 2	2	4 - 5	2
	4-2x10	8 - 8	1	6 - 10	2	5 - 10	2	8 - 3	2	6 - 6	2	5 - 7	2	7 - 10	2	6 - 2	2	5 - 3	2
	4-2x12	10 - 2	2	8 - 1	2	6 - 10	2	9 - 8	2	7 - 8	2	6 - 7	2	9 - 2	2	7 - 3	2	6 - 2	2
Roof, ceiling and two clear span floors	1-2x6	2 - 3	2	1 - 9	2	1 - 5	2	2 - 3	2	1 - 9	2	1 - 5	3	2 - 2	2	1 - 8	2	1 - 5	3
	1-2x8	2 - 10	2	2 - 2	3	1 - 10	3	2 - 10	2	2 - 2	3	1 - 10	3	2 - 9	2	2 - 1	3	1 - 10	3
	1-2x10	3 - 4	2	2 - 7	3	2 - 2	3	3 - 4	3	2 - 7	3	2 - 2	4	3 - 3	3	2 - 6	3	2 - 2	4
	1-2x12	4 - 0	3	3 - 0	3	2 - 7	4	4 - 0	3	3 - 0	4	2 - 7	4	3 - 10	3	3 - 0	4	2 - 6	4
	2-2x4	2 - 3	1	1 - 8	1	1 - 4	1	2 - 3	1	1 - 8	1	1 - 4	1	2 - 2	1	1 - 8	1	1 - 4	2
	2-2x6	3 - 4	1	2 - 6	2	2 - 2	2	3 - 4	2	2 - 6	2	2 - 2	2	3 - 3	2	2 - 6	2	2 - 1	2
	2-2x8	4 - 3	2	3 - 3	2	2 - 8	2	4 - 3	2	3 - 3	2	2 - 8	2	4 - 1	2	3 - 2	2	2 - 8	3
	2-2x10	5 - 0	2	3 - 10	2	3 - 2	3	5 - 0	2	3 - 10	2	3 - 2	3	4 - 10	2	3 - 9	3	3 - 2	3

	2-2x12	5 - 11	2	4 - 6	3	3 - 9	3	5 - 11	2	4 - 6	3	3 - 9	3	5 - 8	2	4 - 5	3	3 - 9	3
	3-2x8	5 - 3	1	4 - 0	2	3 - 5	2	5 - 3	2	4 - 0	2	3 - 5	2	5 - 1	2	3 - 11	2	3 - 4	2
	3-2x10	6 - 3	2	4 - 9	2	4 - 0	2	6 - 3	2	4 - 9	2	4 - 0	2	6 - 1	2	4 - 8	2	4 - 0	3
	3-2x12	7 - 5	2	5 - 8	2	4 - 9	3	7 - 5	2	5 - 8	2	4 - 9	3	7 - 2	2	5 - 6	3	4 - 8	3
	4-2x8	6 - 1	1	4 - 8	2	3 - 11	2	6 - 1	1	4 - 8	2	3 - 11	2	5 - 11	1	4 - 7	2	3 - 10	2
	4-2x10	7 - 3	2	5 - 6	2	4 - 8	2	7 - 3	2	5 - 6	2	4 - 8	2	7 - 0	2	5 - 5	2	4 - 7	2
	4-2x12	8 - 6	2	6 - 6	2	5 - 6	2	8 - 6	2	6 - 6	2	5 - 6	2	8 - 3	2	6 - 4	2	5 - 4	3

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. Spans are given in feet and inches.

b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir.

c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.

d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.

e. Use 30 psf ground snow load for cases in which ground snow load is less than 30 psf and the roof live load is equal to or less than 20 psf.

f. Spans are calculated assuming the top of the header or girder is laterally braced by perpendicular framing. Where the top of the header or girder is not laterally braced (e.g. cripple studs bearing on the header), tabulated spans for headers consisting of 2x8, 2x10, or 2x12 sizes shall be multiplied by 0.70 or the header or girder shall be designed.

Final Action: AS (Approved as Submitted)

S289-16

IBC: 2308.4.1.1, 2308.4.1.1(1) (New).

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

2015 International Building Code

Revise as follows:

~~2308.4.1.1~~ (1)

~~HEADER AND GIRDER SPANS[a, b] FOR EXTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine and Spruce-Pine-Fir[b] and required number of jack studs)~~

~~GIRDERS AND HEADERS SUPPORTING~~	~~SIZE~~	~~GROUND SNOW LOAD (psf)[e]~~											
		~~30~~						~~50~~					
		~~Building width[c] (feet)~~											
		~~20~~		~~28~~		~~36~~		~~20~~		~~28~~		~~36~~	
		~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~
~~Roof and ceiling~~	~~2-2 × 4~~	~~3-6~~	~~1~~	~~3-2~~	~~1~~	~~2-10~~	~~1~~	~~3-2~~	~~1~~	~~2-9~~	~~1~~	~~2-6~~	~~1~~
	~~2-2 × 6~~	~~5-5~~	~~1~~	~~4-8~~	~~1~~	~~4-2~~	~~1~~	~~4-8~~	~~1~~	~~4-1~~	~~1~~	~~3-8~~	~~2~~
	~~2-2 × 8~~	~~6-10~~	~~1~~	~~5-11~~	~~2~~	~~5-4~~	~~2~~	~~5-11~~	~~2~~	~~5-2~~	~~2~~	~~4-7~~	~~2~~
	~~2-2 × 10~~	~~8-5~~	~~2~~	~~7-3~~	~~2~~	~~6-6~~	~~2~~	~~7-3~~	~~2~~	~~6-3~~	~~2~~	~~5-7~~	~~2~~
	~~2-2 × 12~~	~~9-9~~	~~2~~	~~8-5~~	~~2~~	~~7-6~~	~~2~~	~~8-5~~	~~2~~	~~7-3~~	~~2~~	~~6-6~~	~~2~~
	~~3-2 × 8~~	~~8-4~~	~~1~~	~~7-5~~	~~1~~	~~6-8~~	~~1~~	~~7-5~~	~~1~~	~~6-5~~	~~2~~	~~5-9~~	~~2~~
	~~3-2 × 10~~	~~10-6~~	~~1~~	~~9-1~~	~~2~~	~~8-2~~	~~2~~	~~9-1~~	~~2~~	~~7-10~~	~~2~~	~~7-0~~	~~2~~
	~~3-2 × 12~~	~~12-2~~	~~2~~	~~10-7~~	~~2~~	~~9-5~~	~~2~~	~~10-7~~	~~2~~	~~9-2~~	~~2~~	~~8-2~~	~~2~~
	~~4-2 × 8~~	~~9-2~~	~~1~~	~~8-4~~	~~1~~	~~7-8~~	~~1~~	~~8-4~~	~~1~~	~~7-5~~	~~1~~	~~6-8~~	~~1~~
	~~4-2 × 10~~	~~11-8~~	~~1~~	~~10-6~~	~~1~~	~~9-5~~	~~2~~	~~10-6~~	~~1~~	~~9-1~~	~~2~~	~~8-2~~	~~2~~
	~~4-2 × 12~~	~~14-1~~	~~1~~	~~12-2~~	~~2~~	~~10-11~~	~~2~~	~~12-2~~	~~2~~	~~10-7~~	~~2~~	~~9-5~~	~~2~~
~~Roof, ceiling and one center bearing floor~~	~~2-2 × 4~~	~~3-1~~	~~1~~	~~2-9~~	~~1~~	~~2-5~~	~~1~~	~~2-9~~	~~1~~	~~2-5~~	~~1~~	~~2-2~~	~~1~~
	~~2-2 × 6~~	~~4-6~~	~~1~~	~~4-0~~	~~1~~	~~3-7~~	~~2~~	~~4-1~~	~~1~~	~~3-7~~	~~2~~	~~3-3~~	~~2~~
	~~2-2 × 8~~	~~5-9~~	~~2~~	~~5-0~~	~~2~~	~~4-6~~	~~2~~	~~5-2~~	~~2~~	~~4-6~~	~~2~~	~~4-1~~	~~2~~
	~~2-2 × 10~~	~~7-0~~	~~2~~	~~6-2~~	~~2~~	~~5-6~~	~~2~~	~~6-4~~	~~2~~	~~5-6~~	~~2~~	~~5-0~~	~~2~~
	~~2-2 × 12~~	~~8-1~~	~~2~~	~~7-1~~	~~2~~	~~6-5~~	~~2~~	~~7-4~~	~~2~~	~~6-5~~	~~2~~	~~5-9~~	~~3~~
	~~3-2 × 8~~	~~7-2~~	~~1~~	~~6-3~~	~~2~~	~~5-8~~	~~2~~	~~6-5~~	~~2~~	~~5-8~~	~~2~~	~~5-1~~	~~2~~

	~~3 2 × 10~~	~~8 9~~	~~2~~	~~7 8~~	~~2~~	~~6 11~~	~~2~~	~~7 11~~	~~2~~	~~6 11~~	~~2~~	~~6 3~~	~~2~~
	~~3 2 × 12~~	~~10 2~~	~~2~~	~~8 11~~	~~2~~	~~8 0~~	~~2~~	~~9 2~~	~~2~~	~~8 0~~	~~2~~	~~7 3~~	~~2~~
	~~4 2 × 8~~	~~8 1~~	~~1~~	~~7 3~~	~~1~~	~~6 7~~	~~1~~	~~7 5~~	~~1~~	~~6 6~~	~~1~~	~~5 11~~	~~2~~
	~~4 2 × 10~~	~~10 1~~	~~1~~	~~8 10~~	~~2~~	~~8 0~~	~~2~~	~~9 1~~	~~2~~	~~8 0~~	~~2~~	~~7 2~~	~~2~~
	~~4 2 × 12~~	~~11 9~~	~~2~~	~~10 3~~	~~2~~	~~9 3~~	~~2~~	~~10 7~~	~~2~~	~~9 3~~	~~2~~	~~8 4~~	~~2~~
	~~2 2 × 4~~	~~2 8~~	~~1~~	~~2 4~~	~~1~~	~~2 1~~	~~1~~	~~2 7~~	~~1~~	~~2 3~~	~~1~~	~~2 0~~	~~1~~
	~~2 2 × 6~~	~~3 11~~	~~1~~	~~3 5~~	~~2~~	~~3 0~~	~~2~~	~~3 10~~	~~2~~	~~3 4~~	~~2~~	~~3 0~~	~~2~~
	~~2 2 × 8~~	~~5 0~~	~~2~~	~~4 4~~	~~2~~	~~3 10~~	~~2~~	~~4 10~~	~~2~~	~~4 2~~	~~2~~	~~3 9~~	~~2~~
	~~2 2 × 10~~	~~6 1~~	~~2~~	~~5 3~~	~~2~~	~~4 8~~	~~2~~	~~5 11~~	~~2~~	~~5 1~~	~~2~~	~~4 7~~	~~3~~
~~Roof , ceiling and~~	~~2 2 × 12~~	~~7 1~~	~~2~~	~~6 1~~	~~3~~	~~5 5~~	~~3~~	~~6 10~~	~~2~~	~~5 11~~	~~3~~	~~5 4~~	~~3~~
~~one clear span~~	~~3 2 × 8~~	~~6 3~~	~~2~~	~~5 5~~	~~2~~	~~4 10~~	~~2~~	~~6 1~~	~~2~~	~~5 3~~	~~2~~	~~4 8~~	~~2~~
~~floor~~	~~3 2 × 10~~	~~7 7~~	~~2~~	~~6 7~~	~~2~~	~~5 11~~	~~2~~	~~7 5~~	~~2~~	~~6 5~~	~~2~~	~~5 9~~	~~2~~
	~~3 2 × 12~~	~~8 10~~	~~2~~	~~7 8~~	~~2~~	~~6 10~~	~~2~~	~~8 7~~	~~2~~	~~7 5~~	~~2~~	~~6 8~~	~~2~~
	~~4 2 × 8~~	~~7 2~~	~~1~~	~~6 3~~	~~2~~	~~5 7~~	~~2~~	~~7 0~~	~~1~~	~~6 1~~	~~2~~	~~5 5~~	~~2~~
	~~4 2 × 10~~	~~8 9~~	~~2~~	~~7 7~~	~~2~~	~~6 10~~	~~2~~	~~8 7~~	~~2~~	~~7 5~~	~~2~~	~~6 7~~	~~2~~
	~~4 2 × 12~~	~~10 2~~	~~2~~	~~8 10~~	~~2~~	~~7 11~~	~~2~~	~~9 11~~	~~2~~	~~8 7~~	~~2~~	~~7 8~~	~~2~~
	~~2 2 × 4~~	~~2 7~~	~~1~~	~~2 3~~	~~1~~	~~2 0~~	~~1~~	~~2 6~~	~~1~~	~~2 2~~	~~1~~	~~1 11~~	~~1~~
	~~2 2 × 6~~	~~3 9~~	~~2~~	~~3 3~~	~~2~~	~~2 11~~	~~2~~	~~3 8~~	~~2~~	~~3 2~~	~~2~~	~~2 10~~	~~2~~
	~~2 2 × 8~~	~~4 9~~	~~2~~	~~4 2~~	~~2~~	~~3 9~~	~~2~~	~~4 7~~	~~2~~	~~4 0~~	~~2~~	~~3 8~~	~~2~~
	~~2 2 × 10~~	~~5 9~~	~~2~~	~~5 1~~	~~2~~	~~4 7~~	~~3~~	~~5 8~~	~~2~~	~~4 11~~	~~2~~	~~4 5~~	~~3~~
~~Roof , ceiling and~~	~~2 2 × 12~~	~~6 8~~	~~2~~	~~5 10~~	~~3~~	~~5 3~~	~~3~~	~~6 6~~	~~2~~	~~5 9~~	~~3~~	~~5 2~~	~~3~~
~~two center bearing~~	~~3 2 × 8~~	~~5 11~~	~~2~~	~~5 2~~	~~2~~	~~4 8~~	~~2~~	~~5 9~~	~~2~~	~~5 1~~	~~2~~	~~4 7~~	~~2~~
~~floors~~	~~3 2 × 10~~	~~7 3~~	~~2~~	~~6 4~~	~~2~~	~~5 8~~	~~2~~	~~7 1~~	~~2~~	~~6 2~~	~~2~~	~~5 7~~	~~2~~
	~~3 2 × 12~~	~~8 5~~	~~2~~	~~7 4~~	~~2~~	~~6 7~~	~~2~~	~~8 2~~	~~2~~	~~7 2~~	~~2~~	~~6 5~~	~~3~~
	~~4 2 × 8~~	~~6 10~~	~~1~~	~~6 0~~	~~2~~	~~5 5~~	~~2~~	~~6 8~~	~~1~~	~~5 10~~	~~2~~	~~5 3~~	~~2~~
	~~4 2 × 10~~	~~8 4~~	~~2~~	~~7 4~~	~~2~~	~~6 7~~	~~2~~	~~8 2~~	~~2~~	~~7 2~~	~~2~~	~~6 5~~	~~2~~
	~~4 2 × 12~~	~~9 8~~	~~2~~	~~8 6~~	~~2~~	~~7 8~~	~~2~~	~~9 5~~	~~2~~	~~8 3~~	~~2~~	~~7 5~~	~~2~~
~~Roof , ceiling, and~~	~~2 2 × 4~~	~~2 1~~	~~1~~	~~1 8~~	~~1~~	~~1 6~~	~~2~~	~~2 0~~	~~1~~	~~1 8~~	~~1~~	~~1 5~~	~~2~~
~~two clear span~~	~~2 2 × 6~~	~~3 1~~	~~2~~	~~2 8~~	~~2~~	~~2 4~~	~~2~~	~~3 0~~	~~2~~	~~2 7~~	~~2~~	~~2 3~~	~~2~~
~~floors~~	~~2 2 × 8~~	~~3 10~~	~~2~~	~~3 4~~	~~2~~	~~3 0~~	~~3~~	~~3 10~~	~~2~~	~~3 4~~	~~2~~	~~2 11~~	~~3~~

~~GIRDERS AND HEADERS SUPPORTING~~	~~SIZE~~	~~GROUND SNOW LOAD (psf)[e]~~											
		~~30~~						~~50~~					
		~~Building width[c] (feet)~~											
		~~20~~		~~28~~		~~36~~		~~20~~		~~28~~		~~36~~	
		~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~
~~Roof, ceiling, and two clear span floors~~	~~2-2 × 10~~	~~4-9~~	~~2~~	~~4-1~~	~~3~~	~~3-8~~	~~3~~	~~4-8~~	~~2~~	~~4-0~~	~~3~~	~~3-7~~	~~3~~
	~~2-2 × 12~~	~~5-6~~	~~3~~	~~4-9~~	~~3~~	~~4-3~~	~~3~~	~~5-5~~	~~3~~	~~4-8~~	~~3~~	~~4-2~~	~~3~~
	~~3-2 × 8~~	~~4-10~~	~~2~~	~~4-2~~	~~2~~	~~3-9~~	~~2~~	~~4-9~~	~~2~~	~~4-1~~	~~2~~	~~3-8~~	~~2~~
	~~3-2 × 10~~	~~5-11~~	~~2~~	~~5-1~~	~~2~~	~~4-7~~	~~3~~	~~5-10~~	~~2~~	~~5-0~~	~~2~~	~~4-6~~	~~3~~
	~~3-2 × 12~~	~~6-10~~	~~2~~	~~5-11~~	~~3~~	~~5-4~~	~~3~~	~~6-9~~	~~2~~	~~5-10~~	~~3~~	~~5-3~~	~~3~~
	~~4-2 × 8~~	~~5-7~~	~~2~~	~~4-10~~	~~2~~	~~4-4~~	~~2~~	~~5-6~~	~~2~~	~~4-9~~	~~2~~	~~4-3~~	~~2~~
	~~4-2 × 10~~	~~6-10~~	~~2~~	~~5-11~~	~~2~~	~~5-3~~	~~2~~	~~6-9~~	~~2~~	~~5-10~~	~~2~~	~~5-2~~	~~2~~
	~~4-2 × 12~~	~~7-11~~	~~2~~	~~6-10~~	~~2~~	~~6-2~~	~~3~~	~~7-9~~	~~2~~	~~6-9~~	~~2~~	~~6-0~~	~~3~~

~~For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.~~

~~a. Spans are given in feet and inches.~~

~~b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir and Spruce-Pine-Fir. No. 1 or better grade lumber shall be used for Southern Pine.~~

~~c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.~~

~~d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.~~

~~e. Use 30 psf ground snow load for cases in which ground snow load is less than 30 psf and the roof live load is equal to or less than 20 psf.~~

TABLE 2308.4.1.1(1)

HEADER AND GIRDER SPANS[a,b] FOR EXTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir and required number of jack studs)

GIRDERS AND HEADERS SUPPORTING	SIZE	GROUND SNOW LOAD (psf)[e]																	
		30						50						70					
		Building width[c] (feet)																	
		12		24		36		12		24		36		12		24		36	
		Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]
Roof and ceiling	1-2x6	4 - 0	1	3 - 1	2	2 - 7	2	3 - 5	1	2 - 8	2	2 - 3	2	3 - 0	2	2 - 4	2	2 - 0	2
	1-2x8	5 - 1	2	3 - 11	2	3 - 3	2	4 - 4	2	3 - 4	2	2 - 10	2	3 - 10	2	3 - 0	2	2 - 6	3
	1-2x10	6 - 0	2	4 - 8	2	3 - 11	2	5 - 2	2	4 - 0	2	3 - 4	3	4 - 7	2	3 - 6	3	3 - 0	3
	1-	7 - 1	2	5 - 5	2	4 - 7	3	6 - 1	2	4 - 8	3	3 - 11	3	5 - 5	2	4 - 2	3	3 - 6	3

	2x12																		
	2-2x4	4 - 0	1	3 - 1	1	2 - 7	1	3 - 5	1	2 - 7	1	2 - 2	1	3 - 0	1	2 - 4	1	2 - 0	1
	2-2x6	6 - 0	1	4 - 7	1	3 - 10	1	5 - 1	1	3 - 11	1	3 - 3	2	4 - 6	1	3 - 6	2	2 - 11	2
	2-2x8	7 - 7	1	5 - 9	1	4 - 10	2	6 - 5	1	5 - 0	2	4 - 2	2	5 - 9	1	4 - 5	2	3 - 9	2
	2-2x10	9 - 0	1	6 - 10	2	5 - 9	2	7 - 8	2	5 - 11	2	4 - 11	2	6 - 9	2	5 - 3	2	4 - 5	2
	2-2x12	10 - 7	2	8 - 1	2	6 - 10	2	9 - 0	2	6 - 11	2	5 - 10	2	8 - 0	2	6 - 2	2	5 - 2	3
	3-2x8	9 - 5	1	7 - 3	1	6 - 1	1	8 - 1	1	6 - 3	1	5 - 3	2	7 - 2	1	5 - 6	2	4 - 8	2
	3-2x10	11 - 3	1	8 - 7	1	7 - 3	2	9 - 7	1	7 - 4	2	6 - 2	2	8 - 6	1	6 - 7	2	5 - 6	2
	3-2x12	13 - 2	1	10 - 1	2	8 - 6	2	11 - 3	2	8 - 8	2	7 - 4	2	10 - 0	2	7 - 9	2	6 - 6	2
	4-2x8	10 - 11	1	8 - 4	1	7 - 0	1	9 - 4	1	7 - 2	1	6 - 0	1	8 - 3	1	6 - 4	1	5 - 4	2
	4-2x10	12 - 11	1	9 - 11	1	8 - 4	1	11 - 1	1	8 - 6	1	7 - 2	2	9 - 10	1	7 - 7	2	6 - 4	2
	4-2x12	15 - 3	1	11 - 8	1	9 - 10	2	13 - 0	1	10 - 0	2	8 - 5	2	11 - 7	1	8 - 11	2	7 - 6	2
Roof, ceiling and one center-	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
bearing floor	1-2x8	4 - 1	2	3 - 3	2	2 - 9	2	3 - 9	2	3 - 0	2	2 - 6	3	3 - 6	2	2 - 9	2	2 - 4	3
	1-2x10	4 - 11	2	3 - 10	2	3 - 3	3	4 - 6	2	3 - 6	3	3 - 0	3	4 - 1	2	3 - 3	3	2 - 9	3
	1-2x12	5 - 9	2	4 - 6	3	3 - 10	3	5 - 3	2	4 - 2	3	3 - 6	3	4 - 10	3	3 - 10	3	3 - 3	4
	2-2x4	3 - 3	1	2 - 6	1	2 - 2	1	3 - 0	1	2 - 4	1	2 - 0	1	2 - 8	1	2 - 2	1	1 - 10	1
	2-2x6	4 - 10	1	3 - 9	1	3 - 3	2	4 - 5	1	3 - 6	2	3 - 0	2	4 - 1	1	3 - 3	2	2 - 9	2
	2-2x8	6 - 1	1	4 - 10	2	4 - 1	2	5 - 7	2	4 - 5	2	3 - 9	2	5 - 2	2	4 - 1	2	3 - 6	2
	2-2x10	7 - 3	2	5 - 8	2	4 - 10	2	6 - 8	2	5 - 3	2	4 - 5	2	6 - 1	2	4 - 10	2	4 - 1	2
	2-2x12	8 - 6	2	6 - 8	2	5 - 8	2	7 - 10	2	6 - 2	2	5 - 3	3	7 - 2	2	5 - 8	2	4 - 10	3
	3-2x8	7 - 8	1	6 - 0	1	5 - 1	2	7 - 0	1	5 - 6	2	4 - 8	2	6 - 5	1	5 - 1	2	4 - 4	2

	3-2x10	9 - 1	1	7 - 2	2	6 - 1	2	8 - 4	1	6 - 7	2	5 - 7	2	7 - 8	2	6 - 1	2	5 - 2	2
	3-2x12	10 - 8	2	8 - 5	2	7 - 2	2	9 - 10	2	7 - 8	2	6 - 7	2	9 - 0	2	7 - 1	2	6 - 1	2
	4-2x8	8 - 10	1	6 - 11	1	5 - 11	1	8 - 1	1	6 - 4	1	5 - 5	2	7 - 5	1	5 - 11	1	5 - 0	2
	4-2x10	10 - 6	1	8 - 3	2	7 - 0	2	9 - 8	1	7 - 7	2	6 - 5	2	8 - 10	1	7 - 0	2	6 - 0	2
	4-2x12	12 - 4	1	9 - 8	2	8 - 3	2	11 - 4	2	8 - 11	2	7 - 7	2	10 - 4	2	8 - 3	2	7 - 0	2
Roof, ceiling and one clear span floor	1-2x6	2 - 11	2	2 - 3	2	1 - 11	2	2 - 9	2	2 - 1	2	1 - 9	2	2 - 7	2	2 - 0	2	1 - 8	2
	1-2x8	3 - 9	2	2 - 10	2	2 - 5	3	3 - 6	2	2 - 8	2	2 - 3	3	3 - 3	2	2 - 6	3	2 - 2	3
	1-2x10	4 - 5	2	3 - 5	3	2 - 10	3	4 - 2	2	3 - 2	3	2 - 8	3	3 - 11	2	3 - 0	3	2 - 6	3
	1-2x12	5 - 2	2	4 - 0	3	3 - 4	3	4 - 10	3	3 - 9	3	3 - 2	4	4 - 7	3	3 - 6	3	3 - 0	4
	2-2x4	2 - 11	1	2 - 3	1	1 - 10	1	2 - 9	1	2 - 1	1	1 - 9	1	2 - 7	1	2 - 0	1	1 - 8	1
	2-2x6	4 - 4	1	3 - 4	2	2 - 10	2	4 - 1	1	3 - 2	2	2 - 8	2	3 - 10	1	3 - 0	2	2 - 6	2
	2-2x8	5 - 6	2	4 - 3	2	3 - 7	2	5 - 2	2	4 - 0	2	3 - 4	2	4 - 10	2	3 - 9	2	3 - 2	2
	2-2x10	6 - 7	2	5 - 0	2	4 - 2	2	6 - 1	2	4 - 9	2	4 - 0	2	5 - 9	2	4 - 5	2	3 - 9	3
	2-2x12	7 - 9	2	5 - 11	2	4 - 11	3	7 - 2	2	5 - 7	2	4 - 8	3	6 - 9	2	5 - 3	3	4 - 5	3
	3-2x8	6 - 11	1	5 - 3	2	4 - 5	2	6 - 5	1	5 - 0	2	4 - 2	2	6 - 1	1	4 - 8	2	4 - 0	2
	3-2x10	8 - 3	2	6 - 3	2	5 - 3	2	7 - 8	2	5 - 11	2	5 - 0	2	7 - 3	2	5 - 7	2	4 - 8	2
	3-2x12	9 - 8	2	7 - 5	2	6 - 2	2	9 - 0	2	7 - 0	2	5 - 10	2	8 - 6	2	6 - 7	2	5 - 6	3
	4-2x8	8 - 0	1	6 - 1	1	5 - 1	2	7 - 5	1	5 - 9	2	4 - 10	2	7 - 0	1	5 - 5	2	4 - 7	2
	4-2x10	9 - 6	1	7 - 3	2	6 - 1	2	8 - 10	1	6 - 10	2	5 - 9	2	8 - 4	1	6 - 5	2	5 - 5	2
	4-2x12	11 - 2	2	8 - 6	2	7 - 2	2	10 - 5	2	8 - 0	2	6 - 9	2	9 - 10	2	7 - 7	2	6 - 5	2
Roof, ceiling and two center-	1-2x6	2 - 8	2	2 - 1	2	1 - 10	2	2 - 7	2	2 - 0	2	1 - 9	2	2 - 5	2	1 - 11	2	1 - 8	2

bearing floors	1-2x8	3 - 5	2	2 - 8	2	2 - 4	3	3 - 3	2	2 - 7	2	2 - 2	3	3 - 1	2	2 - 5	3	2 - 1	3
	1-2x10	4 - 0	2	3 - 2	3	2 - 9	3	3 - 10	2	3 - 1	3	2 - 7	3	3 - 8	2	2 - 11	3	2 - 5	3
	1-2x12	4 - 9	3	3 - 9	3	3 - 2	4	4 - 6	3	3 - 7	3	3 - 1	4	4 - 3	3	3 - 5	3	2 - 11	4
	2-2x4	2 - 8	1	2 - 1	1	1 - 9	1	2 - 6	1	2 - 0	1	1 - 8	1	2 - 5	1	1 - 11	1	1 - 7	1
	2-2x6	4 - 0	1	3 - 2	2	2 - 8	2	3 - 9	1	3 - 0	2	2 - 7	2	3 - 7	1	2 - 10	2	2 - 5	2
	2-2x8	5 - 0	2	4 - 0	2	3 - 5	2	4 - 10	2	3 - 10	2	3 - 3	2	4 - 7	2	3 - 7	2	3 - 1	2
	2-2x10	6 - 0	2	4 - 9	2	4 - 0	2	5 - 8	2	4 - 6	2	3 - 10	3	5 - 5	2	4 - 3	2	3 - 8	3
	2-2x12	7 - 0	2	5 - 7	2	4 - 9	3	6 - 8	2	5 - 4	3	4 - 6	3	6 - 4	2	5 - 0	3	4 - 3	3
	3-2x8	6 - 4	1	5 - 0	2	4 - 3	2	6 - 0	1	4 - 9	2	4 - 1	2	5 - 8	2	4 - 6	2	3 - 10	2
	3-2x10	7 - 6	2	5 - 11	2	5 - 1	2	7 - 1	2	5 - 8	2	4 - 10	2	6 - 9	2	5 - 4	2	4 - 7	2
	3-2x12	8 - 10	2	7 - 0	2	5 - 11	2	8 - 5	2	6 - 8	2	5 - 8	3	8 - 0	2	6 - 4	2	5 - 4	3
	4-2x8	7 - 3	1	5 - 9	1	4 - 11	2	6 - 11	1	5 - 6	2	4 - 8	2	6 - 7	1	5 - 2	2	4 - 5	2
	4-2x10	8 - 8	1	6 - 10	2	5 - 10	2	8 - 3	2	6 - 6	2	5 - 7	2	7 - 10	2	6 - 2	2	5 - 3	2
	4-2x12	10 - 2	2	8 - 1	2	6 - 10	2	9 - 8	2	7 - 8	2	6 - 7	2	9 - 2	2	7 - 3	2	6 - 2	2
Roof, ceiling and two clear span floors	1-2x6	2 - 3	2	1 - 9	2	1 - 5	2	2 - 3	2	1 - 9	2	1 - 5	3	2 - 2	2	1 - 8	2	1 - 5	3
	1-2x8	2 - 10	2	2 - 2	3	1 - 10	3	2 - 10	2	2 - 2	3	1 - 10	3	2 - 9	2	2 - 1	3	1 - 10	3
	1-2x10	3 - 4	2	2 - 7	3	2 - 2	3	3 - 4	3	2 - 7	3	2 - 2	4	3 - 3	3	2 - 6	3	2 - 2	4
	1-2x12	4 - 0	3	3 - 0	3	2 - 7	4	4 - 0	3	3 - 0	4	2 - 7	4	3 - 10	3	3 - 0	4	2 - 6	4
	2-2x4	2 - 3	1	1 - 8	1	1 - 4	1	2 - 3	1	1 - 8	1	1 - 4	1	2 - 2	1	1 - 8	1	1 - 4	2
	2-2x6	3 - 4	1	2 - 6	2	2 - 2	2	3 - 4	2	2 - 6	2	2 - 2	2	3 - 3	2	2 - 6	2	2 - 1	2
	2-2x8	4 - 3	2	3 - 3	2	2 - 8	2	4 - 3	2	3 - 3	2	2 - 8	2	4 - 1	2	3 - 2	2	2 - 8	3
	2-2x10	5 - 0	2	3 - 10	2	3 - 2	3	5 - 0	2	3 - 10	2	3 - 2	3	4 - 10	2	3 - 9	3	3 - 2	3

	2-2x12	5 - 11	2	4 - 6	3	3 - 9	3	5 - 11	2	4 - 6	3	3 - 9	3	5 - 8	2	4 - 5	3	3 - 9	3
	3-2x8	5 - 3	1	4 - 0	2	3 - 5	2	5 - 3	2	4 - 0	2	3 - 5	2	5 - 1	2	3 - 11	2	3 - 4	2
	3-2x10	6 - 3	2	4 - 9	2	4 - 0	2	6 - 3	2	4 - 9	2	4 - 0	2	6 - 1	2	4 - 8	2	4 - 0	3
	3-2x12	7 - 5	2	5 - 8	2	4 - 9	3	7 - 5	2	5 - 8	2	4 - 9	3	7 - 2	2	5 - 6	3	4 - 8	3
	4-2x8	6 - 1	1	4 - 8	2	3 - 11	2	6 - 1	1	4 - 8	2	3 - 11	2	5 - 11	1	4 - 7	2	3 - 10	2
	4-2x10	7 - 3	2	5 - 6	2	4 - 8	2	7 - 3	2	5 - 6	2	4 - 8	2	7 - 0	2	5 - 5	2	4 - 7	2
	4-2x12	8 - 6	2	6 - 6	2	5 - 6	2	8 - 6	2	6 - 6	2	5 - 6	2	8 - 3	2	6 - 4	2	5 - 4	3

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. Spans are given in feet and inches.

b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir.

c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.

d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.

e. Use 30 psf ground snow load for cases in which ground snow load is less than 30 psf and the roof live load is equal to or less than 20 psf.

f. Spans are calculated assuming the top of the header or girder is laterally braced by perpendicular framing. Where the top of the header or girder is not laterally braced (e.g. cripple studs bearing on the header), tabulated spans for headers consisting of 2x8, 2x10, or 2x12 sizes shall be multiplied by 0.70 or the header or girder shall be designed.

Reason: The update of Table 2308.4.1.1(1) Header and Girder Spans for Exterior Bearing Walls is proposed. Updated spans address use of Southern Pine No. 2 in lieu of Southern Pine No. 1. Footnote "f" is added to clarify that header spans are based on laterally braced assumption such as when the header is raised. For dropped headers consisting of 2x8, 2x10, or 2x12 sizes that are not laterally braced, a factor of 0.7 can be applied to determine the spans or alternatively the header or girder can be designed to include any adjustment for potential buckling. Laterally braced (raised) and not laterally braced (dropped) header conditions and building widths for which header spans are tabulated represent the same condtions used to develop header span tables in the Wood Frame Construction Manual (WFCM).

Cost Impact: Will increase the cost of construction
Increased cost may be associated with reduced spans that result from the not laterally braced condition and application of footnote f. Due to smaller building width column (12'), permissible use of Southern Pine No. 2, and the laterally braced assumption for tabulated spans, there are also cases where this change will not increase the cost of construction and may reduce cost of construction.

Final Action: AS (Approved as Submitted)

S289-16 : TABLE 2308.4.1.1-TYREE12519

S8260

Date Submitted	12/14/2018	**Section**	2308.4.1.1	**Proponent**	Paul Coats
Chapter	23	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes **Alternate Language** No

Related Modifications

Summary of Modification

Replacement table for T2308.4.1.1(2) Header and Girder Spans for Interior Bearing Walls

Rationale

The update of Table 2308.4.1.1(2) Header and Girder Spans for Interior Bearing Walls is proposed. Updated spans address use of Southern Pine No. 2 in lieu of Southern Pine No. 1. Footnote "e" is added to clarify that header spans are based on laterally braced assumption such as when the header is raised. For dropped headers consisting of 2x8, 2x10, or 2x12 size framing and not laterally braced, a factor of 0.7 can be applied to determine the spans or alternatively the header or girder can be designed to include any adjustment for potential buckling. Laterally braced (raised) and not laterally braced (dropped) header conditions and building widths for which header spans are tabulated represent the same conditions used to develop header span tables in the Wood Frame Construction Manual (WFCM).

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Code officials will need to become familiar with the use of the new table and footnotes.

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

Increased cost may be associated with reduced spans that result from the unbraced header condition and application of footnote e. Due to certain new options in the table, in some circumstances it may reduce the cost of construction.

Impact to industry relative to the cost of compliance with code

Increased cost may be associated with reduced spans that result from the unbraced header condition and application of footnote e. Due to certain new options in the table, in some circumstances it may reduce the cost of construction.

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

Increased cost may be associated with reduced spans that result from the unbraced header condition and application of footnote e. Due to certain new options in the table, in some circumstances it may reduce the cost of construction.

Requirements

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

Maintains correct header sizing for safety and serviceability.

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

Strengthens the code.

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

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

2nd Comment Period

S8260-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

Completely delete the current Table 2308.4.1.1(2) and replace with a new table:

~~**TABLE 2308.4.1.1(2)**~~

~~**HEADER AND GIRDER SPANSa, b FOR INTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine and Spruce-Pine-Firb and required number of jack studs)**~~

TABLE 2308.4.1.1(2)

HEADER AND GIRDER SPANS[a,b] FOR INTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir and required number of jack studs)

See uploaded support file for contents of new Table 2308.4.1.1(2)

Revise as follows:

~~2308.4.1.1~~ (2)

~~HEADER AND GIRDER SPANS[a, b] FOR INTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine and Spruce-Pine-Fir[b] and required number of jack studs)~~

-

~~HEADERS AND GIRDERS SUPPORTING~~	~~SIZE~~	~~BUILDING WIDTH[c] (feet)~~					
		~~20~~		~~28~~		~~36~~	
		~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~
~~One floor only~~	~~2-2 × 4~~	~~3-1~~	~~1~~	~~2-8~~	~~1~~	~~2-5~~	~~1~~
	~~2-2 × 6~~	~~4-6~~	~~1~~	~~3-11~~	~~1~~	~~3-6~~	~~1~~
	~~2-2 × 8~~	~~5-9~~	~~1~~	~~5-0~~	~~2~~	~~4-5~~	~~2~~
	~~2-2 × 10~~	~~7-0~~	~~2~~	~~6-1~~	~~2~~	~~5-5~~	~~2~~
	~~2-2 × 12~~	~~8-1~~	~~2~~	~~7-0~~	~~2~~	~~6-3~~	~~2~~
	~~3-2 × 8~~	~~7-2~~	~~1~~	~~6-3~~	~~1~~	~~5-7~~	~~2~~
	~~3-2 × 10~~	~~8-9~~	~~1~~	~~7-7~~	~~2~~	~~6-9~~	~~2~~
	~~3-2 × 12~~	~~10-2~~	~~2~~	~~8-10~~	~~2~~	~~7-10~~	~~2~~
	~~4-2 × 8~~	~~9-0~~	~~1~~	~~7-8~~	~~1~~	~~6-9~~	~~1~~
	~~4-2 × 10~~	~~10-1~~	~~1~~	~~8-9~~	~~1~~	~~7-10~~	~~2~~
	~~4-2 × 12~~	~~11-9~~	~~1~~	~~10-2~~	~~2~~	~~9-1~~	~~2~~
	~~2-2 × 4~~	~~2-2~~	~~1~~	~~1-10~~	~~1~~	~~1-7~~	~~1~~

	~~2-2 × 6~~	~~3-2~~	~~2~~	~~2-9~~	~~2~~	~~2-5~~	~~2~~
	~~2-2 × 8~~	~~4-1~~	~~2~~	~~3-6~~	~~2~~	~~3-2~~	~~2~~
	~~2-2 × 10~~	~~4-11~~	~~2~~	~~4-3~~	~~2~~	~~3-10~~	~~3~~
	~~2-2 × 12~~	~~5-9~~	~~2~~	~~5-0~~	~~3~~	~~4-5~~	~~3~~
~~Two floors~~	~~3-2 × 8~~	~~5-1~~	~~2~~	~~4-5~~	~~2~~	~~3-11~~	~~2~~
	~~3-2 × 10~~	~~6-2~~	~~2~~	~~5-4~~	~~2~~	~~4-10~~	~~2~~
	~~3-2 × 12~~	~~7-2~~	~~2~~	~~6-3~~	~~2~~	~~5-7~~	~~3~~
	~~4-2 × 8~~	~~6-1~~	~~1~~	~~5-3~~	~~2~~	~~4-8~~	~~2~~
	~~4-2 × 10~~	~~7-2~~	~~2~~	~~6-2~~	~~2~~	~~5-6~~	~~2~~
	~~4-2 × 12~~	~~8-4~~	~~2~~	~~7-2~~	~~2~~	~~6-5~~	~~2~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.~~

~~a. Spans are given in feet and inches.~~

~~b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir and Spruce-Pine-Fir. No. 1 or better grade lumber shall be used for Southern Pine.~~

~~c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.~~

~~d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.~~

TABLE 2308.4.1.1(2)
HEADER AND GIRDER SPANS[a,b] FOR INTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir and required number of jack studs)

HEADERS AND GIRDERS SUPPORTING	SIZE	BUILDING Width[c] (feet)					
		12		24		36	
		Span[e]	NJ[d]	Span[e]	NJ[d]	Span[e]	NJ[d]
One floor only	2-2x4	4 - 1	1	2 - 10	1	2 - 4	1
	2-2x6	6 - 1	1	4 - 4	1	3 - 6	1
	2-2x8	7 - 9	1	5 - 5	1	4 - 5	2

	2-2x10	9 - 2	1	6 - 6	2	5 - 3	2
	2-2x12	10 - 9	1	7 - 7	2	6 - 3	2
	3-2x8	9 - 8	1	6 - 10	1	5 - 7	1
	3-2x10	11 - 5	1	8 - 1	1	6 - 7	2
	3-2x12	13 - 6	1	9 - 6	2	7 - 9	2
	4-2x8	11 - 2	1	7 - 11	1	6 - 5	1
	4-2x10	13 - 3	1	9 - 4	1	7 - 8	1
	4-2x12	15 - 7	1	11 - 0	1	9 - 0	2
Two floors	2-2x4	2 - 7	1	1 - 11	1	1 - 7	1
	2-2x6	3 - 11	1	2 - 11	2	2 - 5	2
	2-2x8	5 - 0	1	3 - 8	2	3 - 1	2
	2-2x10	5 - 11	2	4 - 4	2	3 - 7	2
	2-2x12	6 - 11	2	5 - 2	2	4 - 3	3
	3-2x8	6 - 3	1	4 - 7	2	3 - 10	2
	3-2x10	7 - 5	1	5 - 6	2	4 - 6	2
	3-2x12	8 - 8	2	6 - 5	2	5 - 4	2
	4-2x8	7 - 2	1	5 - 4	1	4 - 5	2
	4-2x10	8 - 6	1	6 - 4	2	5 - 3	2
	4-2x12	10 - 1	1	7 - 5	2	6 - 2	2

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. Spans are given in feet and inches.

b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir.

c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.

d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.

e. Spans are calculated assuming the top of the header or girder is laterally braced by perpendicular framing. Where the top of the header or girder is not laterally braced (e.g. cripple studs bearing on the header), tabulated spans for headers consisting of 2x8, 2x10, or 2x12 sizes shall be multiplied by 0.70 or the header or girder shall be designed.

Final Action: AS (Approved as Submitted)

S288-16

IBC: 2308.4.1.1, 2308.4.1.1(2) (New).

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

2015 International Building Code

Revise as follows:

~~2308.4.1.1~~ (2)

~~HEADER AND GIRDER SPANS[a, b] FOR INTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine and Spruce-Pine-Fir[b] and required number of jack studs)~~

~~HEADERS AND GIRDERS SUPPORTING~~	~~SIZE~~	~~BUILDING WIDTH[c] (feet)~~					
		~~20~~		~~28~~		~~36~~	
		~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~	~~Span~~	~~NJ[d]~~
~~One floor only~~	~~2-2 × 4~~	~~3-1~~	~~1~~	~~2-8~~	~~1~~	~~2-5~~	~~1~~
	~~2-2 × 6~~	~~4-6~~	~~1~~	~~3-11~~	~~1~~	~~3-6~~	~~1~~
	~~2-2 × 8~~	~~5-9~~	~~1~~	~~5-0~~	~~2~~	~~4-5~~	~~2~~
	~~2-2 × 10~~	~~7-0~~	~~2~~	~~6-1~~	~~2~~	~~5-5~~	~~2~~
	~~2-2 × 12~~	~~8-1~~	~~2~~	~~7-0~~	~~2~~	~~6-3~~	~~2~~
	~~3-2 × 8~~	~~7-2~~	~~1~~	~~6-3~~	~~1~~	~~5-7~~	~~2~~
	~~3-2 × 10~~	~~8-9~~	~~1~~	~~7-7~~	~~2~~	~~6-9~~	~~2~~
	~~3-2 × 12~~	~~10-2~~	~~2~~	~~8-10~~	~~2~~	~~7-10~~	~~2~~
	~~4-2 × 8~~	~~9-0~~	~~1~~	~~7-8~~	~~1~~	~~6-9~~	~~1~~
	~~4-2 × 10~~	~~10-1~~	~~1~~	~~8-9~~	~~1~~	~~7-10~~	~~2~~
	~~4-2 × 12~~	~~11-9~~	~~1~~	~~10-2~~	~~2~~	~~9-1~~	~~2~~
	~~2-2 × 4~~	~~2-2~~	~~1~~	~~1-10~~	~~1~~	~~1-7~~	~~1~~

	~~2-2 × 6~~	~~3-2~~	~~2~~	~~2-9~~	~~2~~	~~2-5~~	~~2~~
	~~2-2 × 8~~	~~4-1~~	~~2~~	~~3-6~~	~~2~~	~~3-2~~	~~2~~
	~~2-2 × 10~~	~~4-11~~	~~2~~	~~4-3~~	~~2~~	~~3-10~~	~~3~~
	~~2-2 × 12~~	~~5-9~~	~~2~~	~~5-0~~	~~3~~	~~4-5~~	~~3~~
~~Two floors~~	~~3-2 × 8~~	~~5-1~~	~~2~~	~~4-5~~	~~2~~	~~3-11~~	~~2~~
	~~3-2 × 10~~	~~6-2~~	~~2~~	~~5-4~~	~~2~~	~~4-10~~	~~2~~
	~~3-2 × 12~~	~~7-2~~	~~2~~	~~6-3~~	~~2~~	~~5-7~~	~~3~~
	~~4-2 × 8~~	~~6-1~~	~~1~~	~~5-3~~	~~2~~	~~4-8~~	~~2~~
	~~4-2 × 10~~	~~7-2~~	~~2~~	~~6-2~~	~~2~~	~~5-6~~	~~2~~
	~~4-2 × 12~~	~~8-4~~	~~2~~	~~7-2~~	~~2~~	~~6-5~~	~~2~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.~~

~~a. Spans are given in feet and inches.~~

~~b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir and Spruce-Pine-Fir. No. 1 or better grade lumber shall be used for Southern Pine.~~

~~c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.~~

~~d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.~~

TABLE 2308.4.1.1(2)
HEADER AND GIRDER SPANS[a,b] FOR INTERIOR BEARING WALLS (Maximum spans for Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir and required number of jack studs)

HEADERS AND GIRDERS SUPPORTING	SIZE	BUILDING Width[c] (feet)					
		12		24		36	
		Span[e]	NJ[d]	Span[e]	NJ[d]	Span[e]	NJ[d]
One floor only	2-2x4	4 - 1	1	2 - 10	1	2 - 4	1
	2-2x6	6 - 1	1	4 - 4	1	3 - 6	1
	2-2x8	7 - 9	1	5 - 5	1	4 - 5	2

	2-2x10	9 - 2	1	6 - 6	2	5 - 3	2
	2-2x12	10 - 9	1	7 - 7	2	6 - 3	2
	3-2x8	9 - 8	1	6 - 10	1	5 - 7	1
	3-2x10	11 - 5	1	8 - 1	1	6 - 7	2
	3-2x12	13 - 6	1	9 - 6	2	7 - 9	2
	4-2x8	11 - 2	1	7 - 11	1	6 - 5	1
	4-2x10	13 - 3	1	9 - 4	1	7 - 8	1
	4-2x12	15 - 7	1	11 - 0	1	9 - 0	2
Two floors	2-2x4	2 - 7	1	1 - 11	1	1 - 7	1
	2-2x6	3 - 11	1	2 - 11	2	2 - 5	2
	2-2x8	5 - 0	1	3 - 8	2	3 - 1	2
	2-2x10	5 - 11	2	4 - 4	2	3 - 7	2
	2-2x12	6 - 11	2	5 - 2	2	4 - 3	3
	3-2x8	6 - 3	1	4 - 7	2	3 - 10	2
	3-2x10	7 - 5	1	5 - 6	2	4 - 6	2
	3-2x12	8 - 8	2	6 - 5	2	5 - 4	2
	4-2x8	7 - 2	1	5 - 4	1	4 - 5	2
	4-2x10	8 - 6	1	6 - 4	2	5 - 3	2
	4-2x12	10 - 1	1	7 - 5	2	6 - 2	2

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. Spans are given in feet and inches.

b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas Fir-Larch, Hem-Fir, Southern Pine, and Spruce-Pine-Fir.

c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.

d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.

e. Spans are calculated assuming the top of the header or girder is laterally braced by perpendicular framing. Where the top of the header or girder is not laterally braced (e.g. cripple studs bearing on the header), tabulated spans for headers consisting of 2x8, 2x10, or 2x12 sizes shall be multiplied by 0.70 or the header or girder shall be designed.

Reason: The update of Table 2308.4.1.1(2) Header and Girder Spans for Interior Bearing Walls is proposed. Updated spans address use of Southern Pine No. 2 in lieu of Southern Pine No. 1. Footnote "e" is added to clarify that header spans are based on laterally braced assumption such as when the header is raised. For dropped headers consisting of 2x8, 2x10, or 2x12 size framing and not laterally braced, a factor of 0.7 can be applied to determine the spans or alternatively the header or girder can be designed to include any adjustment for potential buckling. Laterally braced (raised) and not laterally braced (dropped) header conditions and building widths for which header spans are tabulated represent the same conditions used to develop header span tables in the Wood Frame Construction Manual (WFCM).

Cost Impact: Will increase the cost of construction
Increased cost may be associated with reduced spans that result from the not laterally braced condition and application of footnote e. Due to smaller building width column (12'), permissible use of Southern Pine No. 2, and the laterally braced assumption for tabulated spans, there are also cases where this change will not increase the cost of construction and may reduce cost of construction.

S288-16 : TABLE 2308.4.1.1-TYREE11413

Final Action: AS (Approved as Submitted)

S8262

Date Submitted	12/14/2018	**Section**	2308.5.5.1	**Proponent**	Paul Coats
Chapter	23	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes **Alternate Language** No

Related Modifications

Summary of Modification

Adds provisions for single-member headers in exterior walls

Rationale

This modification was approved by the ICC committee and membership and appears in the 2018 edition of the International Building Code. This proposal adds prescriptive framing and connection requirements for single member (single ply) headers consistent with the residential code. Additionally, provisions of 2308.5.5.1 are revised to coordinate with tabulated header sizes consisting of 2, 3, or 4-member headers.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

New framing detail for certain headers.

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

No cost-related impact.

Impact to industry relative to the cost of compliance with code

No cost-related impact.

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

No cost-related impact.

Requirements

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

Provides a framing option related to headers and therefore safety.

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

Provides equivalent methods of construction.

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

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

2nd Comment Period

S8262-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

2308.5.5.1Openings in exterior bearing walls.

Headers shall be provided over each opening in exterior bearing walls. The size and spans in Table 2308.4.1.1(1) are permitted to be used for one- and two-family *dwellings*. Headers for other buildings shall be designed in accordance with Section 2301.2, Item 1 or 2. Headers ~~shall be~~ of two <u>or more</u> pieces of nominal 2-inch (51 mm) framing lumber set on edge ~~as~~ <u>shall be</u> permitted ~~by~~ <u>in accordance with</u> Table 2308.4.1.1(1) and nailed together in accordance with Table 2304.10.1 or of solid lumber of equivalent size.

<u>Single member headers of nominal 2-inch thickness shall be framed with a single flat 2-inchnominal (51 mm) member or wall plate not less in width than the wall studs on the top and bottom of the header in accordance with Figures 2308.5.5.1(1) and 2308.5.5.1(2) and face nailed to the top and bottom of the header with 10d box nails (3 inches × 0.128 inches) spaced 12 inches on center.</u>

Wall studs shall support the ends of the header in accordance with Table 2308.4.1.1(1). Each end of a lintel or header shall have a bearing length of not less than 1 1/2 inches (38 mm) for the full width of the lintel.

(See uploaded support file for new figures, <u>Figure 2308.5.5.1(1) Single Member Header in Exterior Bearing Wall</u> and <u>Figure 2308.5.5.1(2) Alternative Single Member Header Without Cripple)</u>

Revise as follows:

2308.5.5.1 Openings in exterior bearing walls. Headers shall be provided over each opening in exterior bearing walls. The size and spans in Table 2308.4.1.1(1) are permitted to be used for one- and two-family *dwellings*. Headers for other buildings shall be designed in accordance with Section 2301.2, Item 1 or 2. Headers ~~shall be~~ of two or more pieces of nominal 2-inch (51 mm) framing lumber set on edge ~~as~~ shall be permitted ~~by~~ in accordance with Table 2308.4.1.1(1) and nailed together in accordance with Table 2304.10.1 or of solid lumber of equivalent size.

Single member headers of nominal 2-inch thickness shall be framed with a single flat 2-inch-nominal (51 mm) member or wall plate not less in width than the wall studs on the top and bottom of the header in accordance with Figures 2308.5.5.1(1) and 2308.5.5.1(2) and face nailed to the top and bottom of the header with 10d box nails (3 inches × 0.128 inches) spaced 12 inches on center.

Wall studs shall support the ends of the header in accordance with Table 2308.4.1.1(1). Each end of a lintel or header shall have a bearing length of not less than $1^{1}/_{2}$ inches (38 mm) for the full width of the lintel.

Add new text as follows:

FIGURE 2308.5.5.1(1)
Single Member Header in Exterior Bearing Wall

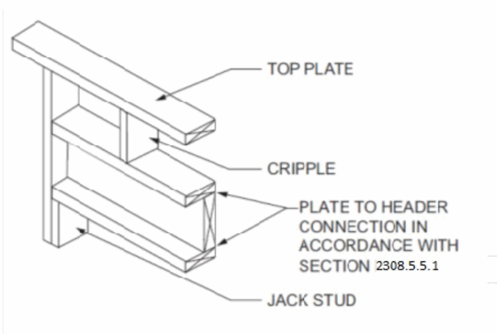
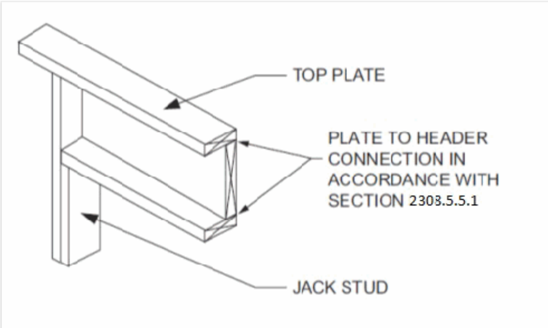


FIGURE 2308.5.5.1(2)

Alternative Single Member Header Without Cripple



Final Action: AS (Approved as Submitted)

S292-16

IBC: 2308.5.5.1, 2308.5.5.1(1) (New), 2308.5.5.1(2) (New).

Proponent : Paul Coats, PE CBO, representing American Wood Council (pcoats@awc.org)

2015 International Building Code

Revise as follows:

2308.5.5.1 Openings in exterior bearing walls. Headers shall be provided over each opening in exterior bearing walls. The size and spans in Table 2308.4.1.1(1) are permitted to be used for one- and two-family *dwellings*. Headers for other buildings shall be designed in accordance with Section 2301.2, Item 1 or 2. Headers ~~shall be~~ of two or more pieces of nominal 2-inch (51 mm) framing lumber set on edge ~~as~~ shall be permitte~~d by~~ in accordance with Table 2308.4.1.1(1) and nailed together in accordance with Table 2304.10.1 or of solid lumber of equivalent size.

Single member headers of nominal 2-inch thickness shall be framed with a single flat 2-inch-nominal (51 mm) member or wall plate not less in width than the wall studs on the top and bottom of the header in accordance with Figures 2308.5.5.1(1) and 2308.5.5.1(2) and face nailed to the top and bottom of the header with 10d box nails (3 inches × 0.128 inches) spaced 12 inches on center.

Wall studs shall support the ends of the header in accordance with Table 2308.4.1.1(1). Each end of a lintel or header shall have a bearing length of not less than $1^{1}/_{2}$ inches (38 mm) for the full width of the lintel.

Add new text as follows:

FIGURE 2308.5.5.1(1)
Single Member Header in Exterior Bearing Wall

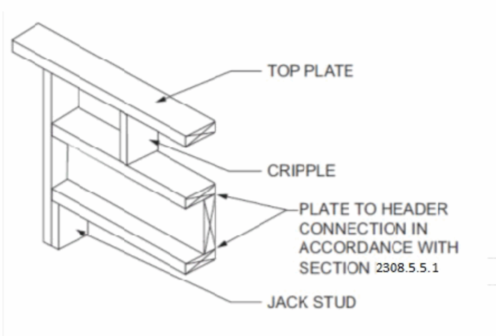
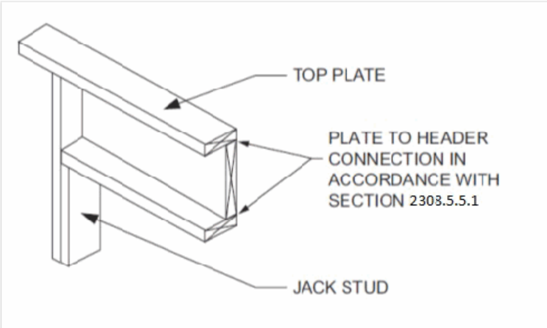


FIGURE 2308.5.5.1(2)

Alternative Single Member Header Without Cripple



Reason: This propsoal adds prescriptive framing and connection requirements for single member (single ply) headers consistent with the IRC. Additionally, provisions of 2308.5.5.1 are revised to coordinate with tabulated header sizes consisting of 2, 3, or 4 member headers.

Cost Impact: Will not increase the cost of construction
This change adds a more efficient single member header option in some cases and will not raise the cost of construction.

S292-16 : 2308.5.5.1-COATS13384

Final Action: AS (Approved as Submitted)

S8338

Date Submitted	12/15/2018	**Section**	2603.12	**Proponent**	John Woestman
Chapter	26	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	No Affirmative Recommendation				
Commission Action	Pending Review				

Comments

General Comments Yes **Alternate Language** No

Related Modifications

Summary of Modification

This proposal updates the existing tables by applying a consistent rounding down to the nearest 0.05" for foam sheathing thickness and adds an 18 psf cladding weight category at the request of the brick industry.

Rationale

This proposal updates the existing tables by applying a consistent rounding down to the nearest 0.05" for foam sheathing thickness to better and more efficiently accommodate various foam sheathing products that have actual thickness that may vary from nominal thickness currently in the table. The same rounding is applied to the addition of an 18 psf cladding weight category at the request of the brick industry. All of the values were determined using the same analysis and research basis of the original tables, including limiting foam thicknesses to 3" maximum for #8 screw as was done for the existing tables based on availability of fastener lengths and practicality considerations.

COST IMPACT: This proposal will not increase cost. This proposal will actually decrease cost as a result of more efficient design for foam thickness and fastener sizing.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

The proposal refines the values in the existing table regarding maximum thickness of foam sheathing. There should be no differences in code enforcement.

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

This proposal will not increase cost. This proposal will actually decrease cost as a result of more efficient design for foam thickness and fastener sizing.

Impact to industry relative to the cost of compliance with code

This proposal will not increase cost. This proposal will actually decrease cost as a result of more efficient design for foam thickness and fastener sizing.

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

This proposal will not increase cost. This proposal will actually decrease cost as a result of more efficient design for foam thickness and fastener sizing.

Requirements

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

Improves the technical requirements of these two tables - which are related to energy efficiency aspects of a building.

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

Strengthens the code by improving the technical requirements in these tables.

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

Does not discriminate against materials.

Does not degrade the effectiveness of the code

Maintains the effectiveness of the code.

2nd Comment Period

S8338-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

Revise Tables 2603.12.1 and 2603.12.2 as follows:

TABLE 2603.12.1 CLADDING MINIMUM FASTENING REQUIREMENTS

FOR DIRECT ATTACHMENT OVER FOAM PLASTIC SHEATHING

TO SUPPORT CLADDING WEIGHT[1]

Cladding Fastener Through Foam Sheathing into:	Cladding Fastener -Type and Minimum Size[2]	Cladding Fastener Vertical Spacing (inches)	Maximum Thickness of Foam Sheathing[3] (inches)							
			16"oc Fastener Horizontal Spacing				24"oc Fastener Horizontal Spacing			
			Cladding Weight:				Cladding Weight:			
			3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Steel Framing (minimum penetration of steel thickness + 3 threads)	#8 screw into 33 mil steel or thicker	6	3.00	2.95~~3~~	2.20	1.45	3.00	2.35	1.25	DR
		8	3.00	2.55	1.60	0.60~~5~~	3.00	1.80~~5~~	DR	DR
		12	3.00	1.80~~5~~	DR	DR	3.00	0.65~~75~~	DR	DR
	#10 screw into 33 mil steel	6	4.00	3.50	2.70	1.95~~2~~	4.00	2.90~~3~~	1.70	0.55
		8	4.00	3.10	2.05	1.00	4.00	2.25	0.70	DR
		12	4.00	2.25	0.70	DR	3.70	1.05	DR	DR
	#10 screw into 43 mil steel or thicker	6	4.00	4.00	4.00	3.60	4.00	4.00	3.45	2.70
		8	4.00	4.00	3.70	3.00~~2~~	4.00	3.85	2.80	1.80~~5~~
		12	4.00	3.85	2.80	1.80~~5~~	4.00	3.05	1.50	DR

(Table notes unchanged)

TABLE 2603.12.2 FURRING MINIMUM FASTENING REQUIREMENTS FOR APPLICATION

OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[1]

Furring Material	Framing Member	Fastener Type and Minimum Size[2]	Minimum Penetration into Wall Framing (inches)	Fastener Spacing in Furring (inches)	Maximum Thickness of Foam Sheathing[4] (inches)							
					16"oc FURRING[5]				24"oc FURRING[5]			
					Cladding Weight:				Cladding Weight:			
					3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Minimum 33mil Steel Furring or Minimum 1x Wood Furring[3]	33 mil Steel Stud	#8 screw	Steel thickness + 3 threads	12	3.00	1.80~~5~~	DR	DR	3.00	0.65	DR	DR
				16	3.00	1.00	DR	DR	2.85	DR	DR	DR
				24	2.85	DR	DR	DR	2.20	DR	DR	DR
		#10 screw	Steel thickness + 3 threads	12	4.00	2.25	0.70	DR	3.704	1.05	DR	DR
				16	3.854	1.45	DR	DR	3.40	DR	DR	DR
				24	3.40	DR	DR	DR	2.70	DR	DR	DR
	43 mil or thicker Steel Stud	#8 Screw	Steel thickness + 3 threads	12	3.00	1.80~~5~~	DR	DR	3.00	0.65	DR	DR
				16	3.00	1.00	DR	DR	2.85	DR	DR	DR
				24	2.85	DR	DR	DR	2.20	DR	DR	DR

		#10 screw	Steel thickness + 3 threads	12	4.00	3.85	2.80	1.80~~5~~	4.00	3.05	1.50	DR
				16	4.00	3.30	1.95	0.60~~5~~	4.00	2.25	DR	DR
				24	4.00	2.25	DR	DR	4.00	0.65	DR	DR

(Table notes unchanged)

Date Submitted	12/15/2018	**Section**	3115	**Proponent**	Joseph Belcher for Bison
Chapter	31	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

Related definitions in Section 202

Summary of Modification

Adds section for exterior elevated flooring systems.

Rationale

Exterior elevated flooring systems are increasingly seen on rooftops and other exterior locations. The systems are used to create space typically used for assembly occupancies such as restaurants, bars, and nightclubs, and gathering places. The code does not adequately address such systems. This proposal is to address that need.

In many cases, the flooring system is treated as a roof, and overly restrictive provisions are applied. The exterior elevated flooring system is not a roof but is a floor created on a rooftop or other supporting structure. The proposal provides for continuing to treat the systems as a roof by attaching the support pedestals to the roof surface. However, considerable research has shown that these systems due to their air-permeability react to wind forces differently than the typical rooftop. The application of current literature and the use of wind tunnel testing coupled with new provisions on air-permeable cladding in ASCE 7-16 will allow more economical construction of these popular systems with no reduction in safety.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact on the cost of enforcement of code.

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

The provisions will likely result in savings to property owners desiring to turn rooftops and other exterior spaces into useable areas.

Impact to industry relative to the cost of compliance with code

The provisions will allow economical expansion of the conversion of unusable spaces. The provisions will likely result in savings to industry constructing exterior elevated flooring system to turn rooftops and other spaces into useable areas.

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

The provisions will allow economical expansion of the conversion of unusable spaces benefitting the owners of small businesses. The provisions will likely result in savings to small businesses seeking to add useable areas to their business by installing exterior elevated flooring systems.

Requirements

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

Occupied roofs using elevated flooring systems are becoming more common and the code does not adequately address the systems. This proposal will help to assure the health, safety, and welfare of members of the public using such facilities.

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

The change to the code will improve the code by addressing a system not adequately addressed by the code and helping to assure the safety of the public.

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

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

Does not degrade the effectiveness of the code

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

Alternate Language

2nd Comment Period

8357-A3

Proponent Joseph Belcher **Submitted** 5/26/2019 **Attachments** Yes

Rationale

Forgot to attach files.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None.

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

None.

Impact to industry relative to the cost of compliance with code

None.

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

The provisions will allow economical expansion of the conversion of unusable spaces benefitting the owners of small businesses. The provisions will likely result in savings to small businesses seeking to add useable areas to their business by installing exterior elevated flooring systems.

Requirements

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

None.

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

None.

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

None.

Does not degrade the effectiveness of the code

None.

Alternate Language

2nd Comment Period

8357-A2

Proponent Joseph Belcher **Submitted** 5/26/2019 **Attachments** Yes

Rationale

See uploaded file. The system says the Rationale exceeds the allowed 2000 characters. MS Word Count says the Rationale statement is 1981 characters including spaces.

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

The provisions will likely result in savings to property owners desiring to turn rooftops and other exterior spaces into a useable area.

Impact to industry relative to the cost of compliance with code

The provisions will economically allow the conversion of heretofore unusable spaces into attractive useable spaces. The provisions will likely result in savings to industry constructing exterior elevated flooring system to turn rooftops and other spaces into a useable area.

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

The provisions will allow economical expansion of the conversion of unusable spaces benefitting the owners of small businesses. The provisions will likely result in savings to small businesses seeking to add useable areas to their business by installing exterior elevated flooring systems.

Requirements

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

Occupied roofs using elevated flooring systems are becoming more common, and the code does not address the systems. This proposal will help to assure the health, safety, and welfare of members of the public using such facilities by providing guidelines to designers, contractors, and code enforcers.

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

The change to the code will improve the code by addressing a popular system not addressed by the code and helping to assure the safety of the public.

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

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

Does not degrade the effectiveness of the code

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

This is not alternate language. I forgot to attach the new referenced standards and the research to the Alternate Language submitted earlier.

202

Exterior Elevated Flooring System.~~An elevated flooring system installed over roofing systems or other supporting structures.~~ An assembly installed over a roof assembly ~~and /~~ or other exterior supporting structure consisting of a walking surface of pedestrian deck panels ~~/~~ or pavers mounted on pedestals using other accessory components, ~~and~~ mechanical fasteners ~~and /~~ or adhesives as required by the manufacturer's installation instructions for attaching pedestrian deck panels ~~/~~ or pavers to pedestals and other accessory components. Exterior elevated flooring systems may have pedestals attached to the roof or other supporting structure or pedestals installed independently of the roof or supporting structure with the restraint of the pavers at the perimeter and ~~or~~ discontinuous edges. Exterior elevated flooring systems are not part of the roof assembly.

Attached systems. Attached systems are those where pedestals are attached to the roof or other supporting structure by mechanical fasteners, adhesives, or both.

Independent systems. Independent systems are those where pedestals are not attached to the roof but rest on the roof or other supporting structure.

Pedestrian Deck Panels~~/and~~ or Pavers. Pedestrian deck panels ~~/~~ or pavers for ~~the purpose of~~ this section are manufactured from materials such as naturally durable wood, ceramic, stone, or concrete suitable for exterior applications.

Pedestal. A fixed or adjustable-height support column composed of a ~~plastic~~ support base, ~~plastic~~ vertical structural element, and a ~~plastic~~ load bearing top cap ~~/~~ surface.

Accessory Components. ~~These c~~ Components ~~are~~ used in the installation of pedestals and pedestrian deck panels ~~/~~ or pavers of the exterior elevated flooring system. ~~These~~ Accessory components are made of either plastic, ~~or~~ metal, or other approved materials. ~~These~~ Accessory components may be used to provide lateral bracing of the pedestals, to provide vertical support, for leveling the pedestal~~, and~~ to restrain the pedestrian deck panels ~~/~~ or pavers to the top of the pedestal, or for other system requirements.

3101.1 Scope. The provisions of this chapter shall govern special building construction including membrane structures, temporary structures, pedestrian walkways and tunnels, automatic vehicular gates, awnings and canopies, marquees, signs, ~~and~~ towers and antennas, and exterior elevated flooring systems.

Section 3115

Exterior Elevated Flooring Systems.

3115.1 Scope. This section ~~is applicable~~ applies to exterior elevated flooring systems installed over roof assemblies or other exterior supporting structures such as an exterior deck. Each exterior elevated flooring system consists of pedestrian deck panels ~~/~~ or pavers supported by pedestals placed directly on roof

assemblies or other exterior supporting structures, to provide a level walking surface. Pedestals ~~can~~ may be ~~adjusted~~ adjustable ~~to various heights or installed at~~ or a fixed height.
The pedestals need not be mechanically or adhesively attached to the supporting structure. The exterior elevated flooring system comprised of the pedestrian deck panels ~~/~~ or pavers and pedestals ~~must~~ shall be restrained on all sides and along any ramps and ~~/or~~ walkway areas against horizontal and vertical movement using a perimeter-restraining system.

3115.1.1 Attached exterior elevated flooring systems. Attached systems shall be designed and constructed as a roofing system in accordance with Chapter 15 of this code.

3115.1.2 Independent exterior elevated flooring systems. Independent systems shall comply with the provisions of Section 3115.

3115.2 Materials Information Submitted with Permit Application. In addition to other information required to accompany the permit application, product-specific information shall be provided as follows:

3115.2.1 Pedestrian Deck panels~~/~~ or pavers. Documentation describing the weight, dimensions, specifications, and the manufacturing process of the materials. Specifications for ~~cementitious~~materials ~~such as concrete pavers~~ shall include required material strength properties used in analysis or reference to appropriate tests used to determine paver load capacity.

3115.2.2 Pedestals. Documentation describing materials, dimensions, specifications, ~~compression strength,~~ and manufacturer's installation instructions. Specifications shall include the allowable axial compression capacity of the pedestal.

3115.2.3 Fasteners. Documentation describing mechanical fasteners and adhesives as applicable. A statement shall be provided regarding whether or not the fasteners are commonly available or are proprietary.

3115.2.4 Plastics for outdoor exposure HVHZ. Plastics for outdoor exposure in the HVHZ shall comply with Florida Building Code-Building Section 2615.2.

3115.2.5 Packaging and Identification. A description of the method of packaging and identification of pedestrian deck panels ~~/~~ or pavers, pedestals, and accessory components. Identification provisions shall include the manufacturer's name, the product name, and copy of the installation instructions, as packaged with the product.

3115.3 Product Approval and Manufacturer's Installation Instructions.

3115.3.1 Product approval. Exterior elevated flooring systems shall have Florida ~~P~~product ~~A~~ approval or local product approval.

3115.3.2 Manufacturer's installation instructions. Manufacturer's installation instructions shall include information on the protection of the roof surface during installation, procedures for removing pavers to facilitate reroofing, roofing repairs, and roofing maintenance. In addition to the copy of the manufacturer's installation instructions submitted with the permit application, the manufacturer's installation instructions shall be kept on the job site and made available to inspection personnel.

3115.4 Structural Requirements for Exterior Elevated Flooring Systems.

3115.4.1 General. Exterior elevated flooring systemsshall withstand the applicable uniform loads of Florida Building Code-Building Table 1607.1, the applicable load combinations, and other applicable loads contained in ~~FBC-B~~ the Florida Building Code-Building, Chapter 16.

3115.4.2 Pedestrian Deck panels ~~/~~ or pavers. Where analysis of panels or pavers is not consistent with codified material design procedures, testing for uniform load and concentrated load capacities shall be performed in accordance with ASTM E2322 and CISCA Recommended Test Procedures for Access Floors achieving a load capacity three (3) times the uniform load capacity designated in the specifications.

3115.4.3 Pedestals. Where analysis of pedestals is not consistent with codified material design procedures, testing for axial load capacity shall be performed in accordance with CISCA Recommended Test Procedures for Access Floors, 2016, Section 5 achieving a load capacity three (3) times the axial load capacity designated in the specifications.

3115.4.4 Wind resistance. Wind resistance of independent exterior elevated flooring systems shall be determined by wind tunnel testing in accordance with ASCE 7 Chapter 31 and Section 30.1.5 where applicable. Testing shall be conducted, and the data analyzed by a registered design professional. Exterior elevated flooring systems shall be evaluated by a registered design professional to withstand applicable wind loads as specified in ASCE 7 Chapters 26 through 30, as applicable, as well as combined load effects of other applicable gravity loads in ~~FBC-B~~ the Florida Building Code-Building, Chapter 16, such as live and dead loads.

3115.4.5 Deflection. Pedestrian deck panels or pavers shall meet the deflection requirement of floor members in Table 1604.3 and Section 1616.3.1 in the HVHZ.

3115.5 Substrate Requirements for Exterior Elevated Flooring Systems.

3115.5.1 Bearing Capacity. Pedestal support surface or roofing membrane shall be able to support a concentrated surface load of 40 psi under the pedestal base.

3115.5.2 Drainage. The substrate immediately below the pedestals shall provide positive drainage.

3115.5.3 Analysis. Load effects on structural members and their connections that provide support for independent exterior elevated flooring systems shall be determined by methods of structural analysis that take into account equilibrium, general stability, geometric compatibility and both short- and long-term material properties. Roof structures that provide support for exterior elevated flooring systems shall be checked for deflection in accordance with Section 1604.3.6 or Section 1616 for buildings sited in the HVHZ. Roof structures shall be checked in accordance with Section 1611 for ponding. The design shall account for concentrated loads of the pedestals.

3115.6 Accessibility. Accessibility shall comply with the Florida Building Code-Accessibility.

Chapter 35:

ASTM:

E2322-03 (Reapproved 2015) Standard Test Method for Conducting Transverse and Concentrated Load Tests on Panels used in Floor and Roof Construction……………………………………….…………...……3115.4.2

CCIS Ceilings and Interior Systems Construction Association

1010 Jorie Blvd., Suite 30

Oak Brook, IL 60523

Recommended Test Procedures for Access Floors……………3115.4.2, 3115.4.3

ASCE/SEI: (Add to existing code section references)

7-16 ……………………………………………………………...…….3115.2.3. 3115.4.4

202

Exterior Elevated Flooring System. An elevated flooring system installed over roofing systems or other supporting structures. Exterior elevated flooring systems may be attached to the supporting structure or installed independently of the supporting structure or a combination thereof.

Attached systems. Attached systems are those where pedestals are attached to the roof or other supporting structure by mechanical fasteners, adhesives, or both.

Independent systems. Independent systems are those where pedestals are not attached to but rest on the roof or other supporting structure.

Exterior Elevated Flooring System. An assembly installed over a roof assembly and/or exterior supporting structure consisting of pedestrian deck panels/pavers mounted on pedestals using other accessory components, and mechanical fasteners and/or adhesives as required by the manufacturer for attaching deck panels/pavers to pedestals and other accessory components.

Pedestrian Deck Panels/Pavers. Pedestrian deck panels/pavers for the purpose of this section are manufactured from materials such as naturally durable wood, ceramic, stone, or concrete suitable for exterior applications.

Pedestal. A fixed or adjustable-height support column composed of a plastic support base, plastic vertical structural element, and a plastic load bearing top cap/surface.

Accessory Components. These components are used in the installation of pedestals and deck panels/pavers of the exterior elevated flooring system. These components are made of either plastic or metal material. These components may be used to provide lateral bracing of the pedestals, vertical support, leveling the pedestal, and to restrain the deck panel/paver to the top of the pedestal.

3101.1 Scope. The provisions of this chapter shall govern special building construction including membrane structures, temporary structures, pedestrian walkways and tunnels, automatic vehicular gates, awnings and canopies, marquees, signs, ~~and~~ towers and antennas, and exterior elevated flooring systems.

Section 3115

Exterior Elevated Flooring Systems

3115.1 Scope. This section is applicable to exterior elevated flooring systems installed over roof assemblies or other exterior supporting structures. Each exterior elevated flooring system consists of deck panels/pavers supported by pedestals placed directly on roof assemblies or exterior supporting structures, to provide a level walking surface. Pedestals can be adjusted to various heights or installed at a fixed height.
The pedestals need not be mechanically or adhesively attached to the supporting structure. The exterior elevated flooring system comprised of the deck panels/pavers and pedestals must be restrained on all sides against horizontal movement using a perimeter-restraining system and along any ramps and/or walkway areas.

3115.1.1 Attached exterior elevated flooring systems. Attached systems shall be designed and constructed as a roofing system in accordance with Chapter 15 of this code.

3115.1.2 Independent exterior elevated flooring systems. Independent systems shall comply with the provisions of Section 3115.

3115.2 Information Submitted with Permit Application. In addition to other information required to accompany the permit application, product-specific information shall be provided as follows:

3115.2.1 Deck Panels/Pavers. Documentation describing the weight, dimensions, specifications, and the manufacturing process of the materials. Specifications for cementitious materials such as concrete pavers shall include 28-day compressive strength ($f_{c'}$), impact resistance, and density.

3115.2.2 Pedestals. Documentation describing materials, dimensions, specifications, and manufacturer's installation instructions.

3115.2.3 Fasteners. Documentation describing mechanical fasteners and adhesives as applicable. A statement shall be provided regarding whether or not the fasteners are commonly available or are proprietary.

3115.2.4 Packaging and Identification. A description of the method of packaging and identification of deck panel/pavers, pedestals, and accessory components. Identification provisions shall include the manufacturer's name, the product name, and a copy of the installation instructions, as packaged with the product.

3115.3 Product Approval and Manufacturer's Installation Instructions.

3115.3.1 Product approval. Exterior elevated flooring systems shall have Florida Product Approval or local product approval.

3115.3.2 Manufacturer's installation instructions. In addition to the copy of the manufacturer's installation instructions submitted with the permit application, manufacturer's installation instructions shall be kept on the job site and made available to inspection personnel.

3115.4 Structural Requirements for Exterior Elevated Flooring Systems.

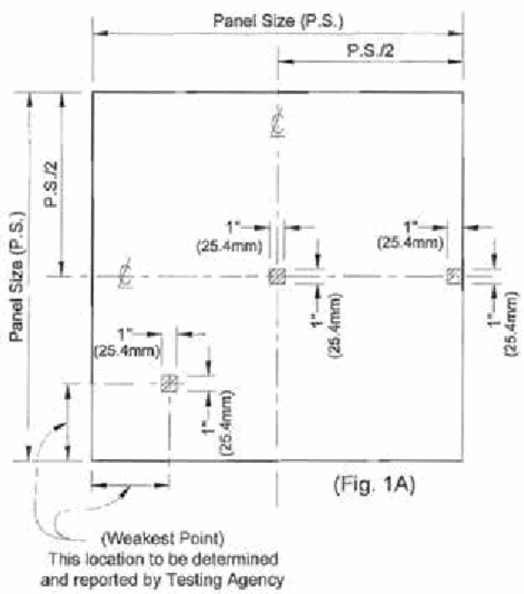
3115.4.1 General. Exterior elevated flooring system shall withstand the applicable uniform loads of FBC-B Table 1607, the applicable load combinations and other loads contained in FBC-B Chapter 16.

3115.4.2 Wind resistance. Wind resistance of independent exterior elevated flooring systems shall be determined by wind tunnel testing in accordance with ASCE 7 Chapter 31and Section 30.1.5 where applicable. Testing shall be conducted and the data analyzed by a registered design professional. Exterior elevated flooring systems shall be evaluated by a registered design professional to withstand applicable wind loads as specified in ASCE/SEI 7 Chapters 26 through 30, and the combined load effects of other applicable gravity loads in FBC-B Chapter 16, such as live and dead loads.

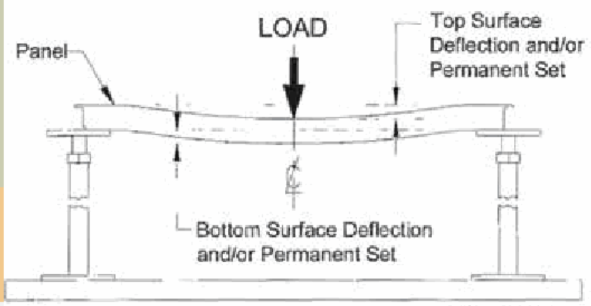
The proposed code change is not intended to provide instructions on the specific design of exterior elevated flooring systems but to provide guidance for the design and installation of the systems. There is no guidance in the code for designers or code enforcers. There is considerable research available on the systems and ASCE 7 permits the use of wind tunnel studies, test data or recognized literature for the design of air permeable systems in Chapter 30 (ASCE 7-16 §30.1.5). (See uploaded file.) The proposed change requires the use of wind tunnel testing per ASCE 7 Chapter 31 and §30.1 where applicable.

Alternate Language A-1 expands the section on structural requirements, adds a section on substrate requirements, expands the requirements to be included in the manufacturer's instructions, adds two reference standards for testing of pedestrian deck panels or pavers, and adds deflection criteria. The change is also modified to address the comments of the Structural TAC members and members of the public.

1. The definition was corrected to a single definition at §202.
2. Concentrated loads on the roofing material are addressed at §3115.5.3.
3. Protection of the roofing membrane during installation is addressed at §3115.3.2.
4. The provisions for limiting pedestals to plastic were removed at. §202 - Pedestal.
5. The provisions have been made as material neutral as possible throughout the proposed change.
6. Plastic weathering requirements for the HVHZ were added at §3115.2.4.
7. Reference to the ADA requirements of the code were added at §3115.6.
8. Provisions addressing interaction between the system and the roofing membrane were added at §3115.5.
9. Provisions related to reroofing, repair, and maintenance of the roofing membrane were added to §3115.3.2.
10. HVHZ specific references are provided. Generally, references to Chapter 16 are intended to invoke the Scope of Chapter 16 to direct users to either the non-HVHZ sections or the HVHZ sections as appropriate.



(Fig. 1A)



(Fig. 1B)

SETUP FOR CONCENTRATED LOAD TEST

Recommended Test Procedures for Access Floors

CISCA
Ceilings & Interior Systems
Construction Association

This publication,

Recommended Test Procedures for Access Floors

was reviewed and no revisions were suggested by the Committee, February, 2016.

Review Committee:

Jim Scissom, Chairman
ASM Modular Systems Inc.
9500 Industrial Center Drive
Ladson, SC 29456
843-534-1110
jscissom@asmproducts.com

Jeff Musculus
Steelcase
PO Box 1967
Grand Rapids, MI 49501
616-698-4685 jmusculu@steelcase.com

Ryan Hulland
Netfloor USA
374 Crompton Street
Charlotte, NC 28273
(844) 638-3566
ryan@netfloorusa.com

Scott Carmichael
Seal Bond
14851 Michael lane
Spring Lake, MI 49456
800-2524144 X 109
scarmichael@seal-bond.com

Amy Rapson
Haworth, Inc.
One Haworth Center
Holland, MI 49423
616-639-3000
amy.rapson@haworth.com

Bill Reynolds
Tate, Inc.
7510 Montevideo Dr.
Jessup, MD 20794
410-799-4720
breynolds@tateinc.com

Mark Krauk
ASM Modular Systems Inc.
9500 Industrial Center Drive
Ladson, SC 29456
843-534-1110
mark.krauk@asmproducts.com

Brian Vogel
Haworth, Inc.
One Haworth Center
Holland, MI 49423
616-639-3000
brian.vogel@haworth.com

Earl Geertgens
FreeAxez 1810 Underwood Blvd.
Delran, NJ 08075
856-764-0400
earl@freeaxez.com

CISCA
Ceilings & Interior Systems
Construction Association

Ceilings & Interior Systems Construction Association (CISCA)
CISCA exists to provide a network of opportunities with all industry leaders through education and a forum to allow the interior construction industry to interact, evolve and prosper.

CISCA's vision is to be the acknowledged leader of participating decision-makers in the promotion and support of the interior construction industry. CISCA aspires to be a dynamic, accessible, and valuable network which is market-driven and is transformational in continually leading the ceiling and interior systems industry to new levels of success.

Recommended Test Procedures for Access Floors Introduction

The publication of CISCA Recommended Test Procedures for Access Floors by the Ceilings & Interior Systems Construction Association (CISCA) represents a significant milestone in establishing a common basis of accepted test methods.

This document is intended to benefit contractors, specifiers, users, and manufacturers. By providing an accepted frame of reference for access floor testing, product characteristics can be judged in a fair context of industry-approved uniform test methods.

CISCA's intent is to provide a method for evaluating access floor characteristics, not criteria requirements. Because differing circumstances demand a range of performance levels, both manufacturers and users benefit from a variety of types of access floors in the marketplace. CISCA is strongly committed to developing test procedures that will appropriately address other performance factors related to all types of access floors.

It is essential, however, that product comparisons be based upon commonly used tests for valid results. These procedures have now been established in an industry-wide spirit of cooperation to achieve our common goal.

History

CISCA's involvement with access floor test procedures began in 1983, when interior contractor Jim Whittaker, Chairman of the CISCA Seismic Committee, proposed that the manufacturers meet and recommend changes to the Uniform Building Code (UBC). The International Conference of Building Officials (ICBO) then incorporated the CISCA-recommended changes into the 1985 UBC.

When the access floor manufacturers met again in May 1985, this time with the intention of developing a fair method of measurement for concentrated and rolling loads on access floors, the CISCA Access Floor Committee was born. The Committee agreed to develop test methods, not criteria; and further agreed that testing should be done by independent laboratories.

Over the next year, drafts of proposed test procedures were circulated to all known access floor manufacturers for review and comment. In 1987, The CISCA Board agreed to adopt the documents as CISCA's recommended test procedures and to encourage manufacturers to test their access floor products in this manner and report the data on the approved forms. The procedures were approved and published in July 1987.

In 2003, the CISCA Access Floor Committee reconvened to address changes in the marketplace. The committee agreed to tackle the task in two phases. In phase one, immediate issues were addressed and an updated version of Recommended Test Procedures for Access Floors was approved by CISCA's Board of Directors and reprinted in April 2004.

For phase two, the committee went back to work to address the more difficult issues as well as changes in the marketplace. The final document was submitted for approval to the Board of Directors in April 2007.

Contents

Testing procedures were established for concentrated load, ultimate load, rolling loads, stringer load, pedestal axial load, pedestal overturning moment, uniform load, drop impact load, fire performance and air leakage. These test procedures are user-oriented and represent sound engineering principles.

Interpretation of Test Results

No particular testing agency is recommended for these tests. Manufacturers are encouraged to select appropriate independent laboratories to test and certify test results.

Because sound engineering principles were used to develop the testing procedures, there should be no requirements to retest components for use in specific installations. For example, pedestals will be tested at the maximum design height; if pedestals are used at lower floor heights, there is no need to retest to assure the desired performance for that lower height. Further, system load tests will be performed utilizing bare panels, eliminating the need to test with each of the wide variety and thicknesses of wearing surfaces utilized in actual installations.

Note regarding the use and priority of units of measure:

All units of measure are expressed Inch/Pounds (in/lb) units, with the corresponding SI (Metric) units noted parenthetically. The in/lb units are to be treated as authoritative. Test results conducted pursuant to these procedures may be expressed in either unit, at the option of the proponent.

CISCA Testing Procedures Index

Section 1
Concentrated Load

Purpose:

To determine the maximum deflection(s) and permanent set(s) of an access floor under load.

Preparation:

1. Test shall be performed on three (3) randomly selected bare panel assemblies. (Four (4) panels are required if panel configuration is not structurally symmetrical.) Panels shall be placed on steel blocks or supports configured to provide support identical to that provided by an installed system. Any coatings, gaskets, pads, clips, fasteners, floor covering, or other materials as required by manufacturer shall be identical to an installed system. Blocks or supports shall not reduce the unsupported edge span below that normally provided with a standard installed system.
2. Panels designed for stringer support shall have stringers spanning the blocks or supports with panel perimeter support and/or interface in an identical manner to the configuration of the installed floor systems. Stringers shall be identical to those of the installed floor system, attached or fitted to the support blocks in an identical manner to the installed floor system, and shall include any coatings, gaskets, pads, clips, fasteners, finishes or other materials as required by the manufacturer in the installed floor system.
3. Height of the test mock-up shall be sufficient to accommodate deflections of stringers and panels and to allow for instrumentation.
4. Concentrated loading shall be applied to the structure though a steel indentor 1" (25.4 mm) square (if applicable, floor covering shall be removed at indentor location). This square indentor may have eased edges at maximum .008" (0.20 mm) radii, but the footprint contact area shall not measure more than 1" x 1" (25.4 mm x 25.4 mm). A round indentor (1.128" [28.65 mm] diameter) may be utilized in lieu of a square indentor provided the footprint contact area shall not exceed one square inch (645 mm2).

Test Procedure:

1. Each panel shall be loaded at its "weakest point," as determined by the Manufacturer's internal and /or independent / certifying testing agency to be the location which allows the greatest deflection under load. In addition to the "weakest point" panels shall be tested at the centroid and midpoint of edge. In the case of access flooring systems where panels are not contiguous, loads shall also be applied to the "weakest point" of the connecting material (e.g. steel cap) between panels.
2. Each panel shall be pre-loaded for each test to the test load at each location. A pre-load of 50 lb (222 N) shall then be applied and the instrumentation measuring deflection and load shall be set at zero. (Reference zero = 50 lb [222 N] pre-load)
3. Each panel shall be tested for each applied load location. After the pre-load each panel shall be tested at each applied load location by increments not exceeding 200 lb (890 N), with initial load no more than one-half test load. Rate of load application shall not exceed 1500 pounds per minute (6.673 kN/min).
4. Top surface deflection and permanent set shall be measured at each applied load location by recording indentor movement. For products with uneven bottom surfaces and where the deflection and set are measured on the bottom of the panel, the measurements shall be taken at the lowest adjacent horizontal surface.
5. Loads shall be applied at each location for a minimum of one (1) minute and deflection readings taken at the end of that period. The load shall then be relaxed to reference zero (Reference zero = 50 lb [222 N] pre-load) for a minimum one (1) minute and deflection shall be recorded.

Report:

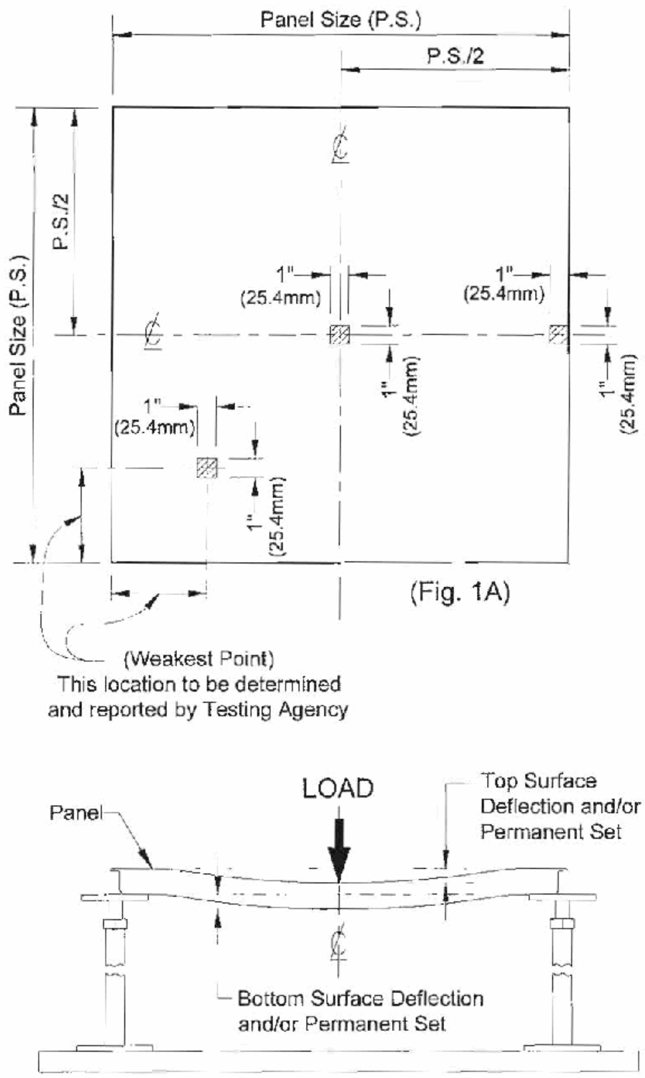
1. Reference of testing procedure described herein by CISCA A/F section number shall be included in report.
2. All apparatus, equipment, instrumentation, accuracy ranges, etc. shall be described including equipment calibration/certification dates.
3. Materials tested and mock-up configuration(s) should be fully described in verbiage or referenced to manufacturers drawings and/or part numbers, either containing the following information:

   Panels:
   - Material(s) of panel construction.
   - Weight, nominal dimensions and thicknesses.

   Stringers:
   - Material(s) of construction.
   - Weight, and nominal dimensions and thickness, including fasteners, gaskets, coatings, clips, etc.

   Other:
   - Fully describe gasketing, pads, other items utilized in the system.
4. Panel deflection measurements, of the top surface shall be reported to the nearest .001" (0.025 mm) for each applied load.
5. Panel permanent set of the top surface shall be reported to the nearest .001" (0.025 mm) for each applied load.

Section 1: – Panel Loading Locations



(Fig. 1A)

(Fig. 1B)

SETUP FOR CONCENTRATED LOAD TEST

(Fig. 1)

Section 1: Concentrated Loads

REPORT FORMAT

	Deflection Top Surface	Set Top Surface	Deflection *Bottom Surface	*Set Bottom Surface
Panel 1: Center 50 lb. (222 N) Pre Load	-0-	-0-	-0-	-0-
Concentrated Load ______ lbs. (N).	______	______	______	______
Panel 2: C_L Edge 50 lb. (222 N) Pre Load	-0-	-0-	-0-	-0-
Concentrated Load ______ lbs. (N).	______	______	______	______
Panel 3: Weakest Point 50 lb. (222 N) Pre Load	-0-	-0-	-0-	-0-
Concentrated Load ______ lbs. (N). (INDICATE LOCATION OF WEAKEST POINT)	______	______	______	______

*BOTTOM SURFACE DEFLECTION AND SET IS OPTIONAL

LOADS AND DEFLECTION(S) MAY BE REPORTED AT ANY INCREMENT LESS THAN OR EQUAL TO 200 lb. (890N).

TOP SURFACE DEFLECTION IS DEFINED AS THE DISTANCE TRAVELED BY THE INDENTOR.

Section 2
Ultimate Loading

Purpose:

To verify the ability of an access floor to accept the manufacturers' published ultimate load.

Preparation:

1. Tests shall be performed on three (3) randomly selected bare panels supported on an understructure support system identical to that utilized in an installed system. (Four (4) panels are required if panel configuration is not structurally symmetrical.)
2. Any coatings, stringers, gaskets, pads, clips, fasteners, or other materials as required by manufacturer shall be identical to that utilized in an installed system.
3. Finish floor height of the test mock-up shall be 12 inches or the maximum height of the system whichever is less.
4. Ultimate loading shall be applied through a steel indentor 1" (25.4 mm) square. This square indentor may have eased edges at maximum of .008" (0.20 mm) radii, but the footprint contact area shall not measure more that 1" x 1" (25.4 mm x 25.4 mm) square or a round indentor 1.128" (28.65 mm) diameter may be utilized in lieu of a square indentor provided the footprint contact area shall not exceed one square inch (645 mm^2).
5. Safety restraining frames or configurations may be utilized in the test procedure to restrain horizontal movement of the tested mock-up if deemed prudent by the testing facility. Frames shall not interfere with vertical movement of the mock-up.

Test Procedure:

1. Testing shall be conducted with the load applied at the "weakest point" of the panel. The "weakest point" is to be determined by the independent certifying/test agency and is that panel location which results in the lowest ultimate load. In addition, testing may be conducted with loads applied at the panel locations, such as center of panel and mid-point of panel edge.

Report:

1. Reference of testing procedure described herein by CISCA A/F section number shall be included in report.
2. All apparatus, equipment, instrumentation, accuracy ranges, etc. shall be described including equipment calibration/certification dates.
3. Materials tested, mock-up configuration(s) and restraining frames, if used, should be fully described in verbiage or referenced to manufacturers' drawings and/or part numbers, either containing the following information:

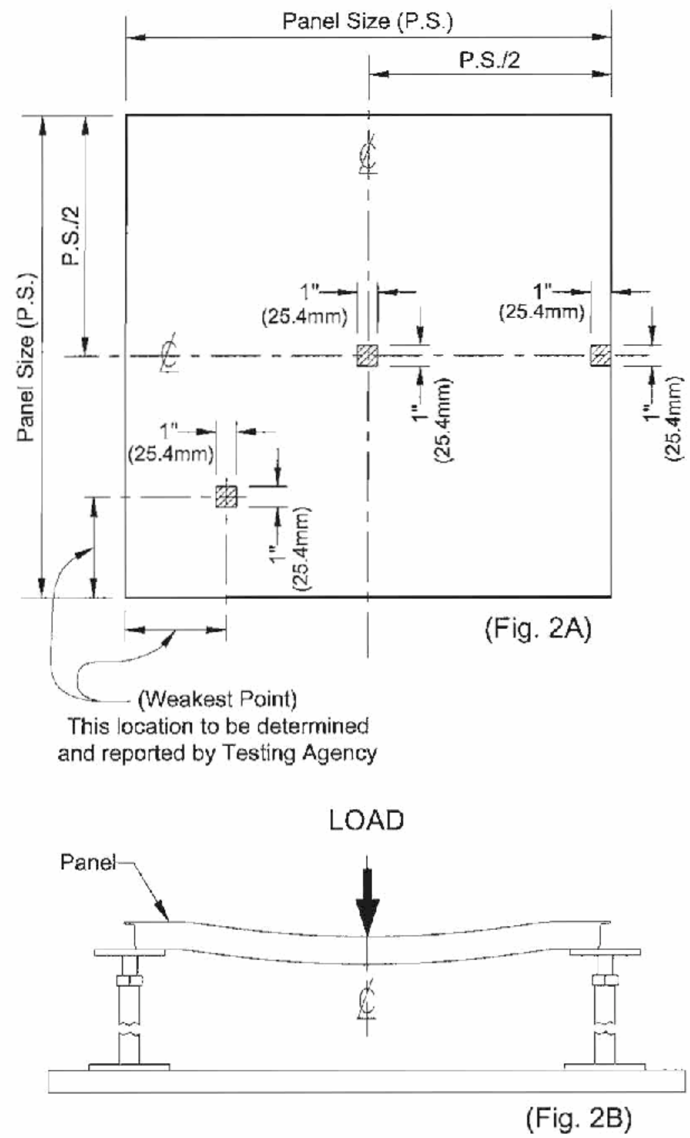
   Panels:
   - Material(s) of panel construction.
   - Weight, nominal dimensions and thickness.

   Pedestals:
   - Height.
   - Material and cross-section.

   Stringers:
   - Material(s) of construction.
   - Weight, nominal dimensions and thickness, including fasteners, gaskets, coatings, clips, etc.

   Other:
   - Fully describe gasketing, pads, or other items utilized in the system.
4. The applied load for each panel at the weakest point, edge and centroid, shall be reported. Additionally, the applied load at other tested locations may be reported.

Section 2: – Panel Loading Locations



SETUP FOR ULTIMATE LOAD TEST

(Fig. 2)

Section 2: Ultimate Loading – Report Format

REPORT FORMAT	
SYSTEM 1 – Panel Center:	Load __________lbs. (N)
SYSTEM 2 – Panel C_L Edge:	Load __________lbs. (N)
SYSTEM 3 – Weakest Point:	Load __________lbs. (N) (indicate location)

Section 3
Rolling Loads

Purpose:

To determine the durability and/or deformation of access floor systems when exposed to commercially anticipated caster traffic using a specified load.

Preparation:

1. Each test shall be performed on a mock-up consisting of a minimum of three (3) randomly selected bare panels installed on a support understructure system identical to the configuration of a normal field installation with a finished floor height of 12" or the maximum height of the system, whichever is less.
   A restraining frame which laterally supports the mock-up assembly may be utilized to protect equipment or for personnel safety, provided said frame is constructed to not interfere with the panels or supporting understructure and provides clearance from any point of the mock-up prior to the start of test.
   Testing apparatus shall be designed to impose caster rolling loads directly on the mock-up system, with the load traversing in a fixed path on the three panels being tested. Dampening of mock-up, load, caster wheel applicator, load carriage or load bed is prohibited.
2. Loads shall be directly imposed through caster wheels manufactured in accordance with attached drawings.

Rolling Load Wheel Specifications

10 pass test

Wheel A -

3" diameter x $1\frac{13}{16}$" width (76.2 mm diameter x 46.0 mm width)
Tread type: hard rubber or phenolic material, maximum .062" (1.57 mm) crown

10,000 pass test

Wheel B - For loads up to 1500 pounds (6.675 kN)

6" diameter x 2" width
(152 mm diameter x 50.8 mm width)
Tread Type: molded urethane tread, maximum $\frac{1}{16}$" (1.59 mm) crown

Wheel C - For loads over 1500 pounds (6.675 kN)

10" diameter x 4" width
(254 mm diameter x 102 mm width)
Tread Type: molded urethane tread, maximum $\frac{1}{16}$" (1.59 mm) crown

Test Procedure:

1. Each mock-up assembly shall be subjected to the imposed caster rolling load traversing the center panel along a fixed path at a speed of 100 FPM (0.5 m/s) (+ - 10%), at a minimum stroke distance of 36" (914 mm) or panel dimension plus 12 inches (305 mm).
2. The fixed paths for the imposed caster rolling loads are defined as follows, with the center of the wheel width dimension being the locator of the path:
   Path "1"
   Fixed path traversing across mock-up panels at panel centers.
   Path "2"
   Fixed path traversing across all three mock-up panels, along a line inboard and parallel from the outer edge as determined by the "weakest point." The "weakest point" is to be determined by the certifying independent testing agency and is defined as the path which yields the greatest top surface deformation under rolling loads as determined by this section.
3. Wheel A (See box with Rolling Load Wheel Specifications) shall be applied to separate mock-ups for each fixed paths 1 & 2 for ten (10) passes with deformation measurements at start and upon completion.
   Wheel B and Wheel C shall be applied to separate mock-ups for each fixed paths 1 & 2 for 10,000 passes with deformation measurements at start and upon completion of 500, 5,000 and 10, 000 passes.
4. Measurement(s) and reference locations prior to test shall be taken as follows:
   a. The center panel, prior to start of test, shall be measured for overall flatness utilizing a 32" (813 mm) long straightedge. The straightedge shall be placed parallel with each panel edge, flush with the edge or not more than 12" (12.7 mm) inboard from the edge. The straightedge shall also be placed along the diagonal in each direction. Measurement shall be taken at each straightedge location (6 locations) at the maximum variation and recorded and located for reference. (Note: If the panel configuration has an upward "crown", it shall be so measured and reported.)
   b. Prior to the start of test, the center panel, at points along the proposed caster path, shall be measured for local variation utilizing a 6" (152 mm) long straightedge. The largest six (6) variations shall be measured, recorded and located for reference.
5. Measurement upon completion of test:
   a. The center panel, upon completion of test shall be measured in an identical manner as described in 4a above. The maximum beam deformation measurements (6 required) shall be recorded and located for reference.
   b. Upon completion of test, the center panel shall be measured in an identical manner as described in 4b above. The maximum local deformation measurements (6 required) shall be measured, recorded and located for reference.

6. Actual vertical wheel force shall be verified with a load cell or similar device before the start of each test.
7. A separate mock-up assembly shall be utilized for each wheel type and path tested.
8. Panels or understructure systems which are not structurally symmetrical, shall be tested in accordance with the above procedure and then re-tested with separate mock-up materials installed (rotated) 90° to the first test mock-up.

Report:

1. Reference of testing procedures described herein by CISCA A/F section number shall be included in report.
2. All apparatus, equipment, instrumentation, accuracy ranges, etc. shall be described including equipment calibration/certification dates.
3. Materials tested, mock-up configuration(s), and restraining frames, if used, should be fully described in verbiage or referenced to manufacturer's drawings and/or part numbers, either containing the following information:

   Panels:
   - Material(s) of panel construction.
   - Weight, nominal dimensions and thickness.

   Stringers and Pedestals:
   - Material(s) of construction.
   - Weight, and nominal dimensions and thickness, including fasteners, gaskets, coatings, clips, etc.

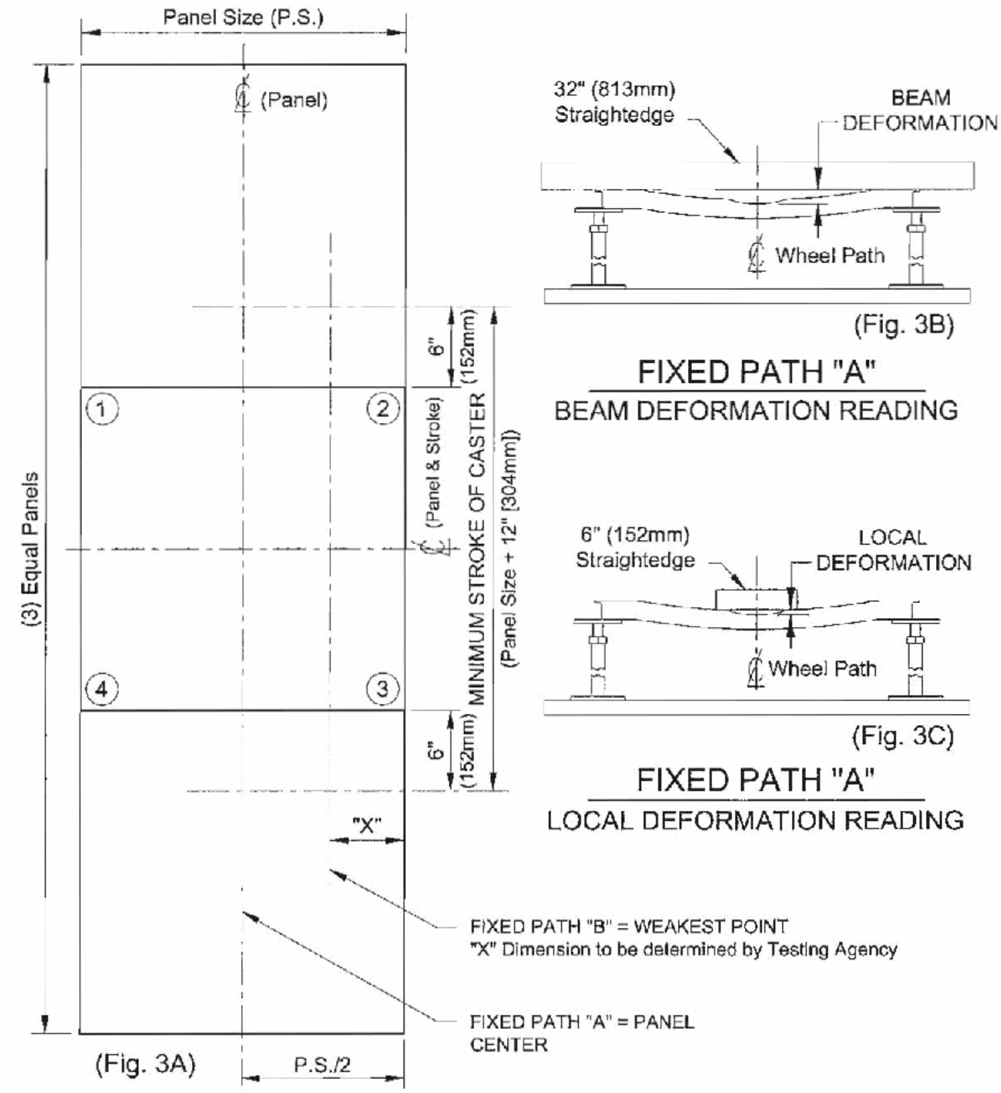
   Other:
   - Fully describe gasketing, pads, or other items utilized in the system.
4. For the 10,000 Pass test, the results of the test with only one wheel shall be reported.
5. Panel deformation shall be reported for each test and each path in accordance with the attached report format. Each listing of data shall indicate the following:

Wheel #	(A, B or C)
Imposed Load	(Lbs) (N)
Fixed Path	(1 or 2)
Number of Passes	
*Deformation Reported	(To nearest .001" [0.025 mm])

   *Deformation reported shall be the maximum measurement for both beam deformation and local deformation.
6. Any visible structural damage to any mock-up component shall be reported.

Section 3: Rolling Loads

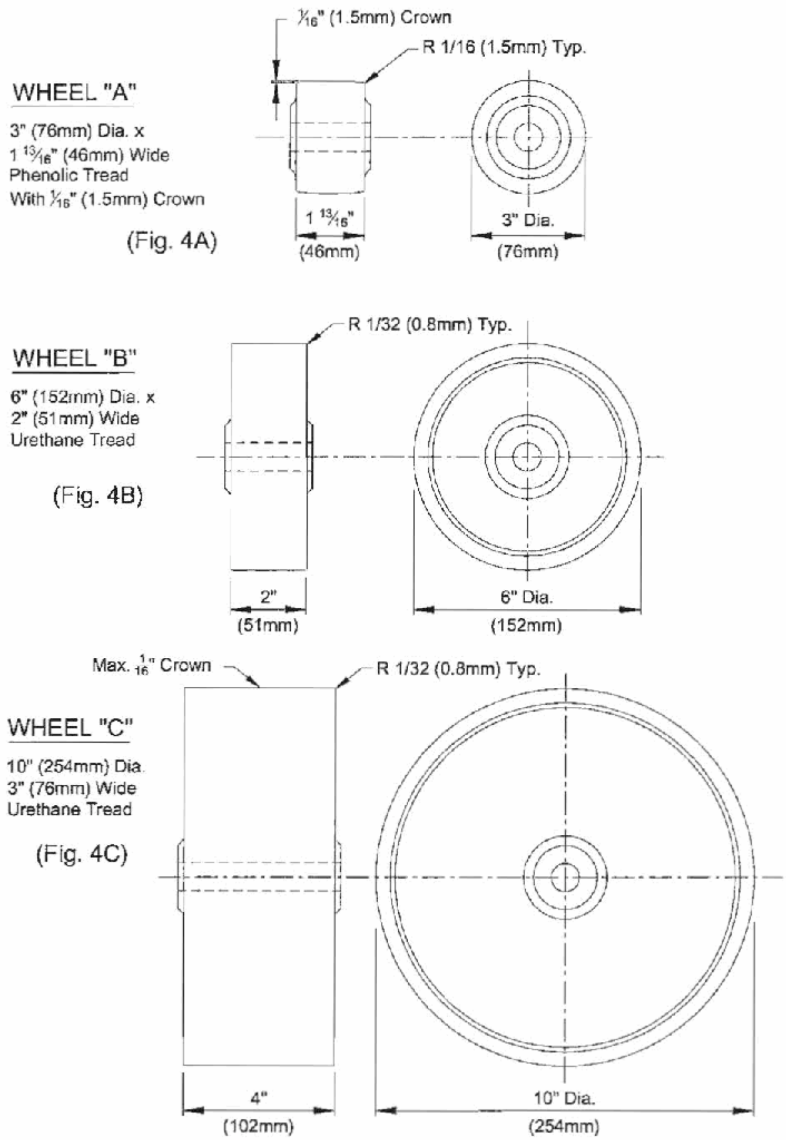
- Fixed Path 1 or 2
- Deformation Readings
- Beam & Local
- Or panel dimension plus 12″ (305 mm) to length of stroke



SETUP FOR ROLLING LOAD TEST

(Fig. 3)

Rolling Load Drawings Section 3:
- Wheel A
- Wheel B
- Wheel C



(Fig. 4)

Report:

Wheel # (A,B, or C) Size ____
Imposed Load ______ Load
Fixed Path 1 or 2 Location ________________
Number of Passes ________

BEAM DEFORMATION: 32" STRAIGHTEDGE MEASUREMENT

EDGE 1 – 2: Beam Deformation (Perpendicular to Caster Path)
Prior: _______ inches. Location: *Example (8" [203 mm] Along Edge from Corner 1)*
After: _______ inches. Location: ________________
Difference: ________inches (Report only if the start/finish locations are identical)

EDGE 3 – 4: Beam Deformation (Perpendicular to Caster Path)
Prior: _______inches. Location: ________________
After: _______inches. Location: ________________
Difference: ________inches (Report only if the start/finish locations are identical)

EDGE 2 – 3: Beam Deformation (Parallel w/Caster Path)
Prior: _______inches. Location: ________________
After: _______inches. Location: ________________
Difference: ________inches (Report only if the start/finish locations are identical)

EDGE 4 – 1: Beam Deformation (Parallel to Caster Path)
Prior: _______inches. Location: ________________
After: _______inches. Location: ________________
Difference: ________inches (Report only if the start/finish locations are identical)

DIAGONAL 1 - 3 Beam Deformation
Prior: _______inches. Location: *Example: (14" [356 mm] Along Diagonal from Corner 1)*
After: _______inches. Location: ________________
Difference: ________inches (Report only if the start/finish locations are identical)

DIAGONAL 2 - 4 Beam Deformation
Prior: _______inches. Location: ________________
After: _______inches. Location: ________________
Difference: ________inches (Report only if the start/finish locations are identical)

Wheel # (A,B, or C) Size ____
Imposed Load ______ Load
Fixed Path 1 or 2 Location ________________
Number of Passes ________

LOCALIZED DEFORMATION: 6" STRAIGHTEDGE MEASUREMENT

Point 1 Location: *Example (8" [204 mm] Along Edge from Corner 1)*
Prior ___________ inches.
After ___________ inches.
Difference _______ inches.

Point 2 Location: ________________
Prior ___________ inches.
After ___________ inches.
Difference _______ inches.

Point 3 Location: ________________
Prior ___________ inches.
After ___________ inches.
Difference _______ inches.

Point 4 Location: ________________
Prior ___________ inches.
After ___________ inches.
Difference _______ inches.

Point 5 Location: ________________
Prior ___________ inches.
After ___________ inches.
Difference _______ inches.

Point 6 Location: ________________
Prior ___________ inches.
After ___________ inches.
Difference _______ inches.

POINT MAXIMUM: "Report this Maximum Measurement of Localized Deformation." ________________

Section 4
Stringer Load Testing

Purpose:

To determine the amount of permanent set sustained by stringer when subjected to a concentrated load.

Preparation:

1. Stringers shall be randomly selected and supported on two pedestal assemblies complete with all coatings, gaskets, clips, and fasteners, identical to that found in the installed floor system. Height shall be equivalent to that found in a 12" (305 mm) finished floor height or the maximum height of the system, whichever is less.
2. The loads shall be applied to the stringer through a steel indentor 1" (25.4 mm) square, imposed and measured through a properly calibrated and appropriately sized load sensor. A round indentor 1.128" (28.65 mm) diameter may be utilized in lieu of a square indentor provided the foot-print contact area shall not exceed one square inch.

Test Procedure:

1. Load shall be applied vertically at mid span of the stringer and held for a minimum of one-minute duration. The load shall then be relaxed and permanent set measured. Permanent set shall be measured at the top surface of the stringer at the point of load application. Rate of load application shall not exceed 500 pounds per minute (2.224 kN/min).

Report:

1. Reference of testing procedure described herein by CISCA A/F section number shall be included in report.
2. All apparatus, equipment, instrumentation, accuracy ranges, etc. shall be described including equipment calibration/certification dates.
3. Materials tested and mock-up configuration(s) should be fully described or referenced to manufacturers' drawings and part numbers containing the following:
   - Material(s) of construction, weight, nominal dimensions and thickness.
   - Span of stringer between pedestal center-lines
   - Height of system
   - Fasteners, gaskets, coatings, clips, etc.
     Record corresponding load(s) applied.
4. Description of any visual defects of any component.

Section 5
Pedestal Axial Load Test

Purpose:
To verify the axial load an access floor pedestal assembly can withstand without structural failure or damage to components inclusive of threads, nuts, collars, etc.

Preparation:
1. A minimum of three (3) randomly selected pedestal assemblies shall be tested for each floor height. Pedestals shall be identical to those used in normal installations for their corresponding floor heights, including thread engagements normally utilized in field conditions.
2. Pedestal assemblies shall be tested for maximum floor heights of each assembly design or configuration.
3. Loads shall be imposed and measured through a properly calibrated and appropriately sized load sensor over the center of the pedestal head. The load indentor or applicator may be machined to integrate with the pedestal head to simulate the loading of the four corners of the panels.

Test Procedure:
1. Align the Pedestal assembly in the testing apparatus and apply an increasing load centered on the pedestal until the desired load is reached. Hold imposed load for minimum of one (1) minute duration. The load shall then be relaxed and the assembly visually inspected for damage. Adjusting devices, locking devices, threads shall be workable by hand. Rate of load application shall not exceed 10,000 pounds per minute (44.5 kN/min).

Report:
1. Reference of testing procedure described herein by CISCA A/F section number shall be included in report.
2. All apparatus, equipment, instrumentation, accuracy ranges, etc. shall be described including equipment calibration/certification dates.
3. Materials tested shall be fully described or referenced to manufacturers' drawings and part numbers containing the following:
   - Materials of construction, weight, nominal dimensions and thicknesses.
4. Report load applied and relaxed for each pedestal and describe damage to components, if any.

Section 5: Pedestal Axial Load Test - Report Format

FINISHED FLOOR HEIGHT:__________________ INCHES (mm)

IMPOSED LOAD

Pedestal Assembly 1 - __________ lbs. (N)

Pedestal Assembly 2 - __________ lbs. (N)

Pedestal Assembly 3 - __________ lbs. (N)

Average: __________ lbs. (N)

Description of Component Damage if any: ______________________________________

Section 6 Pedestal Overturning Moment Test

Purpose:

To determine the overturning moment an access floor pedestal assembly and its application to the sub-floor can resist.

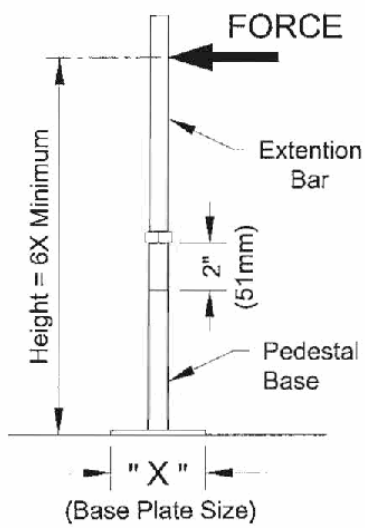
Preparation:

1. A minimum of five (5) pedestal assemblies shall be secured to a sound unsealed surface consistent with practice normally found in actual installations. Application methods shall be noted in report and may include adhesive and/or mechanical fasteners.
   Note: Where pedestals are not axisymmetric, additional sets of pedestals may need to be tested to verify the weakest direction of force application.
2. For adhesive application, follow manufacturers' adhesive application procedure and allow to cure for the minimum cure time recommended by the adhesive manufacturer.
3. For mechanical application, follow fastener manufacturers' recommended procedure.

Test Procedure:

1. Lateral loads shall be applied slowly and continuously to the prescribed location of the assembly until any failure of the pedestal assembly or its methods of application to the sub-floor occurs. Where pedestals are not axisymmetric, loads shall be applied in the direction which will result in the least overturning resistance.

Pedestal Overturning Moment Test



TEST SETUP FOR
PEDESTAL OVERTURNING MOMENT
(Fig. 5)

Report:

1. Reference of testing procedure described herein by CISCA A/F section number shall be included in report.
2. All apparatus, equipment, instrumentation, accuracy ranges, etc. shall be described including equipment calibration/certification dates.
3. Materials tested and load application configuration shall be fully described and referenced to manufacturers' drawings and/or part numbers containing the following:
   - Materials of construction, weight, nominal dimensions and thicknesses.
   - Adhesive if used, designate the manufacturer, product description, and identifying commercial stock numbers, etc., curing time and conditions.
   - Mechanical fasteners, if used, shall be identified by manufacturer, type, catalog number, size, and depth of engagement.
4. If mechanical fasteners are used, state the number used, location of fasteners in base plates, and relationship dimensionally of fastener locations to applied loading direction. Also state method of application. The height measured from the sub-floor to the horizontal location of the applied load (moment arm) shall be reported along with the applied load for each loading.
5. Type of overturn failure and description thereof shall be reported for each test. Where forces have been applied in more than one direction, report worst-case (weakest) results in addition to any other results.

Section 6: - Data Report Format

Pedestal Description: ____________________

*Fastening Method: ____________________ *(Adhesive, Mech., Etc.)*

Pedestal Height ________ for ________ Finished Floor Height.

Height of Applied Load ____________________

Pedestal Assembly:

1 Horizontal Load ____________ lbs. (N) ____________ inch pounds (Nm)

2 Horizontal Load ____________ lbs. (N) ____________ inch pounds (Nm)

3 Horizontal Load ____________ lbs. (N) ____________ inch pounds (Nm)

4 Horizontal Load ____________ lbs. (N) ____________ inch pounds (Nm)

5 Horizontal Load ____________ lbs. (N) ____________ inch pounds (Nm)

AVERAGE ____________ inch pounds (Nm)

* FASTENING METHOD SHALL BE FULLY DESCRIBED: ____________________

____

* DESCRIPTION OF FAILURE (IF ANY) FOR EACH PEDESTAL SHALL BE REPORTED:

____

Section 7
Uniform Load Test

Purpose:

To determine the maximum deflection(s) and permanent set(s) of an access floor under a uniformly distributed load.

Preparation:

1. Test shall be performed on a randomly selected bare panel assembly. Panel shall be placed on steel blocks or supports configured to provide support identical to that provided by an installed system. Any coatings, gaskets, pads, clips, fasteners, floor covering, or other materials as required by manufacturer shall be identical to an installed system. Blocks or supports shall not reduce the unsupported edge span below that normally provided with a standard installed system.
2. Panel designed for stringer support shall have stringers spanning the blocks or supports with panel perimeter support and/or interface in an identical manner to the configuration of the installed floor systems. Stringers shall be identical to those of the installed floor system, attached or fitted to the support blocks in an identical manner to the installed floor system, and shall include any coatings, gaskets, pads, clips, fasteners, finishes or other materials as required by the manufacturer in the installed floor system.
3. Height of the test mock-up shall be sufficient to accommodate deflections of stringers and panels.
4. Load shall be applied as described in the air bag or vacuum methods prescribed in ASTM E2322 Standard Test Method for Conducting Transverse and Concentrated Load Tests on Panels Used in Floor and Roof Construction.
   Note: This ASTM test method is to be used in this section only for evaluation of uniform loading resistance, and is not appropriate for use as a concentrated load test method for access floors.
5. Any restraining frames or configurations utilized in the test procedure shall not interfere with vertical movement of the test specimen.

Test Procedure:

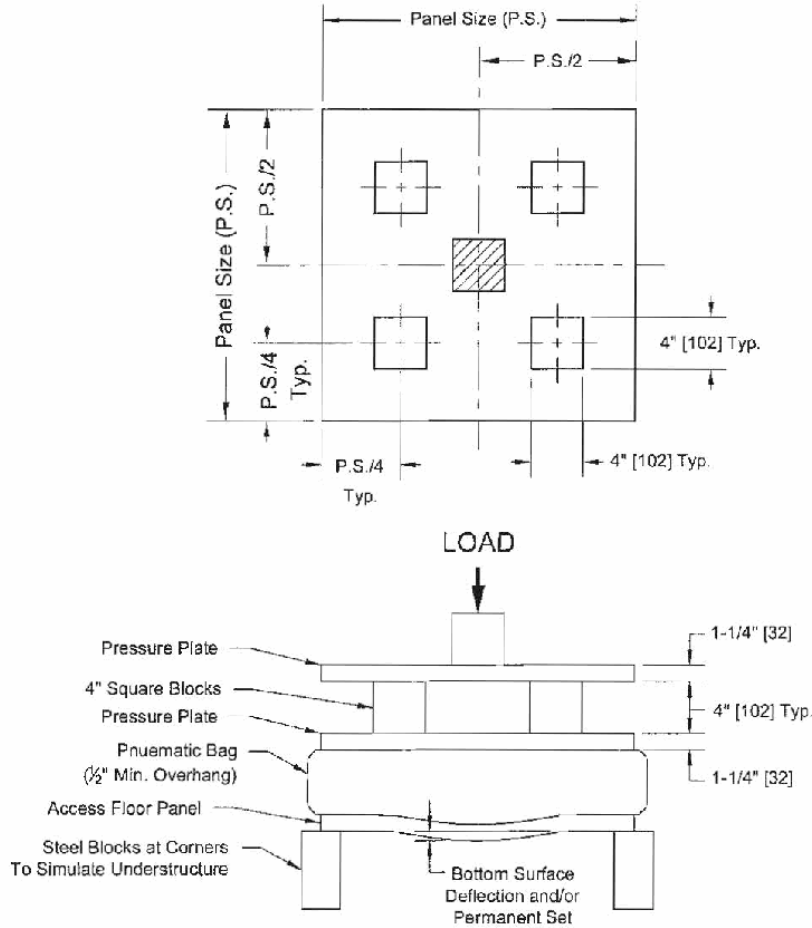
1. Except as outlined in this procedure, the panel shall be loaded according to the air bag or vacuum methods prescribed in ASTM E2322. In the case of access flooring systems where panels are not contiguous, load shall also be applied to any connecting material (e.g. steel cap) between panels.
2. The panel shall be pre-loaded to the test load. A pre-load of 50 lbs/ft² (i.e. 200 lb In the case of a panel that is 4 ft² – 2′ x 2′) shall then be applied and the instrumentation measuring deflection and load shall be set at zero. (Reference zero = 50 lbs/ft² pre-load)
3. After the pre-load, the panel shall be tested by increments not exceeding 50 lbs/ft², with initial load no more than one-half test load. Rate of load application shall not exceed 375 lbs/ft² per minute.
4. Deflection and permanent set shall be measured at the panel's center, midspan of edge, and "weakest point" as defined by the manufacture and verified by the independent test agency.
   Note: For products with uneven bottom surfaces and where the deflection and set are measured on the bottom of the panel, the measurements shall be taken at the lowest adjacent horizontal surface.
5. Loads shall be applied for a minimum of one (1) minute and deflection readings taken at the end of that period. The load shall then be relaxed to reference zero (Reference zero = 50 lbs/ft² pre-load) for a minimum one (1) minute and deflection shall be recorded.

Report:

1. Reference of testing procedure described herein by CISCA A/F section number shall be included in report.
2. All apparatus, equipment, instrumentation, accuracy ranges, etc. shall be described including equipment calibration/certification dates.
3. Materials tested and mock-up configuration(s) should be fully described in verbiage or referenced to manufacturers' drawings and/or part numbers, either containing the following information:
   Panels:
   - Material(s) of panel construction.
   - Weight, nominal dimensions and thicknesses.

   Stringers:
   - Material(s) of construction.
   - Weight, and nominal dimensions and thickness, including fasteners, gaskets, coatings, clips, etc.

   Other:
   - Fully describe gasketing, pads, other items utilized in the system.
4. Panel deflection measurements of the bottom surface shall be reported to the nearest .001" (0.025 mm) for each applied load.
5. Panel permanent set of the bottom surface shall be reported to the nearest .001" (0.025 mm) for each applied load.



SETUP FOR UNIFORM LOAD

(Fig. 6)

Report Format:

	Center Deflection	Midspan Edge Deflection	"Weakest Point" Deflection	Set
Panel 1: 50 lbs/ft² Pre-load				
Uniform Load ___________lbs/ft²				

LOADS AND DEFLECTION(S) MAY BE REPORTED AT ANY INCREMENT LESS THAN OR EQUAL TO 50 LBS/ft².

Section 8
Drop Impact Load Test

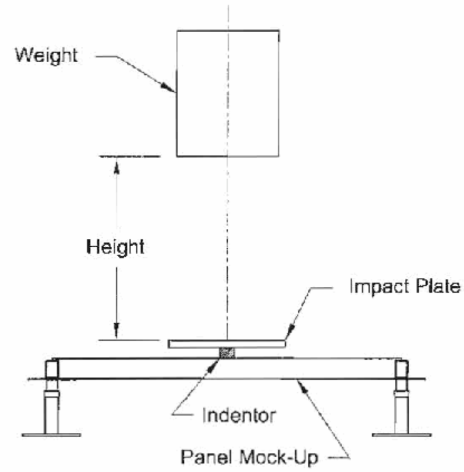
Purpose:

The purpose of this test is to show the effect upon access floor panels and supporting understructure system(s) when subject to impact from heavy loads being accidentally dropped onto the floor panel.

Preparation:

Test(s) shall be performed on three (3) randomly selected bare panels placed on an understructure support system that is configured identical to an installed system. Any stringers, coatings, gaskets, pads, clips, fasteners, locking devices or other materials normally used shall be configured identical to that provided in an installed system. The test mock-up configuration shall be at a finished floor height suitable for the system being tested. A safety-restraining device may be utilized for load constraint to prevent possible injuries, providing it does not restrict the purpose of the test. The load to be dropped shall be either a single hard object or objects placed inside a rigid container that will not flex or distort during the impact of the test. The load shall be dropped vertically from a given height onto the center of a steel "impact" plate of not less than one-half inch (1/2") [12.7 mm] thick x eight inches (8") [20.3 mm] square that is placed centrally on top of a one inch (1") [25.4 mm] square steel indentor not less than one-half inch (1/2") [12.7 mm] thick.

Test Setup:



SETUP FOR DROP IMPACT LOAD TEST

(Fig. 7)

Test Procedure:

1. The load shall be dropped, free fall from a height of 36" (914 mm) measured from the top of the steel "impact" plate to the underside of the weight being dropped.
2. Two one-panel mock-up assemblies shall each be tested with the load target directly in the center of each panel.
3. Two one-panel mock-up assemblies shall each be tested with the load target directly on the midpoint of the edge of each panel.
4. Two one-panel mock-up assemblies shall each be tested with the load target at the discretion of the testing lab to determine the weakest points.
5. After completion of the impact test on each panel, one panel shall be tested according to Section 1: Concentrated Loads at the point of impact, and the other shall be tested according to Section 2: Ultimate Load. (The weights dropped on panels for Concentrated and Ultimate Load testing may be different.)
   NOTE: Panels or understructure systems which are not symmetrical, shall be tested in accordance with the above procedure and then re-tested with separate mock-up materials installed (rotated) 90° to the first test mock-up.

Report:

1. Reference of testing procedure described herein by CISCA A/F section number shall be included in report.
2. All apparatus, equipment, instrumentation etc. shall be described including equipment calibration/certification dates.
3. Materials tested and any load restraining device, if used, should be fully described in verbiage or referenced to manufacturer's drawings and part numbers, containing the following information:
   a. **Panels:**
   - Materials of the panel construction.
   - Weight, nominal dimensions and thickness.

   b. **Stringers and pedestals:**
   - Material(s) of construction.
   - Weight, and nominal dimensions and thickness, including fasteners, gaskets, coatings, clips, etc.

   c. **Other:**
   - Fully describe any gaskets, pads, or other items utilized in the system.
4. Amount of weight dropped onto system.
5. Height from which weight was dropped onto system.
6. For each panel subjected to testing under Section 1, report the impact weight, the concentrated load and deflection realized. For each panel tested according to Section 2, report the impact weight and ultimate load achieved.

SECTION 9
Fire Performance

This guidance is not all-inclusive of the fire test methods that may be applicable to access floors. The authority having jurisdiction (e.g. fire marshal, building inspector, etc.) makes the final determination of what test or other qualification methods may apply. Nor is it to be implied that CISCA requires any of the following be performed on access floors. CISCA has provided clarification for sample preparation for the following test methods:

Surface Burning Characteristics of Building Materials

- ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials
- NFPA 255 Standard Method of Test of Surface Burning Characteristics of Building Materials
- UL 723 Test for Surface Burning Characteristics of Building Materials
- CAN/ULC S102 Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
- UBC Standard 8-1 Test Method for Surface Burning Characteristics of Building Materials

Non-Combustibility Assessment of Materials

- ASTM E 136 Standard Test Method for Behavior of Materials in a Vertical Tube Furnace and 750° C
- CAN/ULC S114 Standard Method of Test for Determination of Non-Combustibility in Building Materials
- UBC Standard 2-1 Noncombustible Material - Tests

Purpose:

To provide a standard practice for specimen preparation and mounting of access floors for testing for Surface Burning Characteristics and Non-Combustibility of Building Materials.

The following practice describes specimen preparation and mounting procedures for such materials. All testing shall be conducted using the methodology described in the referenced test method.

Test for Surface Burning Characteristics of Building Materials

This practice describes procedures for specimen preparation and mounting when testing access floors to assess flame spread and smoke development as surface burning characteristics using the tests methods listed above. This practice does not apply to discrete components such as diffusers, junction boxes, grommets, trim, etc. Discreet components may be tested per UL 2043.

Note: Under floor supports cannot be tested using these test methods.

This practice does not provide pass/fail criteria that can be used as a regulatory tool.

This practice 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 practice to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

Test Specimen:

The test specimen sizes shall comply with those described in the test specimen section of the referenced test methods. The test specimens shall be butted against the vent end of the fire test chamber and shall consist of a continuous, unbroken length, or of sections joined or butted end-to-end. The test specimens shall have a width of 20 to 24 inches (510 to 610 mm), a length of 24 ft. (+12 in /–6 in) (7.32 m [+305 mm /–152 mm]) and a maximum thickness of 4 inches (101 mm).

Preparation:

Access floor products shall be representative of the materials for which the test is intended to examine.

Access floors with sufficient structural integrity to support themselves within the test chamber without sagging more than 1/16 inch (1.5 mm) when measured at the center-line of the test chamber shall be sized to the width of the fire test chamber, butted end-to-end, and mounted on the ledges of the test chamber without using additional means of support.

Access floors without sufficient structural integrity to support themselves within the test chamber without sagging should be supported in accordance with the guidance provided in the respective test methods.

The sample shall be representative of the standard construction and application of the access floor. If raceways, channels, cover plates, etc. are an integral part of the access floor installation, then these products shall also be assembled in the test chamber in the same manner as intended in use. Two tests should be run: one test exposing the underside of the floor, the second test exposing the topside of the floor.

Report:

1. Report a detailed description of the material(s) being tested.
2. Report a detailed description of the specimen preparation method used, including adhesives, if used, and its application method.
3. Report all information required in the reporting section of the referenced test method, including observations, graphical results and the values of the flame spread index and the smoke developed index in each test.

Test for Non-Combustibility Assessment of Materials

This practice describes procedures for specimen preparation for tests for Non-Combustibility of Building Materials.

This practice 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 practice to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

Test Specimen:

Test specimen should contain proportional amounts (by weight) of each material contained within the tested product. Panels and support structures are to be tested independently.

Report:

- Report a detailed description of the material(s) being tested.
- Report a detailed description of the specimen preparation method used, including adhesives, if used, and its application method.
- Report all information as required in the referenced test method.

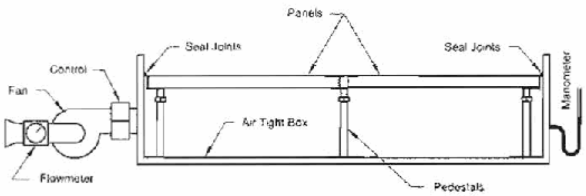
SECTION 10
Air Leakage Test
(Through Panel Seams)

Purpose:

To determine the rate at which air will pass through the cracks and gaps in an access floor panel assembly, at a specified and controlled differential static air pressure. This test applies only to floors used for underfloor air distribution.

Preparation:

1. The test shall be performed on a specimen of panels in a relatively airtight box or chamber, as shown below. The gap between the perimeter of the floor panels and the chamber opening shall be sealed to minimize air leakage.



SETUP FOR AIR LEAKAGE TEST

(Fig. 8)

General arrangement of Air Leakage Test Apparatus

2. The dimensions of the panel assembly shall be at least 72 inches (1829 mm) square. Finished floor height shall be 12 inches (305 mm), or the maximum height of the system; whichever is less.
3. Any coatings, stringers, gaskets, pads, clips, fasteners, or other materials normally used shall be identical to that utilized in an installed system. The pedestals shall be anchored to the base of the chamber only if such anchorage will affect the air leakage rate in some way. If so, such anchorage shall be described in the report.
4. A controllable blower, fan, or air pump shall be fitted to the chamber to supply airflow to the chamber at a rate sufficient to maintain the positive air pressure required. The system should provide essentially constant airflow for a period of time sufficient to obtain readings of airflow rate and pressure.
5. A flowmeter or other suitable device to measure the rate of airflow into the test chamber shall be fitted.

A manometer or other suitable device to measure the differential test pressures shall be connected between the chamber and atmosphere.

Note: The referenced test method, ASTM E283, requires the device be capable of recording the pressure within ±2% of setpoint. The static air pressure differentials typically employed in under floor air distribution systems are much lower than in the referenced method, so care must be taken by the test agency to employ the appropriate pressure measuring device.

Test Procedure:

1. Calibrate the air leakage test equipment in accordance with the calibration instructions in ASTM E283 *Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen,* except that the calibration pressure shall be 0.10 inch of water column (25 Pa).
2. With the floor specimen installed as described above, adjust the total airflow into the chamber to provide the specified test pressure difference across the test specimen. When the test conditions have stabilized, record the airflow through the flowmeter, and the test pressure difference. This measured air flow is designated the total air flow, $Q_t(p)n$, where p is the pressure, and n is the number of the measurement. Measure the barometric pressure, *B*, and temperature of the air at the test specimen, *T*.
3. Repeat the measurement of the leakage at each pressure level at least 4 times. Calculate the arithmetic average of all leakage measurements at each pressure, $Q_t(p)$.
4. Seal all gaps and holes in the floor specimen.
5. With the floor specimen sealed, measure the amount of air leakage through the test chamber itself, at the same air pressure differentials as in step 2. Each measured air flow is designated the extraneous airflow, $Q_e(p)n$.
6. Repeat the measurement of the extraneous leakage at each pressure the same number of times as in step 3. Calculate the arithmetic average of all extraneous leakage measurements at each pressure, Qe(p).
7. Measure the total crack length between the access floor panels, l. Do not include any of the joints between the perimeter of the specimen and the chamber.

The Calculation:

1. Calculate ratio A_p/l_p, where:
   A_p = *Area* of a floor panel, ft² (m²)
   l_p = *Perimeter* of a single floor panel, ft² (m²)
   Note: For some systems, where multiple panel sizes or shapes are employed together in one floor assembly, determination of lp may require more careful analysis. Generally, the perimeter of each panel should be measured only once in determining lp.
2. Express the total average air flow at each pressure $Q_t(p)$, and the extraneous average air flow at each pressure $Q_e(p)$, in terms of flow at standard conditions, as outlined in ASTM E283.
   Note: Ensure all units of measure referenced in the E283 calculation are observed, and that the correct equation is employed.
3. Express the air leakage through the test specimen at each pressure, $Q_s(p)$, as
   $Q_s(p) = Q_t(p) - Q_e(p)$, ft³/min (L/s) (1)
4. Calculate the rate of air leakage per unit crack length at each pressure, $q_l(p)$, as
   $ql(p) = Qs(p)/l$, ft3/min-ft (L/s-m) (2)
5. Calculate the rate of air leakage per unit area at each pressure, $q_A(p)$, as
   $qA(p) = ql(p) /[2 (Ap/lp)]$, ft3/min-ft2 (L/s-m²) (3)

Report:

1. Reference of testing procedure described herein by CISCA A/F section number shall be included in the report.
2. All apparatus, equipment, instrumentation, accuracy ranges, etc., shall be described including equipment calibration/certification dates.
3. Materials tested, and specimen configuration(s) should be fully described in text and/or photograph and/or drawing, or by reference to manufacturer's drawings and/or part numbers, including the following:
   Panels:
   - Floor finishes
   - Materials of the panel construction
   - Weight, and nominal dimensions and thicknesses

   Supporting structure:
   - Height
   - Materials, sections, fasteners, adhesives or other anchors

   Other:
   - Fully describe other materials used in the mock-up
4. For each of test pressures, report the rate of air leakage per unit crack length, and per unit area, as noted. At a minimum, report the air leakage rate at the pressures noted in the table. Other pressures may also be reported, at the discretion of the proponent or authority.
5. Calculated accuracy of the measured air leakage, based on the precision of the air pressure measurement.

Test Pressure inches h2o (Pa)	Air Leakage Rate	
	Per unit crack length ft³/min-ft (L/s-m)	Per unit area ft³/min-ft² (L/s-m²)
0.05 (12.5)		
0.10 (25.0)		

Section 11
Sound Transmission

At the time of the release of this CISCA publication, the ASTM E33 committee was working on a new ASTM standard for airborne sound transmission loss through access floors and therefore, CISCA has yet to review this test method.

Glossary of Terms

Access Floor System

An access floor system is an elevated or "raised" floor area upon another floor (typically a concrete slab in a building) creating an interstitial space for service distribution. It consists of modular floor panels that are designed to be removable from their support so that "access" to services is quickly and easily achieved. These services may include but are not limited to electric power, data, plumbing, telecom, environmental control, air conditioning, fire detection suppression, security, etc.

Air Leakage

As it pertains to access floors, air leakage is defined as the passage of air from an underfloor air cavity through elements other than the designed air outlet devices. Leakage typically falls into two categories: 1) leakage in the air cavity under the floor due to construction quality, and 2) leakage through floor panel seams and other non-air outlet devices.

Axial Load

A vertical load (or force) whose line of action passes through the center of the member's cross sectional area and is perpendicular to the plane of the section such that no bending or torsion moments are produced. This is the load that is typically specified when referring to the axial load performance of an access floor pedestal support.

Beam Deformation

Deformation is defined as the act of distorting or changing the shape or dimensions of a structural element or body resulting from forces or stresses. Beam deformation as related to access floors is generally the term used when referring to the permanent set of the entire span of the access floor panel after application of a rolling load and is determined by measuring the overall flatness of the access floor panel before and after the application of the load.

Cable Management Access Floor Systems

An access floor system which incorporates an easy access, independent of panel removal, creating an interstitial pathway for routing cabling and other supportive services, excluding air distribution.

Concentrated Load

A single load or force that has a small contact area as to be negligible compared with the entire surface area of the supporting member. Concentrated loads (sometimes referred to as static loads) are typically imposed by stationary furniture and equipment with legs. A concentrated load is applied to the surface of the panel (1"x 1" square or 1.128" diameter indentor) (25.4 mm x 25.4 mm square or 28.65 mm diameter) resulting in deflection and permanent set. Concentrated load rating is specified in pounds force applied over a one square inch (645 mm2) area.

Deflection

Deflection is the vertical displacement of a structural member or system under load. This is generally referred to when discussing the vertical displacement a floor panel experiences upon application of a concentrated load or uniform load.

Design Load

The load expected to be imposed on the floor system in service. The access floor concentrated load rating is not the safe working load or design load for the floor system.

Dynamic Load

Loads that vary significantly with time as measurements are being made. Two dynamic loads are generally referred to: rolling loads and impact loads.

Finished Floor Height

Finished floor height is defined as the height of the access floor system as measured from the top of the supporting sub-floor to the top of the access floor panel.

Impact Load

Impact loads are caused by objects being accidentally dropped onto an access floor. These loads are defined by the weight of the load, height or distance dropped, impact area, and hardness/softness of the object. Impact loads generate severe shocks that can cause structural and panel damage. Impact loads most often occur during construction, move-in, and equipment / furniture rearrangements.

Live Load

A live load is produced by the use or occupancy of the building. This does not include construction, environmental, seismic, or access floor dead loads. The live load should not be confused with the uniform load capacity of an access floor.

Local Deformation

Local deformation is generally the term used when referring to the permanent set recorded along the wheel path after a rolling load test. It is determined by measuring the local flatness of the panel along the wheel path before and after the application of the load using a 6" (152 mm) spanner perpendicular to the wheel path. The difference between before and after measurements is defined as local deformation.

Overturning Moment

Overturning moment is the term generally used to refer to the capability of the floor pedestal attached to a supporting floor to withstand tip over forces generated by the application of a lateral force applied to the top of a moment arm. Overturning moment capacity is calculated by multiplying the lateral force by the height at which the force is applied.

Panel/Panel Assembly

Modular and removable structural floor element or elements designed to rest on separate or integral elevated supports that may be used as an interstitial space for distribution of building services (wire, cable, air, etc.).

Pedestal (Adjustable Height)

An access floor pedestal with adjustable height option is defined as the structural element that supports the access floor panel and raises it off the floor slab to create an interstitial space for service distribution. The adjustable height or leveling feature of the pedestal allows the access floor panels to be installed level regardless of the changes in elevation of the floor slab.

Pedestal (Fixed Height)

A fixed height floor pedestal is defined as the structural element that supports the access floor panel and raises it off the slab to create an interstitial space for service distribution. The fixed height floor pedestals and corresponding access floor panels are designed to lay on the floor slab and follow its contour and undulations.

Permanent Set

A material that is deflected so far that its elastic properties have been exceeded and it does not return to its original condition upon release of load is said to have taken a "permanent set."

Raised Floor System (See Access Floor System)

Rolling Load

Rolling loads are dynamic loads typically imposed by equipment on wheels moving across the access floor.

Stanchion

The term stanchion is sometimes used to describe an access floor pedestal.

Static Load

Static load is defined as a force that does not undergo a change in magnitude or direction during a measurement procedure. Three static loads are generally referred to: concentrated, ultimate and uniform loads.

Stringer

A stringer is a structural element used to connect access floor pedestals together, thus providing lateral stability to the system and floor supports.

Uniform Load

Uniform load is a static force applied equally over the entire area of an access panel and is typically imposed by stationary furniture, equipment without legs, boxes, pallets, etc. The uniform load rating is specified in pounds per square foot or Newtons per square meter.

Ultimate Load

The greatest applied vertical static force(s) beyond which additional deflection is achieved without additional load or resistance.

CISCA
Ceilings & Interior Systems Construction Association

Ceilings and Interior Systems Construction Association
1010 Jorie Blvd., Suite 30
Oak Brook, IL 60523
Ph. 630.584.1919
Fax 866.560.8537
Web cisca.org

Design Guidelines for Roof Pavers against Wind Uplift

Maryam Asghari Mooneghi[1]; Peter Irwin[2]; and Arindam Gan Chowdhury[3]

[1]Ph.D. Candidate, Civil and Environmental Engineering/ International Hurricane Research Center, Florida International University, Miami, FL. E-mail: masgh002@fiu.edu
[2]Professor of Practice, Civil and Environmental Engineering/ International Hurricane Research Center, Florida International University, Miami, FL. E-mail: peairwi@fiu.edu
[3]Associate Professor, Civil and Environmental Engineering/ International Hurricane Research Center, Florida International University, Miami, FL. E-mail: chowdhur@fiu.edu

Abstract

The objective of this paper is to develop guidance for design of loose laid roof pavers against wind uplift. Large-scale experiments were performed on concrete roof pavers installed on the flat roof of a low-rise building using the Wall of Wind (WOW) facility at Florida International University (FIU). Both wind blow-off tests and pressure measurements on the top and bottom surfaces of the pavers were performed. The results are used to develop specific guidelines for design of loose-laid roof pavers. Account is taken of pressure equalization, the gaps between the pavers, and the space beneath the pavers. These guidelines are intended to be simple enough to be used by designers in parallel with the usual code provisions for exterior suctions on roofs.

INTRODUCTION

Roofing systems are one of the most commonly damaged portions of the building envelope during high wind events. The ability to withstand wind-induced uplift forces across the building roofs is one of the critical design aspects. Suction forces on the roof can loosen and lift both roof sheathing and roof coverings, such as tiles, shingles, and roof pavers which might become wind born debris impacting other structures downwind causing extensive damage. Also, water leaking through failed roofing systems during hurricanes can result in considerable interior damage.

Flat roofs are commonly used in many residential and commercial buildings. Loose-laid concrete roof pavers are usually used on flat roofs. Concrete pavers are placed on the roof with gaps in between them and with spacing from the surface underneath the pavers (Figure 1).The gaps between the edges of adjacent pavers allow communication of top surface pressures to the underneath which results in a pressure equalization effect that reduces the net uplift (Asghari Mooneghi et al, 2014; Bienkiewicz and Sun, 1992, 1997; Kind and Wardlaw, 1982; Kramer et al, 1979). However, vortices emanating from roof corners can cause localized suctions on the top surface which cannot be fully countered by pressure equalization. These are the main cause of pavers being lifted off under strong winds. The pressure equalization effect is subject to a number of influencing variables such as location relative to a corner, paver size, parapet height, building height, size of the gaps between pavers, and the stand-off distance of the pavers above the underlying roof surface.

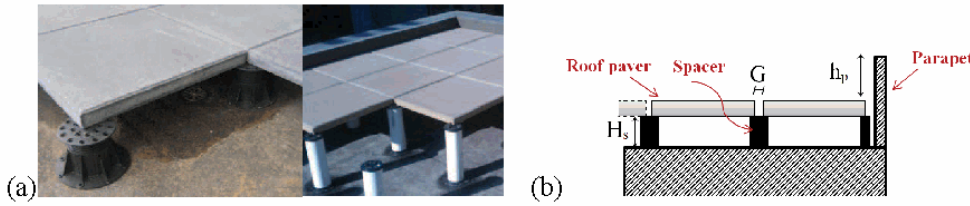


Figure 1. a) Roof pavers on flat roofs; b) Geometrical parameter definition

A number of experimental as well as theoretical research studies have been published in the literature concerning the wind loading mechanism of loose-laid roof pavers and the pressure equalization phenomenon. Researchers such as Cheung and Melbourne (1988), Bienkiewicz and Sun (1992), O'Brien et al (2004) and Asghari Mooneghi et al (2014) showed that the degree of pressure equalization depends on ratio of the size of the gap between the pavers to the spacer height, in such a way that the lower the ratio, the lower the pressure equalization.

Currently little guidance is supplied in most wind codes for the pressures underneath roof pavers. In addition, wind tunnel testing to measure them can be demanding considering both time and cost. With this in mind, some researchers have developed analytical models which are mainly concerned with simulating time-varying pressure distributions underneath roof pavers (i.e., interior pressure in the cavity between the inner and outer layers) given the external pressure data (Amano et al, 1988; Bofah et al, 1996; Gerhardt et al, 1990; Kind, 1994; Lou et al, 2012; Oh and Kopp, 2014; Sun and Bienkiewicz, 1993; Trung et al, 2010). The complexity of the current numerical methods makes it desirable to develop a simplified method that can be used in codes and standards for calculating the net uplift force of roofing systems from the available external pressure data on roofs.

A large-scale experimental study is presented that investigated the wind loading mechanism for concrete roof pavers on the flat roof of a low rise building. Half-scale roof pavers were installed on a square portion of the flat roof of a low-rise building. Results of wind lift-off tests and pressure measurements were used for accurate investigation of the net pressure distributions and the effect of the pavers' edge-gap/spacer height ratio on the wind performance of roof paving systems. Design guidelines are developed for roof pavers against wind uplift.

EXPERIMENTS

The experiments were performed in the Wall of Wind open jet facility at FIU. It can generate up to a Category 5 Saffir–Simpson Scale hurricane wind speed and replicate the mean wind speed profile and turbulence characteristics of hurricane winds. A set of triangular spires and floor roughness elements were used that generate turbulence and boundary layer characteristics (Figure 2). It is to be noted that WOW flow for large-scale wind testing is representative of a flow with partial turbulence simulation. In partial turbulence simulation, only the high frequency part of the wind spectrum is simulated and the low frequencies are missing mainly because of the limited size of the facility. So, the turbulence intensity is lower than that for the ABL flow containing all the low frequency fluctuations. However, using the method proposed by Katsuchi and Yamada (2011), the adequacy of the current turbulence intensity was shown. The size of the test section is 6.1 m wide and 4.3 m. high.

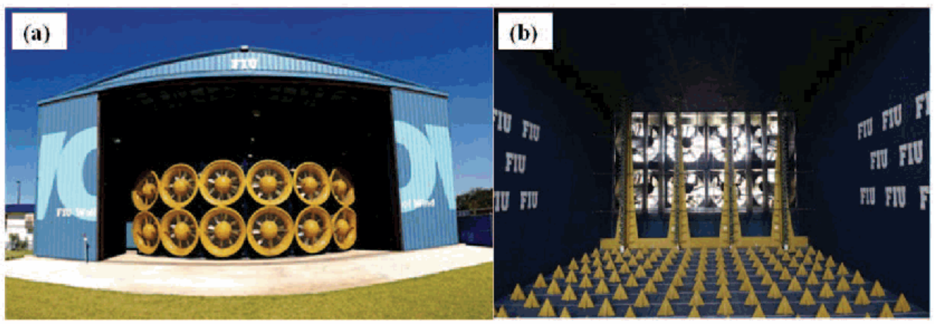


Figure 2. a) Wall of Wind, Florida International University; b) Spires and floor roughness elements

Tests were performed in suburban terrain with the target power law coefficient of α=1/4. The size of the 1:2 test building model was 3.35 m by 3.35 m in plan by 1.524 m high representing a low-rise prototype building with height of 3.48 m. The windward parapet was interchangeable to allow the study of the effects of relative parapet height on the wind loading mechanism of roof pavers (relative parapet heights tested were h_p/H=0, 0.03, 0.05, 0.1, 0.15). In this paper, results are given for the case that the windward parapet height was h_p =7.62 cm above the paver surface (Figure 1.b) resulting in a relative parapet height of h_p/H=0.05. There were no parapets on the leeward side of the building so that the roof can be representative of the windward corner of a bigger roof structure (Asghari Mooneghi et al, 2014; Lin and Surry, 1998; Lin et al, 1995).

Wind blow-off tests and pressure measurements were performed for three different edge-gap to spacer height ratios (G/H_s=0.28, 0.083 and 0.028). Adjustable height pedestals were used to change the space between the paver and the roof deck (H_s, Figure 1.b). A constant G=3.175 mm space between the pavers (Figure 1.b) was maintained. Only one wind angle of attack was tested which was 45° which is the most critical orientation for generating high uplifts under conical vortices on flat rectangular roofs (Holmes, 2007).

Wind blow-off tests were performed first. Concrete pavers with a dimension of 0.305 m by 0.305 m by 2.54cm thickness with weight per unit area of 535 N/m^2 were installed on the roof which can be considered as modeling typical 0.61 m square pavers at half-scale (Figure 3.a). The aim of these tests was to provide guidance on the location where the failure first occurred. This could then be used to decide on the pressure tap layout. The tests were performed by gradually increasing the wind speed in WOW and visually observing the behavior of the roofing system. The most critical pavers which dislodged first were identified. Wind speeds were measured at the roof height of the test model (1.524 m height) using a turbulent flow Cobra probe.

For pressure measurements, the original pavers were replaced by pavers made from Plexiglas with the exact dimension as actual concrete roof pavers (Figure 3.b). Pressure measurements were carried out at wind speed of 18.5 m/s which was below the failure wind speed of concrete pavers (but required some special measures to hold the Plexiglas pavers in place). A total of 447 pressure taps were installed on the external and underneath surfaces of roof pavers on the whole roof. Nine critical pavers, identified during wind lift-off tests were fitted with total of 256 pressure taps to allow detailed measurements of the pressure distribution above and underneath the pavers (Figure 3.c).

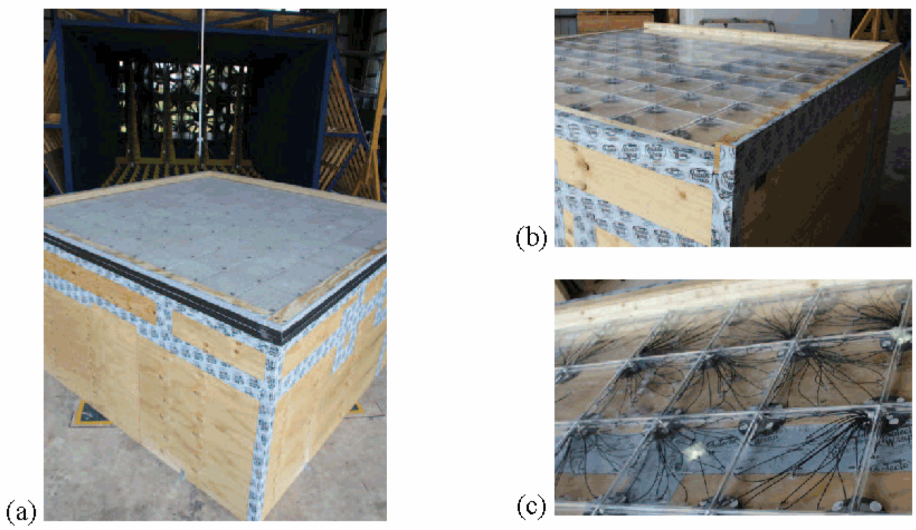


Figure 3. a) Test building for wind blow-off tests; b) Test building for pressure measurements; c) Critical pavers instrumented with pressure taps

Figure 4 shows the numbering of the pavers and the location of the 9 critical pavers. A 512 channel Scanivalve Corporation pressure scanning system was used for pressure measurements. Pressure data were acquired at sampling frequency of 512 Hz for a period of two minutes. A transfer function designed for the tubing (Irwin et al, 1979) was used to correct for tubing effects.

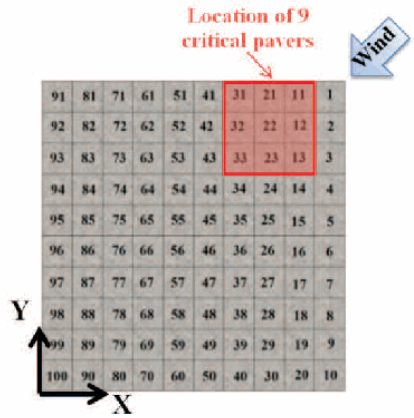


Figure 4. Roof pavers numbering

DATA ANALYSIS

The mean pressure coefficient at any location was obtained from:

$$Cp_{mean} = \frac{P_{mean}}{\frac{1}{2}\rho U_{mean}^2} \quad (1)$$

where P_{mean} is the mean pressure, ρ is the air density at the time of the test (1.225 kg/m^3) and U is the mean wind speed measured at the building height of the test model (1.524 m). The peak pressure coefficient was obtained from:

$$Cp_{peak} = \frac{P_{peak}}{\frac{1}{2}\rho U_{3s}^2} \quad (2)$$

where P_{peak} is the peak pressure. Data were low-pass filtered at 30 Hz (equivalent to 21 Hz at full scale).The Sadek and Simiu (2002) method was used to obtain statistics of pressure peaks from observed pressure time histories. Because estimates obtained from this approach are based on the entire information contained in the time series, they are more stable than estimates based on single observed peaks. For the evaluation of these estimated values 95% confidence was considered. U_{3s} is the peak 3-s gust at the reference height. The peak value of the U_{3s} was obtained by performing moving averages. The net total pressure coefficient defined as the instantaneous difference between the external and the corresponding underneath pressure coefficient at the same location are:

$$Cp_{net} = Cp_{ext} - Cp_{int} \quad (3)$$

The overall wind lift load, L, acting on any single paver is obtained as:

$$L = \frac{1}{2}\rho U^2 \iint_{A_{paver}} Cp_{net}(x,y)\,dA \quad (4)$$

$$C_L = \frac{L}{\frac{1}{2}\rho U^2 A} \quad (5)$$

where A is the surface area of the paver. The reduction in the net wind uplift can be expressed as:

$$r = \frac{C_{L_{net}}}{C_{L_{ext}}} \tag{6}$$

The blow-off takes place when the uplift force is equal to the paver's weight, W. Therefore, the critical wind velocity U_{CRIT} at which blow-off occurs is:

$$U_{CRIT} = \sqrt{\frac{W}{\frac{1}{2}\rho C_L A}} \tag{7}$$

RESULTS AND DISCUSSION

Results from wind lift-off tests and pressure measurements showed that in all cases Paver 21 (Figure 4) was the most critical paver experiencing the highest uplift force. So, results presented in the following are based on the results calculated for this most critical paver (unless otherwise mentioned). Figure 5 shows a comparison between the failure wind speeds when wobbling of pavers was observed, the critical wind speeds calculated using net lift coefficient obtained for Paver 21 from pressure measurement tests using Eq. (7), and a practice based on ASCE 7-10 pressure coefficients for components and claddings using Eq. (7). It should be noted that ASCE 7-10 does not provide any recommendations for the pressure coefficient in the underneath cavity of multi-layered roofing systems. So, the net uplift coefficient cannot be calculated directly from ASCE 7-10. Consequently, a common practice mainly proposed for roof tiles (FPHLM, 2005, Volume II, p. 55) is to consider the external pressure coefficient as the net pressure coefficient. For gable roofs with slope $\theta \leq 7°$ the largest external pressure coefficient for edge Zone 2 and corner Zone 3 for tributary areas less than 0.9 m^2 is given as -1.8 and -2.8 respectively in Figure 30.4-2A (ASCE 7-10). Results presented in Figure 5, demonstrate the effect of pressure equalization for air permeable roofing systems in increasing the critical wind speed at which failure occurs and shows that the values based on ASCE 7-10 external pressure coefficients are conservative. This was in agreement with past studies in the literature which showed that for double-layer roof systems (e.g. roof pavers), estimates of wind loads obtained in most of regions of the roof can be considerably conservative by ignoring the effects of pressure equalization through application of the building codes to the design of the exterior roof layer (Bienkiewicz and Endo, 2009; Bienkiewicz and Sun, 1992, 1997; Chino et al, 1991; Kind and Wardlaw, 1982; Kramer and Gerhardt, 1983; O'Brien et al, 2004). Results in Figure 5 also showed that by increasing the gap to spacer height ratio (G/H_s), the failure wind speed increases. This is in agreement with studies of Bienkiewicz and Endo (2009). Also, tests on the effects of relative parapet height (h_p/H) showed that generally parapets reduce the net uplift force on the roof pavers. However, a certain relative parapet height in the range $h_p/H=0.10$ exists in which the uplift loads reach the worst case values.

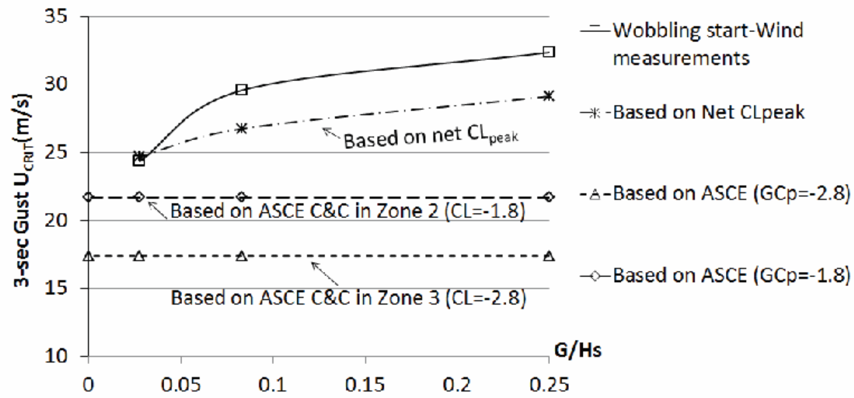


Figure 5. Critical lift-off speed

Figure 6 shows the variation of the net uplift force coefficient and the reduction factor ($r = \frac{C_{L_{net}}}{C_{L_{ext}}}$) with G/H_s on Paver 21. The results show that increasing the G/H_s ratio reduces the net uplift force coefficient on the paver.

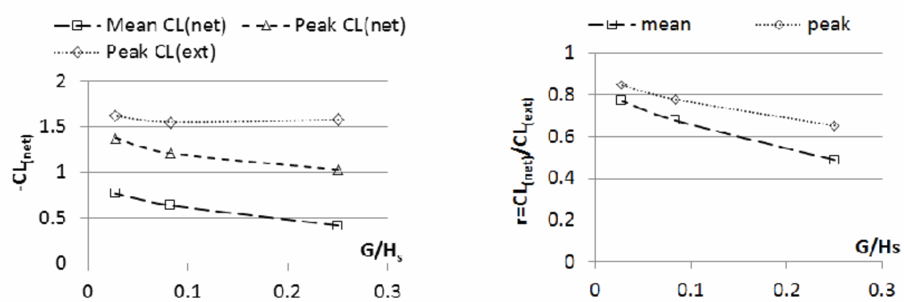


Figure 6. Variations of CL_{net} and $r = \frac{C_{L_{net}}}{C_{L_{ext}}}$ with G/H_s

As explained previously, pressure equalization is dependent on the geometric parameters of the roof pavers (Bienkiewicz and Endo, 2009; Bienkiewicz and Sun, 1992, 1997). These include the gap (G) between panels, the spacer height (H_s) between the pavers and the roof, and the panel size. This research has focused on characterizing the pressure equalization on roof pavers and the effect of the gap to spacer height ratio (G/H_s) and relative parapet height (h_p/H) for developing simple design guidelines for loos-laid roof pavers. A journal paper is in preparation which includes these design guidelines which will be presented during the conference. The guidelines have been formatted so that the existing information in codes and standards such as ASCE 7-10 on exterior pressures on components and cladding can be utilized. The effects of the paver's edge-gap to spacer height ratio and parapet height as a fraction of building height will be included in the guidelines as adjustment factors. These guidelines incorporate appropriate factors of safety in order to achieve the normal levels of reliability used in the design of building envelopes.

CONCLUSIONS AND FUTURE WORK

The objective of this paper was to investigate the wind loading mechanism of concrete roof pavers with the ultimate goal of developing simple design guidelines in code format for design of commonly used loose-laid roof pavers. The experiments were performed in the Wall of Wind, a large-scale hurricane testing facility at Florida International University. Experiments included both wind blow-off tests and detailed pressure measurements on the top and bottom surfaces of the pavers. Large-scale concrete roof pavers were installed on a square portion of a flat roof. The effects of changing the pavers' edge-gap to spacer height ratio were investigated. Based on the information gathered in the current tests and review of literature, guidelines suitable for codes and standards are being developed for the design of roof pavers and will be presented. The guidelines will be formatted so that use can be made of the existing information in codes and standards such as ASCE 7-10 pressures coefficients. Limitations and applications of the guidelines will be addressed.

ACKNOWLEDGEMENT

This research was supported by the Florida Division of Emergency Management (DEM) and the National Science Foundation (NSF) (NSF Award No. CMMI-1151003) through the Wall of Wind flow simulation and large-scale testing of roof pavers. We would like to acknowledge with thanks the Tile Tech Company for providing us with concrete roof pavers and the pedestal system for the wind blow-off tests. The help offered by the Wall of Wind manager, Walter Conklin and research scientists, Roy Liu Marquis and James Erwin is greatly acknowledged. The help offered by graduate research assistant, Ramtin Kargarmoakhar is also greatly appreciated.

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Towards guidelines for design of loose-laid roof pavers for wind uplift

Maryam Asghari Mooneghi[1a], Peter Irwin[2b] and Arindam Gan Chowdhury[*2]

[1]*Advanced Technology and Research, Arup, San Francisco, CA, USA*
[2]*Department of Civil and Environmental Engineering/International Hurricane Research Center, Florida International University, Miami, FL, USA*

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Abstract. Hurricanes are among the most costly natural hazards to impact buildings in coastal regions. Building roofs are designed using the wind load provisions of building codes and standards and, in the case of large buildings, wind tunnel tests. Wind permeable roof claddings like roof pavers are not well dealt with in many existing building codes and standards. The objective of this paper is to develop simple guidance in code format for design of loose-laid roof pavers. Large-scale experiments were performed to investigate the wind loading on concrete roof pavers on the flat roof of a low-rise building in Wall of Wind, a large-scale hurricane testing facility at Florida International University. They included wind blow-off tests and pressure measurements on the top and bottom surfaces of pavers. Based on the experimental results simplified guidelines are developed for design of loose-laid roof pavers against wind uplift. The guidelines are formatted so that use can be made of the existing information in codes and standards such as American Society of Civil Engineering (ASCE) 7-10 standard's pressure coefficients for components and cladding. The effects of the pavers' edge-gap to spacer height ratio and parapet height to building height ratio are included in the guidelines as adjustment factors.

Keywords: design guidelines; roof pavers; large-scale testing; wind uplift

1. Introduction

It is clearly important that roofing materials be designed so that they can withstand the uplift forces that occur in strong winds. Some of the major losses that have occurred in hurricanes have been due to loss of roofing materials (Huang *et al*. 2009). Experience indicates that hurricane winds are well capable of ripping off materials such as tiles, shingles, roof pavers and gravel ballast (Smith 1994, Huang *et al*. 2009). The building itself then becomes vulnerable to considerable additional damage through water infiltration and changes in internal pressure (Bitsuamlak *et al*. 2009, Chowdhury *et al*. 2012). As well, the wind-borne debris coming from the damaged roof often causes extensive additional damage to buildings downwind as it impacts them with high momentum (Fernandez *et al*. 2010, Masters *et al*. 2010).

*Corresponding author, Associate Professor, E-mail: chowdhur@fiu.edu
[a] Ph.D., E-mail: maryam.asghari@arup.com
[b] Professor of Practice, E-mail: peairwi@fiu.edu

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Wind uplift of roof pavers is not only the result of the suction on their top surface, but also of the pressure on their underside for which no guidance is currently supplied in most wind codes. Therefore, for lack of better information, building designers often make the simplifying assumption that the net uplift acting on air permeable roofing elements is the same as the exterior pressure specified in the building code (Florida Public Hurricane Loss Projection Model (FPHLPM) 2005). In reality a significant amount of pressure equalization occurs which tends to make this assumption quite conservative in many instances for roof pavers (Banks *et al*. 2000). On the other hand, the pressure equalization effect is subject to a number of influencing variables such as paver's location relative to a corner, paver size and geometry, parapet height, building height, gaps between pavers, and the stand-off distance of the pavers above the underlying roof surface (Bienkiewicz and Sun 1997, Banks *et al*. 2000). This has deterred the development of more specific guidance in codes. Interlocking and strapping systems are often used to improve the resistance of roof pavers, and they can be very effective (Irwin *et al*. 2012). However failures do still occur and it will help in the design of such systems if better knowledge of the aerodynamic forces working on the pavers can be obtained. The aerodynamic mechanisms that cause uplift are quite complex but in this paper guidance is developed in the form of relatively simple rules for the design of loose-laid roof pavers against uplift wind forces, rules that are amenable to use alongside or within building codes.

A set of large-scale experiments was performed to study the wind loading mechanism of concrete roof pavers using the Wall of Wind (WOW) facility at Florida International University (FIU). Concrete pavers were installed on a square portion of a flat roof of a low-rise building. Both wind blow-off testing and pressure measurements were performed. Experiments included the wind lift-off tests and detailed pressure measurements on the external and underneath surfaces of roof pavers. The effects of the pavers' edge gap to spacer height ratio, relative parapet height and the effects of connecting pavers were studied. The results from the pressure measurements were compared with estimates obtained from American Society of Civil Engineering (ASCE) 7-10 pressure coefficients. Finally, guidelines were proposed for design of loose-laid roof pavers using ACSE 7-10 components and cladding exterior pressure coefficients taking into account the effects of pavers' edge-gap to spacer height ratio, relative parapet height, and pressure equalization.

2. Background

Solid pavers are frequently used as ballast and walking surfaces on flat roofs and as decorative elements on terraces. It is necessary that they be capable of resisting uplift forces due to wind. A number of experimental and analytical studies are reported on wind loading and performance of loose-laid roofing systems. Wind tunnel experiments on small scale models have been performed by researchers to investigate the wind loading and failure mechanism of loose-laid roof paving system (Kind and Wardlaw 1979, Kind and Wardlaw 1982, Bienkiewicz and Sun 1992, Bienkiewicz and Sun 1997, Irwin *et al*. 2012, Oh and Kopp 2015). Large-scale testing is preferred for small structures and building appurtenances for maintaining modeling accuracy and minimizing Reynolds number effects (Kargarmoakhar *et al*. 2015). However, studies using full- and large-scale models (Aly *et al*. 2012, Asghari Mooneghi *et al*. 2014) have been limited. As explained by Geurts (2000), small scale wind tunnel experiments are not normally suitable for investigating the pressure equalization over air permeable roof covering materials and its effects on the net loading. This is because when the batten space and permeability are scaled, their sizes get too small to simulate the realistic mechanisms in the flow due to Reynolds number effects. Therefore, large scale test data or full scale field measurements are necessary for proposing calculation models and design guidelines for these materials.

The complex nature of the flows above and beneath air permeable roofing systems has also been explored using numerical simulations. Amano *et al*. (1988) proposed a simplified numerical model based on the unsteady Bernoulli equation with one value of pressure at each paver edge for obtaining the internal wind pressure distribution of roof pavers under a known external pressure field. Correction terms were employed to take into account the effects of viscosity. The effect of the gap between the pavers was also investigated. Kind *et al*. (1988) proposed a correlation for predicting wind lift-off speeds of loose-laid insulation boards based on extensive wind tunnel testing results. The correlation accounts for the effects of building characteristics (low, intermediate or high–rise building), parapet height, element weight per unit area and interlock effects. The tests of Kind *et al*. (1988) were primarily for pavers laid directly on the roof with no spacers underneath. Gerhardt *et al*. (1990) performed a set of experiments and calculations and developed an equation for calculating the failure wind speed based on the external pressure, the element size relative to smaller plan dimension of the building and the weight of the elements. Diagrams were provided to help choose the best possible solution when using these roofing systems. Sun and Bienkiewicz (1993) stated that the flows between and beneath the loose-laid pavers are very slow because of the boundary effects of the flow field, and should be treated as viscous. They employed Darcy's law to develop a numerical model for calculating the pressure distribution underneath roof pavers. In their model, the pressure distribution along paver edges was assumed piecewise linear. The experimental data and their numerical results show similar trends. This model was refined later to allow arbitrary pressure distribution along paver edges, and to take into account the interlock effects between pavers. This flow model was limited to steady flow and was sufficient to estimate the mean pressure distribution for small stand-off distances between the roof surface and pavers and for low speeds of the flow, which means low Reynolds number. However, it may not be so applicable for a relatively high flow speed with high turbulence (Oh and Kopp 2012). Kind (1994) proposed a numerical method based on Laplace's equation for predicting the underneath pressure distribution for loose laid roof pavers. It was assumed that inertia effects are negligible in the under-element flow and it was thought to be viscosity dominated. Also, the flow resistance in the element/roof deck interface plane was considered as uniform. With these assumptions the flow continuity equation reduces to the Laplace equation. The results were in reasonable agreement with measured pressure distributions in cases where the roof deck and the undersides of the elements were reasonably flat with uniform surface texture. The results are more likely to be applicable for pavers lying directly on the roof surface. Bofah et al. (1996) proposed a theory for calculating the pressure distribution underneath roof pavers based on approximating the underneath flow by a two-dimensional laminar flow in a very shallow channel with a porous upper roof. Sinusoidal and uniform outer pressure distributions were investigated which were consistent with experimental results. Trung *et al*. (2010) applied a method based on the Multiple Discharge Equations (MDE) as described in Oh *et al.* (2007) to predict the underneath pressures of a porous sunshade roof cover from a known external pressure distribution. Computational results were compared with experiments performed on a 1:50 scale model of a low-rise building. The results of the computations were in good agreement with the experiments for 5% and 10% porosity ratios (ratio between the areas of orifices to the area of the sheet) and 4.7 mm height from the roof deck to the cover used in the experiments. Oh and Kopp (2014) developed a one-dimensional analytical model for simulating cavity pressures within multi-layer roofing systems from a known external pressure distribution using the unsteady Bernoulli equation and Couette flow assuming laminar flow in the cavity. The model was verified by comparing its predictions with results obtained from wind tunnel testing.

Previous experimental and numerical studies on the wind loading mechanism of loose-laid roofing systems like roof pavers, gravel ballast, green roofs, etc. can assist in developing code specific models for design of such systems. However, many unanswered questions still remain in the current state of knowledge on this issue. In research aimed at codification of wind loading on porous claddings and covers over roofs which have a similar wind loading mechanism as roof pavers, Cheung and Melbourne (1986) and Cheung and Melbourne (1988) investigated the effect of porosity on wind loading on such systems. Reduction factors were proposed as a function of distance from the roof leading edge for different porosities and different internal volumes for a typical low-pitch roof cladding, and adopted by AS/NZS 1170.2. Design wind loads could then be estimated from external pressure coefficients given in the existing building codes. Bienkiewicz and Meroney (1988) developed a rough design guideline for loose-laid ballast pavers. The system failure condition was considered in terms of the failure wind speed and the wind loading parameters specified by the building code parameters (UBC, ANSI or ASCE 7-05 (Bienkiewicz and Endo 2009). This theory is limited to low buildings with rectangular flat roofs. The allowable building heights are given in the design guidelines for a range of design wind speeds and wind exposures.

Some codes and standards do address the design of roof paver systems. In the Netherlands code, NEN EN 1991-1-4/NA, a set of values for net pressure coefficients (difference between the external and underneath pressure coefficients; $Cp_{net}=Cp_e-Cp_i$) is proposed for design of roofing tiles and pavers. These values were based on a number of experiments and full-scale studies on roof tiles on pitched roofs and roof pavers on flat roofs including those of Geurts (2000), who proposed equalization factors defined as $C_{eq}=Cp_{net}/Cp_e$ from full-scale measurements on roof tiles and roof pavers. The equalization factors are to be applied to the external pressure coefficients given in the Netherlands wind loading code. The proposed value of C_{eq} for roof pavers with and without interlock were 0.25 and 0.6, respectively. In the German Wind Code (DEUTSCHE NORM 2001-03) design pressure coefficients are provided for building envelopes with permeable facades based on a study by Gerhardt and Janser (1995). In the Australian Standard for wind loads (AS 1170.2 2011) reduction factors are given for estimating design wind loads on porous claddings. These factors depend on the cladding porosity and the horizontal distance from windward building edge, and are based on the work of Cheung and Melbourne (1988).

Major international codes and standards for wind loads in USA and Canada (NBCC; ASCE 7-10) specify roof wind pressures for typical roof geometries but there are no specific provisions on how to apply such pressures to roofing elements such as tiles, shingles, and pavers. Using the available numerical methods proposed in literature for designers and suppliers of roof pavers is quite complex, and performing project specific wind tunnel testing is not practical, except for very large projects. This paper proposes a simplified yet reasonably accurate method for calculating the net uplift force on roof paver systems from the existing external pressure coefficients in the current ASCE 7-10 standard and takes into account the effect of pavers' edge gap to spacer height ratio, relative parapet height, and pressure equalization.

3. Pressure gradient effects

Multi-layer building envelopes, e.g. roof pavers are particularly sensitive not just to pressures but to spatial pressure gradients. Concrete roof pavers are usually placed on the roof with spacing above the roof deck and with gaps between the pavers. The pressure distribution produced by the wind flow over the outer surface of the roof produces secondary flows through the spaces between and underneath the paver elements. The so called pressure equalization occurs very quickly, provided the space between the pavers and the roof deck below is not too large, typically in a small fraction of a second, because very small volumes of air exchange are needed to bring the underside pressure into equilibrium with the pressures around the paver perimeter. This phenomenon is controlled by the same physics as the internal pressure. However, in pressure equalization, much smaller volumes of air through many openings are involved. The pressure equalization effect greatly reduces the net uplift force on pavers in most areas of a roof. However, in areas of very high spatial gradients of pressure, such as those which occur under vortices near roof corners, significant net uplift pressures can still occur. Figure 1 illustrates the typical path of the vortices over a flat roof for cornering winds.

Along with the high suctions from the vortices there are also high velocities passing over the surface as the flow rotates rapidly about the vortex center. The vortex is analogous to a small tornado with axis approximately horizontal and with very high velocities near the vortex core. Thus, not only are there high suctions tending to lift roofing material, but also high tangential air speeds immediately adjacent to the roof surface, which are prone to penetrating under the edges of roofing elements and lifting them. It is very important to generate these vortices as part of the test to fully replicate these wind effects on a roof. The bell-shaped curves in Fig. 1 have greatest central suction near the roof corner but as distance from the roof corner increases, the suction reduces and the width of the bell-shape grows larger (Banks *et al.* 2000). The effect of these suction distributions on the roof will depend on the type of roof system being used and is clearly very different from a simple uniform pressure distribution. The diagram in Fig. 2 illustrates schematically the general mechanism of uplift on roof pavers. The aerodynamic uplift force is the difference between the pressure on the lower surface of the paver, P_L and the pressure on the upper surface, P_U (Fig. 2). The pressure on the upper surface due to the presence of a conical vortex (solid curve) is negative (when measured relative to the static pressure in the surrounding air stream) and has a concentrated peak.

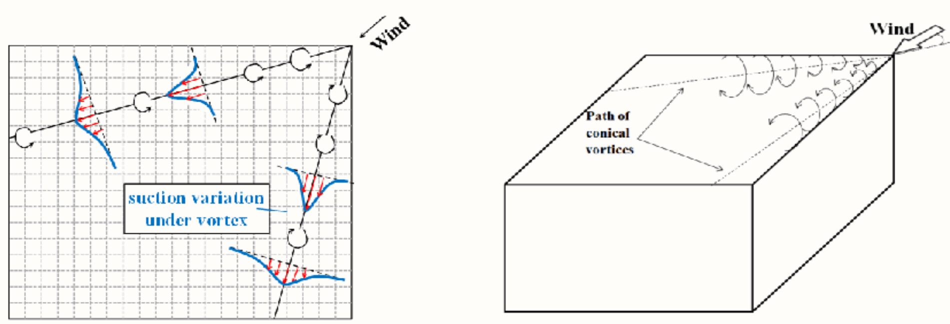
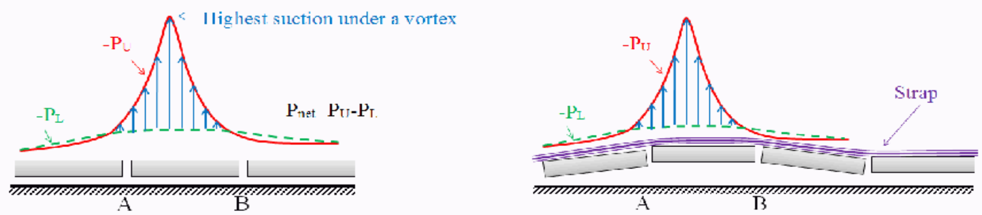


Fig. 1 Conical vortices; Suction variation on roof under corner vortices



(a) Pressure distributions on upper and lower surfaces of a roof paver (b) Straps running transverse to the axis of the vortex

Fig. 2 General mechanism of uplift on roof pavers

The pressure on the lower surface is depicted by the broken curve and at the paver edge it is shown as being equal to that on the top surface. In practice, the top and bottom edge pressures do not always match exactly. The underneath pressure is dictated by the outer pressure distribution and the relative magnitude of the joint resistances compared to the under-element resistance which prevents a complete pressure equilibration between upper and lower surfaces of the element (Bofah *et al*. 1996, Gerhardt *et al.* 1990, Kind 1994). Detailed measurements done by Kind and Wardlaw (1982) showed that the underneath pressure does tend to vary roughly linearly between the pressures at the paver edges as depicted in Fig. 2 (also discussed in Bofah *et al.* (1996)). It is only due to the sharp peak of the upper pressure under a vortex (between points A and B) that a net uplift might occur, signified by the large difference between the solid and broken curves. If the upper surface pressure does not have the peak (e.g., the pavers are not sitting directly under a vortex) then pressure equalization caused by flow around the edges of the paver results in much smaller net uplift as shown by the small differences between the solid and dashed curves on the pavers outside of the zone between points A and B. The impact of pressure equalization depends on the size of the paver relative to the width of the conical vortex. If the paver is much larger than the width of the vortex then the impact is reduced since only a small fraction of the paver area is affected by the high suction. Also, if the paver is much smaller than the width of the vortex then, even if it is sitting in a high suction zone, the pressure equalization effect of the gaps at its edges substantially reduces the difference in pressure between top and bottom surfaces. If the paver and vortex widths are similar the net uplift will tend to be maximized.

At sufficient wind speed the aerodynamic uplift force and/or the overturning moment on the element may become higher than the weight and/or the resisting moment due to gravity or other restraints, such as strapping, and lift off will occur.

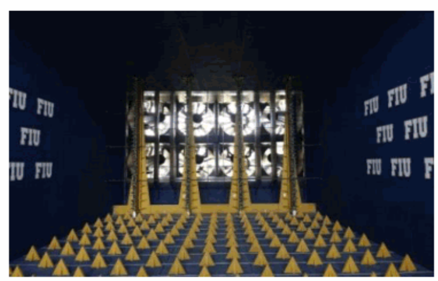
Interlocking and strapping systems are commonly used to improve the wind performance of roof pavers. In this case, the uplift force tends to be shared across several pavers. Fig. 2(b) shows a strapping system running transverse to the axis of the vortex which connects to the center of each paver. The lift on the paver AB is now restrained not only by the weight of the paver AB but also by at least part of the weight of the adjacent pavers, on which there is little if any lift. The lift on the paver AB that is needed to both lift paver AB and also cause the adjacent pavers to rotate so that their edges at A and B become airborne, but not the farther edges, is about double that needed to lift the unconnected paver (Irwin *et al*. 2012). The lift required to cause the farther edges also to become airborne is about 3 times that for the unconnected paver. These considerations, along with the assumption that lift on real pavers varies approximately as wind velocity squared, lead to the expectation that strapping in the direction transverse to the line of the vortex will increase the lift off speed by a factor of approximately $\sqrt{2} = 1.4$ to $\sqrt{3} = 1.7$ (Irwin *et al.* 2012). Aly *et al.* (2012) also showed that locking a group of pavers together can be very effective for preventing lift-off of pavers located in critical regions on the roof. They recommended using a locking system able to hold a group of at least 4x4 or 5x5 pavers together.

4. Experimental setup and testing protocol

A number of large-scale experiments were performed by the authors, and described in an earlier paper (Asghari Mooneghi *et al.* 2014, Mooneghi *et al.* 2014). In the work discussed in this paper, the same experimental setup was used for additional tests to facilitate the development of design guidelines. The experiments were performed in the 12-fan Wall of Wind (WOW) open jet facility at FIU which is able to generate hurricane winds up to Category 5 Saffir–Simpson Scale that replicate a representative mean wind speed profile and the high frequency end of the turbulence spectrum. A set of triangular spires and floor roughness elements was used to generate appropriate turbulence and boundary layer characteristics (Fig. 3).

Fig. 4 shows the comparison of longitudinal WOW spectrum and the Von Karman longitudinal spectrum at full scale using L_u=12 m and I_u=0.3 at 3.048 m height in suburban terrain (z0=0.2). It can be seen that there is a good match between the two spectra at high frequencies which has been noted by a number of previous researchers as necessary for correct simulation of local flow aerodynamics on low-rise buildings (Melbourne 1980, Saathoff and Melbourne 1997, Kumar and Stathopoulos 1998, Tieleman 2003, Richards *et al.* 2007, Yamada and Katsuchi 2008, Irwin 2009, Banks 2011, Kopp and Banks 2013). However, at low frequencies turbulence energy is missing. This is a common limitation when testing at large model scales, due to the limited size of wind tunnel working sections, but it can be largely overcome in post-test analysis using Partial Turbulence Simulation (PTS) theory based on quasi-steady assumptions as described by Asghari Mooneghi (2014) and Asghari Mooneghi *et al.* (2015).

(a) Inlet view



(b) Outlet view, Spires and floor roughness elements

Fig. 3 Wall of Wind, Florida International University

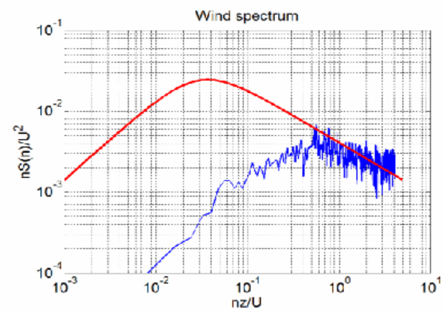
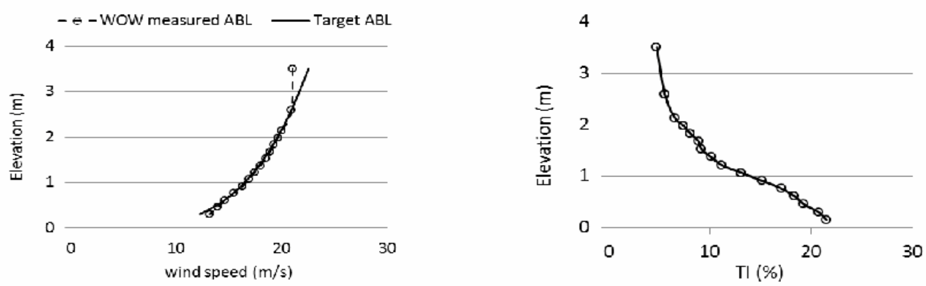


Fig. 4 Comparison of WOW Partial Spectrum and the Von Karman Spectrum at Full Scale



(a) Atmospheric Boundary Layer (ABL) profile (b) Turbulence intensity profile

Fig. 5 Simulated Suburban Terrain

The mean wind speed and turbulence intensity profiles for suburban terrain are shown in Fig. 5 for 20.1 m/s wind speed (target power law coefficient was α=1/4).

The dynamic similarity requirements for the tests and how they were satisfied have been described by Asghari Mooneghi *et al.* (2014). The size of the 1:2 test building model was 3.35 m by 3.35 m in plan by 1.524 m high, representing at half scale a low-rise prototype building with height of 3.048 m. The size of the test section was 6.1 m wide and 4.3 m. high.

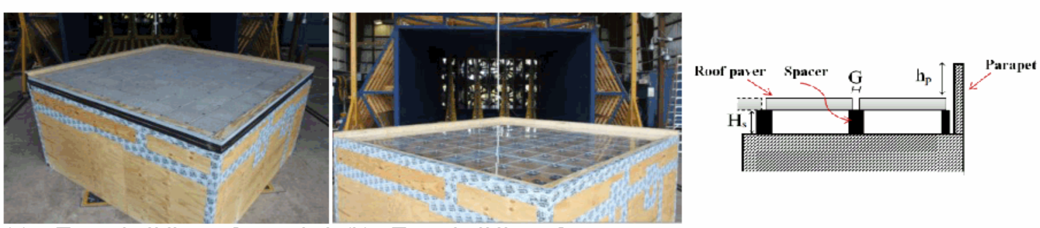
The test model height was around 35% of the wind field height generated by the WOW. This was within the 33% to 50% of the wind field height recommended by Aly *et al.* (2011) for obtaining roof pressure measurements with insignificant blockage effects in open jet facilities (Habte *et al.* 2015). The test model was located at a distance of around 13.70 m from the WOW fans, thus abiding by the minimum proximity requirement recommended by Bitsuamlak *et al.* (2010).

The roof deck was made from plywood and was completely sealed and rigid. The rectangular sharp edged parapets on the building model were interchangeable which allowed the parapet height to be adjusted. There were no parapets on the leeward side of the building. This was done with the intent that the model roof could be representative of the windward corner of a bigger roof structure on which the downwind parapets would not significantly influence flow over the upwind portions of the roof. Lin and Surry (1998) and Lin *et al.* (1995) showed that, for low buildings which are large enough to have reattached flows on the roof, the distribution of pressure coefficients in the corner region is mainly dependent on the eave height, H, and not so much on the building plan dimensions for similar terrain conditions. Moreover, external pressure coefficients measured in the wind tunnel by Kopp *et al.* (2005) on roof corners of a nearly flat building model were consistent with those measured on roof corners of flat roof low-rise building models with the same height but with different plan aspect ratios (Stathopoulos 1982, Stathopoulos and Baskaran 1988, Ho *et al.* 2005, Pierre *et al.* 2005).

Both wind blow-off testing (i.e., blowing at sufficient speed to dislodge pavers) and pressure measurements were performed. For the wind blow-off tests, concrete pavers with dimensions of 0.305 m by 0.305 m by 2.54 cm thickness with weight per unit area of 535 N/m^2 were installed on the roof which can be considered as modeling typical 0.61 m square pavers at half-scale (Fig. 6(a)). The pavers were numbered from 1 to 100 (Fig. 7(a)). For the pressure measurements, pavers with exactly the same dimensions as the concrete pavers (0.305 m × 0.305 m × 2.54 cm thickness) were made from Plexiglas which made it more convenient to install pressure taps on both upper and lower surfaces.

In order to study the effects of the pavers' edge gap to spacer height ratio, adjustable height pedestals were used to change the space between the pavers and the roof deck (H_s, Fig. 6(c)). A constant gap of G=3.175 mm at model scale (6.35 mm at full scale) between adjacent pavers (Fig. 6(c)) was maintained. Bienkiewicz and Endo (2009) carried out a wind tunnel study for studying the effects of the gap (G) between pavers, and the space (H_s) beneath the pavers on the pressures underside the loose-laid roof pavers. Results from these experiments showed that G reduced the underside pressure significantly but H_s did not show clear tendencies. Instead, they introduced a parameter of the gap to spacer height ratio (G/H_s) and showed that this parameter controls the underside pressures, in a way that the higher the ratio, the less the net pressure on the pavers. Here the authors have adopted the same approach of using the G/H_s ratio as the governing parameter. For very small gap sizes, Reynolds number effects could eventually make this assumption questionable but for the size of gap tested here (which is typical for most current paver systems) Reynolds number effects were expected to be minor.

A total of 13 experiments were carried out, including three wind blow-off tests and 10 pressure measurement tests. A summary of the parameters for each test is given in Table 1.



(a) Test building for wind blow-off tests (b) Test building for pressure measurements (c) Geometrical parameter definition

Fig. 6 Test setup configuration

Table 1 Test number and characteristics

Test Number	G/H_s*	$(h_p/H)_{windward}$**
Wind Uplift 1	0.25	0.05
Wind Uplift 2	0.083	0.05
Wind Uplift 3	0.028	0.05
Pressure 1-1	0.25	0.05
Pressure 1-2	0.25	0.067
Pressure 1-3	0.25	0.1
Pressure 2-1	0.083	0.033
Pressure 2-2	0.083	0.05
Pressure 2-3	0.083	0.1
Pressure 2-4	0.083	0.15
Pressure 3-1	0.028	0
Pressure 3-2	0.028	0.05
Pressure 3-3	0.028	0.1

*Constant G=3.175 mm (at model scale) for all tests

** Parapet height was measured from top of the pavers. Leeward building sides did not have any parapet.

Table 2 Failure wind speed

Test Number	Failure wind speed when wobbling of pavers started (m/s)	Failure wind speed when a couple of pavers lifted off from roof (m/s)
Wind Uplift 1	50	53.7
Wind Uplift 2	45.7	50.1
Wind Uplift 3	37.6	41.3

The test procedure consisted of first conducting wind lift-off tests to find out the location where paver lift-off first occurred so that the pressure tap layout for the pressure measurements could be concentrated on the most critical pavers. Only one wind direction was tested, a quartering direction of 45° relative to the roof edge. Based on past studies this wind direction was assessed to be the critical orientation for generating high paver uplift under conical vortices on flat rectangular roofs (Holmes 2015). Also, extensive experiments on roof pavers by Kind (1981) showed that, even though higher local roof suctions may occur for other directions, 45° is still the most critical direction for paver lift-off. Presumably this is due to the shape of the pressure distribution being less effective in lifting the pavers for other directions. The failure wind speeds measured at the roof height of the test model (1.524 m height) are reported in Table 2. These values are converted to full-scale values using Froude number scaling, i.e. full scale velocity $=\sqrt{2}\times$model velocity. The values reported in Table 2 are equivalent to 3s gust speeds at full scale. A summary of the method to calculate the equivalent 3s gust speeds is given in Appendix A.

The failure mechanism for the wind lift-off tests is explained in detail in the previous paper by the authors (Asghari Mooneghi *et al.* 2014). For pressure measurements, the original concrete pavers were replaced by the Plexiglas pavers with installed pressure taps (total of 447 pressure taps were used). The pressure tap layout is given in Fig. 7(b) for the exterior surface. The pressure tap layout for the underneath surface was about the same as the one given on the exterior surface with some minimal difference in the locations of pavers on the pedestals (Asghari Mooneghi *et al.* 2014). Nine critical pavers were fitted with a total of 256 pressure taps allowing accurate measurements to be made of the pressure distribution on the top and bottom surfaces.

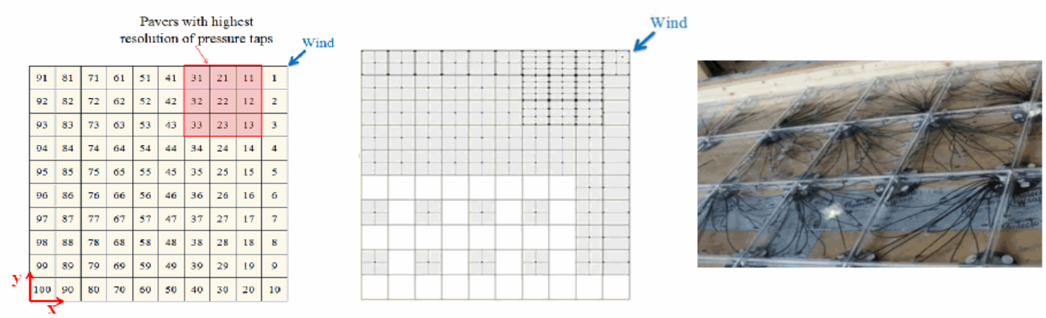
Pressure measurements were carried out at a wind speed of 18.5 m/s which was below the failure speed of concrete pavers. A 512 channel Scanivalve Corporation pressure scanning system was used for pressure measurements. Pressure data were acquired at a sampling frequency of 512 Hz for a period of three minutes. Data were low-pass filtered at 30 Hz (equivalent to 21 Hz at full scale). A transfer function was used to correct for tubing effects in the post-test analysis (Irwin *et al.* 1979).

5. Experimental results and discussion

5.1 Aerodynamic pressure results

In this section the results from the pressure measurement experiments are discussed. The mean pressure coefficient at any location was obtained from

$$Cp_{mean} = \frac{(P-P_0)_{mean}}{\frac{1}{2}\rho U^2} \quad (1)$$



(a) Pavers numbering (b) External pressure tap layout (c) Critical pavers instrumented with pressure taps

Fig. 7 Details of the Experimental Setup where P_{mean} is the mean pressure, P_0 is the static reference pressure, ρ is the air density at the time of the test (1.225 kg/m^3) and U is the mean wind speed measured at the building height of the test model (1.524 m). The peak pressure coefficient was obtained from:

$$Cp_{peak} = \frac{(P-P_0)_{peak}}{\frac{1}{2}\rho U_{3s}^2} \tag{2}$$

where P_{peak} is the peak pressure, and U_{3s} is the peak 3-s gust speed at the reference height. The tests were performed in partial turbulence simulation, hence the turbulence intensity at roof height was lower than that of atmospheric boundary layer (ABL) which contains full spectrum of turbulence. In order to calculate the peak pressure, P_{peak}, a method called "Partial Turbulence Simulation" (PTS) was used. In this method, the turbulence is divided into two distinct statistical processes, one at high frequencies which can be simulated correctly in WOW, and one at low frequencies which can be treated in a quasi-steady manner. The joint probability of load from the two processes is derived, with one part coming from the WOW data and the remainder from the Gaussian behavior of the missing low frequency component. The PTS method is discussed in details in Asghari Mooneghi (2014). It should be noted that in this method, the Cp_{peak} is first calculated based on mean hourly dynamic pressure, that would have been obtained had the full spectrum been present which can then be converted to Cp_{peak} based on gust pressure corresponding to any selected gust duration, e.g., 3 seconds. For the current test configuration, $U_{3600sec}/U_{3sec} = 1.8$ was used. This factor was calculated for suburban terrain at z=3.048 m. The procedure for converting the wind speed averaging time was based on Harris and Deaves (1981) model taken from ESDU (1985). For the evaluation of these estimated values, the peak value with 85% probability of not being exceeded in one hour of full spectrum wind was selected (Asghari Mooneghi 2014). The choice of the 85% probability of non-exceedance for obtaining the peak pressure coefficients is not materially very different from the 80% recommendation of the ISO 4354 standard (International Standard 2009).

The net total pressure coefficient, defined as the instantaneous difference between the external and the corresponding underneath pressure coefficient at the same location, is

$$Cp_{net}(t) = Cp_{ext}(t) - Cp_{int}(t) \tag{3}$$

Mean and peak external pressure coefficients, mean underneath pressure coefficient and net mean pressure coefficients contours for the case of G/H_s=0.028 and h_p/H=0 (i.e., no parapet case) are given in Fig. 8.

The results of the tests show that pavers close to the edges and corners of the roof are subjected to the highest local negative pressures. These areas are under the conical vortices. As compared to external pressures the underneath pressures are lower in magnitude and show more uniformity. Pressure equalization reduces the net uplift force on the pavers. It should be noted that the peak values correspond to the estimated peak values for each tap during the test and do not happen simultaneously on all taps. In all tests, paver 21 was shown to be the most critical paver. So, in the rest of the paper, results are calculated for this paver.

The overall wind lift load, $L(t)$, acting on any single paver and the lift coefficient $C_L(t)$ are obtained as

$$L(t) = \frac{1}{2}\rho U^2 \iint_{A_{paver}} Cp_{net}(t)dA \tag{4}$$

$$C_L(t) = \frac{L(t)}{\frac{1}{2}\rho U^2 A} \tag{5}$$

where A is the surface area of the paver. It should be noted that the highest suction on the paver does not necessarily occur at the center of the paver. This means that even for cases where the total uplift force is less than the weight of the paver, the weight of the paver might not overcome the corresponding overturning moment from the wind suction forces. The overturning moment about a selected axis and the moment coefficient $C_M(t)$ can be obtained from

$$M(t) = \frac{1}{2}\rho U^2 \iint_{A_{paver}} Cp_{net}(t) \times d \times dA \tag{6}$$

$$C_M(t) = \frac{M(t)}{\frac{1}{2}\rho U^2 A a} \tag{7}$$

where d is the moment arm defined as the distance from a selected axis to each point on the paver (Fig. 9).

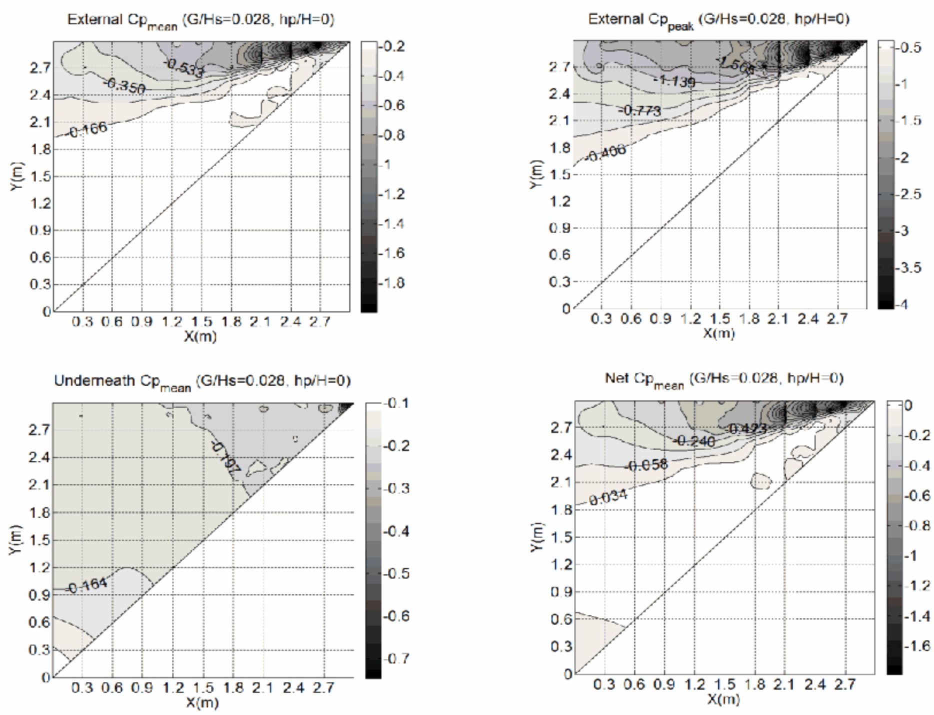


Fig. 8 Pressure coefficient contours (G/H_s=0.028 and h_p/H=0)

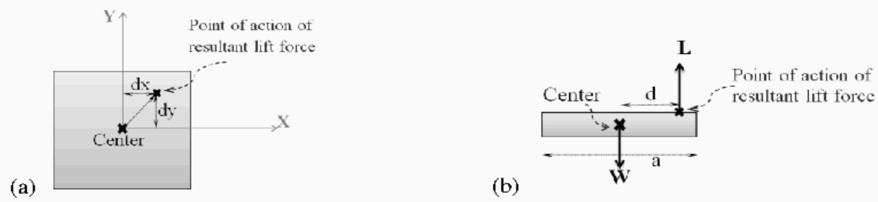


Fig. 9 Definition of the point of action of the resultant lift force: (a) plan view and (b) side view

Table 3 shows the variations of the most negative mean and peak local $C_{p,ext}$ values, C_{Lext}, C_{Lnet}, $C_{Mx,net}$ and $C_{My,net}$ on paver 21. Fig. 10 shows highest local suction coefficients for various G/H_s and h_p/H ratios. The G/H_s ratio affects the underside pressures such that the higher the ratio, the less the net pressure on the pavers.

The highest external single tap pressure coefficients and the external area averaged pressure coefficient (C_{Lext}) observed on the most critical paver (paver 21) obtained for different cases (Table 3) were compared to component and cladding external pressure coefficients for roofs as given in ASCE 7-10. For gable roofs with slope $\theta \leq 7°$ the largest external pressure coefficient for corner Zone 3 for tributary areas less than 0.9 m^2 is given as -2.8 in Fig. 30.4-2A (ASCE 7-10).

Table 3 $C_{p,ext}$, C_{Lext}, C_{Lnet}, $C_{Mx,net}$ and $C_{My,net}$ on paver 21

Test case		Highest $C_{p,ext}$ read on a tap (paver 21)		C_{Lext}		C_{Lnet}		$C_{Mx,net}$		$C_{My,net}$	
G/H_s	**h_p/H**	**Mean**	**Peak**	**Mean**	**Peak**	**Mean**	**Peak**	**Mean**	**Peak**	**Mean**	**Peak**
0.25	0.05	-1.70	-3.14	-0.89	-1.38	-0.44	-0.80	-0.02	-0.10	-0.02	-0.08
0.25	0.067	-1.44	-2.92	-0.90	-1.41	-0.44	-0.80	0.00	-0.10	-0.03	-0.08
0.25	0.1	-1.45	-2.43	-0.96	-1.39	-0.39	-0.77	0.01	-0.06	-0.02	-0.08
0.083	0.033	-1.68	-2.88	-0.86	-1.30	-0.57	-0.96	-0.02	-0.10	-0.03	-0.08
0.083	0.05	-1.71	-2.71	-0.89	-1.35	-0.60	-1.01	-0.01	-0.09	-0.03	-0.09
0.083	0.1	-1.60	-2.44	-0.98	-1.43	-0.59	-0.99	0.02	-0.07	-0.03	-0.09
0.083	0.15	-1.31	-2.05	-0.91	-1.26	-0.47	-0.81	0.01	-0.02	-0.02	-0.07
0.028	0	-1.20	-4.10	-0.70	-1.19	-0.52	-0.98	-0.06	-0.15	-0.01	-0.10
0.028	0.05	-1.86	-2.85	-0.97	-1.44	-0.75	-1.20	-0.01	-0.09	-0.03	-0.10
0.028	0.1	-1.53	-2.50	-0.99	-1.40	-0.74	-1.14	0.02	-0.06	-0.04	-0.09

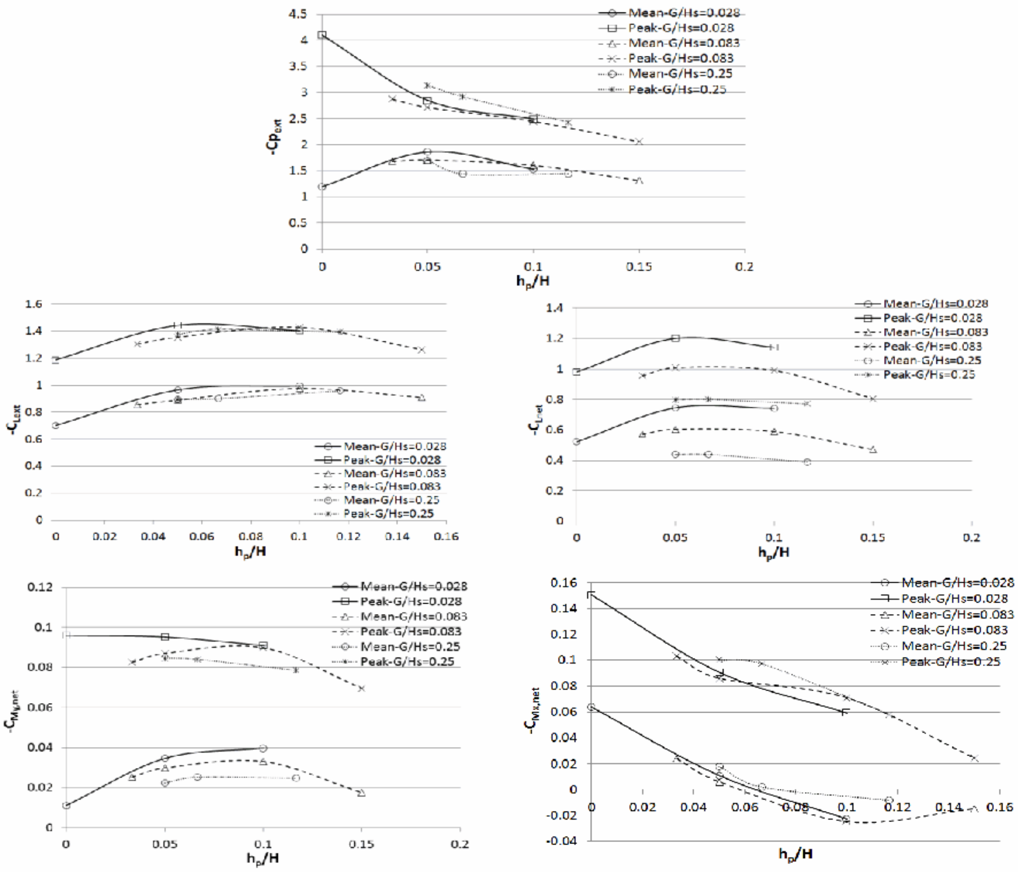


Fig. 10 Highest local suction coefficients on the roof C_{Lext}, C_{Lnet}, $C_{Mx,net}$ and $C_{My,net}$ on paver 21

The highest single tap peak suction coefficients observed in the present tests for all cases ranged from -4.1 for $h_p/H=0$ and $G/H_s=0.028$ to -2.05 for $h_p/H=0.15$ and $G/H_s=0.083$ in the critical paver zone. The highest peak external lift coefficients ranged from -1.44 for $h_p/H=0.05$ and $G/H_s=0.028$ to -1.19 for $h_p/H=0$ and $G/H_s=0.028$. The underneath pressure coefficients required for calculating the net pressure coefficients are not dealt with in ASCE 7-10.

The reduction in the net wind uplift can be expressed as

$$r = \frac{C_{L\,net}}{C_{L\,ext}} \tag{8}$$

The reduction factor defined as the ratio of the net lift coefficient to the external lift coefficient is plotted as a function of relative parapet height (h_p/H) for different G/H_s for paver 21 (Fig. 11).

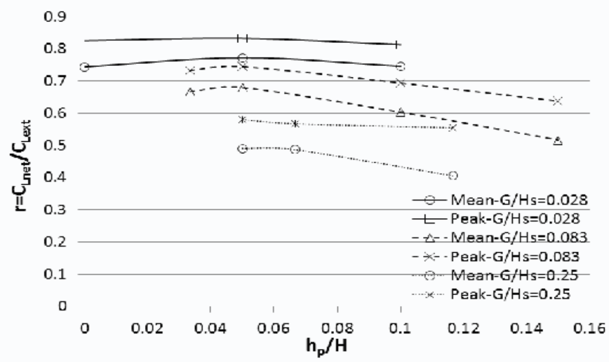


Fig. 11 Reduction factor $r = C_{L_{net}}/C_{L_{ext}}$

The results show that increasing the G/H_s ratio decreases the reduction factor. This means that the correlation between upper and lower surface pressures decreases with decreasing the G/H_s ratio. Thus, increasing the ratio of the pavers' edge-gap to spacer height can reduce the net wind-induced uplift loading on the pavers and improve the performance of the pavers. The reduction factor is not very sensitive to parapet height for h_p/H less than about 0.1. For h_p/H ratios beyond 0.1 the reduction factor reduces gradually, i.e., improved performance of the pavers can be expected.

5.2 Effect of connecting pavers

There are various types of interlocking and strapping systems available to improve the wind performance of roof paving systems. The effect of a specific system has not been dealt with during the experiments in this study. However, guidance on the effectiveness of these systems can be obtained by evaluating the net uplift on groups of pavers rather than only one. The $C_{L_{net}}$ value is calculated for 6 different cases shown in Fig. 12 and compared to the highest $C_{L_{net}}$ value observed during the experiments on Paver 21 (Fig. 13). In Fig. 12, the highlighted pavers were assumed to act as a single unit for the case of G/H_s=0.083 and h_p/H=0.05. The most critical paver is shown with an X mark.

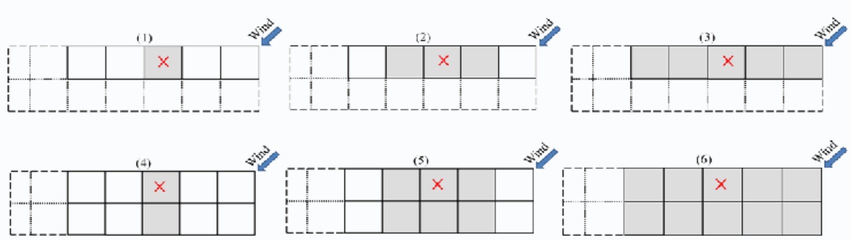


Fig. 12 Interlocked pavers in different configurations

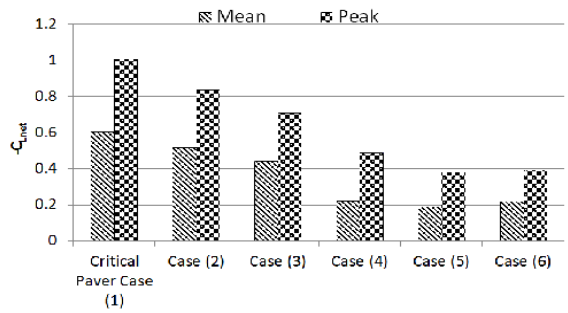


Fig. 13 Comparison between $C_{L_{net}}$ values for different configurations defined in Fig. 12

The results illustrate the effect of connecting pavers together in reducing the net uplift force on the linked pavers as a unit. Based on the characteristics of the strapping or interlocking system in hand, different degrees of improvement can be expected. It should be noted that the surface pressure variation along the axis of the vortex varies much more slowly than in the transverse direction. So, strapping in the direction roughly parallel to the axis of the vortex is not expected to be as effective in restraining pavers from lift off as strapping in the transverse direction. If there is a high uplift on one paver the adjacent pavers in the direction along the vortex axis are likely to also experience significant uplift. Real strapping systems rarely align directly with the vortex axis or transverse to it. Therefore strapping in both orthogonal directions of a paving system is preferable.

5.3 Comparison of the results from pressure measurement experiments with wind lift-off tests

In this section the critical wind velocities for pavers' lift-off are calculated from the pressure measurement results and are compared to the results obtained from the wind lift-off tests. This is done to verify that the wind lift-off speeds that were calculated from the pressure measurements were in accord with the blow off tests. Lift-off takes place when the moment caused by the uplift force equals (or just exceeds) the resisting moment from the paver weight, W. Therefore, the critical wind velocity U_{CRIT} at which lift-off occurs is calculated from Eq. (10) in which the moment is taken about the edge of the paver.

$$\frac{1}{2}\rho U_{CRIT}{}^2 C_L A\left(d+\frac{a}{2}\right)=W\times\frac{a}{2} \tag{9}$$

$$U_{CRIT}=\sqrt{\frac{a}{2\left(d+\frac{a}{2}\right)}\times\frac{W}{\frac{1}{2}\rho C_L A}} \tag{10}$$

where C_L is the lift coefficient obtained from the pressure measurement results and a and d are defined in Fig. 9. Fig.14 shows the critical wind lift-off speeds obtained from wind lift-off tests (Table 2) as compared to the critical wind lift-off speeds calculated from Eq. (10) using the pressure measurement results. The wind speeds presented in Fig. 14 are the equivalent 3-sec gust speed.

For the limiting case of G/H_s ~ zero (meaning a very large spacer height for a specific edge-gap between the pavers) one can assume that the underneath pressure needed would be similar to the internal pressure inside a building with a porous roof. The underneath pressure coefficient for this case is calculated as the average of external pressure coefficients recorded at the center of all pavers using

$$C_{p_{int}}(t) = \frac{1}{N}\left(\sum_{i=1}^{n=N} C_p(t)_{ext}\,|_{center\ of\ paver\ i}\right) \tag{11}$$

where N is the total number of pavers. The net lift coefficient was then calculated using

$$C_{L_{net}}(t) = C_{L_{ext,on\ paver\ 21}}(t) - C_{L_{int}}(t) \tag{12}$$

It is not known in advance what averaging time for wind load the pavers react to except by hypothesizing various values and seeing what lines up best with the lift-off test results. Therefore the lift-off speeds from pressure measurements presented in Fig. 14 were calculated once based on the mean C_{Lnet} and once based on peak C_{Lnet}. The results showed that wobbling of the pavers started at slightly lower speed than would be predicted purely on the basis of the mean C_{Lnet} value combined with 3 second gust speed. This implies that some of the high frequency gust action occurring at shorter duration than 3 seconds was also necessary to initiate wobbling. However, assuming that the full gust speed is required to start wobbling of the pavers would be on the conservative side. The results show that beyond a certain value of Hs (i.e., for small G/H_s values) the pressures on the underneath can communicate very rapidly with other parts of the roof and further increases in H_s do not make much difference. Once this point is reached there are no further decreases in lift-off velocity. The point where this situation is reached is around G/H_s ~ 0.03 (H_s/G ~ 30).

5.4 Comparison of the critical wind lift-off speeds from experiments with those obtained from studies based on ASCE 7-10 pressure coefficients

The design wind pressures on buildings in the United States are determined using the ASCE 7-10 standard. It provides wind loads for the design of the Main Wind Force Resisting System (MWFRS), as well as Components and Cladding. These provisions cover buildings with common shapes, such as those with Flat, Gable, Hip, and Mono-slope roofs, under simple surrounding conditions. For the design of roof components and cladding, the roof is divided into rectangular shaped zones within which a constant pressure coefficient is specified. For permeable roof claddings such as loose-laid roof pavers, the ASCE standard currently does not provide specific guidance for estimating net wind uplift loads. Two methods were examined in this paper for estimating the critical wind lift-off speeds from the exterior pressure coefficients given in ASCE 7-10 as follows

Case I: A practice proposed for roof tiles (Florida Public Hurricane Loss Projection Model (FPHLPM), 2005, Volume II, p. 55) is to assume a zero underneath pressure coefficient and consider the exterior pressure coefficient as the net pressure coefficient. The critical lift of speed can then be calculated using

$$U_{CRIT} = \sqrt{\frac{W}{\frac{1}{2}\rho C_{p_{ext}} A}} \tag{13}$$

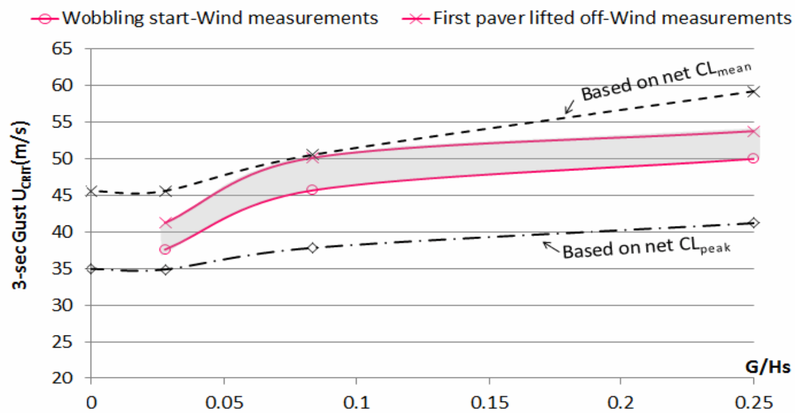


Fig. 14 Comparison between wind lift-off speeds from wind blow-off tests and those obtained from pressure measurements

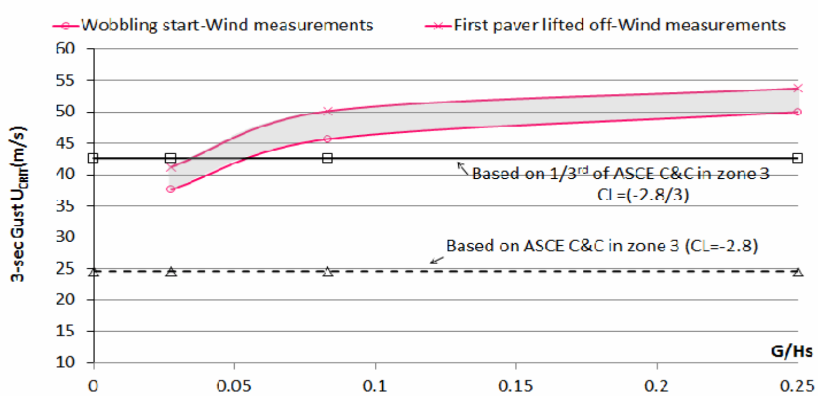


Fig. 15 Comparison between wind lift-off speeds from wind blow-off tests and those obtained from a typical practice based on ASCE 7-10 exterior pressures on C&C and 1/3rd Rule

Fig. 15 shows a comparison of this approach with the lift off speeds from the current experiments. For the estimates based on ASCE 7-10 exterior pressures, the wind blow-off speeds were calculated using GCp=-2.8 (external pressure coefficient in Zone 3 for A_{eff}=0.09 m^2 $\leq$ 0.93 m^2). In Fig. 15 the critical wind blow-off speed calculated based on this approach is clearly very conservative. This emphasizes the need for better guidelines.

Case II: In Building Research Establishment (1985) it is stated that the magnitude of the net uplift coefficient was found empirically to be generally less than 1/3rd of the magnitude of the peak negative external pressure coefficient on the upper surface of the paver. In other words as a rule of thumb, $C_L \leq -\frac{1}{3} Cp_{peak}$. This is broadly in line with earlier findings of Kind and Wardlaw (1982). Therefore, 1/3rd of the ASCE 7-10 exterior pressure coefficients for components and claddings was used to estimate the critical wind lift-off speed (Eq. (13)) and results are also shown in Fig. 15. This approach, called here the 1/3rd Rule, can be seen from Fig. 15 to over predict the wind lift-off speeds for lower G/H$_s$ ratios and under predict them at higher G/H$_s$ ratios. The design guidelines presented in Section 6 of this paper do take into account the effects of different G/H$_s$ ratios, thereby improving on the simple 1/3rd rule.

6. Design guidelines for roof pavers

Based on the results presented in the previous sections, the following equation is proposed for the design of loose-laid roof pavers

$$C_{L_{net}} = R_1 \times R_2 \times Cp_{ASCE\ 7-10, exterior, C\&C, Zone\ 3} \quad (14)$$

where R_1 is a reduction factor for different gap ratios and R_2 is a reduction factor for different parapet heights. These are to be applied to the ASCE 7-10 exterior pressure coefficients for components and claddings in Zone 3. Here, Zone 3 in ASCE 7-10 is chosen as the worst case scenario for design of roof pavers. However, R_1 in Eq. (14) can be modified to take into account the effects of location on the roof. Failure is defined here as the start of wobbling. R_1 and R_2 are to be calculated from the diagrams proposed in the following. The equivalent uplift force can then be calculated by multiplying Eq. (14) by the dynamic pressure at roof height.

6.1 R_1 reduction factor: Effect of G/H$_s$ ratio

The R_1 reduction factor is defined as $C_{L_{net}}/Cp_{ext}$ in which Cp_{ext} is the ASCE 7-10 exterior pressure coefficient for components and cladding in Zone 3 and $C_{L_{net}}$ values were calculated using the following formula in which failure is assumed to occur with the start of wobbling.

$$U = \sqrt{\frac{W}{\frac{1}{2}\rho C_L A}} \rightarrow C_{L_{estimated}} = \frac{(W/A)}{\frac{1}{2}\rho U^2{}_{CRIT(wobbling\ start\ from\ wind\ tests)}} \quad (15)$$

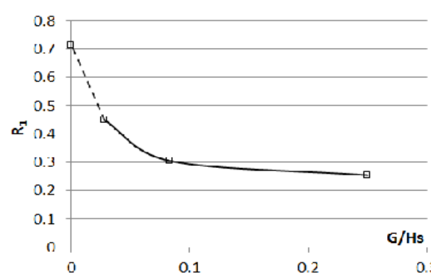


Fig. 16 R_1 reduction factor for different G/H$_s$ ratios

The proposed reduction factor R_1 based on G/H$_s$ ratio is plotted in Fig. 16. The value at G/H$_s$ ~ 0 comes from assuming $C_{L_{net}} = -2$ in which $C_{L_{ext}}$ is assumed to be -2.8 and $C_{L_{int}} = -0.8$ which is approximately calculated from averaging the external peak pressure coefficients on pavers 11, 12, 21, 22, 31, and 32. The R_1 factor changes an exterior local peak pressure coefficient into a net lift coefficient taking into account the pressure distribution over the paver and the effect of G/H$_s$ on pressure equalization.

6.2 R_2 reduction factor: Effect of parapet height

R_2 reduction factor is proposed based on results presented in Fig. 11. For relative parapet height ratios less than 0.1 no reduction in the C_L value is proposed (i.e., $R_2 = 1$). In ASCE 7-10 Figure 30.4-2A it is stated that the external pressure coefficients for Zone 3 can be reduced to the values in Zone 2 for parapets higher that 0.9144 m. (3 ft.). This means about 36% reduction for h$_p$/H ratio of 0.3 and higher for the current experimental setup. This value is considered as the upper limit of the proposed reduction proposed in Fig. 17 (i.e., h$_p$/H=0.3). Kind *et al.* (1987) proposed h$_p$/H =0.1, h$_p$/H =0.02 and h$_p$/H =0.03 for low, mid and high-rise buildings respectively, above which a somewhat rapid reduction in the worst suction values due to the parapet was observed. This would imply that application of the reduction factor in Fig. 17 to mid and high-rise buildings would be conservative.

In Fig. 18 the proposed curve in Fig. 17 for R_2 reduction factor is compared to the experimental results presented previously in Fig. 11. The solid and dashed lines are plotted by applying respectively the R_2 factor to the maximum of peak and mean reduction factor $r = C_{L_{net}}/C_{L_{ext}}$ obtained from experiments (given in Fig. 11). This was done to make comparisons possible between the curves since due to pressure equalization effects, the experimental reduction factor $r = C_{L_{net}}/C_{L_{ext}}$ curves do not start at one as is the case for proposed R_2 reduction factor. The results show a good degree of agreement. In some cases (e.g. left graph in Fig. 18) the reduction due to parapet height from experiments ($r = C_{L_{net}}/C_{L_{ext}}$) might start at h$_p$/H ratios lower that the assumed h$_p$/H=0.1.

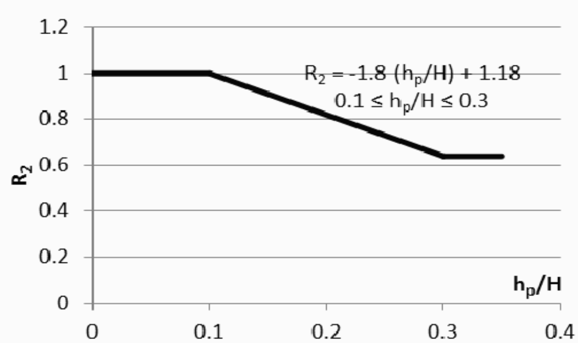
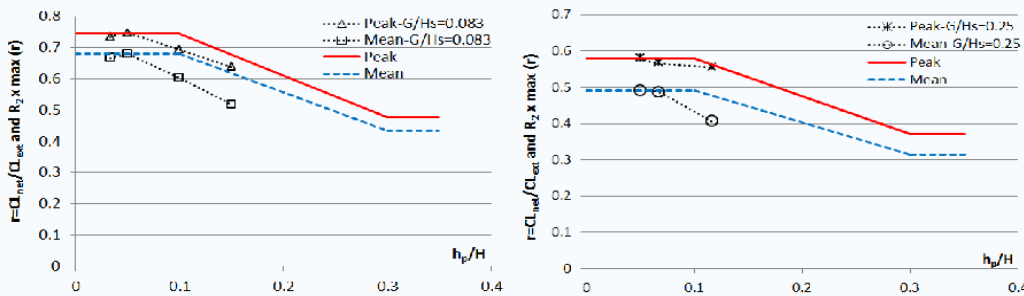


Fig. 17 R_2 reduction factor for different h$_p$/H ratios



(a) G/H$_s$=0.083 (b) G/H$_s$=0.25

Fig. 18 Comparison of proposed R_2 curve with r as a function of h$_p$/H

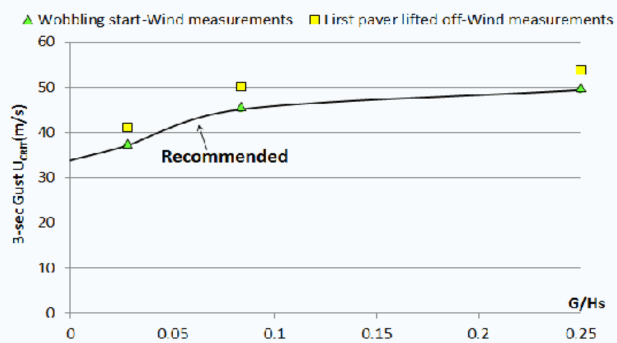


Fig. 19 Critical wind speed vs. G/H$_s$ (h$_p$/H=0.05 for wind measurements)

However, h$_p$/H=0.1 and the corresponding curve proposed in Fig. 18 are based on results obtained from multiple experiments in order to have a universal curve. The h$_p$/H=0.1 value is also obtained from the experiments of Kind et al. (1987). It should be noted that the rate of decrease of reduction factor $r = C_{L net}/C_{L ext}$ versus h$_p$/H (slope of the diagram between h$_p$/H=0.1 to h$_p$/H=0.3) obtained from experiments is in good agreement with that of proposed R_2 curve (Fig. 18).

Fig. 19 shows the critical lift-off speeds from the measurements compared to values from the proposed guideline.

6.3 Applications and special notes

1. The proposed guidelines were derived assuming a full scale paver size of 0.61 m by 0.61 m by 5.05 cm thickness. This particular size was selected as it represents a very common paver size on typical flat roof low-rise buildings used in the United States. The guidelines will work best for pavers that have sizes close to the size tested. Future experiments are

needed to investigate the applicability of the proposed guidelines for pavers with sizes and aspect ratios very different from the ones tested for the current work.

2. The effect of building height has not been examined in this paper. The building in the current experiments was a representative of a low-rise building. Based on the wind lift-off experiments performed by Kind *et al.* (1987) on the failure wind speeds for roof pavers on low-rise, mid-rise and high-rise buildings, the results presented in this paper are expected to be conservative when applied to mid and high-rise buildings provided the increase in roof height wind speed with building height is accounted for. However, further experiments are needed to fully quantify the effects of building height for mid and high-rise buildings.
3. The effect of paver size and geometry has not been evaluated in this paper. It is to be noted that the element size have an effect on the failure of non-interlocking roof pavers (Kind *et al*. 1987). Previous studies by Bienkiewicz and Sun (1997) indicated that square pavers are more wind-resistant than rectangular pavers.
4. The general effect of interlocking and strapping systems was investigated in this paper through the effect of load sharing mechanism between pavers. These systems are usually effective and improve the wind performance of roof pavers. The application of the proposed guidelines is primarily for loose-laid roof pavers without any interlocking or strapping system. However, some guidance of the effective reduction in lift-off forces can be drawn from the results in Figs. 12 and 13. For more precise results it is recommended to perform wind tunnel testing at large scale or full scale to find out the characteristics and wind performance of a specific interlocking or strapping system.
5. The experiments were performed in a simulated suburban terrain. The effect of wind turbulence was not examined in this paper but provided the 3 second gust speed is used to estimate lift-off the effects of different turbulence levels should be reasonably well accounted for.
6. The effect of thickness of the pavers on resistance to flow through the gaps between pavers was not examined in this paper. Increased thickness for the same gap might be expected to increase resistance to flow, thereby having a similar effect to reducing the gap. This is an area for further research.
7. It should be noted that the developed design guidelines are intended for use with the external pressure coefficients given in ASCE7-10 for components and claddings in zone 3. Caution should be exercised in using the proposed reduction factors in conjunction with external pressure coefficients given in other codes and standards.

7. Conclusions

The objective of this paper was to develop simple guidance in code format for design of commonly used loose-laid roof pavers. A set of 1:2 scale experiments was performed to investigate the wind loading on concrete roof pavers on the flat roof of a low-rise building. The experiments were performed in the Wall of Wind (WOW) hurricane testing facility at Florida International University (FIU). Experiments included both wind blow-off tests and detailed pressure measurements on the top and bottom surfaces of the pavers. Several conclusions were drawn:

- The paver's edge-gap to spacer height ratio affects the underside pressures such that the higher the ratio, the less the net uplift pressure on the paver. This may be regarded as increasing the failure wind speed.
- The relative parapet height, defined as the ratio of the parapet height to the building height, affects the failure wind speed. For very low-height parapets ($\sim h_p/H<0.1$), a small reduction in the failure wind speed was observed as compared to zero-height parapet. However, for taller parapets, increasing the parapet height results in an increased failure wind speed.
- The general effect of interlocking and strapping systems was studied through the effect of the load sharing mechanism between pavers. Interlocking and strapping systems improve the wind performance of the roof pavers since the uplift loads tend to be shared across several pavers.

Based on the experimental results and review of literature, guidelines are proposed for designing loose-laid roof pavers against wind uplift. The guidelines have been formatted so that use can be made of the existing information in codes and standards such as ASCE 7-10 on exterior pressures on components and cladding. The effects of pressure equalization, the paver's edge-gap to spacer height ratio and parapet height as a fraction of building height on the wind performance of roof pavers were investigated and are included in the guidelines as adjustment factors. The applications and limitations of the guidelines are discussed.

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AD

Appendix: Method for obtaining 3-second gust speed from wind blow-off tests

In large-sale testing there are challenges in simulating the full wind turbulence spectrum of the natural wind mainly due to the limited size of the wind tunnels. As a result, just the high frequency part of the turbulence spectrum can be simulated adequately and low frequencies are missing as shown in Fig. 4 in the paper. A test procedure and analysis technique called Partial Turbulence Simulation (PTS) methodology was developed by Asghari Mooneghi (2014) and Asghari Mooneghi *et al.* (2015) in order to produce aerodynamic data for low-rise buildings by using large-scale models in wind tunnels and open-jet wind testing facilities like the Wall of Wind at FIU. Asghari Mooneghi (2014) showed that Eq. (A1) can be used for approximately calculating a cut-off frequency between the high frequency and the low-frequency turbulence.

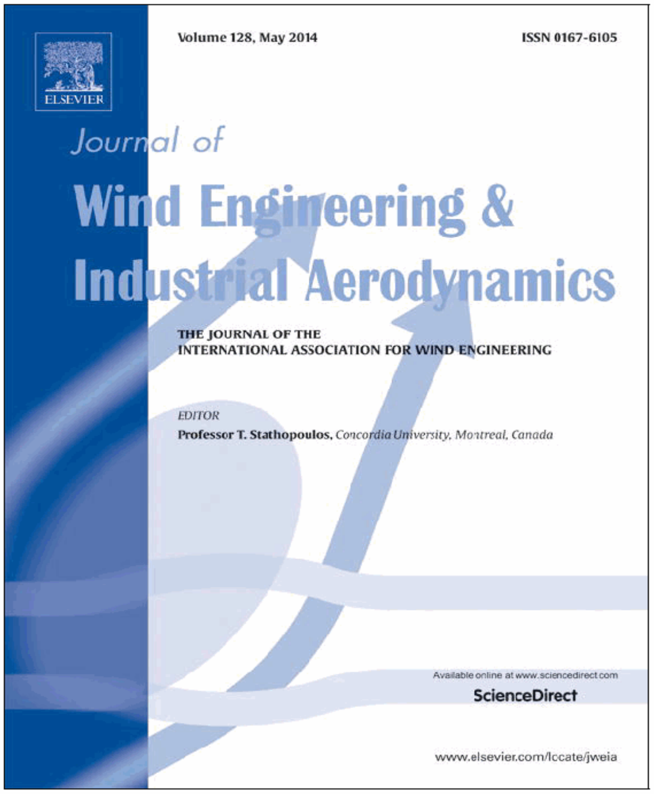
$$n_c = 0.0716 \frac{U}{{}^{x}L_u} \left(\frac{I_u}{I_{uH}}\right)^3 \quad \text{(A1)}$$

where the ${}^{x}L_u$ and U are the full spectrum values of longitudinal integral scale and the mean velocity respectively. I_{uH} is the turbulence intensity in a partial turbulence simulation and I_u is the full-spectrum longitudinal turbulence intensity. For the current problem representative values of $U = 30$ m/s, ${}^{x}L_u = 12$ m, $I_u = 0.3$ and $I_{uH} = 0.07$ were used, implying $n_c = 14$ Hz.

The cut-off frequency as calculated from the above Eq. (A1) can be used to estimate the equivalent gust-duration at full scale using (Asghari Mooneghi 2014)

$$t_{gust} = 0.45/n_c \quad \text{(A2)}$$

The derivation of the above equations is a separate topic by itself and has been described in detail in Asghari Mooneghi (2014) and Asghari Mooneghi *et al.* (2015). Using the above methodology, the equivalent gust duration at full scale for the current test is equal to 0.032 s. A moving average was performed to calculate the peak 0.03 s gust from wind speed measurements during the wind lift-off tests. In order to convert the wind lift-off speeds to a 3-second gust speed a conversion factor equal to $U_{3sec}/U_{0.03\,sec} = 0.83$ was calculated for suburban terrain at z=3.048 m (building height at full scale). The procedure for converting the wind speeds averaging time was based on Harris and Deaves (1981) model taken from ESDU (1985).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Large-scale testing on wind uplift of roof pavers

Maryam Asghari Mooneghi [a], Peter Irwin [b], Arindam Gan Chowdhury [b,*]

[a] Department of Civil and Environmental Engineering and International Hurricane Research Center, Florida International University, Miami, FL, USA
[b] Department of Civil and Environmental Engineering, Florida International University, Miami, FL, USA

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ABSTRACT

This paper presents a large-scale experimental study to investigate the wind loading on concrete roof pavers on the flat roof of a low rise building. The experiments were performed in Wall of Wind, a large-scale hurricane testing facility at Florida International University. Experiments included both wind blow-off tests and pressure measurements on the top and bottom surfaces of the pavers. The effects of the pavers' edge-gap to spacer height ratio and the relative parapet height on the wind performance of roof pavers were also investigated. The results showed that increasing the edge-gap to spacer height ratio parameter decreases the net pressures by enhancing pressure equalization between top and bottom surfaces. Also, increasing the relative parapet height reduces the worst suctions for the parapet heights considered in this study. The resolution of the pressure taps was found to have significant influence on the test results. Too few taps can result in underestimation of the net uplift and overturning moments that can cause failure under strong winds. Guidelines on the resolution and location of pressure taps were provided for better capturing the effects of conical vortices on wind loads on pavers. Results of the wind blow-off tests are compared with those obtained from pressure measurements and a typical practice based on ASCE 7-10 exterior pressures.

1. Introduction

Due to the rising loss of life and economic losses associated with the frequent occurrence of severe wind storms, wind induced loads are one of the most critical design parameters for coastal construction. Roof systems are exposed to higher loading than any other building element (Smith and McDonnald, 1991). Suction forces on the roof can loose and lift both roof sheathing and roof coverings, such as tiles, shingles, and roof pavers. Dislodged roofing elements may become wind-borne debris impacting other structures downwind. Internal pressure generated when windows, doors, or sections of the roof are breached can lift and separate the roof from the rest of the structure. This may result in total failure of the building or increased losses because of water infiltration and interior damage.

Loose-laid roof pavers are commonly used on flat roofs and as decorative elements on terraces. Wind uplift of roof pavers is not only the result of the suction on their top surface, but also of the pressure on their underside. Designers of these materials often rely on a significant amount of pressure equalization between top and bottom to help keep them in place. Interlocking and strapping systems are used to improve the resistance of pavers but these typically are not based on true knowledge of the forces involved and failures still occur despite such systems.

Many studies are reported on wind loading and performance of loose laid roofing systems. The failure mechanisms have been extensively studied (Kind, 1988; Kind and Wardlaw, 1982). Bienkiewicz and Sun (1992) performed wind tunnel experiments to investigate the wind loading of loose-laid roof paving systems on a low-rise building with flat roof. The effects of space under the paver and the parapet height on the pressure correlation were investigated. Kramer and Gerhardt (1983) investigated the critical loading on permeable roofing elements including tiles and paving slabs and presented typical test results for roof tiles and flat roof elements. Bienkiewicz and Endo (2009) carried out a wind tunnel study on wind loads on loose-laid roof pavers and photovoltaic roofing systems. Effects of the edge-gap between pavers, and the space beneath the pavers on the pressures underside the pavers were discussed. Trung et al. (2009) conducted wind tunnel tests in order to investigate the effects of parapet height and underside volume on wind loading of porous roof cover sheets. They concluded that the correlation between upper and lower surface pressures decreased with increasing the underside volume. This means that increasing the underside volume increases the net pressure on porous roofs. Studies of wind effects on full- and large-scale building models have been limited. Aly et al. (2012) performed an experimental study to assess wind induced pressures on full-scale loose concrete roof pavers using the 6-fan Wall

* Corresponding author.

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of Wind, at Florida International University (FIU). A limited number of numerical simulations of wind loading on roof paver systems have been proposed in the literature (Amano et al., 1988; Bofah et al., 1996; Gerhardt et al., 1990; Kind, 1994; Sun and Bienkiewicz, 1993; Trung et al., 2010). Results from some of the preceding studies have been used for the development of models for design of loose-laid roofing systems e.g. roof pavers (Bienkiewicz and Endo, 2009; Cheung and Melbourne, 1986; Cheung and Melbourne, 1988). Some codes and standards address the design of these systems. In the Netherlands code, NEN EN 1991-1-4/NA, 1991, a set of values for net pressure coefficients (difference between the external and underneath pressure coefficients; $Cp_{\text{net}}=Cp_e-Cp_i$) is proposed for design of roofing tiles and pavers. These values were based on a number of experiments and full-scale studies on roof tiles on pitched roofs and roof pavers on flat roofs including those of Geurts (2000), who proposed equalization factors defined as $C_{\text{eq}}=Cp_{\text{net}}/Cp_e$ from full-scale measurements on roof tiles and roof pavers to be applied to the external pressure coefficients given in the Netherlands wind loading code. The proposed values for roof pavers with and without interlock were 0.25 and 0.6, respectively. In the German Wind Code (DEUTSCHE NORM, 2001-03) design pressure coefficients are provided for building envelopes with permeable facades based on a study by Gerhardt and Janser (1995). In the Australian Standard for wind loads (AS 1170.2, 2011) reduction factors are given for estimating design wind loads on porous claddings. These factors depend on the cladding porosity and the horizontal distance from windward building edge. Other major international codes and standards for wind loads in Canada and USA (ASCE 7-10; NBCC, 1995) specify roof wind pressures for typical roof geometries but there are no specific provisions on how to apply such pressures to roofing elements such as tiles, shingles, and pavers.

To better understand the effects of conical vortices on roof pavers under cornering winds, the present work focused on a large-scale experimental study on the wind loading mechanism of concrete roof pavers using the 12-fan Wall of Wind (WOW) facility at FIU. Half-scale concrete pavers were installed on a square portion of a flat roof of a low-rise building. Tests in which pavers were actually lifted off by the wind were conducted and pressure measurements were performed. The aim of the study was to investigate the external and underneath pressure distributions over loose-laid roof pavers in order to develop more effective protections against wind damage. In the course of the work guidelines were developed for the resolution and location of pressure taps on critical pavers to better resolve the effects of conical vortices. The effects of paver's edge-gap to spacer height ratio and the relative parapet height were also explored. Wind blow-off speeds were compared to those calculated using a typical informal practice based on ASCE 7-10 external pressures and also with the current net-pressure measurements.

2. Wind loading mechanism on permeable roofing elements

Solid pavers are frequently used as ballast and walking surfaces on roofs and it is necessary that they be capable of resisting uplift forces due to wind. Usually concrete pavers are placed on the roof with gaps in between them and with spaces between their under sides and the roof deck. This is necessary to allow for water drainage and for vapor diffusion when using an "inverse roof" in which the principal thermal insulation material is applied on top of the waterproof covering. Since air can readily leak around the edges of pavers, the pressure distribution produced by the wind flow over the outer surface of the roof produces secondary flows through the spaces between and underneath the paver elements. A pressure distribution is generated under the roof pavers which is related to, but different from, that on the outer surface. The pressure equalization occurs very quickly, typically in less than 0.1 of a second, because very small volumes of air exchange are needed to bring the underside pressure into equilibrium with the pressures around the paver perimeter. The pressure equalization effect greatly reduces the net uplift force on pavers in most areas of roofs. However, in areas of very high spatial gradients of pressure, such as those which occur under vortices near roof corners, significant net uplift pressures can still occur. Fig. 1 illustrates the typical path of the vortices over a flat roof for cornering winds.

The diagram in Fig. 2 illustrates the general mechanism of uplift on roof pavers. The aerodynamic uplift force is the difference between the pressure on the lower surface of the paver, P_L and the pressure on the upper surface, P_U (Fig. 2). The pressure on the upper surface due to the presence of a corner vortex (solid curve) is negative (when measured relative to a non-zero baseline, e.g. the static pressure in the surrounding air stream) and has a

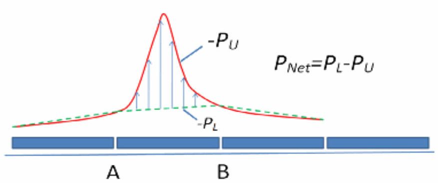

Fig. 2. General mechanism of pressure distributions on upper and lower surfaces of a roof paver.

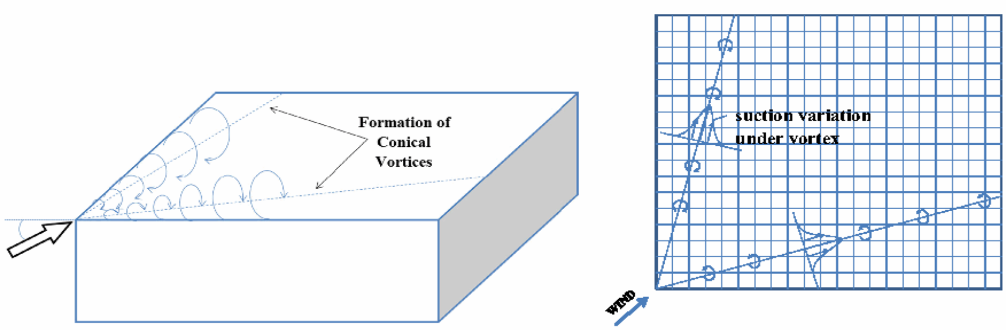

Fig. 1. Paths of corner vortices and resulting suction variations on roof.

concentrated peak. The pressure on the lower surface is depicted by the broken curve and it is shown as being equal to that on the top surface at the paver edges. In practice the top and bottom edge pressures do not always match exactly. The underneath pressure depends on the outer pressure distribution and the relative magnitude of the joint resistances compared to the under-element resistance which prevents a complete pressure equilibration between upper and lower surfaces of the element (Bofah et al., 1996; Gerhardt et al., 1990; Kind, 1994). Detailed measurements done by Kind and Wardlaw (1982) showed that the underneath pressure does tend to vary roughly linearly between the pressures at the paver edges as depicted in Fig. 2 (this is also discussed in Bofah et al. (1996)). More precisely, it should satisfy the Laplace equation as explained by Kind (1994). It is only due to the sharp peak of the negative pressure under a vortex (between points A and B) that a net uplift occurs, signified by the large difference between the solid and broken curves. If the upper surface pressure does not have the peak then pressure equalization caused by flow around the edges of the paver results in smaller net uplift as shown by the small differences between the solid and dashed curves on the pavers outside the zone between points A and B.

The aerodynamic uplift force and/or the overturning moment on the element may become higher than the weight and/or the resisting moment. Parameters influencing the wind loading mechanism of roof pavers in terms of the nonlinear net (i.e., external minus internal) pressure distribution over the paver due to conical vortices include: paver size, paver edge-gap to spacer height ratio, distance of the paver from the roof corner, and height of parapets. Roof external pressures are a function of building height, exposure, building orientation, parapet height, and other roof top features such as elevator housings, stairwell cover, and cooling towers (Kramer and Gerhardt, 1983). The internal pressure (i.e. pressure underneath the pavers) depends on the external pressure distribution, the edge-gap to spacer height ratio, and the flow resistance underneath the pavers. A large gap between the pavers has a considerable effect on the reduction of the wind force because it makes the internal pressure approach the external one (Kramer and Gerhardt, 1983).

3. Description of the experimental set up and testing procedure

3.1. 12-Fan Wall of Wind facility

The full-scale 12-fan Wall of Wind (WOW) open jet facility at FIU was used to generate the wind field for the present study. It can generate up to a Category 5 Saffir–Simpson Scale hurricane wind speed that reasonably replicates mean wind speed and partial turbulence characteristics of real hurricane winds. Fig. 3 shows the comparison between the atmospheric boundary layer (ABL) full spectrum for suburban terrain as simulated in a boundary layer wind tunnel by Fu (2013) and the WOW partial spectrum. The dimensionalized Kaimal spectrum is also shown. Note that the high frequency portions of the WOW and wind tunnel spectra match satisfactorily and show good agreement with the $-5/3$ slope corresponding to the inertial subrange of the dimensionalized Kaimal spectrum. As noted by several researchers (Banks, 2011; Irwin, 2009; Kopp and Banks, 2013; Kumar and Stathopoulos, 1998; Melbourne, 1980; Richards et al., 2007; Saathoff and Melbourne, 1997; Tieleman, 2003; Yamada and Katsuchi, 2008), accurate simulation of high frequency turbulence is necessary for an adequate simulation of the separated flows on local aerodynamic effects on low-rise structures. A set of triangular spires and floor roughness elements were used to generate the turbulence and the boundary layer characteristics (Fig. 4).

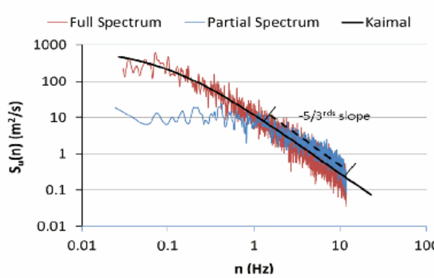

Fig. 3. Comparison of ABL full spectrum for suburban terrain simulated in wind tunnel by Fu (2013), WOW partial spectrum and the dimensionalized Kaimal spectrum.

The mean wind speed and turbulence intensity profiles for suburban terrain are shown in Fig. 5 for 20.1 m/s wind speed at $z=2.6$ m elevation (target power law coefficient was $\alpha=1/4$). It should be noted that the tests were performed in a partial turbulence simulation in which the turbulence intensity was lower than that for the ABL flow containing the full spectrum of turbulence. However, using the method proposed by Katsuchi and Yamada (2011), the adequacy of the current turbulence intensity was shown.

3.2. Test condition

If the tests results are to be meaningful, conditions must be such that the test model behavior is dynamically similar to that of the prototype. The wind approaching the model should satisfactorily simulate the natural wind, and the Reynolds number (UL/ϑ), the Froude number (U^2/Lg), and the density ratio (ρ_s/ρ) should have the same numerical values between the model and the prototype. U

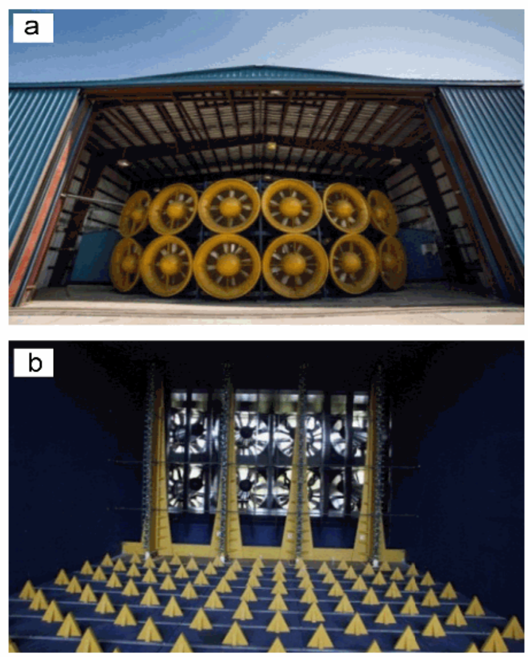

Fig. 4. (a) Wall of Wind, Florida International University and (b) spires and floor roughness elements.

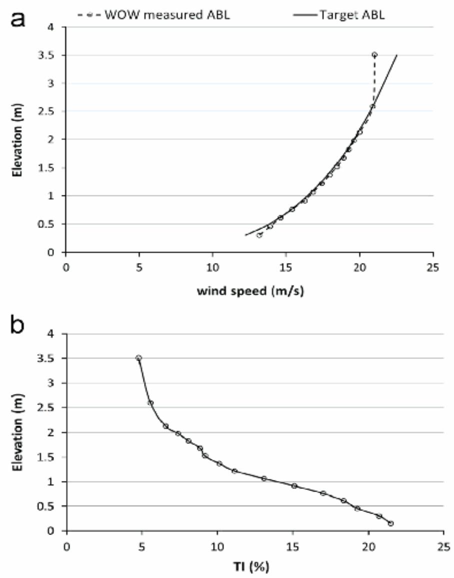

Fig. 5. Suburban terrain: (a) ABL profile and (b) turbulence intensity profile.

is the speed of approaching wind at roof height, L is a reference length, ϑ is the kinematic viscosity of air, g is the gravitational acceleration, ρ is the density of air, and ρ_s is the density of the solid paver. In the case of thin objects, the requirement that the density ratios be matched between the model and the prototype can be relaxed, if the weight per unit area of the model is correctly scaled meaning that $(\rho_s t)_M/(\rho_s t)_P = L_M/L_P$ in which symbol t denotes the thickness of the pavers and subscripts M and P denote the model and the prototype, respectively. Except at a scale of 1:1, Froude number and Reynolds number similarity cannot be satisfied simultaneously. The flow underneath and through the joints might be somewhat dependent on Reynolds number but it was assumed in the present experiments that being out by a factor of 2 in Reynolds number would have very minor effect on the results. Kind and Wardlaw (1982) discuss Re effects and accepted a larger mismatch in their experiments. The complete simulation of the atmospheric boundary layer is not possible at ½ scale in most wind testing facilities due to their limited size. Typically, the large scale turbulence present at full scale cannot be generated and only the high-frequency part of the power spectrum can be simulated (Fu et al., 2012; Yeo and Chowdhury, 2013). However, previous experiments have shown that the flow pattern over the upwind corner of the building roof is mainly dependent on the correct simulation of high frequency turbulence, as was done in the present tests, and achieving a Reynolds number of approximately the right order.

3.3. *Test building*

A test building was constructed to install the roof pavers (a total of 100) in a similar way to real roof pavement systems. The size of the 1:2 test building model was 3.35 m by 3.35 m in plan by 1.524 m high; thus it represented a low-rise prototype building with height of 3.48 m. The model was engulfed completely in the 6.1 m wide and 4.3 m high wind field generated by the WOW. The roof deck was made from plywood and was completely sealed and rigid. The rectangular sharped edge parapets on the building model were interchangeable which allowed evaluation of the effect of parapet height on the wind effects on pavers. The parapet height

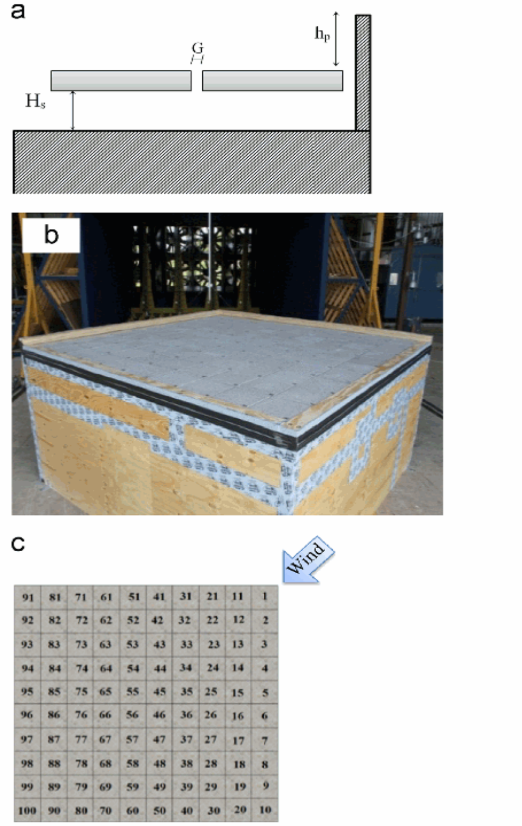

Fig. 6. (a) Geometrical parameter definition, (b) test building for wind blow-off tests, and (c) roof pavers numbering.

was measured from the top of the pavers (Fig. 6a). There were no parapets on the leeward side of the building so that the roof could be representative of the windward corner of a bigger roof structure. The justification of this comes from the studies of Lin and Surry (1998) and Lin et al. (1995) who found that for low buildings which are large enough to have reattached flows on the roof, the distribution of pressure coefficients in the corner region is mainly dependent on the eave height, H, and not so much on the building plan dimensions as long as terrain conditions are similar. Also, external pressure coefficients measured in wind tunnel by Kopp et al. (2005) on roof corners of a nearly flat building model were consistent with those measured on roof corners of flat roof low-rise building models with different plan aspect ratios as reported by Stathopoulos (1982), Stathopoulos and Baskaran (1988), Ho et al. (2005), and Pierre et al. (2005). The experiments included both the wind blow-off testing (i.e. blowing at sufficient speed to dislodge pavers) and pressure measurements. For the wind blow-off tests, concrete pavers with a dimension of 0.305 m by 0.305 m by 2.54 cm thickness and having weight per unit area of 532 N/m^2 were installed on the roof which can be considered as modeling typical 0.61 m square pavers at half-scale. Fig. 6b shows the test building for the wind blow-off tests with the concrete roof pavers installed. For pressure measurements, pavers with exactly the same dimensions as the actual concrete pavers were made from Plexiglas. This made it more convenient to install pressure taps on both upper and lower surfaces of the pavers. Adjustable height pedestals were used to change the space between the paver and the roof deck (H_s, Fig. 6a). Pedestals had top caps which created a constant G=3.175 mm space between the pavers (Fig. 6a). Pavers were numbered from 1 to 100 (Fig. 6c). Pressure taps were installed on Plexiglas roof pavers for simultaneous measurement of the external and the underneath pressures. Fig. 7 shows the external and underneath pressures tap layout (total of 447).

3.4. Test procedure

A total of 9 experiments were carried out, including three wind blow-off tests and 6 pressure measurement tests. A summary of each test characteristics is shown in Table 1. Only one wind direction was tested which was 45°. Based on past studies this wind direction was selected as the most critical orientation for generating high uplifts under conical vortices on flat rectangular roofs (Holmes, 2007).

The basic test procedure consisted of first conducting wind blow-off tests. The aim of these tests was to provide guidance on the location where paver blow-off, i.e. failure, first occurs, which

Table 1
Test number and characteristics.

Wind test number	Spacer height (H_s) (cm)	Windward parapet height (cm)	*G/H_s	h_p/H
Wind Uplift 1	1.27	7.62	0.25	0.05
Wind Uplift 2	3.81	7.62	0.083	0.05
Wind Uplift 3	11.43	7.62	0.028	0.05
Pressure 1-1	1.27	7.62	0.25	0.05
Pressure 2-1	3.81	5.08	0.083	0.033
Pressure 2-2	3.81	7.62	0.083	0.05
Pressure 2-3	3.81	15.24	0.083	0.1
Pressure 2-4	3.81	22.86	0.083	0.15
Pressure 3-2	11.43	7.62	0.028	0.05

* Constant G=3.175 mm for all tests.

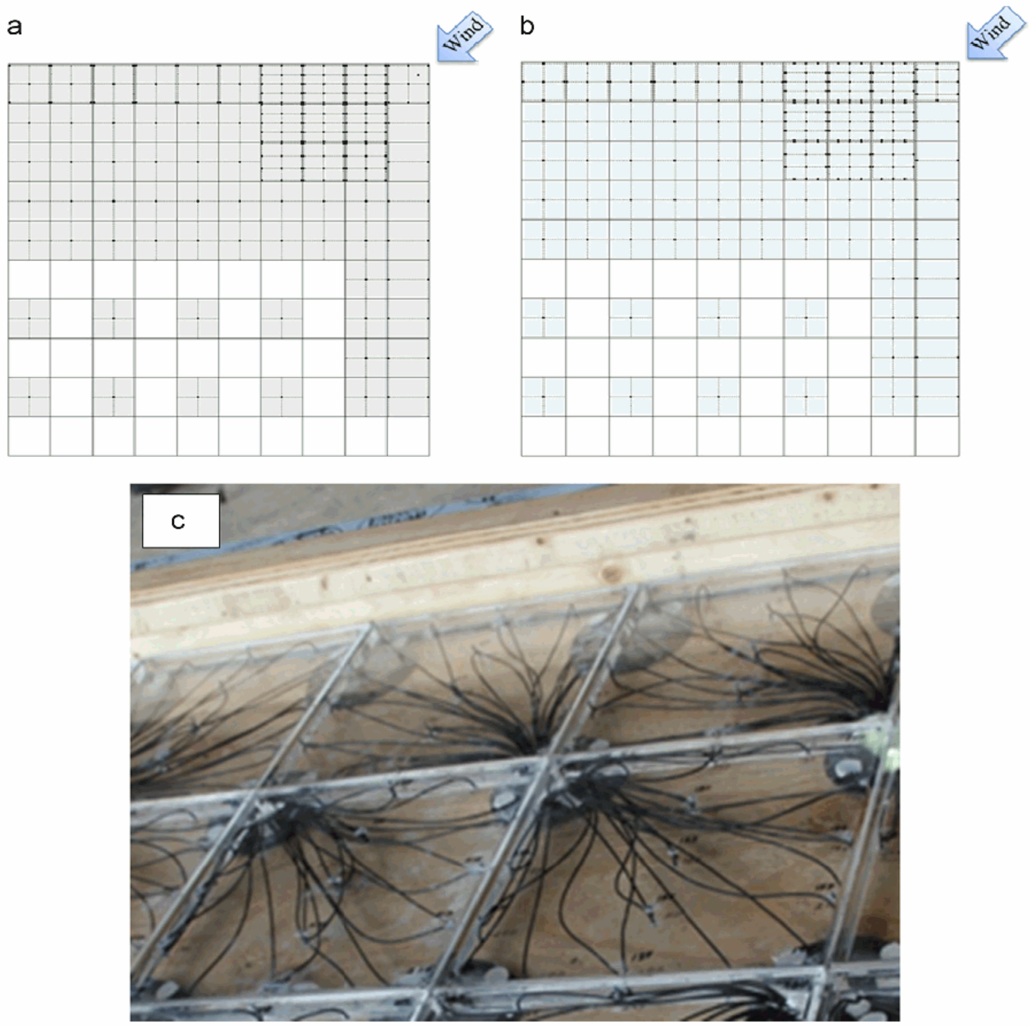

Fig. 7. (a) External pressure tap layout, (b) underneath pressure tap layout, and (c) plexiglas pavers with pressure taps.

could then be used to decide on the pressure tap layout. The test was done by gradually increasing the wind speed in WOW and visually observing the behavior of the roofing system. The most critical pavers which dislodged first were identified. Wind speeds were measured at the roof height of the test model (1.524 m height) using a turbulent flow Cobra probe. After identifying the critical pavers and deciding on the pressure tap layout, the original pavers were replaced by the Plexiglas pavers with pressure taps. Pressure measurements were carried out at wind speed = 18.5 m/s which was below the failure speed of concrete pavers (but required some special measures to hold the Plexiglas pavers in place). Nine critical pavers were fitted with total of 256 pressure taps to allow accurate measurements of the pressure distribution above and underneath the pavers. A 512 channel Scanivalve Corporation pressure scanning system was used for pressure measurements. Pressure data were acquired at sampling frequency of 512 Hz for a period of two minutes. Each pressure measurement test was repeated for three times to assure repeatability of the data. A transfer function designed for the tubing (Irwin et al., 1979) was used to correct for tubing effects.

3.5. Data analysis

The mean pressure coefficient at any location was obtained from

$$Cp_{\mathrm{mean}} = \frac{P_{\mathrm{mean}}}{\frac{1}{2}\rho U_{\mathrm{mean}}^2} \tag{1}$$

where P_{mean} is the mean pressure, ρ is the air density at the time of the test (1.225 kg/m^3) and U is the mean wind speed measured at the building height of the test model (1.524 m).

For the proper securing of individual pavers, measured values of Cp_{peak} should be considered. Due to the highly fluctuating nature of wind pressures, significant differences might be expected in the peak values of pressure time series obtained from several different tests under nominally identical conditions. The Sadek and Simiu (2002) method was used to obtain statistics of pressure peaks from observed pressure time histories (unless otherwise stated). Because estimates obtained from this approach are based on the entire information contained in the time series, they are more stable than estimates based on single observed peaks. For the evaluation of these estimated values, the peak value with 85% probability of not being exceeded in one hour of full spectrum wind was selected. The peak pressure coefficient was normalized by the three second gust dynamic pressure as follows:

$$Cp_{\mathrm{peak}} = \frac{P_{\mathrm{peak}}}{\frac{1}{2}\rho U_{3s}^2} \tag{2}$$

where P_{peak} is the peak pressure, and U_{3s} is the peak 3-s gust at the reference height. For the WOW the wind speed U_{3s} was obtained using time scale $\lambda_t = 0.7$ ($\lambda_t = (\lambda_L = 0.5)/\lambda_V = 0.71$ (based on Froud Number Similarity)), meaning that $512 \times 3 \times 0.7 = 1075$ data points were required for its determination. The peak value of the U_{3s} was obtained by performing moving averages. Data were low-pass filtered at 30 Hz equivalent to 21 Hz full scale.

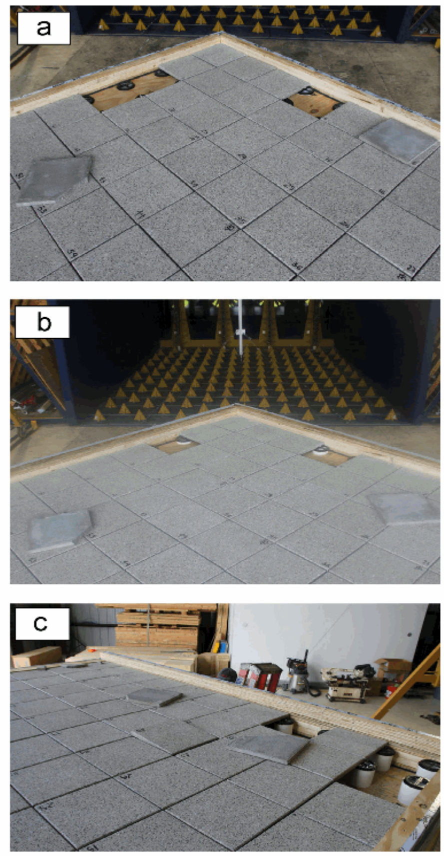

Fig. 9. Failure of roof pavers during wind blow-off tests: (a) $G/H_s = 0.25$, (b) $G/H_s = 0.083$, and (c) $G/H_s = 0.028$.

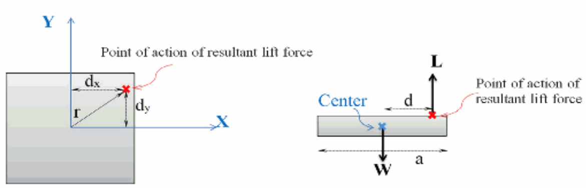

Fig. 8. Definition of the point of action of the resultant lift force.

Table 2
Failure wind speeds and failure mechanisms.

Test number	1st failure wind speed (m/s)	2nd failure wind speed (m/s)
Wind Uplift 1	**37.2**:paver 1 wobbling, paver 21 lifted off	**40:** paver 1 wobbling, paver 4 lifted off **43:** paver 1 wobbling, paver 31 lifted off
Wind Uplift 2	**34:** pavers 1, 11 wobbling	**37.3:** pavers 4, 21 lifted off
Wind Uplift 3	**28:** pavers 1, 2 wobbling **30.7:** paver 1 lifted off	**34:** pavers 3, 4 wobbling **37:** pavers 2, 21 lifted off

To properly design and secure the most critical pavers in place, it is necessary to know the wind-induced loads acting on individual pavers under the designed wind speed. It should be noted that the highest suction on the paver does not necessarily occur at the center of the paver. This means that even for cases where the total uplift force is less than the weight of the paver, the weight of

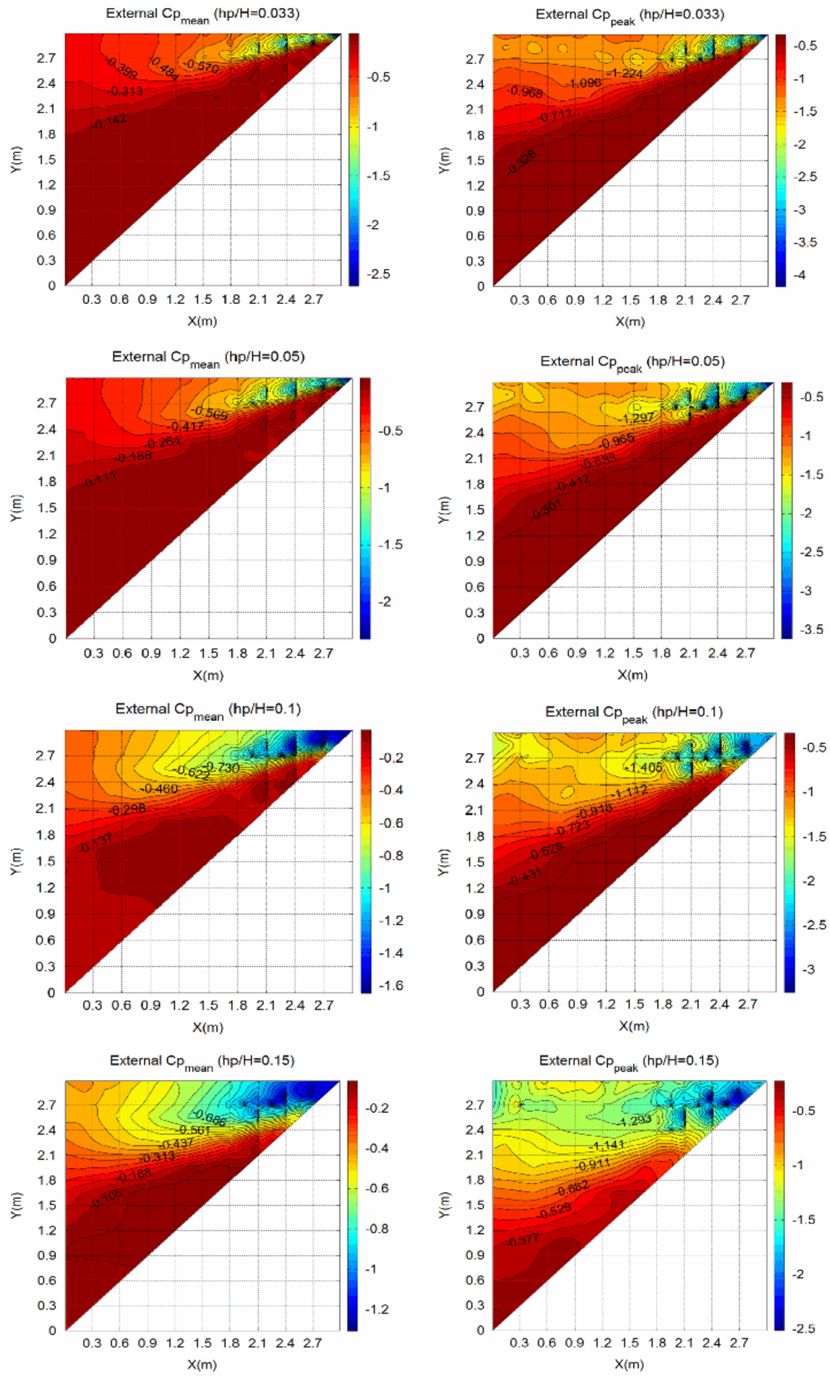

Fig. 10. External Cp_{mean} and Cp_{peak} ($G/H_s = 0.083$).

the paver might not overcome the corresponding overturning moment. The overall wind uplift load, $L(t)$, and lift coefficient, $C_L(t)$, acting on any single paver are obtained as

$$L(t)=\frac{1}{2}\rho U^2 \iint_{A_{paver}} Cp_{net}(t,x,y)\,dA \tag{3}$$

$$C_L(t)=\frac{L(t)}{\frac{1}{2}\rho U^2 A} \tag{4}$$

where A is the surface area of the paver and $Cp_{net}(t)=Cp_{ext}(t)-Cp_{int}(t)$ is the net total pressure coefficient defined as the instantaneous difference between the external and the corresponding underneath pressure coefficients at the same location. The overturning moment and moment coefficient about a selected axis are obtained from

$$M(x,y,t)=\frac{1}{2}\rho U^2 \iint_{A_{paver}} Cp_{net}(t,x,y)\times d(x,y)\times dA \tag{5}$$

$$C_M(t)=\frac{M(t)}{\frac{1}{2}\rho U^2 Aa} \tag{6}$$

where a is the width of the paver and $d(x,y)$ is the moment arm defined as the distance from the selected axis to each point on the paver (Fig. 8). Another important parameter is the point of action of the uplift force (Fig. 8). Having the net lift, L, and moments M_x and M_y, offsets of point of action of lift from the center are

$$d_y=M_x/L; \quad d_x=M_y/L \tag{7}$$

The blow-off takes place when the moment caused by the uplift force is equal to the moment from the paver weight, W. Therefore, the critical wind velocity U_{CRIT} at which blow-off occurs is calculated from

$$\frac{1}{2}\rho U_{CRIT}{}^2 C_L A\left(d+\frac{a}{2}\right)=W\times\frac{a}{2} \tag{8}$$

From which it can be deduced that

$$U_{CRIT}=\sqrt{\frac{a}{2\left(d+\frac{a}{2}\right)}\times\frac{W}{\frac{1}{2}\rho C_L A}}\ (d \text{ is the larger of } d_x \text{ and } d_y) \tag{9}$$

4. Results and discussion

4.1. Wind blow-off test results

Table 2 shows the failure wind speeds and the failure mechanism for wind blow-off tests (see Table 1 for each test characteristics). 1st failure wind speed is defined as the wind speed at which minor displacement and/or limited failure (wobbling of pavers and/or 1 paver lifted off) was observed. 2nd failure wind speed corresponds to the situation when more failure occurred (2 or 3 pavers were lifted off). The failure in each case is shown in Fig. 9.

The results showed that by increasing the spacer height (H_s), the failure wind speed decreases. This is in agreement with studies of Bienkiewicz and Endo (2009) who showed that increasing the height H_s while having a constant edge-gap between the pavers increases the net pressures on the pavers which may be regarded as lowering the failure wind speed. The location of the failure was in all cases near the edge of the roof (Fig. 9). Pavers 1, 2, 3, 4, 11, 21, and 31 were the most critical pavers. The pressure tap layout (Fig. 7) was decided based on the wind blow-off tests for detailed evaluation of the pressure distribution over the roof and the most critical pavers.

4.2. Pressure measurement results

4.2.1. Effect of relative parapet height (h_p/H)

4.2.1.1. External pressure distribution. Fig. 10 shows the surface plots of the external mean and external peak pressure coefficients for various relative parapet height ratios (h_p/H). The peak values correspond to the estimated peak value for each tap during the test and do not occur simultaneously on all taps.

Results in Fig. 10 show that pavers close to the edges and corners of the roof are subjected to the highest local negative pressures. It can be seen that the highest local mean suction pressure coefficient is reduced by about 50% by changing h_p/H from 0.033 to 0.15. The width of the zone of high suctions caused by the conical vortices increases and their strength decreases with taller parapets. This trend is in agreement with the results obtained by Kind (1988) on the effect of parapet height on worst mean suction pressure coefficient for a 1:20 scale low-rise building.

Several studies have been done on the effect of parapets on the external pressure coefficients on flat roofs (Kopp et al., 2005; Stathopoulos, 1982; Stathopoulos and Baskaran, 1987). In order to put the current data in context with the previously published data, it was attempted to compare the external pressure coefficients with those obtained in the literature. Table 3 shows the characteristics of the experiments used for comparison. Note that comparisons

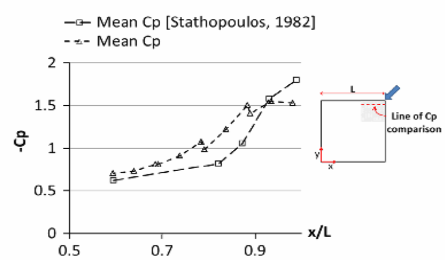

Fig. 11. Comparison of external Cp_{mean} ($h_p/H=0.1$; $G/H_s=0.083$) with Stathopoulos (1982).

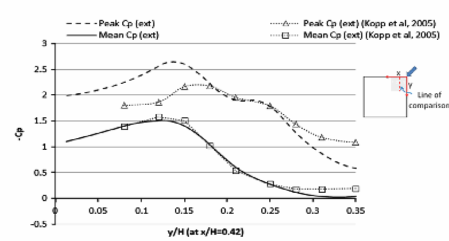

Fig. 12. Comparison of external Cp ($h_p/H=0.1$; $G/H_s=0.083$) with Kopp et al. (2005).

Table 3
Characteristics of the experiments used for comparison between external pressure coefficients.

	H (m)	h_p/H	Plan aspect ratio	Terrain	Scale	Wind direction
Current study	3.48	0.1	1	Suburban	1/2	45
Stathopoulos, 1982	9.8	0.122	3	Suburban	1/250	Most critical, from tests for 0–90 is presented
Kopp et al., 2005	4.6	0.1	1.5	Open	1/50	325

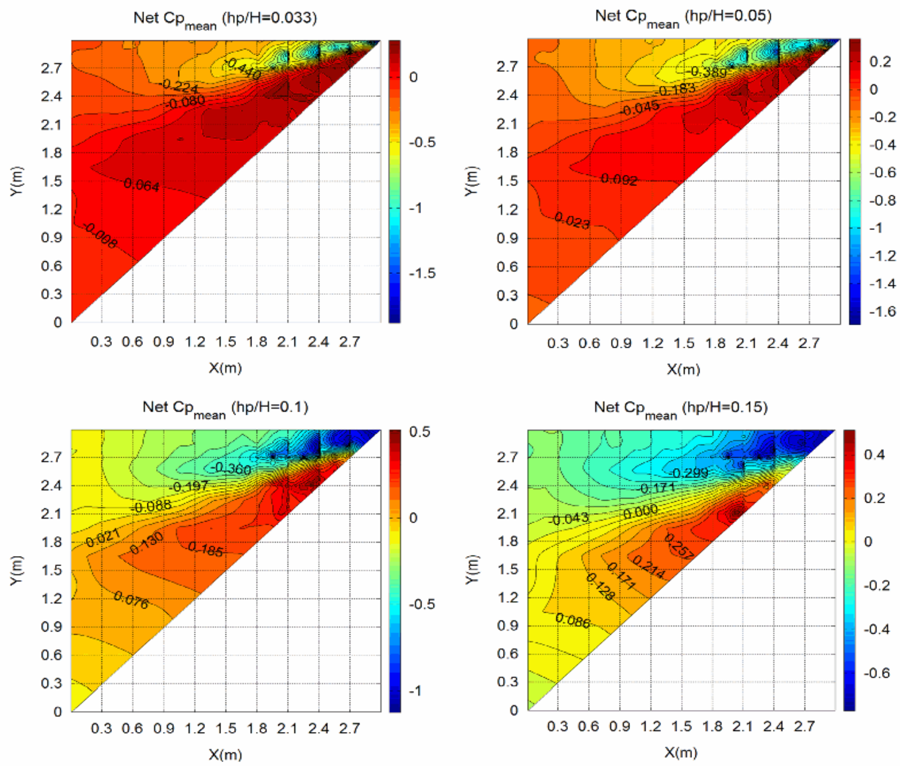

Fig. 13. Net Cp_{mean} ($G/H_s = 0.083$).

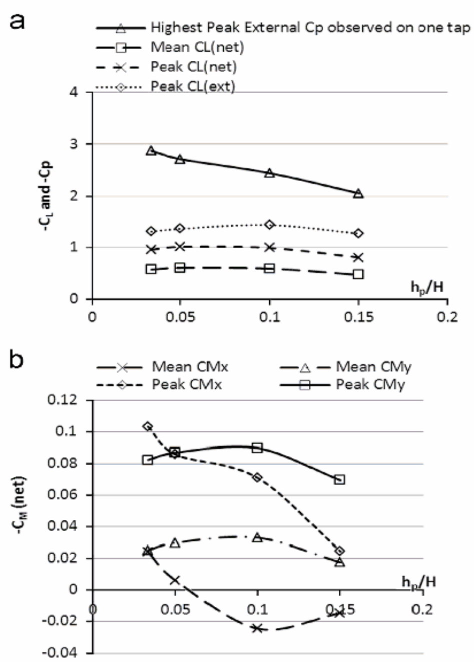

Fig. 14. Variations of (a) C_{Lnet} and (b) C_{Mnet} on paver 21 with h_p/H ($G/H_s = 0.083$).

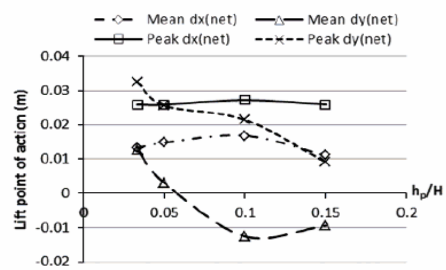

Fig. 15. Variation of L_{net} point of action on paver 21 with h_p/H ($G/H_s = 0.083$).

pertain to the closest possible match of geometric and exposure configurations as found in the literature and could not be performed for exactly similar test configurations. Comparison was limited to the corner region where 45° wind direction usually dominates the behavior of peak suctions and since 45° was the only angle tested in the present research.

Fig. 11 shows the external mean pressure coefficients measured at the edge taps of the building with the corresponding values from the literature (Stathopoulos, 1982). Note that in the latter reference the published values are the highest ones as obtained from all the wind directions tested, rather than those at 45° only. However, close to the corner the 45° case dominates. It can be seen that the values obtained in the present work are generally in a good agreement with those from Stathopoulos (1982).

As explained previously, the peak values presented in this paper are normalized to the 3-s gust wind speed. In order to be able to

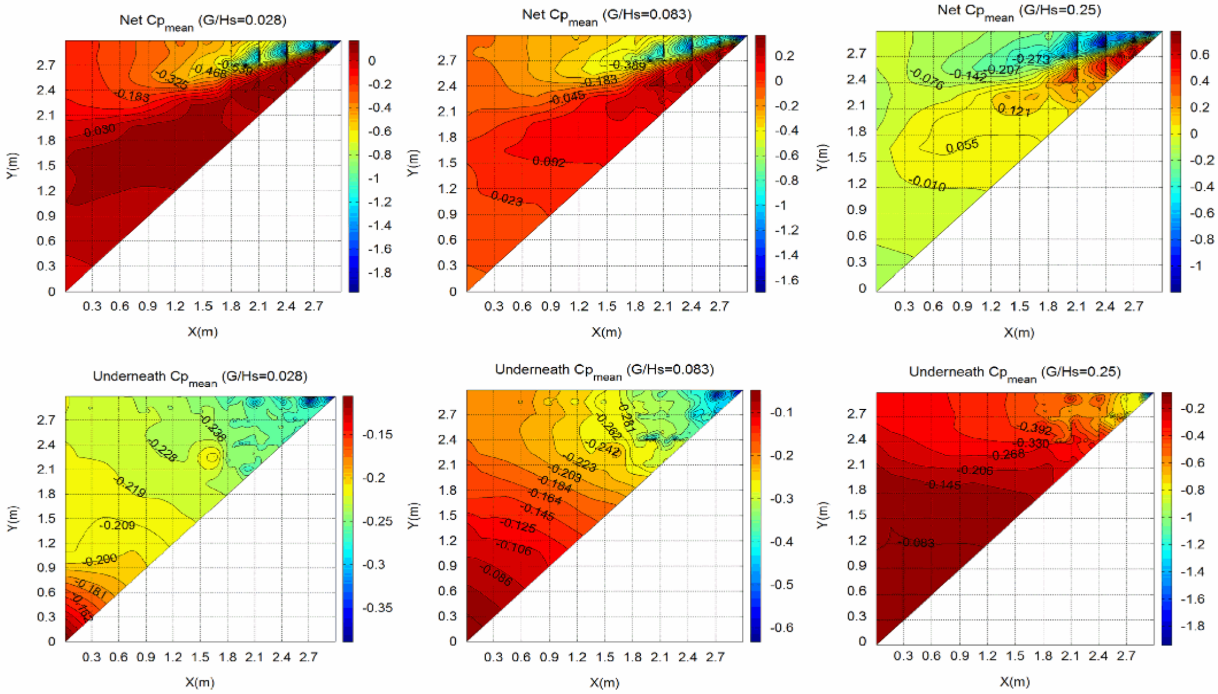

Fig. 16. Underneath Cp_{mean} and net Cp_{mean} ($h_p/H=0.05$).

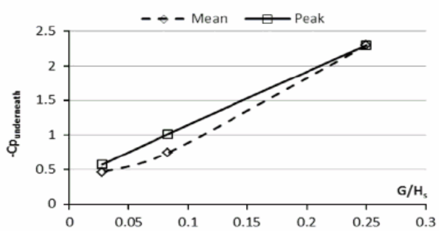

Fig. 17. Highest underneath Cp ($h_p/H=0.05$).

compare our peak pressures with those obtained in wind tunnel by Kopp et al. (2005) the procedure explained by Pierre et al. (2005) was used to calculate the equivalent wind tunnel pressure coefficient

$$(GCp)_{eq} = \frac{q_H \hat{C}p}{q_{10m,\,3s} K_{zt} K_h K_d I} = F_{WT} \hat{C}p \tag{10}$$

where $\hat{C}p$ is the peak coefficient based on the mean hourly wind speed measured at the eave height in a wind tunnel, $q_{10m,\,3s}$ and q_H are the dynamic wind pressures at heights of 10 m and H, respectively, as given in the ASCE 7-10, K_{zt} is the topographic factor, K_h is the exposure factor, K_d is the directionality factor and I is the importance factor. The factors K_{zt}, K_d and I were set to unity. The coefficient F_{WT} was given as 0.38 for $H=4.6$ m in the open country terrain which was used to re-reference the peak pressure coefficients obtained by Kopp et al. (2005) for comparison purposes. Fig. 12 shows the comparison between the mean and peak pressure coefficients obtained in the current study with the corresponding values in Kopp et al. (2005). The comparison was limited to corner region along the line of $x/H=0.42$ from the windward corner of the roof as defined by Kopp et al. (2005). Results show that the mean pressure coefficients are in very good agreement with the results in

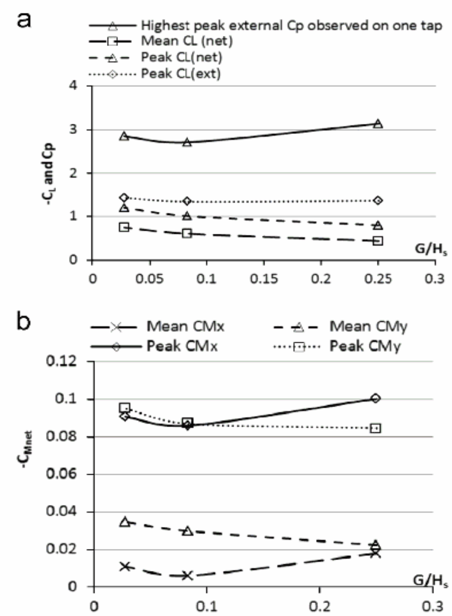

Fig. 18. Variation of: (a) C_{Lnet} and (b) C_{Mnet} on paver 21 with G/H_s ($h_p/H=0.05$)

Kopp et al. (2005). The differences in the peak pressure coefficients are probably due to different building geometries, different terrains, and Reynolds number effect. Higher peak pressures are generally expected for suburban terrain as compared to open terrain results for similar building configurations.

External pressure coefficients measured in this paper are in very good agreement with an earlier full-scale study performed in 6-fan Wall of Wind facility at FIU on concrete roof pavers (Aly et al., 2012). It is to be noted that although the 45° cornering wind is usually considered as the most critical direction for pavers, very localized higher suctions than seen at 45° can occur in small regions near the roof edges for other wind directions (Aly et al., 2012), but apparently the size of the effected region is too small to be the most critical case for pavers.

4.2.1.2. Net pressure distribution. Fig. 13 shows the variation of net pressure coefficients for various relative parapet height ratios (h_p/H) showing that taller parapets ($h_p/H>0.1$) reduce the net Cp_{mean} on the roof. This was mainly due to reductions made on the mean external pressure coefficients. However, results show that low parapets might significantly increase the peak roof corner suctions for oblique wind directions (Bienkiewicz and Meroney, 1988; Stathopoulos and Baskaran, 1987).

Fig. 14 shows the variation of the net uplift force coefficient and the net pitching moment coefficient on paver 21 with h_p/H. Results show that in contrast to local suctions, the net uplift and the net moment on a paver are both less sensitive to parapet height. For example, in going from h_p/H from 0.033 to h_p/H in the range of 0.05 to 0.10, the values of both C_{Lnet} and C_{Mnet} are increased which makes the range $h_p/H=0.05$ to 0.10 the worst case scenario among the parapets considered for this study.

The variation of the location of the point of action of the net uplift force with relative parapet height (h_p/H) is plotted in Fig. 15. It shows that increasing the parapet height to above h_p/H from 0.1 to 0.15 moves the point of action of the net uplift force more towards the center of the paver while the lift coefficient also decreases. This situation can be interpreted as an improved wind performance for higher parapets. Thus from the current study it was found that a relative parapet height ratio of 0.15 could significantly reduce the suction pressure on pavers under conical vortices. It also reduces the offset distance of the point of action of the lift force from the center of the paver.

4.2.2. Effect of pavers' edge-gap to spacer height ratio (G/H_s)

Fig. 16 shows the surface plots of the underneath mean and net mean pressure coefficients for various G/H_s ratios. Results presented in Fig. 16 show the effect of edge-gap to spacer height (G/H_s) ratio on the wind loading of roof pavers. It can be seen that in these cases also pavers close to the edges and corners of the roof are subjected to the highest negative pressures which is mainly due to the wind-induced conical vortices. Compared to external pressures, the values of underneath pressures acting on the lower surfaces of the pavers are low in magnitude and exhibit more uniformity. For lower G/H_s ratios (larger height spacers), the underneath pressure becomes nearly uniform, probably due to the lower flow resistance underneath the pavers. As concluded by Bienkiewicz and Endo (2009), the G/H_s ratio affects the underside pressures such that the higher the ratio, the lesser the net pressure on the pavers. Fig. 17 clearly shows that increasing the G/H_s ratio results in higher suctions underneath the pavers.

Fig. 18 shows the variation of the net uplift force coefficient and the net pitching moment coefficient on paver 21 with G/H_s. The results show that increasing G/H_s ratio reduces the net uplift force coefficient on the paver but the pitching moment is less sensitive to this parameter. The variation of the location of the point of action of the net uplift force with G/H_s ratio is plotted in Fig. 19. For higher G/H_s ratios, the point of action of the lift force is more offset from the center of the paver.

Comparing the results presented in Figs. 18 and 19 shows that even though by increasing the G/H_s ratio the lift force is more offset from the center of the paver, nonetheless its value decreases in such a way that an overall better wind performance is observed for higher G/H_s ratio.

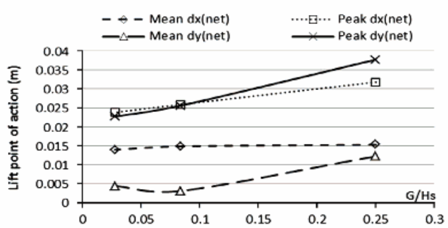

Fig. 19. Variation of L_{net} point of action on paver 21with G/H_s ($h_p/H=0.05$).

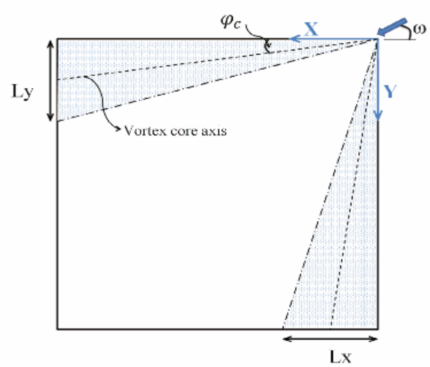

Fig. 21. Defining vortex core angle.

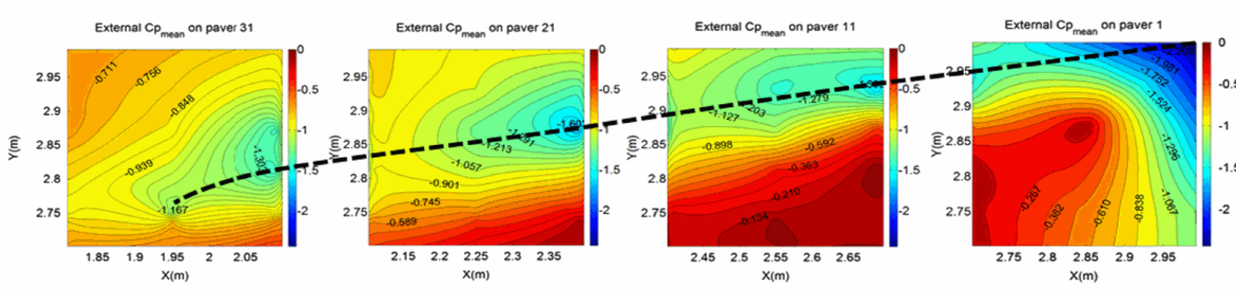

Fig. 20. External Cp_{mean} on critical pavers ($G/H_s=0.083$, $h_p/H=0.05$).

4.2.3. Effect of pressure tap resolution on aerodynamic lift and moment results

Fig. 20 shows the external mean pressure distribution on pavers 1, 11, 21 and 31 and the line indicates the path of the corner vortex. It is noteworthy that the highest suctions are observed at the upwind edge of each paver. It is hypothesized that this is due to the interaction of the high velocity rotating flow caused by the corner vortex with a vertical flow coming out of the upwind end of the paver. Wind lift-off tests showed that paver 1 wobbled but did not fail, whereas paver 21 failed (corresponding to Wind Uplift 2 in Table 2). Results showed that the magnitude of the mean and peak uplift coefficients for paver 21 (mean $C_{Lnet}=-0.6$, peak $C_{Lnet}=-1.0$) was higher than that for paver 1 (mean $C_{Lnet}=-0.25$, peak $C_{Lnet}=-0.76$). This was because the size of the high suction zone relative to the paver size was bigger for paver 21 than for paver 1 (Fig. 20). The aerodynamic mechanisms that cause uplift are quite complex, involving significant interaction between the external flow and the internal flow into and out of the gaps between pavers. This interaction can increase the offset of the lift force from the center of the paver. As pointed out by Gerhardt et al. (1990), the impact of vortices on pavers significantly depends on the size of the paver relative to the width of the corner vortex. If the paver is much larger than the width of the vortex then the impact is reduced since only a small fraction of the paver area is affected by the high suction. Also, if the paver is much smaller than the width of the vortex then, even if it is sitting in a high suction zone, the pressure equalization effect of the gaps at its edges substantially reduces the difference in pressure between top and bottom surfaces. However, if the paver and vortex widths are similar the net uplift will tend to be at a maximum.

Banks et al. (2000) proposed an empirical equation valid for incident wind angle of $\omega=30$–$70°$ to calculate the vortex core angle: $\varphi_c=2.94\,e^{0.0297\,\omega}$ (Fig. 21). The vortex core angle measured during experiments for $G/H_s=0.083$, $h_p/H=0.05$ case, was 11.31° which was in a very good agreement with the results obtained from $\varphi_c=2.94\,e^{0.0297\times 45°}=11.2°$ (Banks et al., 2000).

Fig. 22 shows the contour plot for the $h_p/H=0.05$ and $G/H_s=0.25$ case in which the same pressure tap layouts as for pavers 2, 3, and 4 were considered for paver 11, 21, and 31. This results in loss of detail and the resulting pressure patterns resemble some of the earlier patterns obtained by other workers (Kind and Wardlaw, 1982) who had less density of taps available to them at the time of their experiments. It appears that a fairly high density of taps is required to capture all the detailed aerodynamic effects.

In order to find the effect of the tap arrangement and required resolution for pressure taps on the critical pavers, six different tap layouts were evaluated, the results of which are plotted in Fig. 23. The results show that having the pressure taps near the edges, especially those edges which are perpendicular to the parapet, is quite necessary for capturing an accurate measurement of high suctions.

Figs. 24 and 25 show the net uplift force and net moment coefficients on paver 21 for different tap layouts defined in Fig. 23.

The results demonstrate that the net uplift force coefficient and net moment coefficient are sensitive to the resolution and arrangement of the pressure taps. Figs. 24 and 25 also show that there might be significant differences in the calculated lift and overturning moment obtained from a particular layout. Case (f) shows the tap layout used in this study on critical pavers with 30 pressure taps (15 taps on top and 15 taps on bottom). The results show that inaccuracies can occur when having low resolution of pressure taps. High suction areas can be missed as is the case of Tap Layout a, or lift can be overestimated as in Tap Layout d. The latter is mainly because one of the taps captured a very high local suction on the paver. Integrating such local high suction using a large tributary area and neglecting the effect of pressure gradient can lead to overestimation of the lift. The results of this study show that to obtain accurate measurements of aerodynamic lift and moment a high density of taps is needed, higher than typically used in the past. If the analysis requires higher degrees of accuracy, it is recommended that additional pressure taps be added evenly on lines perpendicular to the corresponding building edge. Of course vortices do not only occur at roof corners but can also occur at setbacks and next to roof obstructions, and similar detailed pressure patterns can be expected at these discontinuities in building geometry.

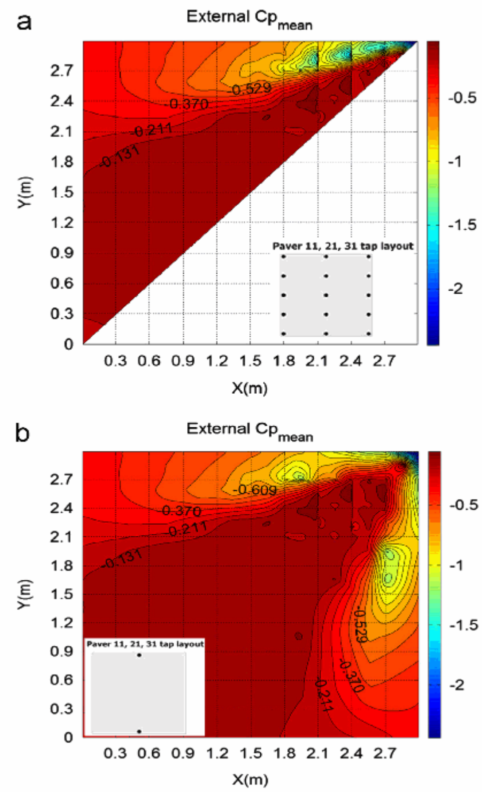

Fig. 22. External Cp_{mean}: (a) high density of pressure taps and (b) low density of pressure taps ($h_p/H=0.05$, $G/H_s=0.25$).

4.3. Comparison with wind blow-off tests and practice based on ASCE 7-10 exterior pressures

The highest external single tap pressure coefficients and the external area averaged pressure coefficient (C_{Lext}) observed on the most critical paver (paver 21) obtained for different cases (Table 1) were also compared to component and cladding external pressure coefficients for roofs as given in ASCE 7-10 (2010). Chapter 30 of ASCE 7-10 provides the peak pressure coefficients for components and claddings. For gable roofs with slope $\theta\le 7°$ the peak external pressure coefficient for corner Zone 3 for tributary areas less than 0.9 m^2 is given as -2.8 in Fig. 30.4-2A (ASCE 7-10, 2010). The highest single tap peak suction coefficients observed in the present tests for all cases ranged from -4.1682 for $h_p/H=0.033$ and $G/H_s=0.083$ to -3.5486 for $h_p/H=0.15$ and $G/H_s=0.083$ in the corner zone. Being single tap values, they correspond to much

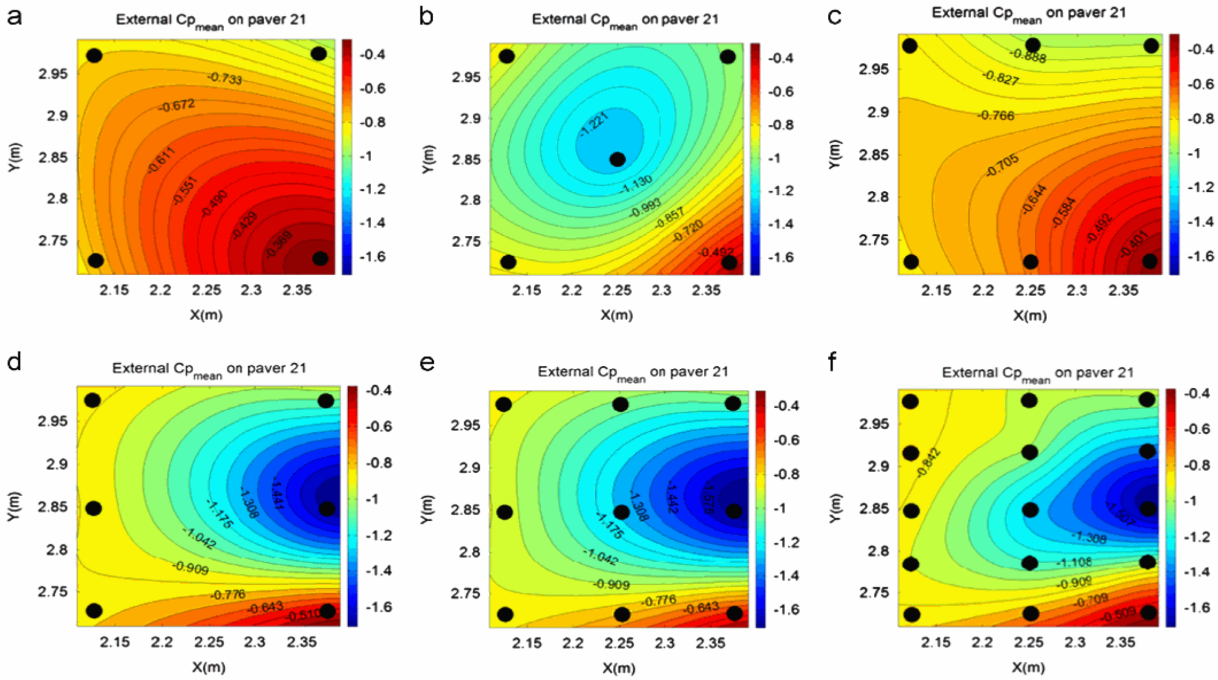

Fig. 23. Effect of pressure tap layout on external Cp_{mean} ($h_p/H=0.05$ and $G/H_s=0.25$).

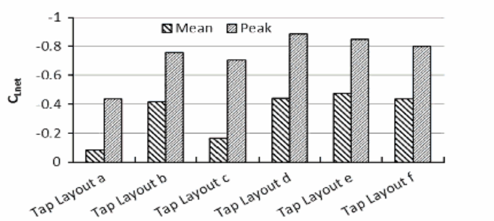

Fig. 24. C_{Lnet} for different pressure tap layouts ($h_p/H=0.05$; $G/H_s=0.25$).

smaller tributary area than 0.9 m^2 and so would be expected to be somewhat higher in magnitude than the ASCE 7 value. The highest peak external lift coefficients ranged from -1.44 for $h_p/H=0.05$ and $G/H_s=0.028$ to -1.26 for $h_p/H=0.15$ and $G/H_s=0.083$. The underneath pressure coefficients required for calculating the net pressure coefficients are not dealt with in ASCE 7-10. One informal practice is to assume the underneath pressure coefficient to be zero (FPHLM study on tiles, 2005, Volume II, p. 55) and that the net uplift force acts on the center of the paver.

In order to see the overall effect of high local Cp values on the failure wind speeds, the critical wind blow-off speeds were calculated from the pressure measurements using Eq. (9) and compared to those obtained from the wind blow-off tests (Table 4) and the wind blow-off speeds calculated from a typical informal practice based on ASCE 7-10 exterior pressures (i.e. using the ASCE 7-10 external pressure coefficients, taking the effective internal pressure as zero and simply assuming that the net uplift acts at the paver's center). Results calculated from pressure measurements are for paver 21 which was shown to be one of the most critical in all three cases. The values recorded for the wind blow-off tests correspond to the case where both wobbling of pavers and first failure were observed. For the practice based on ASCE 7-10 exterior pressures, wind blow-off speed values are calculated using $GCp=-2.8$ (external pressure coefficient in Zone 3 for $A_{eff}=0.09\ \mathrm{m}^2 \le 0.9\ \mathrm{m}^2$).

Results show that quite good agreement exists between the results from wind blow-off tests and those obtained from mean C_{Lnet} values. This means that although high peak suctions were observed on critical pavers, which can cause instantaneous wobbling, the fluctuations did not last long enough to actually cause lift off. The best agreement between the blow tests and the pressure measurements would be obtained by calculating the lift based on the mean coefficient plus a small contribution from the fluctuations. The critical wind blow-off value calculated using ASCE 7-10 exterior pressures is clearly conservative in comparison to the current experiments.

Table 5 shows equalization factors, as defined by Geurts (2000), for different G/H_s ratios for the critical paver 21. A value of 0.6 was proposed by Geurts based on full-scale pressure measurements. Comparison between the results shows the present values ranging around 0.6. The results presented in Geurts (2000) were for a single G/H_s ratio. The present results indicate the value 0.6 may underestimate the ratio on pavers with low G/H_s ratios. The results presented in this paper are for 45° cornering winds only which is the most critical for paver lift-off on a flat roof. The equalization factor may well be a function of wind direction and Geurts' results covered various wind directions. For the purposes of codification the concept of an equalization factor is useful but it needs also to take account of the results in Table 4. These results show that the best correlation with observed blow off speeds is obtained using the mean C_{Lnet}, not the peak C_{Lnet}. It appears that most of the fluctuations in C_{Lnet} do not last long enough to disturb the paver. Therefore a more meaningful factor for codification purposes is likely to be the ratio of mean C_{Lnet} (or perhaps mean plus a small contribution from fluctuations) to the peak Cp that is provided in codes for cladding design. Future work is in progress to explore

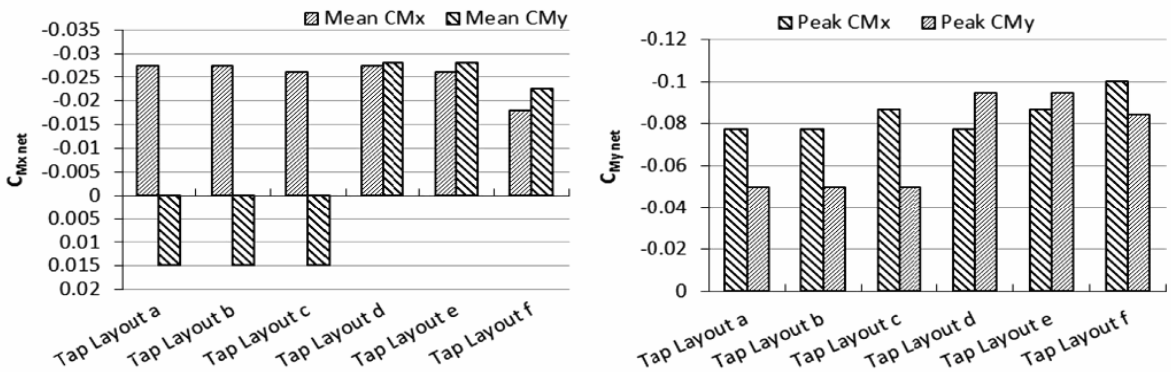

Fig. 25. $C_{M\text{net}}$ for different pressure tap layouts ($h_p/H=0.05$; $G/H_s=0.25$).

Table 4
Critical wind blow-off speed.

Test	Critical wind blow-off speed (m/s)			
	Practice based on ASCE 7-10 exterior pressures	**Wind blow-off tests**	**Pressure measurement tests**	
	$\left(U_{CRIT}=\sqrt{\frac{W}{\frac{1}{2}\rho C_{p,ext}A}}\right)$		$\left(U_{CRIT}=\sqrt{\frac{a}{2(d+\frac{g}{2})}\times\frac{W}{\frac{1}{2}\rho C_{Lnet,\ mean\ or\ peak}A}}\right)$	
			Based on mean C_{Lnet}	Based on peak C_{Lnet}
$G/H_s=0.25$	17.6	37.2	41.84	29.14
$G/H_s=0.083$		35.7	35.72	26.8
$G/H_s=0.028$		30.7	32.24	24.7

*22 (m/s) for $GCp=-1.8$ (external pressure coefficient in Zone 2 for $A_{eff}=0.09\ m^2 \le 0.9\ m^2$).

Table 5
Equalization factor based on G/H_s.

G/H_s	$\frac{\text{Mean } C_{Lnet}}{\text{Mean } C_{Lext}}$	$\frac{\text{Peak } C_{Lnet}}{\text{Peak } C_{Lext}}$	Geurts (2000) $\frac{Cp_{net}}{Cp_{ext}}$
0.25	0.49	0.58	0.6
0.083	0.68	0.75	
0.028	0.77	0.83	

this aspect in more detail, as well as the effects of building geometry, paver size, G/H_s ratio and h_p/H.

5. Conclusions and future work

The wind loading mechanism of concrete roof pavers was investigated in this project. Wind blow-off tests and pressure measurements were carried out on a square portion of a flat roof for the critical wind direction that generates corner vortices. The experiments were performed in the Wall of Wind, at FIU. The influence of an edge parapet on net uplift pressures was also explored. Increasing the pavers' edge-gap to spacer height ratio improves the system behavior. A certain relative parapet height in the range $h_p/H=0.10$–0.15 exists in which the uplift loads reach the worst case values. The results demonstrated that the net uplift force and moment coefficients are sensitive to the resolution and layout of the pressure taps. The location and spacing of pressure taps needed to accurately resolve the uplift pressures were investigated. A larger number of taps than typically used in the past was found to be needed. Based on the information gathered in the current tests and review of the literature, guidelines suitable for codes and standards are being developed for the design of roof pavers. These guidelines will need to incorporate appropriate factors of safety in order to achieve the normal levels of reliability used in the design of building envelopes. Similar phenomena observed for the roof pavers affect roof tiles and shingles, further complicated by the profiles of the particular tile and shingle systems used. The large-scale testing methods used in the present investigation are also applicable to these other roofing systems and provide new insights through accurately reproducing critical aerodynamic effects at full scale, or close to full scale Reynolds numbers.

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Yamada, H., Katsuchi, H., 2008. Wind-tunnel study on effects of small-scale turbulence on flow patterns around rectangular cylinder. In: Proceedings of the 4th International Colloquium on Bluff Bodies Aerodynamics & Applications, Italy.
Yeo, D., Chowdhury, A.G., 2013. Simplified wind flow model for the estimation of aerodynamic effects on small structures. J. Eng. Mech. 139, 367–375.

Date Submitted	11/26/2018	**Section**	35	**Proponent**	Bonnie Manley
Chapter	35	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

7452, 7454, 7455, S299-16 (Structural, Structural, Chart #1)

Summary of Modification

This proposal is one in a series adopting the latest generation of AISI standards for cold-formed steel.

Rationale

This proposal is one in a series adopting the latest generation of AISI standards for cold-formed steel. This particular proposal focuses on Chapter 35 by updating references to the AISI suite of standards, including the addition of three new cold-formed steel standards -- AISI S240, AISI S400, and AISI S202 – now referenced in Chapters 22 and 25. All AISI standards are published and available for a free download at: www.aisistandards.org.

AISI S240, North American Standard for Cold-Formed Steel Structural Framing, addresses requirements for construction with cold-formed steel structural framing that are common to prescriptive and engineered light frame construction. This comprehensive standard was formed by merging the following AISI standards: AISI S200, AISI S210, AISI S211, AISI S212, AISI S213, and AISI S214. Consequently, AISI S240 supersedes all previous editions of the above mentioned individual AISI standards.

AISI S400, North American Standard for Seismic Design of Cold-Formed Steel Structural Systems, addresses the design and construction of cold-formed steel structural members and connections used in the seismic force-resisting systems in buildings and other structures. AISI S400 supersedes AISI S110 and the seismic design provisions of AISI S213 and is intended to be applied in conjunction with both AISI S100 and AISI S240, as applicable.

AISI S202, Code of Standard Practice for Cold-formed Steel Structural Framing, is intended to service as a state-of-the-art mandatory document for establishing contractual relationships between various parties in a construction project where cold formed steel structural materials, components and assemblies are used. While it is not specifically intended to be a direct reference in the building code, portions of AISI S202 are recommended for adoption in this proposal to establish the minimum requirements for cold-formed steel truss design drawings.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

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

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

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

No change in cost is anticipated.

Requirements

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

Yes, it does.

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

Yes, it does.

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

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

Alternate Language

2nd Comment Period

7458-A1

Proponent Bonnie Manley **Submitted** 5/16/2019 **Attachments** Yes

Rationale

This public comment recommends adopting the original text of S7458 with one modification to adopt the latest edition of AISI S230 (2019). The 2019 edition of AISI S230 is based upon ASCE 7-16, rather than ASCE 7-10, and is now available at www.steel.org. The other modifications, which were recommended in the original proposal, are necessary to coordinate with Proposals S7452, S7454, S7455 and S299-16(Structural, Structural, Chart #1).

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.

2nd Comment Period

S7458-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with the alternate language of this modification.

AISI S100—16~~12~~, *North American Specification for the Design of Cold-formed Steel Structural Members*, 2016~~2012~~

~~AISI S110—07/S1-09 (2012),*Standard for Seismic Design of Cold-Formed Steel Structural Systems—Special Moment Frames*, 2007 with Supplement 1, dated 2009 (Reaffirmed 2012)~~

~~AISI S200—12, *North American Standard for Cold-Formed Steel Framing-General Provisions*, 2012~~

~~AISI S210—07(2012), *North American Standard for Cold-Formed Steel Framing-Floor and Roof System Design*, 2007 (Reaffirmed 2012)~~

~~AISI S211—07/S1-12(2012), *North American Standard for Cold-Formed Steel Framing-Wall Stud Design*, 2007 including Supplement 1, dated 2012 (Reaffirmed 2012)~~

~~AISI S212—07(2012), *North American Standard for Cold-Formed Steel Framing-Header Design*, 2007 (Reaffirmed 2012)~~

~~AISI S213—07/S1-09 (2012), *North American Standard for Cold-Formed Steel Framing-Lateral Design*, 2007 with Supplement 1, dated 2009 (Reaffirmed 2012)~~

~~AISI S214—12,North American Standard for Cold-formed Steel Framing-Truss Design, 2012~~

AISI S220—15~~11~~, *North American Standard for Cold-formed Steel Framing-Nonstructural Members*, 2015

AISI S230—19~~07/S3-12(2012)~~, *Standard for Cold-formed Steel Framing-Prescriptive Method for One- and Two-family Dwellings*, 2019~~2007 with Supplement 3, dated 2012 (Reaffirmed 2012)~~

AISI S240—15, *North American Standard for Cold-Formed Steel Structuring Framing*, 2015

AISI S400—15/S1—16, *North American Standard for Seismic Design of Cold-formed Steel Structural Systems*, 2015, with Supplement 1, dated 2016.

AISI S100—16~~12~~, *North American Specification for the Design of Cold-formed Steel Structural Members*, 2016~~2012~~

~~AISI S110—07/S1-09 (2012),*Standard for Seismic Design of Cold-Formed Steel Structural Systems—Special Moment Frames*, 2007 with Supplement 1, dated 2009 (Reaffirmed 2012)~~

~~AISI S200—12, *North American Standard for Cold-Formed Steel Framing-General Provisions*, 2012~~

~~AISI S210—07(2012), *North American Standard for Cold-Formed Steel Framing-Floor and Roof System Design*, 2007 (Reaffirmed 2012)~~

~~AISI S211—07/S1-12(2012), *North American Standard for Cold-Formed Steel Framing-Wall Stud Design*, 2007 including Supplement 1, dated 2012 (Reaffirmed 2012)~~

~~AISI S212—07(2012), *North American Standard for Cold-Formed Steel Framing-Header Design*, 2007 (Reaffirmed 2012)~~

~~AISI S213—07/S1-09 (2012), *North American Standard for Cold-Formed Steel Framing-Lateral Design*, 2007 with Supplement 1, dated 2009 (Reaffirmed 2012)~~

~~AISI S214—12,North American Standard for Cold-formed Steel Framing-Truss Design, 2012~~

AISI S220—15~~11~~, *North American Standard for Cold-formed Steel Framing-Nonstructural Members*, 2015

AISI S230—15~~07/S3-12(2012)~~, *Standard for Cold-formed Steel Framing-Prescriptive Method for One- and Two-family Dwellings*, 2015~~2007 with Supplement 3, dated 2012 (Reaffirmed 2012)~~

AISI S240—15, *North American Standard for Cold-Formed Steel Structuring Framing*, 2015

AISI S400—15/S1—16, *North American Standard for Seismic Design of Cold-formed Steel Structural Systems*, 2015, with Supplement 1, dated 2016.

S7952

Date Submitted	12/12/2018	**Section**	35	**Proponent**	Borjen Yeh
Chapter	35	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **Yes**

Related Modifications

Summary of Modification

Update the referenced standards published by APA.

Rationale

This proposal updates the referenced standards published by APA.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

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

No impact to building and property owners relative to cost of compliance with code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code.

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

No impact to small business relative to the cost of compliance with code.

Requirements

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

This proposal updates the referenced standards published by APA.

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

This proposal improves the code.

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

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

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Alternate Language

2nd Comment Period

7952-A2

Proponent Joe Bigelow **Submitted** 5/10/2019 **Attachments** Yes

Rationale

This comment was rebuilt by staff due original A1 being overwritten by 2nd comment period alternate language comment - It is original A1 from first 45 day cycle submitted by BJ Yeh- -- As the original proponent for S7952, I just noticed that the date of the current version for these 4 APA PDS Supplements hasnot been changed (i.e., "-12") and does not need to be updated to "-14". Note that the other changes proposed in S7952 arevalid as proposed

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

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

No impact to building and property owners relative to cost of compliance with code

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code.

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

No impact to small business relative to the cost of compliance with code.

Requirements

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

This proposal updates the referenced standards published by APA.

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

This proposal improves the code.

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

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

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Alternate Language

2nd Comment Period

7952-A1

Proponent Borjen Yeh **Submitted** 4/14/2019 **Attachments** Yes

Rationale

At the last Structural TAC meeting in March 2019, there was a confusion on the year of the proposed changes on PDS-Supplements. The intent of my proposal was/is to keep PDS Supplements 1 through 4 without changes, but simply update PDS-Supplement 5 from 2012 to 2016 to reflect its current publication date. In this public comment, I also updated other publications. Note that ANSI 117 was approved by TAC in S7948 and ANSI/APA PRG 320 was simply updated to 2018 and relocated to be with other ANSI standards. I also updated the source sections (2306 ans 2314) in which the references are cited as appropriate.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

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

No impact to building and property owners relative to cost of compliance with code.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to the cost of compliance with code.

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

No impact to small business relative to the cost of compliance with code.

Requirements

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

This proposal updates the referenced standards published by APA.

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

This proposal improves the code.

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

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

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Is the proposed code modification part of a prior code version? No

APA PDS Supplement 1—12~~14~~ Design and Fabrication of Plywood Curved Panels (revised 2013) 2306.1 2314.4.3

APA PDS Supplement 2—12~~14~~ Design and Fabrication of Plywood lumber Beams (revised 2013) 2306.1 2314.4.3

APA PDS Supplement 3—12~~14~~ Design and Fabrication of Plywood Stressed-skin Panels (revised 2013) 2306.1 2314.4.3

APA PDS Supplement 4—12~~14~~ Design and Fabrication of Plywood Sandwich Panels (revised 2013) 2306.1 2314.4.3

SECTION2306
ALLOWABLE STRESS DESIGN

APA—The Engineered Wood Association.

Panel Design Specification

Plywood Design Specification Supplement 1—

Design & Fabrication of Plywood Curved Panel

Plywood Design Specification Supplement 2—

Design & Fabrication of Glued Plywood-lumber Beams

Plywood Design Specification Supplement 3—

Design & Fabrication of Plywood Stressed-skin Panels

Plywood Design Specification Supplement 4—

Design & Fabrication of Plywood Sandwich Panels

Plywood Design Specification Supplement 5—

Design & Fabrication of All-plywood Beams

~~EWS~~ APA T300 Glulam Connection Details

~~EWS~~ APA S560 Field Notching and Drilling of Glued Laminated Timber Beams

~~EWS~~ APA S475 Glued Laminated Beam Design Tables

~~EWS~~ APA X450 Glulam in Residential Building Construction Guide

~~EWS~~ APA X440 Product and Application Guide: Glulam

~~EWS~~ APA R540 Builders Tips: Proper Storage and Handling of Glulam Beams

SECTION 2314
HIGH-VELOCITY HURRICANE ZONES

2314.4.2

American Institute of Timber Construction, 333 West Hampden Avenue, Englewood, CO 80110 AITC.

1.Typical Construction Details, AITC 104.

2.Code of Suggested Practices, AITC 106.

3.Standard for Heavy Timber Construction, AITC 108.

4.Standard for Preservative Treatment for Structural Glued Laminated Timber, AITC 109.

5.Standard Appearance Grades for Structural Glued Laminated Timber, AITC 110.

6.Standard for Tongue and Groove Heavy Timber Roof Decking, AITC 112.

7.Standard for Dimensions of Glued Laminated Structural Members, AITC 113.

~~8.Standard Specifications for Structural Glued Laminated Timber of Softwood Species, AITC 117.~~

8 ~~9~~ .Standard Specifications for Hardwood Glued Laminated Timber, AITC 119.

9 ~~10~~ .Technical Report No. 7, Calculation of Fire Resistance of Glued Laminated Timber.

~~11.Structural Glued Laminated Timber, ANSI/AITC A190.1.~~

2314.4.3

APA The Engineered Wood Association (formerly APA American Plywood Association), ~~P.O. Box 11700~~ 7011 South 19th Street, Tacoma, WA ~~98411~~ 98466.

1.APA Design Construction Guide, ~~Residential and Commercial~~ E30~~D~~.

2.Plywood Design Specification Y510~~J~~.

3.Plywood Design Specification—Design and Fabrication of Plywood Beams, Supplement No. 1 S811.

4.Plywood Design Specification—Design and Fabrication of Plywood Beams, Supplement No. 2 S812.

5.Plywood Design Specification-Design and Fabrication of Plywood Stressed-Skin Panels, Supplement No. 3 U813.

6.Plywood Design Specifications—Design and Fabrication of Plywood Sandwich PanelsSupplement No. 4 U814.

7.Plywood Design Specifications—Design and Fabrication of All-Plywood Beams, Supplement No.5 H815.

8.Plywood Folded Plate, Laboratory Report 21 V910.

9.APA Design/Construction Guide Diaphragms L350.

10.Performance Standards and Policies for Structural-Use Panels PRP-108.

11.303 Siding Manufacturing Specifications B840.

12. Standard Specifications for Structural Glued Laminated Timber of Softwood Species, ANSI 117.

13. Structural Glued Laminated Timber, ANSI A190.1.

APA

APA - Engineered Wood Association 7011 South 19th Street, Tacoma, WA 98466

Standard reference number	Title	Referenced in code section number
ANSI 117—2015	Structural Glued Laminated Timber of Softwood Species	2306.1 2314.4.3
~~ANSI/A 190.1—12~~ ANSI A190.1—2017	Structural Glued Laminated Timber	2303.1.3 2306.1 2314.4.3
ANSI/APA PRG 320—2018	Standard for Performance-Rated Cross-Laminated Timber	2303.1.4
ANSI/APA PRP 210—~~08~~2014	Standard for Performance-Rated Engineered Wood Siding	2303.1.52304.72306.3Table 2306.3(1)
ANSI/APA PRR 410—~~11~~2016	Standard for Performance-Rated Engineered Wood Rim Boards	2303.1.13
APA PDS—12	Panel Design Specification	2306.12314.4.3
APA PDS Supplement 1—12	Design and Fabrication of Plywood Curved Panels (revised 2013)	2306.12314.4.3
APA PDS Supplement 2—12	Design and Fabrication of Plywood-lumber Beams (revised 2013)	2306.12314.4.3
APA PDS Supplement 3—12	Design and Fabrication of Plywood Stressed-skin Panels (revised 2013)	2306.12314.4.3
APA PDS Supplement 4—12	Design and Fabrication of Plywood Sandwich Panels (revised 2013)	2306.12314.4.3
APA PDS Supplement 5—~~12~~16	Design and Fabrication of All-plywood Beams ~~(revised 2013)~~	2306.12314.4.3
APA B840—16	303Siding Manufacturing Specifications	2314.4.3
APA L350—07	Design/Construction Guide Diaphragms and Shearwalls	2314.4.3
APA PRP-108—18	Performance Standards and Policies for ~~Structural Use~~ Wood Structural Panels	2314.4.3
APA V910—90	Plywood Folded Plate Laboratory Report 121	2314.4.3
~~APA PRG 320—11~~	~~Standard for Performance-Rated Cross-Laminated Timber~~	~~2303.1.4~~
APA ~~EWCG~~ E30—16	Engineered Wood Construction Guide~~, Form E30~~	2314.4.3
~~EWS~~ APA R540—~~12~~13	Builders Tips: Proper Storage and Handling of Glulam Beams	2306.1
~~EWS~~ APA S475—~~07~~16	Glued Laminated Beam Design Tables	2306.1
~~EWS~~ APA S560—~~10~~14	Field Notching and Drilling of Glued Laminated Timber Beams	2306.1
~~EWS~~ APA T300—~~07~~16	Glulam Connection Details	2306.1
~~EWS~~ APA X440—~~08~~17	Product Guide-Glulam	2306.1
~~EWS~~ APA X450—~~01~~18	Glulam in Residential BuildingConstruction Guide ~~Western Edition~~	2306.1

APA APA - The Engineered Wood Association. 7011 South 19th Street, Tacoma, WA 98466

Standard reference number	Title	Referenced in code section number
ANSI 117-2015	Structural Glued Laminated Timber of Softwood Species	2306.1
ANSI A190.1-2017~~ANSI/A 190.1—12~~	Structural Glued Laminated Timber	2303.1.3 2306.1
ANSI/APA PRP 210—2014~~08~~	Standard for Performance-Rated Engineered Wood Siding	2303.1.5 2304.7 2306.3 Table 2306.3(1)
ANSI/APA PRR 410—2016~~11~~	Standard for Performance-Rated Engineered Wood Rim Boards	2303.1.13
APA PDS—12	Panel Design Specification	2306.1 2314.4.3
APA PDS Supplement 1—14~~12~~	Design and Fabrication of Plywood Curved Panels (revised 2013)	2306.1 2314.4.3
APA PDS Supplement 2—14~~12~~	Design and Fabrication of Plywood-lumber Beams (revised 2013)	

2306.1 2314.4.3

APA PDS Supplement 3—14~~12~~

Design and Fabrication of Plywood Stressed-skin Panels (revised 2013)

2306.1 2314.4.3

APA PDS Supplement 4—14~~12~~

Design and Fabrication of Plywood Sandwich Panels (revised 2013)

2306.1 2314.4.3

APA PDS Supplement 5—16~~12~~

Design and Fabrication of All-plywood Beams (revised 2013)

2306.1 2314.4.3

APA B840

Siding Manufacturing Specifications

2314.4.3

APA L350

Design/Construction Guide Diaphragms and Shearwalls

2314.4.3

APA PRP108

Performance Standards and Policies for Structural-Use Panels

2314.4.3

APA V910

Plywood Folded Plate Laboratory Report 21

2314.4.3

APA PRG 320—2018~~11~~

Standard for Performance-Rated Cross-Laminated Timber

2303.1.4

APA EWCG

Engineered Wood Construction Guide, Form E30

2314.4.3

APA~~EWS~~ R540—13~~12~~

Builders Tips: Proper Storage and Handling of Glulam Beams

2306.1

APA~~EWS~~ S475—16~~07~~

Glued Laminated Beam Design Tables

2306.1

APA~~EWS~~ S560—14~~10~~

Field Notching and Drilling of Glued Laminated Timber Beams

2306.1

APA~~EWS~~ T300—16~~07~~

Glulam Connection Details

2306.1

APA~~EWS~~ X440—17~~08~~

Product Guide-Glulam

2306.1

APA~~EWS~~ X450—18~~01~~

Glulam in Residential Building Construction Guide~~-Western Edition~~

2306.1

S7997

Date Submitted 12/12/2018
Chapter 35
Section 35
Affects HVHZ No
Proponent Bonnie Manley
Attachments No
TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

Summary of Modification

This proposal updates the AISI S230 reference to the 2018 edition.

Rationale

The 2018 editions of the IBC and IRC reference the 2015 edition of AISI S230. The 2015 edition of AISI S230 is based upon ASCE 7-10. With the Florida code cycle happening in 2019, there is an opportunity to adopt the 2018 edition of AISI S230, which is based upon ASCE 7-16. If ASCE 7-16 is chosen as a basis for both the Florida Building Code and Florida Residential Code, it would be appropriate to adopt this latest edition of AISI S230 for coordination.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

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

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

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

No change in cost is anticipated.

Requirements

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

Yes, it does.

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

Yes, it does.

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

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

2nd Comment Period

S7997-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

AISI S230--18~~—07/S3-12 (2012)~~ *Standard for Cold-formed Steel Framing—Prescriptive Method for One- and Two-family Dwellings*, 2018~~2007 with Supplement 3, dated 2012 (Reaffirmed 2012)~~

S8113

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

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

Summary of Modification

Updates the SJI reference documents.

Rationale

This proposal updates the SJI reference documents.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

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

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

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

No change in cost is anticipated.

Requirements

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

Yes, it does.

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

Yes, it does.

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

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

Alternate Language

2nd Comment Period

8113-A3

Proponent Bonnie Manley **Submitted** 5/16/2019 **Attachments** Yes

Rationale

This public comment is one of two that split the original proposal updating the SJI reference documents. This modification updates the references listed in the HVHZ portion (Section 2214) of Chapter 22. These documents were updated in Mod. 8099, which was approved as modified. This comment simply reflects the correct editions in 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.

Alternate Language

2nd Comment Period

8113-A2

Proponent Bonnie Manley **Submitted** 5/16/2019 **Attachments** Yes

Rationale

This public comment splits the update to the SJI documents into two parts. This first part updates the latest SJI standards that are adopted as part of FBC Section 2207. These standards are ANSI developed and adopted in the non-HVHZ portion of the chapter.

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.

2nd Comment Period

S8113-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with the alternate language of this modification.

SJI—17~~10 43~~rd44th Edition Standard Specifications ~~and~~ Load Tables and Weight Tables for Steel Joists and Joist Girders~~, which includes Errata No. 1 and No. 2~~

SJI—18~~13 85~~90 Years of Open Web Steel Joist Construction

...

SJI

SJI 100-15, Standard Specification for K-Series, LH-Series, and DLH-Series Open Web Steel Joists and for Joist Girders, 2015

SJI 200-15 ~~CJ—10~~ Standard Specification for Composite Steel Joists, CJ-series , 2015

~~JG—10 Standard Specification for Joist Girders~~

~~K—10 Standard Specification for Open Web Steel Joists, K-series~~

~~LH/DLH—10 Standard Specification for Longspan Steel Joists, LH-series and Deep Longspan Steel Joists, DLH-series~~

...

SJI

SJI 100-15, Standard Specification for K-Series, LH-Series, and DLH-Series Open Web Steel Joists and for Joist Girders, 2015

SJI 200-15 ~~CJ—10~~ Standard Specification for Composite Steel Joists, CJ-series , 2015

~~JG—10 Standard Specification for Joist Girders~~

~~K—10 Standard Specification for Open Web Steel Joists, K-series~~

~~LH/DLH—10 Standard Specification for Longspan Steel Joists, LH-series and Deep Longspan Steel Joists, DLH-series~~

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SJI—17~~10~~ ~~43rd~~44th Edition Standard Specifications ~~and~~ Load Tables and Weight Tables for Steel Joists and Joist Girders~~, which includes Errata No. 1 and No. 2~~

SJI—18~~13~~ ~~85~~90 Years of Open Web Steel Joist Construction

...

S8394

Date Submitted	12/15/2018	**Section**	35	**Proponent**	Joseph Belcher for AAF
Chapter	35	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **Yes**

Related Modifications

N/A

Summary of Modification

Updates the AAF Guide to Aluminum Construction in High Wind Areas.

Rationale

The AAF is working with Dr. Timothy Reinhold, P.E. to get the AAF Guide updated to comply with ASCE 7-16. The design pressure for screen enclosures of Table 2002.4 are not affected because they are based on wind tunnel testing and the analysis of the wind tunnel data. There will be increases on solid roofs and we are working on completing those updates. Unfortunately, Hurricane Michael took some time and delayed the work. I am going to forward a copy of the AAF to the Structural TAC members and the staff and will provide the updated information during the Public Comment period.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact on cost of enforcement of code as the AAF Guide has been adopted for a number of years.

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

No impact on cost of code compliance for property owners as the AAF Guide has been adopted for a number of years.

Impact to industry relative to the cost of compliance with code

No impact on cost of code compliance to industry as the AAF Guide has been adopted for a number of years. There will be an increase in uplift loads in the 15% range on solid roofs but that is due to changes in ASCE 7-16; not the AAF Guide.

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

No cost impact relative to compliance with the code. No impact on cost of code compliance to small business as the AAF Guide has been adopted for a number of years. There will be an increase in uplift loads in the 15% range on solid roofs but that is due to changes in ASCE 7-16; not the AAF Guide.

Requirements

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

The proposal is connected with the welfare and safety of the public because it updates a construction document to meet the latest design pressures due to the effects of wind.

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

The proposal improves the code because it is updating a prescriptive document to meet the latest design pressures due to the effects of wind.

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

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

Does not degrade the effectiveness of the code

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

Alternate Language

2nd Comment Period

8394-A1

Proponent Joseph Belcher **Submitted** 5/26/2019 **Attachments** Yes

Rationale

The purpose of this Alternate Language Public Comment is to upload the revised AAF Guide to Aluminum Construction in High Wind Areas (2020). All the tables were reviewed by Timothy Reinhold, P.E., Ph.D. and tables affected by the changes to ASCE 7-16 are updated and are in compliance with ASCE 7-16. The design pressure for screen enclosures of Table 2002.4 are not affected because they are based on wind tunnel testing and the analysis of the wind tunnel data. The size of the documents will require delivery by a large file transfer service.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact on the cost of enforcement of code as the AAF Guide to Aluminum Construction in High Wind Areas has been adopted for a number of years.

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

No impact on the cost of code compliance for property owners for screen enclosures with screen roofs. Structures with solid roofs will see an estimated 15% increase in uplift loads and there will be an increase in cost for compliance. The increase in uplift loads is because of changes to ASCE 7-16.

Impact to industry relative to the cost of compliance with code

No impact on the cost of code compliance to the industry for screen enclosures with screen roofs. Changes to ASCE 7-16 increase the uplift loads for solid roofs by 15%. The increased uplift loads on solid roofs will result in an increase in cost.

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

No cost impact relative to compliance with the code. No impact on cost of code compliance to small business as the AAF Guide has been adopted for a number of years. There will be an increase in uplift loads in the 15% range on solid roofs but that is due to changes in ASCE 7-16; not the AAF Guide.

Requirements

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

The proposal relates to the welfare and safety of the public because it updates a construction document to meet the latest design pressures due to the effects of wind.

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

The proposal improves the code because it is updating a prescriptive document to meet the latest design pressures due to the effects of wind.

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

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

Does not degrade the effectiveness of the code

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

Chapter 35 AAF

AAF	Aluminum Association of Florida 3203 Lawton Road #110 Orlando, FL 32803	
Standard Reference Number	Title	Referenced in code section number
AAF- ~~14~~ 20	Guide to Aluminum Construction in High Wind Areas (~~2014~~) (2020).	2002.4.1, 1622.1.2

Chapter 35 AAF

AAF	Aluminum Association of Florida 3203 Lawton Road #110 Orlando, FL 32803	
Standard Reference Number	Title	Referenced in code section number
AAF- ~~14~~ 20	Guide to Aluminum Construction in High Wind Areas (~~2014~~) (2020).	2002.4.1, 1622.1.2

S8111

Date Submitted	12/13/2018	**Section** 101		**Proponent**	Ann Russo5
Chapter	Appendix M	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	No Affirmative Recommendation				
Commission Action	Pending Review				

Comments

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

Related Modifications

M101.1, M101.2, M101.3, M101.4

Summary of Modification

The amendments to Appendix M are necessary because the analysis and structural design aspects of FEMA P-646 (2012) have been superseded by ASCE 7-2016

Rationale

The amendments to Appendix M are necessary because the analysis and structural design aspects of FEMA P-646 (2012), Guidelines for Design of Structures for Vertical Evacuation from Tsunamis, have been superseded by ASCE 7-2016, Minimum Design Loads and Associated Criteria for Buildings and Other Structures. ASCE 7-16 now has a Chapter 6 on tsunami loads and effects, which also includes a set of tsunami design zone maps. As an accredited consensus- based standard, ASCE 7-16 incorporates more recent knowledge that takes precedence over the older FEMA guidelines. In particular, the FEMA guidelines for determining inundation depth, flow speed, and waterborne debris impact forces were found to lack reliability. The proposal updates Appendix M to make it refer to the tsunami evacuation and site planning criteria of P-646-12 and not to its tsunami hazard mapping and structural design guidelines, thereby removing conflicts that would otherwise occur between the two documents. The title of Appendix M is revised because the original title was overly broad; FEMA P646 only concerns tsunami refuge structures.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None expected

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

None expected

Impact to industry relative to the cost of compliance with code

None expected

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

None expected

Requirements

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

Improves options for life safety in affected zones

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

Improves design guidance and Code enforcement where appendix adopted

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

Does not

Does not degrade the effectiveness of the code

Does not

2nd Comment Period

S8111-G1

Proponent Borrone Jeanette **Submitted** 5/21/2019 **Attachments** No

Comment:

I agree with the proposed revision.

2nd Comment Period

S8111-G2

Proponent Michael Savage **Submitted** 5/22/2019 **Attachments** No

Comment:

I agree with the proposed revision.

2nd Comment Period

S8111-G3

Proponent Jennifer Privateer **Submitted** 5/24/2019 **Attachments** No

Comment:

I agree this should be corrected/amended

2nd Comment Period

S8111-G4

Proponent Ann Russo5 **Submitted** 5/24/2019 **Attachments** No

Comment:

The modification was submitted as an abundant caution of conformance to FEMA standards and assurance of coverage for those affected in case there is such an occurance as a Tsunami. Flooding from rogue waves, sometimes classified as Tsunami type, can occur and effect coastal areas of the State and as this is located in an Appendix, it allows those coastal areas which adopt additional requirements guidance and a standard to refer to

2nd Comment Period

S8111-G5

Proponent Harold Barrineau **Submitted** 5/25/2019 **Attachments** No

Comment:

I agree with this modification

Revise as follows:

SECTIONM101
REFUGE STRUCTURES FOR VERTICAL EVACUATION FROMTSUNAMI-GENERATED FLOOD HAZARD

Date Submitted	12/13/2018	**Section**	101.1	**Proponent**	Ann Russo5
Chapter	Appendix M	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

M101, M101.2, M101.3, M101.4

Summary of Modification

The amendments to Appendix M are necessary because the analysis and structural design aspects of FEMA P-646 (2012) have been superseded by ASCE 7-2016

Rationale

The amendments to Appendix M are necessary because the analysis and structural design aspects of FEMA P-646 (2012), Guidelines for Design of Structures for Vertical Evacuation from Tsunamis, have been superseded by ASCE 7-2016, Minimum Design Loads and Associated Criteria for Buildings and Other Structures. ASCE 7-16 now has a Chapter 6 on tsunami loads and effects, which also includes a set of tsunami design zone maps. As an accredited consensus- based standard, ASCE 7-16 incorporates more recent knowledge that takes precedence over the older FEMA guidelines. In particular, the FEMA guidelines for determining inundation depth, flow speed, and waterborne debris impact forces were found to lack reliability. The proposal updates Appendix M to make it refer to the tsunami evacuation and site planning criteria of P-646-12 and not to its tsunami hazard mapping and structural design guidelines, thereby removing conflicts that would otherwise occur between the two documents. The title of Appendix M is revised because the original title was overly broad; FEMA P646 only concerns tsunami refuge structures.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None expected

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

None expected

Impact to industry relative to the cost of compliance with code

None expected

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

None expected

Requirements

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

Improves options for life safety in affected zones

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

Improves design guidance and Code enforcement where appendix adopted

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

Does not

Does not degrade the effectiveness of the code

Does not

2nd Comment Period

S8115-G1

Proponent Borrone Jeanette **Submitted** 5/21/2019 **Attachments** No

Comment:

I agree with the proposed revision.

2nd Comment Period

S8115-G2

Proponent Michael Savage **Submitted** 5/22/2019 **Attachments** No

Comment:

I agree with the proposed revision.

2nd Comment Period

S8115-G3

Proponent	Jennifer Privateer	Submitted	5/24/2019	Attachments	No

Comment:

I agree with revision as proposed

2nd Comment Period

S8115-G4

Proponent	Harold Barrineau	Submitted	5/26/2019	Attachments	No

Comment:

I agree with this modification.

Revise as follows:

~~**M101.1General.**~~

The purpose of this appendix is to provide tsunami ~~regulatory~~ vertical evacuation planning criteria for those coastal communities that have a tsunami hazard ~~and have elected to develop and adopt~~ as shown in ~~a map of their tsunami hazard inundation zone~~ Tsunami Design Zone Map.

S8117

Date Submitted 12/13/2018 | **Section** 101.2 | **Proponent** Ann Russo5
Chapter Appendix M | **Affects HVHZ** No | **Attachments** No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes | **Alternate Language** No

Related Modifications

M101, M101.1, M101.3, M101.4

Summary of Modification

The amendments to Appendix M are necessary because the analysis and structural design aspects of FEMA P-646 (2012) have been superseded by ASCE 7-2016

Rationale

The amendments to Appendix M are necessary because the analysis and structural design aspects of FEMA P-646 (2012), Guidelines for Design of Structures for Vertical Evacuation from Tsunamis, have been superseded by ASCE 7-2016, Minimum Design Loads and Associated Criteria for Buildings and Other Structures. ASCE 7-16 now has a Chapter 6 on tsunami loads and effects, which also includes a set of tsunami design zone maps. As an accredited consensus- based standard, ASCE 7-16 incorporates more recent knowledge that takes precedence over the older FEMA guidelines. In particular, the FEMA guidelines for determining inundation depth, flow speed, and waterborne debris impact forces were found to lack reliability. The proposal updates Appendix M to make it refer to the tsunami evacuation and site planning criteria of P-646-12 and not to its tsunami hazard mapping and structural design guidelines, thereby removing conflicts that would otherwise occur between the two documents. The title of Appendix M is revised because the original title was overly broad; FEMA P646 only concerns tsunami refuge structures.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None expected

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

None expected

Impact to industry relative to the cost of compliance with code

None expected

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

None expected

Requirements

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

Improves options for life safety in affected zones

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

Improves design guidance and Code enforcement where appendix adopted

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

Does not

Does not degrade the effectiveness of the code

Does not

2nd Comment Period

S8117-G1

Proponent Borrone Jeanette | **Submitted** 5/21/2019 | **Attachments** No

Comment:

I agree with the proposed revision.

2nd Comment Period

S8117-G2

Proponent Michael Savage | **Submitted** 5/22/2019 | **Attachments** No

Comment:

I agree with the proposed revision.

2nd Comment Period

S8117-G3

Proponent	Jennifer Privateer	**Submitted**	5/24/2019	**Attachments**	No

Comment:

I agree

2nd Comment Period

S8117-G4

Proponent	Harold Barrineau	**Submitted**	5/26/2019	**Attachments**	No

Comment:

I agree with this modification.

Revise as follows:

M101.2Definitions.

The following words and terms shall, for the purposes of this appendix, have the meanings shown herein. Refer to Chapter 2 of this code for general definitions.

~~**TSUNAMI HAZARD ZONE.** The area vulnerable to being flooded or inundated by a design event tsunami as identified on a community's Tsunami Hazard Zone Map.~~

TSUNAMI HAZARD ~~**HAZARD**~~ **DESIGN ZONE MAP.** ~~A map adopted by the community~~ that designates the extent of inundation by a ~~design event tsunami. This map shall be based on the tsunami inundation map that is developed and provided to a community~~ Maximum Considered Tsunami as defined by ~~either the applicable state agency or the National Atmospheric and Oceanic Administration (NOAA) under the National Tsunami Hazard Mitigation Program, but shall be permitted to utilize a different probability or hazard level~~ Chapter 6 of ASCE 7.

S8118

Date Submitted	12/13/2018	**Section**	101.3	**Proponent**	Ann Russo5
Chapter	Appendix M	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	No Affirmative Recommendation				
Commission Action	Pending Review				

Comments

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

Related Modifications

M101, M101.1, M101.2, M101.4

Summary of Modification

The amendments to Appendix M are necessary because the analysis and structural design aspects of FEMA P-646 (2012) have been superseded by ASCE 7-2016

Rationale

The amendments to Appendix M are necessary because the analysis and structural design aspects of FEMA P-646 (2012), Guidelines for Design of Structures for Vertical Evacuation from Tsunamis, have been superseded by ASCE 7-2016, Minimum Design Loads and Associated Criteria for Buildings and Other Structures. ASCE 7-16 now has a Chapter 6 on tsunami loads and effects, which also includes a set of tsunami design zone maps. As an accredited consensus- based standard, ASCE 7-16 incorporates more recent knowledge that takes precedence over the older FEMA guidelines. In particular, the FEMA guidelines for determining inundation depth, flow speed, and waterborne debris impact forces were found to lack reliability. The proposal updates Appendix M to make it refer to the tsunami evacuation and site planning criteria of P-646-12 and not to its tsunami hazard mapping and structural design guidelines, thereby removing conflicts that would otherwise occur between the two documents. The title of Appendix M is revised because the original title was overly broad; FEMA P646 only concerns tsunami refuge structures.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None expected

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

None expected

Impact to industry relative to the cost of compliance with code

None expected

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

None expected

Requirements

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

Improves options for life safety in affected zones

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

Improves design guidance and Code enforcement where appendix adopted

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

Does not

Does not degrade the effectiveness of the code

Does not

2nd Comment Period

S8118-G2

Proponent Borrone Jeanette **Submitted** 5/21/2019 **Attachments** No

Comment:

I agree with the proposed revision.

2nd Comment Period

S8118-G3

Proponent Michael Savage **Submitted** 5/22/2019 **Attachments** No

Comment:

I agree with the proposed revision.

2nd Comment Period

S8118-G4

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

Revise as follows:

M101.3 Establishment of tsunami ~~hazard~~ design zone.

Where applicable~~, if a community has adopted a~~ the Tsunami ~~Hazard~~ Design Zone Map~~, that map~~ shall ~~be used to establish a community's tsunami hazard zone~~ meet or exceed the inundation limit given by the ASCE 7 Tsunami Design Geodatabase.

S8120

Date Submitted	12/13/2018	**Section**	101.4	**Proponent**	Ann Russo5
Chapter	Appendix M	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	No Affirmative Recommendation				
Commission Action	Pending Review				

Comments

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

Related Modifications

M101, M101.1, M101.2, M101.3

Summary of Modification

The amendments to Appendix M are necessary because the analysis and structural design aspects of FEMA P-646 (2012) have been superseded by ASCE 7-2016

Rationale

The amendments to Appendix M are necessary because the analysis and structural design aspects of FEMA P-646 (2012), Guidelines for Design of Structures for Vertical Evacuation from Tsunamis, have been superseded by ASCE 7-2016, Minimum Design Loads and Associated Criteria for Buildings and Other Structures. ASCE 7-16 now has a Chapter 6 on tsunami loads and effects, which also includes a set of tsunami design zone maps. As an accredited consensus- based standard, ASCE 7-16 incorporates more recent knowledge that takes precedence over the older FEMA guidelines. In particular, the FEMA guidelines for determining inundation depth, flow speed, and waterborne debris impact forces were found to lack reliability. The proposal updates Appendix M to make it refer to the tsunami evacuation and site planning criteria of P-646-12 and not to its tsunami hazard mapping and structural design guidelines, thereby removing conflicts that would otherwise occur between the two documents. The title of Appendix M is revised because the original title was overly broad; FEMA P646 only concerns tsunami refuge structures.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None expected

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

None expected

Impact to industry relative to the cost of compliance with code

None expected

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

None expected

Requirements

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

Improves options for life safety in affected zones

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

Improves design guidance and Code enforcement where appendix adopted

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

Does not

Does not degrade the effectiveness of the code

Does not

2nd Comment Period

S8120-G1

Proponent Borrone Jeanette **Submitted** 5/21/2019 **Attachments** No

Comment:

I agree with the proposed revision.

2nd Comment Period

S8120-G2

Proponent Michael Savage **Submitted** 5/22/2019 **Attachments** No

Comment:

Farinelli

2nd Comment Period

S8120-G3

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

Revise as follows:

M101.4 ~~Construction~~Planning of tsunami vertical evacuation refuge structures within the tsunami ~~hazard~~design zone.

~~Construction of structures designated Risk Categories III and IV as specified under Section 1604.5 shall be prohibited~~ Tsunami Vertical Evacuation Refuge Structures located within a tsunami hazard design zone shall be planned, sited, and developed in general accordance with the planning criteria of FEMA P646 guidelines.

~~**Exceptions:**~~

1. ~~1.A vertical evacuation tsunami refuge shall be permitted to be located in a tsunami hazard zone provided it is constructed in accordance with FEMA P646.~~
2. ~~2.Community critical facilities shall be permitted to be located within the tsunami hazard zone when such a location is necessary to fulfill their function, providing suitable structural and emergency evacuation measures have been incorporated.~~

Exception: These criteria shall not be considered mandatory for evaluation of existing buildings for evacuation planning purposes.

S8391

63

Date Submitted	12/15/2018	**Section**	202	**Proponent**	Kimberly Gilliam
Chapter	2	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

[BS] 1007.1, [BS] 1007.2, [BS] 1007.3.2

Summary of Modification

This proposal clarifies the structural provisions of the FBC, Existing Building with the added definition of "risk category" that is drawn from the FBC, Building.

Rationale

This proposal clarifies the structural provisions of the FBC, Existing Building with the added definition of "risk category" that is drawn from the FBC, Building.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None. The proposed modification is a clarification.

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

None. The proposed modification is a clarification.

Impact to industry relative to the cost of compliance with code

None. The proposed modification is a clarification.

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

None. The proposed modification is a clarification.

Requirements

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

No, the proposed modification is a clarification.

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

Yes, the clarifications provide a better coordinated Code.

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

No, it does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

No, the clarifications provide a better coordinated Code.

2nd Comment Period

S8391-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

Section 202
Add new definition as follows:

RISK CATEGORY. A categorization of buildings and other structures for determination of flood, wind,snow, ice and earthquake loads based on the risk associated with unacceptable performance, as provided in Section 1604.5 of the *Florida Building Code, Building*.

Section 1007

Revise as follows:

[BS]1007.1 ~~Gravity~~ Live loads.

~~Buildings or portions thereof subject to~~ Structural elements carrying tributary live loads from an area with a *change of occupancy* ~~where such change in~~ shall satisfy the ~~nature~~ requirements of ~~occupancy results in higher uniform or concentrated loads based on the Florida Building Code, Building, Table 1607.1 shall comply with the gravity load provisions~~ Section 1607 of the Florida Building Code, Building. Design live loads for areas of new occupancy shall be based on Section 1607 of the *Florida Building Code, Building.* Design live loads for other areas shall be permitted to use previous approved design live loads.

> **Exception:** ~~Structural elements whose stress is not increased by more than 5 percent.~~ Structuralelements whose demand-capacity ratio considering the change of occupancy is not more than 5percent greater than the demand-capacity ratio based on previously approved live loads need notcomply with this section.

[BS]1007.2 Snow and wind loads.

~~Buildings and structures subject to~~ When a *~~change of occupancy~~* ~~where such~~ change ~~in the nature~~ of occupancy results in a structure being assigned to a higher ~~wind or snow~~ risk ~~categories based on~~ category, the structure shall satisfy the requirements of Sections 1608 and 1609 of the Florida Building Code, Building ~~Table 1604.5~~, (High-Velocity Hurricane Zones shall comply with Section 1620) ~~shall be analyzed and shall comply with~~ the ~~applicable wind or snow load provisions of the~~ Florida Building Code, Building~~.~~ for the new risk category.

> **Exception:** ~~Where the new occupancy with a higher risk category is less than or equal to 10 percent of the total building floor area. The cumulative effect of the area of occupancy changes shall be considered for the purposes of this exception.~~ Where the area of the new occupancy is less than 10percent of the building area, compliance with this section is not required. The cumulative effect ofoccupancy changes over time shall be considered.

BACK

Code Change No: EB50-16

Original Proposal

Section: 202 (New), [BS] 1007.1, [BS] 1007.2, [BS] 1007.3.2

Proponent: David Bonowitz, representing National Council of Structural Engineers Associations (dbonowitz@att.net)

THIS CODE CHANGE WILL BE HEARD BY THE IBC-STRUCTURAL CODE COMMITTEE. SEE THE TENTATIVE HEARING ORDER FOR THIS COMMITTEE.

Add new definition as follows:

RISK CATEGORY. A categorization of buildings and other structures for determination of flood, wind, snow, ice and earthquake loads based on the risk associated with unacceptable performance, as provided in Section 1604.5 of the *International Building Code*.

Revise as follows:

[BS] 1007.1 ~~Gravity~~ Live loads. ~~Buildings or portions thereof subject to~~ Structural elements carrying tributrary live loads from an area with a *change of occupancy* ~~where such change in~~ shall satisfy the ~~nature~~ requirements of ~~occupancy results in higher uniform or concentrated loads based on Table 1607.1 of the *International Building Code* shall comply with the gravity load provisions~~ Section 1607 of the *International Building Code*. Design live loads for areas of new occupancy shall be based on Section 1607 of the *International Building Code*. Design live loads for other areas shall be permitted to use previously approved design live loads.

> **Exception:** ~~Structural elements whose stress is not increased by more than 5 percent.~~ Structural elements whose demand-capacity ratio considering the change of occupancy is not more than 5 percent greater than the demand-capacity ratio based on previously approved live loads need not comply with this section.

[BS] 1007.2 Snow and wind loads. ~~Buildings and structures subject to~~ When a ~~*change of occupancy* where such~~ change ~~in the nature~~ of occupancy results in a structure being assigned to a higher ~~wind or snow~~ risk ~~categories based on Table 1604.5~~ category, the structure shall satisfy the requirements of Sections 1608 and 1609 of the *International Building Code* ~~shall be analyzed and shall comply with~~ for the ~~applicable wind or snow load provisions of the *International Building Code*~~ new risk category.

> **Exception:** ~~Where the new occupancy with a higher risk category is less than or equal to 10 percent of the total building floor area. The cumulative effect of the area of occupancy changes shall be considered for the purposes of this exception.~~ Where the area of the new occupancy is less than 10 percent of the building area, compliance with this section is not required. The cumulative effect of occupancy changes over time shall be considered.

[BS] 1007.3.2 Access to Risk Category IV. ~~Where a *change of occupancy* is such~~ Any structure that ~~compliance with Section 1007.3.1 is required and the building is~~ provides operational access to an adjacent structure assigned to Risk Category IV, as the ~~operational access to the building~~ result of a change of occupancy shall ~~not be through an adjacent structure, unless that structure conforms to~~ itself satisfy the requirements of Section 1613 of the *International Building Code* for Risk Category IV structures using *International Building Code*-level seismic forces. Where operational access to the Risk

Category IV structure is less than 10 feet (3048 mm) from either an interior lot line or from another structure, access protection from potential falling debris shall be provided ~~by the owner of the Risk Category IV structure~~.

Reason: This proposal makes editorial changes for consistency, clarity, and simplification. The revisions use the preferred wording and logic approved for other sections in recent code cycles, so as to make the structural provisions more uniformly understandable and enforceable throughout the IEBC. The revisions by section:
202:

- Add the definition of Risk Category, identical to that provided in the IBC, but with reference to IBC Section 1604.5. This makes it unnecessary to refer repeatedly to Table 1604.5 and other rules for mixed occupancies and risk categories.

1007.1:

- Change title to Live loads. The code does not define "gravity loads," which could be construed to include snow and rain. More important, any change in dead load would indicate an alteration, not a change of occupancy.
- There is no need to determine whether the CoO has increased the design live loads. Instead, just design for the new design loads and use the 5% exception where it applies. This is the effect of the current provision in any case. More important, we believe it is not the intent of the code to permit a new occupancy in an under-designed space. Therefore, to compare the Table 1607.1 design loads for the new occupancy and the previous occupancy might not be sufficient if the actual structure was designed originally for much smaller design live loads than Table 1607.1 would requiretoday.
- The allowance for "previously approved design live loads" outside the Change of Occupancy area is consistent with the allowance for alterations in 807.3 and 403.3.1.
- The 5 percent rule is retained, with the comparison clarified.

1007.2:

- Update the wording. There is no longer a "wind or snow risk category."
- Retain the 10% exception for a small area of changed occupancy. Note that 1007.3.1 allows this exception only for a change to RC II or III, not to RC IV. If that is sensible for seismic loads, it is probably also sensible for wind and snow, but this proposal is meant to be editorial only.

1007.3 and 1007.3.1: No changes proposed here. Since the Prescriptive method has a similar seismic provision (but no wind, snow, or live load provision yet), editorial revisions to 1007.3 and 1007.3.1 will be proposed separately in tandem with revisions to 407.4
1007.3.2:

- Clarify the logic.
- Clarify the applicable seismic criteria consistent with similar sections.
- Delete the reference to the owner. The owner or permit applicant is always responsible for compliance; there is nothing about this provision that requires a special charge to the owner.

Cost Impact: Will not increase the cost of construction
This is an editorial change, so there will be no change to construction requirements.

Report of Committee Action Hearings

Committee Action: **Approved as Submitted**

Committee Reason: Agreement with the proponent's reason which indicates this proposal clarifies the structural provisions of the IEBC with the added definition of "risk category" that is drawn from the IBC. These changes, which are primarily editorial, make the IEBC provisions more understandable and enforceable.

Assembly Action: **None**

Final Action Results

EB50-16	**AS**

200

S7840

Date Submitted	12/10/2018	**Section**	303.3	**Proponent**	Steve Szoke
Chapter	3	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

Chapter 35

Summary of Modification

Add reference to ACI 562-19:Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures for evaluation and repair of structural concrete

Rationale

Reason statement and cost impact provided in uploaded file: Mod_7840_Rationale_03-01 FL IEBC Sec 303 Add 562 181210 DRAFT.pdf

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Where used, ACI 562 will provide increased uniformity in the evaluation and repair of existing structural concrete.

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

Where used, ACI 562 improve the understanding and expectations of property owners, contractors, designers, and code officials. Further the code will improve the confidence in the performance of repairs fro all involved in future use of the building, inlcuding the occupants.

Impact to industry relative to the cost of compliance with code

The use of ACI 562 in many cases reduces the cost of repair. See cost impact on reason statement.

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

No increase in cost is anticipated. There is the potential to reduce costs as previously described. See cost impact on reason statement.

Requirements

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

Yes, see the background in the attached reason statement.

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

Yes, See reason statement.

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

There is no discrimination of materials, products, methods, or systems. Building code still allow for alternative means and methods.

Does not degrade the effectiveness of the code

Improves the effectiveness of the code and is expected to be especially beneficial where degradation to concrete is common, such as marine environments and structures exposed to salt air and moisture.

2nd Comment Period

S7840-G6

Proponent Steve Szoke **Submitted** 5/22/2019 **Attachments** Yes

Comment:

The American Concrete Institute recommends approval as submitted. ACI 562-19 Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures is now in print and available. ACI stands on its previous reason statements.

1st Comment Period History

S7840-G1

Proponent Hany Jawaheri Zadeh **Submitted** 2/15/2019 **Attachments** Yes

Comment:

Please see the attached letter.
Thanks.

1st Comment Period History

S7840-G2

Proponent	Garth Fallis	Submitted	2/16/2019	Attachments	Yes

Comment:

Vector Corrosion Services Inc. recommends ACI 562 Repair code to be adopted into Florida building code.

1st Comment Period History

S7840-G3

Proponent	Garth Fallis	Submitted	2/16/2019	Attachments	Yes

Comment:

Vector Construction Inc. fully recommends and supports the adoption of the ACI 562 repair code into the building code of Florida.

1st Comment Period History

S7840-G4

Proponent	Ball Chris	Submitted	2/16/2019	Attachments	Yes

Comment:

NDT Corporation supports the adoption of the ACI 562 Repair Code into Florida Building Code.

1st Comment Period History

S7840-G5

Proponent	Ball Chris	Submitted	2/16/2019	Attachments	Yes

Comment:

Vector Corrosion Technologies Inc. fully supports the adoption of ACI 562 Repair Code into Florida Building Code.

301.1.3 Performance compliance method.

Repairs, *alterations*, *additions*, changes in occupancy and relocated buildings complying with Chapter 14 of this code shall be considered in compliance with the provisions of this code.

301.1.4 Concrete evaluation and design procedures.

Evaluation and design of structural concrete in compliance with ACI 562 shall be permitted.

Exception: ACI 562 shall not be used to comply with provisions of this code for seismic evaluation and design procedures.

[BS]**301.1.45 Seismic evaluation and design procedures.**

The seismic evaluation and design shall be based on the procedures specified in the Florida Building Code, Building or ASCE 41. The procedures contained in Appendix A of this code shall be permitted to be used as specified in Section 301.1.4.2.

Add reference to **Chapter 16**

ACI
Concrete Institute
Country Club Drive
Hills, MI 48331
ACI 562-19: Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concr
301.1.4

Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures (ACI 562-19) and Commentary

An ACI Standard

Reported by ACI Committee 562

Keith E. Kesner, Chair
Kevin Conroy, Secretary

Voting Members

Tarek Alkhrdaji
F. Michael Bartlett
Randal M. Beard
Eric L. Edelson
Garth J. Fallis
Paul E. Gaudette
Susan Isble
Gaur Johnson
Lawrence F. Kahn
Carl J. Larosche
Ming Liu
John S. Lund
Marjorie M. Lynch
Antonio Nanni
Guillermo Alberto Riveros
Constadino Sirakis
Kyle D. Stanish
Gene R. Stevens
J. Gustavo Tumialan
David W. Whitmore

Consulting Members

James Peter Barlow
Peter Emmons
Fred R. Goodwin
Paul L. Kelley
Tracy D. Marcotte
Jay H. Paul

Subcommittee Members

Jared Brewe
Jeremiah D. Fasl
Kip Gatto
Anton Gueorguiev
Patrick D. Martin
Timothy M. Montgomery
Jose Pacheco

ACI 562-19, "Code Requirements for Assessment, Repair and Rehabilitation of Existing Concrete Structures," was developed to provide design professionals involved in the assessment of existing concrete structures a code for the assessment of the damage and deterioration, and the design of appropriate repair and rehabilitation strategies. The code provides minimum requirements for assessment, repair, and rehabilitation of existing structural concrete buildings, members, systems and where applicable, nonbuilding structures. ACI 562-19 was specifically developed to work with the International Existing Building code (IEBC) or to be adopted as a stand-alone code.

Keywords: assessment; bond; damage; durability; evaluation; existing structure; fiber-reinforced polymer (FRP); interface bond; licensed design professional; maintenance; rehabilitation; reliability; repair; strengthening; unsafe.

CONTENTS

Chapter 7—Design of structural repairs

7.1—General

7.2—Strength and serviceability

7.3—Behavior of repaired systems

7.4—Interface bond of cementitious repair materials

7.5—Materials

7.6—Design and detailing considerations

7.7—Repair using supplemental post-tensioning

7.8—Repair using fiber-reinforced polymer (FRP) composites

7.9—Performance under fire and elevated temperatures

Chapter 8—Durability

8.1—General

8.2—Cover

8.3—Cracks

8.4—Corrosion and deterioration of reinforcement and metallic embedments

8.5—Surface treatments and coatings

Chapter 9—Construction

9.1—General

9.2—Stability and temporary shoring requirements

9.3—Temporary conditions

9.4—Environmental issues

Summary of Revisions

Modifications were largely based upon comments received informally after the publication of ACI 562-16.

Major Revisions

The major changes are as follows:

(a) Text was added to simplify use of new materials that have the equivalent of an ICC-ES evaluation report in Chapter 1.

(b) The requirements for the basis of design report were simplified in Chapter 1.

(c) Clarified requirements related to detailing of existing reinforcing steel in Chapter

(d) The commentary in Chapter 8 was updated to include a listing of exposure categories that may affect durability.

Minor Revisions

The minor revisions were aimed at improving the current text to improve readability and integration with other documents. An effort was also made for consistency in terminology with ASCE and other organizations.

PREFACE

This code provides minimum requirements for assessment, repair, and rehabilitation of existing structural concrete buildings, members, systems and where applicable, nonbuilding structures. This code was developed by an ANSI-approved consensus process. This code can supplement the International Existing Building Code (IEBC), supplement the code governing existing structures of a local jurisdictional authority, or act as a stand-alone code in a locality that has not adopted an existing-building code. When this code is used as a stand-alone code, Appendix A is used in place of Chapter 4.

This code provides minimum requirements for assessment, design and construction, or implementation of repairs and rehabilitation, including quality assurance requirements, for structural concrete in service. This code has no legal status unless it is adopted by the jurisdictional authority. Where the code has not been adopted, it serves as a standard to provide minimum requirements for assessment, and design and construction of repair and rehabilitation of existing structural concrete. ACI 318 provides minimum requirements for the materials, design, and detailing of structural concrete buildings and, where applicable, nonbuilding structures, and for new construction within existing structures where noted herein.

Key changes from ACI 562-16 to ACI 562-19 include:

(a) Text was added to simplify use of new materials that have the equivalent of an ICC-ES evaluation report in Chapter 1.

(b) The requirements for the basis of design report were simplified in Chapter 1.

(c) Requirements related to detailing of existing reinforcing steel in Chapter 4 have been clarified.

(d) The commentary in Chapter 8 was updated to include a listing of exposure categories that may affect durability.

CHAPTER 1—GENERAL REQUIREMENTS

1.1—General

1.1.1 ACI 562, “Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures,” is hereafter referred to as “this code.”

1.1.2 Scope—This code shall apply to assessment, repair, and rehabilitation of existing concrete structures as:

(1) A code supplementing the International Existing Building Code (IEBC)

(2) As part of a locally adopted code governing existing buildings or structures

(3) Or as a stand-alone code for existing concrete structures

1.1.2C *This code defines assessment, design, construction and durability requirements for repair and rehabilitation of existing concrete structures. Throughout this code, the term “structure” means an existing building, member, system, and, where applicable, nonbuilding structures where the construction is concrete or mixed construction with concrete and other materials.*

Chapter 4 provides assessment, repair, and rehabilitation criteria if this code is used as a supplement to the International Existing Building Code (IEBC) for concrete members and systems.

Appendix A provides assessment, repair, and rehabilitation criteria when this code is used as a stand-alone code in a jurisdiction without a code governing existing structures.

1.1.3 The intent of this code is to safeguard the public by providing minimum structural requirements for existing structural concrete members, systems, and buildings.

1.1.3C *The intent of this code is to address the safety of existing structures through assessment requirements that demonstrate an approximation of the structural reliability using demand-capacity ratio limits of Chapter 4 or Appendix A and, if necessary as determined by the assessment, increase the structural capacity by repair or rehabilitation.*

Unless prohibited by the jurisdictional authority, if an existing structure is shown to be unsafe in accordance with 4.3 or A.3, the structure should be rehabilitated using 4.3 or A.3.

Using the demand-capacity ratio limits of 4.5.1 or A.5.1, repair of the existing structural concrete to its predeteriorated state is permitted based on material properties specified in the original construction (per Chapter 6), and substantiated engineering principles of the original design. Where requirements of the original building code are appreciably changed in the current building code, the licensed design professional may consider using 4.5.2 or A.5.2.

Beyond the restoration assessment requirements of 4.5.1 and 4.5.3 or A.5.1 and A.5.3, the structural reliability principles of 4.5.2 or A.5.2 are permitted. These alternative requirements provide acceptable safety if the current building code demand exceeds the original building code demand or if the regulations of the original building code provide an unacceptable level of structural reliability.

1.1.4 All references in this code to the licensed design professional shall be understood to mean persons who possess the knowledge, judgment, and skills to interpret and properly use this code and are licensed in the jurisdiction where this code is being used. The licensed design professional for the project is responsible for, and in charge of, the assessment or rehabilitation design, or both.

1.1.5 The requirements of this code are provided using strength design provisions for demands and capacities, unless otherwise noted.

1.1.5C *When this code permits the original building code regulations to be used and that code uses allowable stress design: those provisions should be substituted for strength design as noted in 4.5.3 or A.5.3; the licensed design professional is not required to use, but should consider using strength design provisions of this code as a check in the assessment of existing structures originally designed with allowable stress methods; and the licensed design professional may judge when the* *original building code is to be replaced by the current building code to provide structurally adequate resistance and reliability.*

1.2—Criteria for the assessment and design of repair and rehabilitation of existing concrete structures

1.2.1 The "existing building code" refers to the code adopted by a jurisdiction that regulates existing buildings or structures.

1.2.1C *The code governing existing buildings in the United States is commonly the IEBC developed by the International Code Council (ICC). The IEBC provides regulations for evaluations of damage and the limit for damage to be repaired using the original building code. If this limit is exceeded or if the licensed design professional judges the structural safety to be unacceptable based on rational engineering principles, rehabilitation is necessary in accordance with the requirements of the current building code.*

1.2.2 The "current building code" refers to the general building code adopted by a jurisdiction that presently regulates new building design and construction.

1.2.2C *The current building code establishes the design and construction regulations for new construction. Strength design regulations of the current building code include:*

(a) Required strengths computed using combinations of factored loads (strength design demands)

(b) Design strengths (capacities) based on testing of materials, members, and systems

(c) Analytical methods used to calculate member and system capacity

(d) Strength reduction factors, which have been established to be consistent with reliability indices used with the strength design demands

The load factors and strength reduction factors in the current building code are obtained through rational design code calibration procedures to achieve the targeted reliability indices which produce historically acceptable structural safety for new structures. The targeted reliability indices are generally based on past structural behavior, engineering experiences, costs and consequences of loss, among other criteria. The resulting demand-capacity ratios for new structures provide the limits that are not to be exceeded if designing new construction, but these demand-capacity ratio limits need not to be the same as those for existing structures as noted in sections 4.5.2 and A.5.2.

The general building code in the United States is usually based on the International Building Code (IBC) published by the ICC. Prior to 2015, Chapter 34 of the IBC included provisions for existing structures. For the design and construction of new concrete structures, the IBC and most other older general building codes often reference ACI 318, Building Code Requirements for Structural Concrete and Commentary, with exceptions and additions.

1.2.3 The "original building code" refers to the general building code applied by the jurisdictional authority to the structure in question at the time the existing structure was permitted for construction.

1.2.3C *This definition of "original building code" is consistent with the building code in effect at the time of original permitted construction per the IEBC. In assessing existing structures, the licensed design professional may need to consider changes in the codes enforced by the local jurisdictional authority for the structure from the time of the original design through the time of the completion of construction.*

Reference to design requirements of the original building code should include: demands determined using either nominal loads, load factors, and load combinations of the original *building code, or using allowable design loads and load combinations of the original building code; capacities determined using either strength design and reinforcement detailing provisions, and strength reduction factors of the original building code or using allowable stress design provisions of the original building code; and construction materials. Requirements for concrete design and construction include previous versions of ACI 318, concrete codes predating ACI 318, or concrete provisions within the original building code. A structural assessment using allowable stress design provisions of the original building code should be coupled with an evaluation using current standards or the strength design and reinforcement detailing provisions of this code to increase the understanding of structural behavior and to judge if more consistent and safe remedial recommendations are necessary using the current building code.*

For a structure constructed prior to the adoption of a building code, the licensed design professional should research available standards and practices in effect at the time of construction. The Historic American Engineering Record, a program of the United States Park Service, has information on construction and preservation of historic structures (https://www.nps.gov/hdp/haer/).

1.2.4 Design-basis code criteria

1.2.4.1 The types of design-basis code criteria used in this code are assessment criteria and design-basis criteria. The design-basis code criteria of this code shall be used to assess and design rehabilitations of existing members, systems, and structures.

1.2.4.1C *The design-basis code criteria include requirements for assessment of the existing structure and for design when repairs are required based upon assessment results.*

If a jurisdiction has adopted the IEBC, then the design-basis code criteria are based on the IEBC with supplemental requirements of this code for unsafe structural conditions, damage less than *substantial structural damage, deterioration of concrete and reinforcement, faulty construction, serviceability issues, and durability of existing concrete.*

For substantial structural damage, additions, alterations, and changes in occupancy, the IEBC establishes limits to which an assessment and design of repair and rehabilitation can occur in accordance with the original building code. Above these limits, an assessment and design of the repair and rehabilitation is in accordance with the current building code. Current and original building code provisions are supplemented by this code to address existing concrete members, systems, and structures.

Appendix A applies if a jurisdiction has not adopted the IEBC and has adopted this code. Appendix A of this code can provide design-basis code criteria for unsafe structural conditions, substantial structural damage, damage less than substantial structural damage, deterioration of concrete and reinforcement, faulty construction, additions, alternations, and changes in occupancy, serviceability issues, and durability of existing concrete.

1.2.4.2 Assessment and design-basis criteria and the requirements for applying these criteria are provided in Chapter 4 and Appendix A. Chapter 4 applies if a jurisdiction has adopted the International Existing Building Code (IEBC) as the existing building code. Appendix A applies if a jurisdiction has not adopted the IEBC or if a jurisdiction has adopted this code.

1.2.4.2C Classifying the rehabilitation category using criteria and requirements of Chapter 4 or Appendix A defines the design-basis criteria, which is used to design the repair or rehabilitation work.

1.2.4.3 Assessment criteria shall be used to classify the rehabilitation work and to establish the design-basis criteria.

1.2.4.3.1 It shall be permitted to use the current building code as the assessment criteria for all existing structures.

1.2.4.4 Design-basis criteria shall be used to establish the applicable building code for repair and rehabilitation design.

1.2.4.5 The current building code shall be the design basis code for new members and for connection of new members to existing structures.

1.3—Applicability of this code

1.3.1 This code is applicable when performing an assessment, repair or rehabilitation design and remedial construction of the structural components of existing concrete structures, including buildings and nonbuilding structures.

***1.3.1C** Existing concrete structures may require an assessment, repair or rehabilitation design for considerations beyond the minimum requirements of this code.*

Nonbuilding concrete structures can include, but are not limited to arches, tanks, reservoirs, bins and silos, blast- and impact-resistant structures, and chimneys.

1.3.2 Considerations beyond the minimum requirements of this code, such as those for progressive collapse resistance, redundancy, or integrity provisions are permitted. The licensed design professional is permitted to require assessment, design, construction, and quality assurance activities that exceed the minimum requirements of this code. Regulations of the current building code need not be exceeded when assessing, designing repair and rehabilitation work, or installing remedial work of existing structures.

1.3.3 Foundations

1.3.3.1 This code shall apply to the assessment and repair or rehabilitation of existing structural concrete foundation members.

1.3.3.1C *Foundation members and systems should include those constructed using plain or reinforced concrete including but not limited to spread footings, mat foundations, concrete piles, drilled piers, grade beams, pile and pier caps, and caissons embedded in the ground. The design and installation of new pilings fully embedded in the ground are regulated by the current building code. For repair of existing foundation members and systems, the provisions of this code apply if not in conflict with the code governing existing building. For the portions of concrete piling in air or water, or in soil not capable of providing adequate lateral restraint throughout the piling to prevent buckling, the provisions of this code govern.*

1.3.4 Soil-supported slabs

1.3.4.1 This code shall apply to the assessment and repair or rehabilitation of soil-supported structural slabs that transmit vertical loads or lateral forces from the structure to the soil.

1.3.5 Composite members

1.3.5.1 This code shall apply to the assessment and repair or rehabilitation of the concrete portions of composite members.

1.3.6 Precast and prestressed concrete

1.3.6.1 This code shall apply to the assessment and repair or rehabilitation of structural precast and prestressed concrete members, systems, and connections, and cladding transmitting lateral loads to diaphragms or bracing members.

1.3.7 Nonstructural concrete

1.3.7.1 This code is not intended for repair of nonstructural concrete or for aesthetic improvements, except if failure of such repairs would result in an unsafe condition.

1.3.7.1C *Where nonstructural concrete requires repair, that repair is not required to comply with or satisfy the requirements of this code. The licensed design professional designing repairs to nonstructural concrete should consider the consequence of repair failure to determine if there are provisions of this code that are applicable.*

1.3.8 Seismic resistance

1.3.8.1 Evaluation of seismic resistance and rehabilitation design shall be in accordance with the code governing existing buildings if one has been adopted or this code if a code governing existing buildings has not been adopted. If using this code for evaluation of seismic resistance and rehabilitation design, ASCE/SEI 41 shall apply.

1.3.8.1C *Provisions in Chapter 10 of ASCE/SEI 41 are based on ACI 369.1-17, which provides specific guidance on evaluation, repair and rehabilitation for existing concrete structures.*

1.3.8.2 If rehabilitation for seismic resistance is not required by the code governing existing buildings or this code, voluntary retrofit for seismic resistance shall be permitted. IEBC shall apply if the IEBC is used with this code for voluntary retrofit of seismic resistance. When this code is used without a code governing existing buildings, the licensed design professional shall use the current building code supplemented by ASCE/SEI 41 and ASCE/SEI 7 to design seismic retrofits.

1.3.8.2C *Conditions for evaluation of seismic resistance and design of retrofits are provided in Chapter 3 of ACI 369R, Chapter A2 of Appendix A of IEBC, and ASCE/SEI 41.*

Critical conditions requiring engineering review include, but are not limited to: irregular building configurations; nonductile or strong-beam-weak-column frames; and anchorage of walls to diaphragms. Significant improvements to the seismic resistance of a building can be made using *repair techniques that provide less than those detailing and reinforcement methods required for new construction. As an example, providing additional reinforcement to confine concrete in flexural hinging regions will increase the energy dissipation and seismic performance even though the amount of confinement reinforcement may not satisfy the confinement requirements for new structures (Kahn 1980; Priestley et al. 1996; Harris and Stevens 1991). Visual Screening for Potential Seismic Hazards (FEMA P-154), Mitigation of Nonductile Concrete Buildings (ATC-78 Project), Seismic Performance Assessment of Buildings (ATC-58), and Quantification of Building Seismic Performance Factors (FEMA P-695 Report) Identification and Mitigation of Nonductile Concrete Buildings (ATC-78-1) address seismic assessment and resistance in existing concrete structures.*

Components of the seismic-force-resisting system that require strength and ductility should be identified. Force-controlled (nonductile) action is acceptable for some classifications of components of the seismic-force-resisting system (ASCE/SEI 41). The strength requirement of this code, Section 7.1 is applicable to these force-controlled components. ASCE/SEI 41 and ACI 369R provide information on rehabilitation for seismic resistance. Seismic-resisting components requiring energy-dissipating capability should maintain the ability to dissipate energy after repair. Design and detailing requirements for seismic resistance of cast-in-place or precast concrete structures are addressed in ACI 318 and 369R.

1.4—Administration

1.4.1 Whenever this code is in conflict with the regulations of the jurisdictional authority or code governing existing buildings, the jurisdictional authority or code governing existing buildings shall govern.

1.4.2 Whenever this code is in conflict with requirements in other referenced standards, this code shall govern.

1.4.3 Approval of special systems of design or construction—

Systems that are approved by the jurisdictional authority through alternative means and methods clauses in the building design-basis code shall be permitted.

1.4.3C *New methods of design, new materials, and new uses of materials for repair and rehabilitation usually undergo a period of development before being specifically covered in a code. Hence, good systems or components might be excluded from use by implication if means are not available to obtain acceptance. For systems considered under this section, specific tests, load factors, strength reduction factors, deflection limits, and other pertinent requirements should be set by the local jurisdictional authority and should be consistent with the intent of this code. Provisions of this section do not apply to model analysis used to supplement calculations or to strength evaluation of existing structures.*

1.4.4 Materials that are evaluated in a process equivalent to the requirements of the IBC shall be used in accordance with the requirements of the written evaluation report for the material. Material use shall satisfy requirements of this code.

1.4.4C *The IBC (Section 1703 in IBC 2018) includes provisions for approval of alternate materials in new construction. The approval process requires the evaluation to be completed by an approved agency, and the material properties and use requirements be summarized in a written evaluation report. The same process may be used for materials in repair applications, provided* *the materials satisfy the provisions of this code. This process is intended to allow for use of new materials and new classes of materials that do not have approved design or material standards.*

1.5—Responsibilities of the licensed design professional

1.5.1 The licensed design professional for the project is responsible for 1) assessing; 2) designing, detailing, and specifying the work proposed and material requirements; 3) establishing requirements to maintain load paths for the work proposed; and 4) preparing construction documents of the work proposed and specifying a quality assurance program. Construction documents shall indicate the location, nature, and extent of the work proposed.

1.5.1C *During the assessment part of the investigation, the licensed design professional should request that the owner provide all available information regarding the condition of the building, plans, previous engineering reports, disclose the presence of any known hazardous materials in the work area, and any other pertinent information to the parties involved in the work. This information may require that remedial measures be taken before or during the construction process and should be considered in the scope of work.*

1.5.2 Unsafe structural conditions—The licensed design professional for the project shall report observations of exposed structural defects in the existing construction within the work area representing obvious unsafe structural conditions requiring immediate attention to the owner and appropriate authorities.

1.5.2C *During investigation or repair construction, unsafe structural conditions in the work area may be revealed. To protect the public safety, an observed unsafe structural condition should be reported to the contractor, owner, or jurisdictional authority to initiate mitigation of the condition. Mitigation may include temporary shoring or construction as part of the remedial work.*

1.5.3 The licensed design professional for the project shall document the basis of design. The basis of design shall address rehabilitation categories and repair construction within the work area for each structural element and include:

(a) A description of the building,

(b) Modifications such as additions, alterations, or changes in occupancy

(c) Shoring needs

(d) Quality assurance and quality control (QA/QC) requirements

(e) Conditions and details of the proposed rehabilitation work

(f) Known history of concrete repairs and rehabilitations

(g) Assessment criteria and findings

(h) Repair material parameters

1.5.3C *The basis of design provides a summary of the assessment of the existing structure, and a summary of the construction documents from original construction or prior rehabilitation used in the developing the basis of design. The basis of design can be documented in a written report or included in construction documents. Information on some structures may be unavailable or unnecessary if strengthening is not required and should be so documented in the basis of design. The licensed design professional should review requirements of the jurisdictional authority to determine the information to include in the basis of design documentation and filing requirements for the basis of design.*

Additional materials that may be documented in the basis of design include:

(a) Detailed building description, including age of construction, structural systems, identified original building code, and past and current uses

(b) Documentation of unsafe structural conditions in the work area of the structure determined in the assessment

(c) Documentation of substantial structural damage in the work area

(d) Members and systems of the work area requiring increase in capacity beyond the demand of the original building code

(e) Conditions and details of the proposed rehabilitation work

(f) Past history of concrete repairs and rehabilitations

(g) Assessment criteria and findings

(h) Design-basis code criteria and basis of rehabilitation design

(i) Material selection parameters

(j) Shoring requirements such as loads and spacing of shoring members

(k) Quality assurance and quality control (QA/QC) requirements

(l) Types and frequency of future inspection

(m) Types and frequency of future maintenance

(n) Recommendations to address serviceability conditions as discussed in Section 6.6

A maintenance protocol that addresses project-specific conditions provides the most effective method to ensure durability and should be established as part of the repair or rehabilitation design that includes inspections and period of time between inspections, after completion of the repair installation. Maintenance and frequent preventative approaches that occur early in the service life of the structure generally result in improved service life with less interruption and a lower life-cycle cost (Tuutti 1980; ACI 365.1R). Recommendations should be provided to the Owner on inspection and maintenance to be undertaken during the remaining design service life of the repair material or the repaired part of the structure.

A maintenance protocol should be provided in the basis of design, or in as-built or close-out documents. Maintenance of the repair can be incorporated in the instruction manuals from the licensed design professional, contractor, or product manufacturers. Documents and records of observations, inspections and tests should be provided to the owner as necessary for future work.

1.6—Construction documents

1.6.1 The construction documents for rehabilitation work proposed shall provide sufficient detail and clarity to convey the location, nature and extent of the work, and the necessary information to perform the work in conformance with the requirements of this code and the local jurisdictional authority. Specifications shall require that materials used for repair and rehabilitation construction satisfy this code and governing regulatory requirements at the time the work is implemented.

1.6.1C *As necessary, the construction documents should indicate:*

(a) Name and date of issue of the building code and supplements to which the assessment, repairs, or rehabilitation conforms

(b) Design basis code criteria used for conditions addressed by the documents

(c) Design assumptions and construction requirements including specified properties of existing and remedial materials used for the project and the strength requirements at stated ages or stages of the construction

(d) Details, locations and notes indicating the size, configuration, reinforcement, anchors, repair materials, preparation requirements, and other pertinent information to implement the repairs, strengthening, or rehabilitation of the structure

(e) Magnitude and location of prestressing forces

(f) Anchor details for prestressing reinforcement

(g) Development length of reinforcement and length of lap splices

(h) Type and location of mechanical or welded splices of reinforcement

(i) Shoring or bracing criteria necessary before, during, and at completion of the assessment, repair, or rehabilitation projects

(j) Quality assurance program including specific inspections and testing requirements

1.6.2 Calculations pertinent to design shall be filed with the construction documents if required by the jurisdictional authority. Scale-model testing and analysis shall be permitted to supplement calculations.

1.6.2C *Analyses and designs should include calculations, evaluation and design assumptions. If computer-based analyses and designs, such as finite element methods are used, they should include input, and computer-generated output.*

1.6.3 The licensed design professional shall provide the owner with copies of the basis of design report, assessment reports, project documents, field reports, and other project documents produced by the licensed design professional in addition to documenting the location of the completed repairs to the extent of the licensed design professional's contractual obligations.

1.6.3C *Documentation of the project and repairs that have been carried out, including structural observations, inspection reports by others, test results, and recommendations on inspection and maintenance to be undertaken during the remaining design service life of the repaired part of the concrete structure, should be provided to the owner. The extent and type of quality assurance records should include those required in the construction documents. It is good practice for the owner to keep documentation of repairs, inspections, testing, monitoring, and investigations for future reference.*

1.7—Preliminary assessment

1.7.1 Preliminary assessment of an existing structure shall include investigation and review of the structure, plans, construction data, reports, local jurisdictional codes, and other available documents of the existing structure. Existing in-place conditions shall be visually or otherwise investigated to verify existing geometry and structural conditions.

1.7.1C *The goal of the preliminary assessment is to examine available information about the structure within the work area, and to make an initial determination of its adequacy to withstand in-place environmental conditions and design loads. The results of the preliminary assessment should be used to make decisions regarding the current in-place condition, need for additional information, work items necessary as part of the assessment, possible rehabilitation design and construction work to consider, and if there is a need for temporary shoring for safety of the existing structure. The preliminary assessment results should be updated as additional data regarding the examined structure become available.*

The licensed design professional may determine that 4.6 or A.6 applies in a preliminary assessment based on engineering judgment and without analysis if all of the following are confirmed:

(a) Historical performance of the structure and visual observation of the structural condition of members and systems indicate acceptable behavior precluding assessment by 4.3 or A.3

(b) Review of plans and observation of current structural conditions indicate damage or deterioration of the structure below the level requiring assessment by 4.4 and 4.5 or A.4 and A.5

(c) Modifications for additions, alterations, and changes in occupancy are not planned.

Repairs are permitted that address durability and serviceability of 4.6 or A.6 without analyzing members and systems and checking the demand-capacity ratio limits of 4.3 through 4.5 or A.3 *through A.5 if the structure is determined to be structurally acceptable. Structural performance should be considered acceptable if past and present performance has been satisfactory and observations do not indicate structural distress beyond levels expected.*

The extent of damage or deterioration should be limited and the licensed design professional should not have a concern about the capacity of the structure if repairs are completed using the provisions of 4.6 with verifying the demand to capacity limits of 4.4 and 4.5 or A.4 and A.5.

1.7.2 The preliminary assessment shall determine if visibly unsafe structural conditions are present, and shall report these conditions in accordance with 1.5.2 and 1.5.3.

1.7.2C *Unsafe structural conditions may require the owner to install shoring, limit access, or take other measures to mitigate these conditions.*

1.7.3 For the purpose of performing a preliminary assessment, it is permitted to use the criteria of the original or current building code or assessment criteria of Chapter 4 or Appendix A.

1.7.3C *The assumed preliminary assessment criteria should be substantiated or modified in accordance with the assessment details of Chapter 6.*

1.7.4 The in-place strength of the existing structure shall be determined considering in-place geometric dimensions and material properties including effects of material deterioration and other deficiencies. If material properties are not immediately available, a preliminary assessment shall be completed using material properties as described in Chapter 6.

1.7.4C *When required as a part of the preliminary assessment, strength calculations should be based on in-place conditions and should include an assessment of the loss of strength due to deterioration mechanisms. Guidelines for assessing in-place conditions include ACI 201.2R, ACI 214.4R, ACI 228.1R, ACI 228.2R, ACI 364.1R, ACI 437.1R, FEMA P-58, FEMA P-154, FEMA 306, FEMA 307, ASCE/SEI 11, ASCE/SEI 41, ATC-20, ATC-45, and ATC-78 as well as The*

Concrete Society Technical Report 68 (2008). When material test results are initially unavailable, historical properties based on typical values used at the time of construction can be used in preliminary evaluation. If available, material properties from construction documents can also be used in a preliminary evaluation.

The assessment of existing structures should initially focus on critical gravity-load-resisting members such as columns, walls, and members that are expected to have limited ductility, followed by an assessment of the lateral-load-resisting system.

Assessing fire damage and other deterioration mechanisms that result in a change in material properties (such as compressive strength or modulus of elasticity) should include an evaluation of the effect of the damage on the material properties and the impact of the damage on the performance of the existing structure. Examples of deterioration mechanisms that result in possible changes in material properties include corrosion of steel reinforcement, thermal damage, concrete reactions such as alkali-aggregate, and freezing and thawing.

Deficiencies to be documented include cracking, spalls, member deflection, cross-section dimensions different than specified on the original construction drawings, and construction tolerances exceeding those permitted under the original building code.

1.7.5 A structural assessment in accordance with Chapter 6 shall be performed when a member or structure exhibits damage, displacement, deterioration, structural deficiencies, or behavior is observed during the preliminary assessment that are unexpected or inconsistent with available design and construction documents or code requirements for existing structures in effect at the time of construction.

1.7.5C *The preliminary assessment is generally the first portion of the work necessary to determine the rehabilitation category. Based upon preliminary assessment results, a structural* *assessment may be required to determine the extent of damage or if unsafe structural conditions are present. However, in some cases the licensed design professional may deem that a structural assessment is not required based on judgement in accordance with 1.7.1 and 1.7.1C.*

CHAPTER 2—NOTATION AND DEFINITIONS

This chapter defines notation and terminology used in this code.

c = depth of neutral axis, in.

D = dead load acting on the structure

d_t = distance from extreme compression fiber to centroid of extreme tension reinforcement, in.

$\overline{f}_c$ = average core strength modified to account for the diameter and moisture condition of the core, psi

f_c' = specified concrete compressive strength, psi

f_{ceq} = equivalent specified concrete strength used for evaluation, psi

f_y = specified yield strength of steel reinforcement, psi

$\overline{f}_y$ = average yield strength value for steel reinforcement, psi

f_{yeq} = equivalent yield strength of steel reinforcement used for evaluation, psi

k_c = coefficient of variation modification factor for concrete testing sample sizes

k_s = coefficient of variation modification factor for steel testing sample sizes

L = live load acting on the structure

l_t = span of member under load test and taken as the smaller of: (a) distance between centers of supports; and (b) clear distance between supports plus thickness h of member; for a cantilever, it shall be taken as twice the distance from face of support to cantilever end, in.

n = number of sample tests

R_a = service load capacity of structural member, system, or connection including effects of damage, deterioration of concrete and reinforcement, and faulty construction determined using allowable stresses according to the original building code.

R_n = nominal capacity of structural member, system, or connection excluding the effects of damage, deterioration of concrete and reinforcement, and faulty construction

R_{cn} = current in-place nominal capacity of structural member, system, or connection including the effects of damage, deterioration of concrete and reinforcement, and faulty construction

R_{ex} = nominal resistance of the structure during an extraordinary (that is, low-probability) event computed using the probable material properties

S = snow load acting on the structure

T_g = glass transition temperature, °F

U = demand using nominal loads and factored load combinations for strength design provisions (LRFD)

U_c = demand using nominal loads of the current building code and factored load combinations of ASCE/SEI 7 for strength design provisions (LRFD)

U_o = demand using nominal loads and factored load combinations of the original building code for strength design provisions (LRFD)

U_o^* = demand using nominal loads of the original building code and factored load combinations of ASCE/SEI 7 for strength design provisions (LRFD)

U_s = demand using service loads of the original building code and load combinations of the original building code

V = coefficient of variation (a dimensionless quantity equal to the sample standard deviation divided by the mean) determined from testing of concrete or steel samples from structures

v_u = resultant interface stress demand from the transfer of tension and shear

v_{ni} = nominal interface shear stress capacity

ε_t = net tensile strain in the extreme tension reinforcement at nominal strength

ε_y = yield strain of steel reinforcement

ϕ = strength reduction factor

ϕ_{ex} = strength reduction factor used to check strength of the structure without external reinforcement after an extraordinary event

ϕ_o = strength reduction factor from the original building code used in the design of an existing structure

2.2—Definitions

ACI provides a comprehensive list of definitions through an online resource, "ACI Concrete Terminology." Definitions provided here complement that resource.

2.2C Additional repair-related definitions are provided by "ICRI Concrete Repair Terminology,".

Assessment—refer to structural assessment

assessment criteria—codes, standards, loads, demands, capacities, strength reduction factors, materials, material properties, connections, details, and protections used in the evaluation

bond—(1) adhesion of applied materials to reinforcement or other surfaces against which they are placed, including friction due to shrinkage and longitudinal shear in the concrete and repair materials engaged by the bar deformations; (2) adhesion or cohesion between layers of a repair area or between a repair material and a substrate produced by adhesive or cohesive properties of the repair material or other supplemental materials throughout the service life of the repair.

bond-critical application—strengthening or repair system that relies on load transfer from the substrate to the system material achieved through shear and tension transfer at the interface, where bond rather than mechanical attachment is used as the primary load transfer mechanism.

capacity—the strength, stiffness, ductility, energy dissipation and durability, of a material, member or system as determined by analysis or testing.

Commentary: *This definition has been expanded from ACI Concrete Terminology for this code.*

compatible—the ability of two or more materials to be placed in contact or in sufficiently close proximity to interact with no significant detrimental results.

connector steel—steel elements, such as reinforcing bars, shapes, or plates, embedded in concrete or connected to embedded elements to transfer load, restrain movement, or provide stability.

contact-critical application—strengthening or repair system that relies on load transfer from the substrate to the system material achieved through bearing perpendicular to the interface.

Commentary: An example of a contact critical application is the addition of a confinement jacket around a column.

construction documents—written and graphic documents and specifications prepared or assembled that describe the location, design, materials, and physical characteristics of the elements of a project necessary for obtaining a building permit and for construction of the project.

damage—changes in the capacity of an existing structure resulting from events, such as loads and displacements.

Commentary: Deterioration of existing concrete from aging and faulty construction should not be considered as damage.

dangerous—any concrete building, structure, or portion thereof that meets any of the conditions described below shall be deemed dangerous:

1. The building or structure has collapsed, has partially collapsed, has moved off its foundation, or lacks the necessary support of the ground.

2. There exists a significant risk of collapse, detachment or dislodgement of any portion, member, appurtenance, or ornamentation of the concrete building or structure under nominal loads.

3. Unsafe structural condition has been determined in the building or structure.

Commentary: This definition has been modified from the IEBC for existing concrete. Potentially dangerous conditions of an existing concrete member or system include the following: unsafe structural conditions, instability, falling hazards, or noncompliance with fire resistance ratings.

demand—the force, deformation, energy input, and chemical or physical attack imposed on a material, member, or system which is to be resisted.

design basis code—legally adopted code requirements under which the assessments, repairs, and rehabilitations are designed and constructed.

design-basis criteria—codes, standards, loads, displacement limits, material properties, connections, details, and protections used in the design of mandated or voluntary work.

design service life (of a building, component, or material)—the period of time after installation or repair during which the performance satisfies the specified requirements if routinely maintained but without being subjected to an overload or extreme event.

durability—ability of a material or structure to resist weathering action, chemical attack, abrasion, and other conditions of service and maintain serviceability over a specified time or service life.

effective area of concrete—cross-sectional area of a concrete member that resists axial, shear, or flexural stresses.

effective area of reinforcement—cross-sectional area of reinforcement that resists axial, shear, or flexural stresses.

equivalent cover—a system to supplement insufficient concrete cover to improve durability or fire protection to that equivalent to the minimum cover specified in the design basis code.

evaluation—refer to structural evaluation

existing structure—structure for which a legal certificate of occupancy has been issued. For structures that are not covered by a certificate of occupancy, existing structures are those that are complete and permitted for use or otherwise legally defined as an existing structure or building.

factored load—product of the nominal load and load factor.

faulty construction—deficient construction resulting from errors or omissions in design or improper construction causing displacement of supporting portions of the structure or resulting in deficient materials, geometry, size or location of concrete members, reinforcement or connections.

in-place condition—current condition of an existing structure, system, member, connection including component sizes and geometry, material properties, faulty construction, deterioration, and damage from an event.

interface reinforcement—existing or supplemental reinforcement that is properly anchored on both sides of an interface; post-installed reinforcement such as adhesive anchors or mechanical anchors, or other mechanical connections providing a method of force transfer across an interface.

interface shear stress—shear stress resulting from transfer of forces at bonded interfaces between repair material and existing substrate used to achieve composite behavior.

jurisdictional authority—person or entity that has legal control over the applicable building code and permitting procedures for a structure.

Commentary: An example of a jurisdictional authority is the local building official.

licensed design professional—(1) an engineer or architect who is licensed to practice structural design as defined by the statutory requirements of the professional licensing laws of a state or jurisdiction; (2) the engineer or architect, licensed as described, who is responsible for the structural design of a particular project (also historically engineer of record).

Commentary: This definition is adopted from ACI Concrete Terminology.

nominal load—magnitude of load specified by the design-basis code before application of any factor.

nonstructural concrete—any element made of plain or reinforced concrete that is not required to transfer gravity load, lateral load, or both, along a load path of a structural system to the ground.

owner—corporation, association, partnership, individual, or public body or authority with whom the contractor enters into an agreement and for whom the work is provided. The owner is the party in legal possession of the structure.

rehabilitation—repairing or modifying an existing structure to a desired useful condition.

Commentary: this definition is adapted from ACI Concrete Terminology – "the process of repairing or modifying a structure to a desired useful condition." The definition is specific for concrete rehabilitation and is inclusive of the IEBC definition – "Any work, as described by the categories of work defined herein, undertaken in an existing building." Herein, concrete rehabilitations include: repair to restore original capacity; strengthening to increase the capacity to the current building code requirements; seismic retrofits per ASCE/SEI 41; and modifications addressing additions, alterations, and change of occupancy.

repair—the reconstruction or renewal of concrete parts of an existing structure for the purpose of its maintenance or to correct deterioration, damage, or faulty construction of members or systems of a structure.

Commentary: The definition of repair from ACI Concrete Terminology is "to replace or correct deteriorated, damaged, or faulty materials, components, or elements of a structure." The definition of repair from IEBC is "The reconstruction or renewal of any part of any part of an existing building for the purpose of its maintenance or to correct damage." The definition herein is adapted from the IEBC and is specific for repair of materials, components, or elements of existing concrete structures where structural repair or durability is addressed. Faulty materials, components, or elements of a structure are interpreted to be faulty construction resulting from errors or omissions in design or construction.

repair reinforcement—reinforcement used to provide additional strength, ductility, confinement, or any combination of the three, to the repaired member.

repair, structural—restoring a damaged or deteriorated structure or increasing the capacity of a structure.

Commentary: This definition is adapted from ACI Concrete Terminology – "increasing the load-carrying capacity of a structural component beyond its current capacity or restoring a damaged structural component to its original design capacity." Herein, the definition addresses increasing the capacity to include enhancements such as ductility of existing concrete members. Repairs to nonstructural members, whose failure would cause or result in unsafe structural conditions are considered structural repairs.

repair system—the combination of existing and new components, which may include existing reinforcement, repair materials, supplementary reinforcement and supplemental structural members

retrofit—modification of an existing member, system, or structure to increase its strength, ductility, or both as a means of improving the seismic performance of the structure.

Commentary: Typically used to refer to seismic modifications to increase resistance in an existing structure per ASCE/SEI 41. The definition is adapted from ASCE/SEI 41 – "Improving the seismic performance of structural or nonstructural components of a building."

serviceability—structural performance under service loads.

shoring—props or posts of timber, steel, or other material in compression used for the temporary support of excavations, formwork, or unsafe structures; the process of erecting shores.

specialty engineer—a licensed design professional retained by a contractor to design a delegated portion of the project.

Commentary: The term "specialty engineer" is used in Chapter 9. In this code, the specialty engineer will typically be a licensed design professional that is retained by the contractor to design specific types of components such as precast or shoring members.

stability, global—stability of the overall existing structure with respect to vertical support, uplift, overturning, sway instability, or sliding failure.

stability, local—the stability of an individual member or part of an individual member.

strengthening—process of increasing the load-resistance capacity of an existing structure or a portion thereof.

structural analysis—process of using engineering mechanics to determine internal demands on, and capacities of a structure, member, or system.

structural assessment—the process of investigating by systematically collecting information that affects the performance of an existing structure; evaluating the collected information to make informed decisions regarding the need for repair or rehabilitation; detailing of findings as conclusions and reporting recommendations for the examined structural concrete work area (member, system, or structure).

Commentary: This definition with specific details for existing concrete is adapted from ASCE/SEI 11 – "Systematic collection and analysis of data, evaluation, and recommendations regarding the portions of an existing structure which would be affected by its proposed use."

A structural assessment is the processes of acquiring knowledge of the existing structure used for the purpose of judging the future performance. The results of the investigation and evaluation are used to make decisions on the appropriate course of action regarding the future use of the structure and the suitability of the structure to continue in service.

Herein, assessments should be limited to the work area and may include:

(a) Investigation of the in-place condition of the existing structure by:

i. Collection and review of field data for the structure, such as geometry, material strengths, conditions, symptoms of distress, extent of damage, measurement of displacements, environmental factors and reinforcement sizes, and placement

ii. Collection of background data, such as plans, construction records, original, current, and code governing existing buildings, and historical events

(b) Evaluation of an existing structure, member or system of the work area (refer to commentary for structural evaluation)

(c) Detail findings and conclusions of the investigation and evaluation include:

i. Define the existing structure, member, or system rehabilitation category using the assessment criteria of this code

ii. Identify the work area, scope of work and likely cause or mechanism of damage, distress and deterioration

iii. Identify faulty construction limitations

iv. Appraise test results to determine cause of failure and predict future performance.

(d) Determine repair and rehabilitation concepts, strategies, alternates and recommendations

i. Develop cost-impact or economic study as necessary to appraise remedial work and maintenance

ii. Describe repair and rehabilitation work recommendations

(e) Report conclusions and recommendations include:

i. Work area limits and limitations of information collected and evaluated

ii. Assessment criteria and work of the evaluation such as calculations, tests and analyses

iii. Details of findings (conclusions) and recommendations *iv. Safety issue requirements (for example, recommendation for any temporary shoring)*

structural concrete—plain or reinforced concrete in a member that is part of a structural system required to transfer gravity loads, lateral loads, or both, along a load path to the ground.

structural evaluation—the process of determining, and judging the structural adequacy of a structure, member, or system for its current intended use or performance objective.

Commentary: This definition is adapted from ASCE/SEI 11 – "The process of determining the structural adequacy of the structure or component for its intended use, performance, or both. Evaluation by its nature implies the use of personal and subjective judgment by those functioning in the capacity of experts." An evaluation should determine, to the best of the license design professional's knowledge, the level of quality (structural adequacy, serviceability, or durability) of an existing structure based upon a measured criteria and the judgment of the licensed design professional. An evaluation may require professional judgment to gage structural adequacy. Structural analyses may be required to determine possible ranges of existing structure capacities and variations in demands. The goal of the evaluation process is to appraise the in-place condition to determine adequacy for current or proposed future use. Structural appraisal requires determining capacity and demand, which may vary widely depending on the acquired information, tests, models, and analyses; determining the demand-capacity ratios; and judging structural reliability limits, which may be open to interpretation based on project requirements, structural experience, knowledge, and past performance.

Evaluation activities may include:

(a) Tests to confirm reinforcement location, strength of material properties or structural capacity of existing members or systems or for presence of contaminants.

(b) Analysis of test results to establish reinforcement, statistical equivalent material properties, limits of faulty construction, and structural capacity

(c) Screening of observations and tests for mechanisms and causes of damage, distress, and deterioration

(d) Establishing the assessment criteria

(e) Calculating demand loadings, serviceability limits, lateral displacements, and durability requirements

(f) Analysis of the structure to determine the capacity of the structure to withstand current or future load demands and comply with serviceability limits

i. Determination of demand-capacity ratios to appraise structural adequacy, ascertain classifications, and judge the need for repair and rehabilitation

ii. determination of maintenance requirements necessary for the service life of the structure

substantial structural damage—Except when using Appendix A, substantial structural damage shall be as defined in the IEBC.

When using this code as a stand-alone code, substantial structural damage shall be as defined in A.4.

Commentary: The definition of substantial structural damage is from the IEBC. The definition has been modified, as noted in A.4, when using this code as a stand-alone code.

temporary bracing—temporary supplemental members added to an existing structure to prevent local or global instability during assessment and repair construction.

undercutting—concrete removal above or below reinforcement to allow for existing reinforcement to be encapsulated in repair material.

unsafe structural condition—structural state of existing concrete for an individual structural member, structural system, or structure with instability, potential collapse of overhead components or pieces (falling hazards), noncompliance with fire resistance ratings or demand to capacity ratio limits above acceptable limits defined in this code.

Commentary: This definition is adapted from the IEBC and modified for strength design to be consistent with structural concrete requirements.

CHAPTER 3—REFERENCED STANDARDS

C3 Both current and withdrawn standards are referenced. Standards that are referenced in the design basis code are applicable for the assessment of existing structures. These standards may have been withdrawn by the developing organization; however, they provide information on the materials used at the time of original construction. Refer to 4.3.3 and Chapter 6.

American Concrete Institute

ACI 216.1-14—Code Requirements for Determining Fire Resistance of Concrete and Masonry Construction Assemblies

ACI 318-19—Building Code Requirements for Structural Concrete and Commentary

ACI 369.1-17—Standard Requirements for Seismic Evaluation and Retrofit of Existing Concrete Buildings

ACI 437.2-13—Code Requirements for Load Testing of Existing Concrete Structures and Commentary

ACI 440.6-08—Specification for Carbon and Glass Fiber-Reinforced Polymer Bar Materials for Concrete Reinforcement

ACI 440.8-13—Specification for Carbon and Glass Fiber-Reinforced Polymer (FRP) Materials Made by Wet Layup for External Strengthening of Concrete and Masonry Structures

American Institute of Steel Construction

ANSI/AISC 360-16—Specification for Structural Steel Buildings

American Welding Society

D1.4/D1.4M:2011—Structural Welding Code—Reinforcing Steel

ASTM International

ASTM A15—Specification for Billet-Steel Bars for Concrete Reinforcement (withdrawn 1969)

ASTM A16—Specification for Rail-Steel Bars of Concrete Reinforcement (withdrawn 1969)

ASTM A61—Specification for Deformed Rail Steel Bars for Concrete Reinforcement with 60,000 psi Minimum Yield Strength (withdrawn 1969)

ASTM A160—Specification for Axle-Steel Bars for Concrete Reinforcement (withdrawn 1969)

ASTM A185/A185M-18—Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete (withdrawn 2013)

ASTM A370-14—Standard Test Methods and Definitions for Mechanical Testing of Steel Products

ASTM A408—Specification for Special Large Size Deformed Billet-Steel Bars for Concrete Reinforcement (withdrawn 1968)

ASTM A431—Specification for High-Strength Deformed Billet-Steel Bars for Concrete Reinforcement with 75,000 psi Minimum Yield Strength (withdrawn 1968)

ASTM A432—Specification for Deformed Billet Steel Bars for Concrete Reinforcement with 60,000 psi Minimum Yield Point (withdrawn 1968)

ASTM A497/A497M—Standard Specification for Steel Welded Wire Reinforcement, Deforme4d, for Concrete (withdrawn 2013)

ASTM A615/A615M-14—Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

ASTM A616/A616M-96a—Standard Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement (withdrawn 1999)

ASTM A617/A617M-96a—Standard Specification for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement (withdrawn 1999)

ASTM A706/A706M-14—Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement

ASTM A955/A955M-15—Standard Specification for Deformed and Plain Stainless Steel Bars for Concrete Reinforcement

ASTM A1061/A1061M-09—Standard Test Methods for Testing Multi-Wire Steel Strand

ASTM C42/C42M-13—Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

ASTM C823/C823M-12—Standard Practice for Examination and Sampling of Hardened Concrete in Constructions

ASTM C1580-15—Standard Test Method for Water-Soluble Sulfate in Soil

ASTM C1583/C1583M-13—Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)

ASTM D516-16—Standard Test Method for Sulfate Ion in Water

ASTM D4130-15—Standard Test Method for Sulfate Ion in Brackish Water, Seawater, and Brines

ASTM D4065-12—Standard Practice for Plastics: Dynamic Mechanical Properties: Determination and Report of Procedures

ASTM E329-14a—Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

American Society of Civil Engineers

ASCE/SEI 7—Minimum Design Loads for Buildings and Other Structures

ASCE/SEI 37—Design Loads on Structures during Construction

ASCE/SEI 41—Seismic Evaluation and Retrofit of Existing Buildings

British Standards Institution

BS EN 1504-10:2017—Products and systems for the protection and repair of concrete structures. Definition, requirements, quality control and evaluation of conformity. Site application of products and systems and quality control of the works

International Code Council

IBC—International Building Code

IEBC—International Existing Building Code

CHAPTER 4—CRITERIA WHEN USING THIS CODE WITH THE INTERNATIONAL EXISTING BUILDING CODE (IEBC)

4.1—General

4.1.1 This chapter applies if a jurisdiction has adopted the International Existing Building Code (IEBC) as the existing building code. When this chapter is used, Appendix A does not apply.

4.1.1C *Appendix A is used when this code is used for existing concrete structures as a stand-alone code without the IEBC and may be used to supplement provisions of Chapter 34 in 2012 and previous versions of the IBC.*

4.1.2 The design basis code criteria of the project shall be determined based upon the results of the preliminary assessment (1.7) and the detailed assessment (Chapter 6), if performed, using the requirements set forth in this chapter.

4.1.2C *Structures constructed under previously adopted codes or before the adoption of a building code may not satisfy all current building code requirements. This code and the IEBC contain specific requirements that determine if existing structures should be rehabilitated or retrofitted to satisfy the requirements of the current building code. Local ordinances may also require that a structure be rehabilitated to satisfy the current codes. These requirements should be reviewed at the start of a project.*

An evaluation and remediation of unsafe seismic resistance is excluded from IEBC. The licensed design professional should determine if seismic evaluation and retrofits are necessary using ASCE/SEI 41. Provisions of ASCE/SEI 41 may or may not be applicable to nonbuilding structures. Section 4.3.2 provides minimum assessment criteria for seismic safety provisions.

4.1.3 It shall be permitted to use the current building code as the design basis criteria for all damage states, deterioration, faulty design, or faulty construction.

4.1.4 It shall be permitted to use this code in conjunction with the IEBC to determine the rehabilitation category of work as shown in Table 4.1.4.

4.1.4C *Unless the local jurisdiction provides more restrictive requirements, this chapter with the IEBC should be used to determine the assessment and design basis criteria based on the rehabilitation category of Table 4.1.4.*

Table 4.1.4—Design basis code criteria references for rehabilitation categories

Rehabilitation category	Design basis code criteria reference
Unsafe structural conditions for gravity and wind loads	4.3.2
Unsafe structural conditions for seismic forces in regions of high seismicity	4.3.3
Substantial structural damage, definition	IEBC
Substantial structural damage to vertical elements of the lateral-force-resisting system	IEBC
Substantial structural damage to vertical elements of the gravity-load-resisting system	IEBC
Damage less than substantial structural damage with strengthening	4.5
Damage less than substantial structural damage without strengthening	4.6
Deterioration and faulty construction with strengthening	4.5
Deterioration and faulty construction without strengthening	4.6
Additions	IEBC
Alterations	IEBC
Changes in Occupancy	IEBC

4.1.5 This code shall be used to design repairs of existing structures. The current building code shall be used to design new concrete members and connections between new concrete members and existing construction.

4.1.6 In design of repair to existing structures using the original building code, detailing of the existing reinforcement need not comply with the current building code, if both of the following conditions are satisfied:

(a) The damage or deterioration to the existing reinforcement is addressed

(b) The repaired structure has capacity equal to or greater than demand per 5.2.2 using the original building code requirements or satisfies the requirements of 4.5.3 when using allowable stress design

4.1.6C *The licensed design professional should review the development of existing reinforcing steel, when cracking damage is evident near the ends of reinforcement, to determine if the cracking is indicative of potential development failure beyond the restrictions of this section. Research has shown that development length equations from previous versions of ACI 318 may be unconservative for top cast plain reinforcing steel bars (Feldman and Cairns 2017). Significant changes have occurred in the building code requirements for development of reinforcing steel.*

When the basis of design is the current building code, the licensed design professional should consider the following:

(a) Assessing demand/capacity ratios for the existing reinforcing steel with current development length provisions

(b) Confinement details of the reinforcement when assessing earthquake resistance

The licensed design professional should determine if structural behavior indicates adequate performance. ACI 224.1R, ACI 437R, and ACI 437.1R provide guidance in judging acceptable performance.

4.2—Compliance method

4.2.1 The compliance method selected and the design basis criteria shall be used consistently for all assessment and rehabilitation design, excluding other options.

4.3—Unsafe structural conditions

4.3.1 A structural assessment shall be performed to determine if unsafe structural conditions are present, when there is a reason to question the capacity of the structure or when unsafe structural conditions are observed as a part of the preliminary assessment.

4.3.1C *Structural assessments are required when damage, deterioration, structural deficiencies or behavior are observed during the preliminary assessment that are unexpected or inconsistent with available construction documents. The structural condition assessment will be performed in accordance with 1.7 or Chapter 6, or both. Results of the assessment should be reviewed to identify the presence of unsafe conditions. Based upon the IEBC definitions of dangerous and unsafe, unsafe structural conditions include conditions where a significant risk of collapse exists under service load conditions.*

4.3.2 For gravity, fluid, soil, and wind loads, unsafe structural conditions include instability, partial collapse, potential collapse, detachment or dislodgement of components or pieces (falling hazards), structures where a significant risk of collapse exists under service load conditions, or demand/capacity ratio exceeds the limit of 4.3.2.2.

4.3.2.1 Unsafe structural conditions shall be reported in accordance with 1.5.2.

4.3.2.2 Unsafe structural conditions exist in members or structures where the demand/capacity ratio is greater than 1.5, as shown in Eq. (4.3.2.2).

$$U_c/\phi R_{cn} > 1.5 \quad (4.3.2.2)$$

In Eq. (4.3.2.2), U_c is the strength design demand determined by using the nominal loads identified in the current building code and the factored load combinations of ASCE/SEI 7, excluding seismic forces; and ϕR_{cn} is the capacity adjusted by the strength reduction factor ϕ in Section 5.3 or 5.4 of this code.

4.3.2.2C *Demand to capacity ratios are used to quantify the adequacy of the member or structure. The threshold demand to capacity ratios determine when different levels of intervention may be required. For each demand to capacity ratio, this code provides direction on how the demand and capacity are determined. Demands may be determined based upon loads associated with current building codes (U_c as defined above) or loads specified during the original design (U_o as defined in section 4.5.1) of the structure. The calculated capacity of the structure will vary depending upon the condition of the structure and extent of evaluation used to confirm as-built properties of the structure.*

In assessing unsafe structural conditions, the demand of Eq. (4.3.2.2) combines current building code nominal gravity loads (dead, live and snow) with lateral loads from fluid, soil and wind (excluding seismic forces), using the factored load combinations of ASCE/SEI 7. A demand to capacity ratio greater than 1.5, calculated using Eq. (4.3.2.2), represents a condition with limited to potentially no margin of safety against failure for ASCE/SEI 7 loads (Stevens and Kesner 2016).

In the assessment of unsafe structural conditions, the licensed design professional should determine if it may be appropriate to include structural redundancies, alternate load paths, primary and secondary supporting elements, redistribution of loads, collapse mechanisms, reduced live loads, measured displacements (listing, leaning and tilting), second-order effects, and other loads specific to the structure, such as drifting snow, self-straining loads, ice, and floods. References for unsafe structural conditions are Galambos et al. (1982), Ellingwood et al. (1982), and Ellingwood and Ang (1972). These references provide basic probability theory and concepts for an evaluation using the specific details of the demand as it relates to the capacity with the strength reduction factors of Section 5.3 for new concrete structures.

4.3.2.3 If the demand/capacity ratio exceeds 1.5 for structures, the design basis criteria shall be the current building code.

4.3.2.4 For structure with no unsafe conditions, Sections 4.4 through 4.9 shall be used to determine the design basis criteria.

4.3.3 Assessment criteria for unsafe structural conditions of seismic resistance is limited to structures in Seismic Design Category D, E, and F of ASCE/SEI 7 and shall be determined using ASCE/SEI 41 and this code. The design basis criteria for rehabilitation design and construction of unsafe structures shall be this code and ASCE/SEI 41.

***4.3.3C** Compliance with ASCE/SEI 41 for Structural Performance Level, Collapse Prevention using an applicable Earthquake Hazard Level should be as determined by the local jurisdictional authority for the assessment of unsafe structural conditions. Assessment of unsafe structural conditions for seismic resistance is not required for structures in regions of low or moderate seismicity. If no requirements for unsafe structural conditions are provided by the local* *jurisdictional authority, the licensed design professional should refer to ATC-78, the IEBC and ASCE/SEI 41 appendices for guidance.*

4.4—Substantial structural damage

4.4.1 Substantial structural damage shall be assessed and rehabilitated as referenced in Table 4.1.4.

4.5—Conditions of deterioration, faulty construction, or damage less than substantial structural damage

4.5.1 If a structure has damage less than substantial structural damage, deterioration, or contains faulty construction, and there is a reason to question the capacity of the structure, it shall be assessed by checking the demand/capacity ratio using the original building code demand (U_o) with nominal loads, factored load combinations, and capacities of the original building code to determine if it exceeds 1.0, as shown in Eq. (4.5.1).

$$U_o/\phi_o R_{cn} > 1.0 \quad (4.5.1)$$

In Eq. (4.5.1), U_o is the strength design demand determined by using the nominal loads and factored load combinations of the original building code, excluding seismic loads. ϕR_{cn} is the capacity adjusted by the reduction factor (ϕ_o) of the original building code.

If $U_o/\phi_o R_{cn}$ is greater than 1.0, repairs shall be permitted to restore the structure to the capacity required by the original building code.

Repair of existing concrete structures shall be permitted to be based on the material properties of the original construction. New concrete members and connections to existing construction shall comply with provisions of the current building code.

Repairs shall be permitted that restore a member or system to the capacity of the original building code based on material properties of the original construction.

4.5.1C *Most existing concrete structures with damage less than substantial structural damage, deterioration, or containing faulty construction, will provide acceptable safety if restored to the strength of the original building code.*

The demand/capacity ratio limit of 1.0 as provided in this section allows strengthening that restores the structural reliability of the existing structure to the level prior to damage and deterioration, or as intended in the original building code.

Historical performance is often an acceptable indicator of adequate safety if the structure has been subjected to known loads even if the demand in the original building code was significantly different from the current building code.

If the capacity of the structure is not in question, such as indicated by the commentary provisions of 1.7.1C, assessment checks are not required.

4.5.2 Alternative assessment criteria for deterioration, faulty construction, or damage less than substantial structural damage shall be permitted, when approved by the jurisdictional authority. The selected alternative assessment criterion shall substantiate acceptable structural safety using engineering principles for existing structures.

4.5.2C *Alternative assessment criterion may be to use the current building code and ASCE/SEI 41. The references of 4.3.2.2C should be considered in the selection of applicable assessment criteria.*

Beyond using the current building code, the assessment criteria should address if the demand or capacity of the original structure or member is significantly inconsistent with current standards resulting in unacceptable structural safety. An increase in load intensity, added loads, change in *load factors, strength reduction factors or load combinations, modification of analytical procedures, or changes in the determined capacity between the original and current building codes (such as a change from allowable stress design (ASD) to strength design) or the benefits received versus the costs incurred should lead the licensed design professional to question the applicability of using the original building code for assessment of an existing structure. Engineering principles used to determine acceptable structural safety are to use either a probabilistic evaluation of loads and capacities to show adequate structural reliability indices or an evaluation procedure using demand/capacity ratios that are derived from the basic engineering principles as presented in current standards.*

An assessment criterion for a structure that has damage less than substantial structural damage, deterioration, or faulty construction excluding seismic forces that is based on the demand/capacity ratios consistent with the IEBC is the following:

a) If the current building code demand (U_c) exceeds the original building code demand (U_o^*) increased by 5 percent ($U_c > 1.05U_o^*$), check the demand/capacity ratio using the current building code demand (U_c) to determine if it exceeds 1.1, as shown in Eq. (C4.5.2a).

$$U_c/\phi R_{cn} > 1.1 \quad (C4.5.2a)$$

If the demand/capacity ratio exceeds 1.1, then that system or member should be strengthened using the current building code demand. If the demand/capacity ratio does not exceed 1.1, then no strengthening is required.

b) If the current building code demand (U_c) does not exceed the original building code demand (U_o^*) increased by 5 percent ($U_c \leq 1.05U_o^*$), check the demand/capacity ratio using the original building code demand (U_o^*) to determine if it exceeds 1.05, as shown in Eq. (C4.5.2b).

$$U_o^*/\phi R_{cn} > 1.05 \qquad (C4.5.2b)$$

If the demand/capacity ratio exceeds 1.05, then that system or member strength should be restored using the original building code demand. If the demand/capacity ratio does not exceed 1.05, then strengthening is not required.

In this assessment criterion, the strength reduction factors (ϕ) of Section 5.3 or 5.4 shall be applied in both Eq. (C4.5.2a) and (C4.5.2b).

The current building code strength design demand (U_c) combines current building code nominal gravity loads (dead, live, and snow) with lateral loads from fluid, soil and wind (excluding seismic) using the factored load combinations of ASCE/SEI 7. The original building code strength design demand (U_o^*) combines original building code nominal gravity loads (dead, live, and snow) and lateral loads from fluid, soil and wind (excluding seismic) using the factored load combinations of ASCE/SEI 7.

It may be appropriate to consider ASCE/SEI 41 seismic provisions, redistribution of loads, reduced live loads, measured displacements (listing, leaning, and tilting), second-order effects, and other loads specific to the structure, such as drifting snow, lateral earth and fluid pressures, self-straining loads, ice, and floods.

The use of structure-specific data is acceptable, if substantiated by the licensed design professional. For these assessment criteria, the demand/capacity ratio provisions in C4.5.2a may be used in the assessment, whether the current building code demand does or does not exceed the original building code demand increased by 5 percent.

4.5.3 If the concrete design regulations of the original building code only used allowable stress design and design service loads, the demand/capacity ratio shall be based on service load demand (U_S) and resistance calculated using allowable stresses (R_a) as shown in Eq. (4.5.3).

$$U_s/R_a > 1.0 \qquad (4.5.3)$$

If the demand/capacity ratio exceeds 1.0, then that member or system strength shall be restored using the original building code. If the demand/capacity ratio does not exceed 1.0, then strengthening is not required. Repairs shall be permitted that restore the member or system to its predamage or predeteriorated state. Repair of existing structural concrete is permitted based on material properties of the original construction.

4.5.3C *Before the "Building Code Requirements for Reinforced Concrete (ACI 318-63)" in 1963, the design of reinforced concrete structures was based upon allowable stress or working stress design principles. Original building code demands should include nominal gravity loads (dead, live, and snow) and lateral wind forces including seismic forces using the load combinations of original building code. Displacements (listing, leaning, and tilting), second-order effects, and other loads specific to the structure, such as drifting snow, lateral earth pressures, self-straining loads, ice, and floods should be considered.*

Using allowable stress design is inconsistent with the reliability principles of current strength design provisions. To adequately address safety, consideration should be given to verification using 4.5.2 and a check of seismic resistance using ASCE/SEI 41.

4.5.4 Existing structures other than those to be strengthened per 4.3 through 4.5 shall use 4.6 through 4.9 to determine the design basis criteria.

4.6—Conditions of deterioration, faulty construction, or damage less than substantial structural damage without strengthening

4.6.1 If less-than-substantial structural damage is present, structures damaged, deteriorated, or containing faulty construction that do not require strengthening in accordance with 4.5 shall use Chapters 7 through 10 of this code as the design basis criteria.

4.6.1C *Serviceability requirements including deflection limits and crack control reinforcement in the current building code are not requirements of this code, but should be considered in the assessment and rehabilitation of existing structures.*

4.7—Additions

4.7.1 The existing structure shall be assessed and rehabilitated in accordance with structural requirements of the IEBC per Table 4.1.4 for Additions.

4.8—Alterations

4.8.1 The existing structure shall be assessed and rehabilitated in accordance with structural requirements of the IEBC per Table 4.1.4 according to Alteration level 1, 2, or 3.

4.8.1C *Alterations in this section exclude the remedial work of 4.3 through 4.6.*

4.9—Change of occupancy

4.9.1 The existing structure shall be assessed and rehabilitated in accordance with structural requirements of the IEBC per Table 4.1.4 for changes of occupancy.

CHAPTER 5—LOADS, FACTORED LOAD COMBINATIONS, AND STRENGTH REDUCTION FACTORS

5.1—General

5.1.1 If this code is part of the design basis code, the load factors, load combinations, and strength reduction factors in this chapter shall be used for the assessment of the existing structure and the design of rehabilitation using nominal loads.

5.1.1C *Load factors, load combinations, and strength reduction factors are intended to achieve consistent acceptable levels of safety among all the structural elements in a system. They are obtained through rational design code calibration procedures that consider the accuracy of the strength prediction models and on the expected loads during the design service life of the structure.*

In some instances, a building may need to be upgraded to satisfy current building code requirements in accordance with the provisions of Chapters 4 and 6 or Appendix A and Chapter 6.In this case, nominal loads should be determined in accordance with the existing-building code and standards such as ASCE/SEI 7, ASCE/SEI 37, and ASCE/SEI 41.

5.1.2 It shall not be permitted to use load factors and load combinations from the original building code with strength reduction factors from this chapter. It shall not be permitted to use load factors and load combinations from this chapter with strength reduction factors from the original building code.

5.1.2C *Mixing of load factors and load combinations from one code with strength reduction factors from a different code may result in an inconsistent level of safety. Sections 4.5.2 and A.5.2 use nominal loads from the original codes with factored load combinations and strength reduction factors from this code. The load combinations described in Section 4.5.2C were developed to* *evaluate the demand to capacity ratio of a member when the loads prescribed in the current building code have increased significantly from those used in original construction.*

5.1.3 Loads during the construction period shall be in accordance with the design basis code. If the building is unoccupied during the construction period, it shall be permitted to determine loads in accordance with ASCE/SEI 37. If portions of the building are restricted to construction-only access during the construction period, it shall be permitted to determine loads on only those portions in accordance with ASCE/SEI 37.

5.1.3C *These provisions permit the less stringent loads in ASCE/SEI 37 to be applied for the construction-access only case.*

5.1.4 When assessing an existing structure, consideration shall be given to effects caused by loads or imposed deformations that the structure is subjected to, if required by the jurisdictional authority, even if such effects may not have been specified in the original building code.

5.1.4C *Examples of such loads include vibration or impact loads. Examples of such imposed deformations include unequal settlement of supports, and listing, leaning and tilting, and those due to prestressing, shrinkage, temperature changes, creep.*

5.2—Load factors and load combinations

5.2.1 Design of rehabilitation shall account for existing loads and deformations of the structure; the effects of load redistribution due to damage, deterioration, or load removal; and the sequencing of load application, including construction and shoring loads, during the rehabilitation process.

5.2.2 Rehabilitation design shall confirm that structural members and connections have design strengths at all sections at least equal to the required strengths calculated for factored loads and forces in such combinations as stipulated in this code. Structural evaluation shall consider whether the design strengths of such members and connections at all sections are sufficient.

__5.2.2C__ The basic requirement for strength design or assessment is expressed as:

design strength (for example, capacity) ≥ required strength (for example, demand)

$$\phi(R_n) \geq U$$

The design strength is the nominal strength multiplied by the strength reduction factor ϕ.

5.2.3 Required strength U shall equal or exceed the effects of factored load combinations as specified in the design-basis code.

__5.2.3C__ The required strength U is expressed in terms of factored loads, which are the product of specified nominal loads multiplied by load factors.

5.2.4 Required strength U shall include internal load effects due to reactions induced by prestressing with a load factor of 1.0.

5.2.5 For post-tensioned anchorage zone design or evaluation, a load factor of 1.2 shall be applied to the maximum prestressing jacking force.

__5.2.5C__ The load factor of 1.2 applied to the maximum tendon jacking force results in a design load that exceeds the typical prestressing yield strength. This compares well with the maximum attainable jacking force. For jacking loads less than the maximum tendon jacking force, or for jacking loads applied to nonmetallic prestressing tendons, design of the anchorage for 1.2 times the anticipated jacking force is appropriate given that the jacking load is controlled better than typical dead loads.

5.3—Strength reduction factors for rehabilitation design

5.3.1 Design strength provided by a member, its connections to other members, and its cross sections, in terms of flexure, axial load, shear, and torsion, shall be taken as the nominal strength calculated in accordance with requirements and assumptions of this code, multiplied by the strength reduction factors ϕ in 5.3.2 and 5.3.4.

5.3.2 The strength reduction factor ϕ shall be as follows:

Tension-controlled sections (steel tensile strain at failure exceeding $2.5\varepsilon_y$, where ε_y is the yield strain): 0.90

Compression-controlled sections (tensile strain at failure not exceeding ε_y)

(a) Members with spiral reinforcement: 0.75

(b) Other reinforced members: 0.65

For sections in which the net tensile strain in the extreme tension steel at nominal strength (ε_t) is between the limits for compression-controlled and tension-controlled sections, linear interpolations of ϕ shall be permitted.

Shear and torsion, and interface shear: 0.75

Bearing on concrete (except for post-tensioned anchorage zones and strut-and-tie models): 0.65

Post-tensioned anchorage zones: 0.85

Strut-and-tie models and struts, ties, nodal zones, and bearing areas in such models: 0.75

***5.3.2C** For a steel yield strength of 60 ksi, the steel tensile strains corresponding to the tension- and compression-controlled limits are 0.005 and 0.002, respectively. Because the compressive strain in the concrete at nominal strength is typically assumed to be 0.003, the net tensile strain limits for compression-controlled members may also be stated in terms of the ratio c/d_t, where c is the depth of the neutral axis at nominal strength, and d_t is the distance from the extreme compression fiber to the centroid of extreme tension reinforcement. The c/d_t limits for tension- and compression-controlled sections are 0.375 and 0.6, respectively. The 0.6 limit for compression-controlled sections applies to sections reinforced with Grade 60 steel and to prestressed sections.*

For other grades of steel reinforcement, the term c/d_t is a function of the yield strain of the steel reinforcement (ε_y). The c/d_t ratio is calculated as, $c/d_t = 0.003/(0.003 + \varepsilon_y)$.

5.3.3 Computation of development lengths do not require a ϕ-factor.

5.3.4 For flexure, compression, shear, and bearing of structural plain concrete, ϕ shall be 0.60.

5.4—Strength reduction factors for assessment

5.4.1 If the required structural element dimensions and location of reinforcement are determined in accordance with Chapter 6, and material properties are determined in accordance with 6.4, it shall be permitted to increase ϕ from those specified in 5.3, but ϕ shall not exceed:

Tension-controlled section (steel tensile strain at failure exceeding $2.5\varepsilon_y$, where ε_y is the yield strain): 1.0

Compression-controlled sections (tensile strain at failure not exceeding ε_y):

A - Members with spiral reinforcement: 0.9

B - Other reinforced members: 0.8

Shear, torsion, or both; interface shear: 0.8

Bearing on concrete: 0.8

Strut-and-tie models and struts, ties, nodal zones, and bearing areas in such models: 0.8

5.4.1C *Strength reduction factors given in 5.4.1 are larger than those in 5.3.1. These increased values are justified by the improved reliability due to the use of accurate field-obtained material properties, actual in-place dimensions, and well-understood methods of analysis. They have been deemed appropriate for use in ACI 318and have had a lengthy history of satisfactory performance.*

5.4.2 If an evaluation of members with no observed deterioration is based on historical material properties as given in Tables 6.3.2a through 6.3.2c, the ϕ-factors not exceeding those in 5.3 shall apply.

5.4.3 For flexure, compression, shear, and bearing of structural plain concrete, ϕ shall be 0.60.

5.4.3C *The resistance factor for assessment of plain concrete is the same as that specified for design in 5.3.4. Material properties for plain concrete determined in accordance with 6.3.5 may increase its nominal resistance, but the strength reduction factor remains unchanged because plain concrete failures are usually brittle.*

5.5—Additional load combinations for structures rehabilitated with external reinforcing systems

5.5.1 For rehabilitation achieved with external reinforcing systems that are susceptible to damage by vandalism or collision, the required strength of the structure without rehabilitation shall equal or exceed the effects of the load combinations specified in 5.5.2. The performance of externally reinforced elements subjected to fire shall be evaluated using the load combinations specified in 5.5.3.

5.5.1C *The additional load combinations specified in this section are intended to ensure adequate strength should the reinforcing system be sufficiently damaged to become ineffective. External reinforcing systems should be evaluated to determine if they are susceptible to damage from accidental vehicular impact or vandalism. Alternately, the rehabilitation measures may include physical design features that protect the external reinforcing system from these types of damage. The requirements of this section are not intended for the assessment of the effect of blast loadings, blast effects or a generalized assessment of extraordinary events on structures.*

The requirements of this section are not intended for the design of structures that are exposed to elevated temperatures during routine service.

5.5.2 For external reinforcing systems susceptible to damage, the required strength of the structure without such external reinforcement shall satisfy Eq. (5.5.2a) and (5.5.2b)

$$\phi R_n \geq 1.1D + 0.5L + 0.2S \quad (5.5.2a)$$

$$\phi R_n \geq 1.1D + 0.75L \quad (5.5.2b)$$

where *D, L* and *S* are the effects due to the specified dead, live, and snow loads, respectively, calculated for the rehabilitated structure; ϕ is the strength reduction factor in 5.3 or 5.4, as applicable; and R_n is the nominal strength of the structural member computed using the material properties determined from Chapter 6, without the contribution of the external reinforcing system.

***5.5.2C** These load combinations are intended to minimize the risk of failure of the strengthened structural member in the case where, during normal operating conditions, the external reinforcement is damaged. Such damage may not be detected immediately and so the structure (or structural component) may remain in service until the damage is identified. The load factors for live and snow loads in Eq. (5.5.2a) correspond to the arbitrary point-in-time loadings specified in ASCE7. Equation (5.5.2b) is compatible with ACI 440.2R.*

5.5.2.1 If the applied live load has a high likelihood of being sustained the live load factor in Eq. (5.5.2a) and (5.5.2b) shall be increased to 1.0.

***5.5.2.1C** Examples include library stack areas, heavy storage areas, warehouses, and other occupancies with a live load exceeding 100 lb/ft^2.*

5.5.3 To account for potential performance issues during a fire event, the required strength of the structural member without external reinforcement shall satisfy Eq. (5.5.3)

$$\phi_{ex} R \geq (0.9 \text{ or } 1.2)D + 0.5L + 0.2S \quad (5.5.3)$$

where $\phi_{ex} = 1.0$, R is the nominal resistance of the structural member, computed using the probable material properties during the fire event; S is the specified snow load. The dead load factor of 0.9 shall be applied when the dead load effect mitigates the total load effect.

5.5.3C *Equation (5.5.3) is intended to ensure that the repaired element will maintain sufficient strength, accounting for its probable reduced material properties due to elevated temperatures, during a fire event. If additional fire protection is applied to the repaired element, its effect on the external reinforcement and existing elements should be considered.*

General building code requirements should be reviewed to determine the required duration and temperature profile of the fire event.

Equation (5.5.3) was developed from Eq. (2.5.1) of ASCE/SEI 7-10. When required by the jurisdictional authority or owner, Section 2.5 in ASCE/SEI 7-10 provides strength requirements for the evaluation of extraordinary events, such as blast, fire, and other extreme events on structures. The evaluation of these extraordinary events is outside of the scope of this code: Equation (5.5.3) is limited to the evaluation of fire effects on structures with external reinforcement. Guidance on computing the structural effects caused by the fire event is provided in 5.5.3.1 and 5.5.3.1C.

Strength of the affected portion of the structure during a fire event should be based on reduced steel and concrete strengths. Guidance concerning probable material properties during a fire event may be obtained from ACI 216.1.

5.5.3.1 Additional live loads incurred during a fire shall be considered, with a load factor of 1.0.

5.5.3.1C *Live loads associated with fighting the fire may include wetting of the building contents, which has been idealized as a live load of 20 lb/ft*^{2}.

5.5.3.2 Internal forces and imposed deformations due to thermal expansion during the fire event shall be considered, with a load factor of 1.0, in determining the demands on the structural system.

5.5.3.2C *Thermal expansion of a member during a fire event will generate internal thrust forces if that expansion is restrained. The generated thrust force, while potentially large, is considerably less than that computed using conventional elastic properties and thermal expansion coefficients. This thrust may increase the moment capacity and the corresponding fire endurance of the restrained member.*

Procedures for calculating thermal induced thrust forces can be found in NIST (2010) and Buchanan (2001). PCI (2010) provides methods for determining (a) the magnitude and location of the thrust generated by a given fire temperature and duration, and (b) the increase in moment capacity caused by a known thrust force.

5.5.3.3 Any contribution of external reinforcement that is not protected using a fireproofing system shall be neglected during a fire event. The contribution of any adhesively bonded external reinforcement to the strength of a member during a fire shall be ignored.

5.5.3.3C *Section 7.9 gives member strength requirements for protected and unprotected external reinforcing systems subjected to elevated temperatures during a fire event.*

5.5.3.4 When the design live load acting on the member to be strengthened has a high likelihood of being present for a sustained period of time, a live load factor of 1.0 shall be used in Eq. (5.5.3).

5.5.3.4C *Refer to 5.5.2.1C.*

CHAPTER 6—ASSESSMENT, EVALUATION, AND ANALYSIS

6.1—Structural assessment

6.1.1 A structural assessment shall be performed if required per 1.7.5 or before rehabilitation of an existing structure. The structural assessment shall comprise 1) an investigation to establish the in-place condition of the structure in the work area, including environment, geometry, material strengths, reinforcing-steel sizes and placement, and signs of distress; 2) an evaluation to define the causes of distress, goals of the rehabilitation, and criteria for selection of rehabilitation solution(s); and 3) development of appropriate rehabilitation strategies.

6.1.1C *Field investigations in support of the structural assessment may include visual observations, destructive testing, and nondestructive testing (NDT). Areas of known deterioration and distress in the structural members should be identified, inspected, and recorded as to the type, location, and degree of severity. Investigation procedures are referenced in ACI 201.1R, ACI 228.1R, ACI 228.2R, ACI 364.1R, ACI 437R, ASCE/SEI 11, ASCE/SEI 41 and FEMA P-154. The affected structural members are not only members with obvious signs of distress but also contiguous members and connections in the structural system.*

The data gathered to determine the existing capacity should include the effects of material degradation, such as loss of concrete strength from chemical attack; freezing and thawing; and loss of steel area due to corrosion or other causes, or misplaced reinforcement; and effects of damaging events, such as impact of earthquakes or fire. The effect of deterioration on the ductility of the member should be considered in the evaluation. The strength or serviceability of a member or structure may be compromised by spalling, excessive cracking, large deflections, or other forms of damage or degradation. Seismic evaluation references for undamaged buildings include FEMA

P-58, FEMA P-154 and ASCE/SEI 41 and for damaged buildings include ATC-20, FEMA 306 and FEMA 307.

6.2—Investigation and structural evaluation

6.2.1 An investigation and structural evaluation shall be performed when there is a reason to question the capacity of the structure in the work area and insufficient information is available to determine if an existing structure is capable of resisting design demands.

6.2.2 Where repairs are required to an individual member or connection in a structure, it shall be determined if similar members or connections beyond the work area also require evaluation.

6.2.2C *If there is no evidence of damage, distress or deterioration of similar members or connections elsewhere in the work area that required repair, there is no need to perform an evaluation of similar members unless unsafe conditions are present. Unsafe conditions may be a concern if there are significant variances from the original design intent such as lower-strength concrete or insufficient reinforcement. In addition, if the similar members are in an environment that could foster deterioration, then evaluation of these members may be necessary to determine if strengthening or durability enhancements may be required.*

6.2.3 An investigation shall document conditions as necessary to perform an evaluation of the structure in the work area.

6.2.3C *Conditions which may need to be documented include (a) through (g):*

(a) The physical condition of the structural members to examine the extent and location of degradation or distress

(b) The adequacy of continuous load paths through the primary and secondary structural members to provide for life safety and structural integrity

(c) As-built information required to determine appropriate strength reduction factors in accordance with Chapter 5

(d) Structural members' orientation, displacements, construction deviations, and physical dimensions

(e) Properties of materials and components from available drawings, specifications, and other documents; or by testing of existing materials

(f) Additional considerations, such as proximity to adjacent buildings, load-bearing partition walls, and other limitations for rehabilitation

(g) Information needed to assess lateral-force-resisting systems, span lengths, support conditions, building use and type, and architectural features

The construction documents may not represent as-built conditions. Therefore, the licensed design professional is encouraged to research and verify that the material properties obtained from record documents are accurate. Material testing may be required to verify these values.

6.2.4 When an analysis is required, it shall be performed in accordance with Section 6.5 and shall consider the following items.

(a) As-measured structural member dimensions

(b) The presence and effect of alterations to the structural system

(c) Loads, occupancy, or usage different from the original design

6.3—Material properties

6.3.1 Concrete compressive strength and steel reinforcement yield strength shall be determined for the structure if a structural evaluation is required. Nominal material properties shall be determined by (a), (b) or (c):

(a) Available drawings, specifications, and previous testing documentation

(b) Historical material properties in accordance with 6.3.2

(c) Physical testing in accordance with 6.4

6.3.1C *The construction documents may not represent as-built conditions. Therefore, the evaluation of material properties may require verification by material testing to confirm that the material properties obtained from record documents are representative.*

Additional factors and characteristics affecting materials that may be required to be evaluated include:

(a) Ductility based on the mechanical characteristics of the component materials.

(b) Presence of corrosion of embedded steel reinforcement, including carbonation, chloride intrusion, and corrosion-induced spalling

(c) Presence of other degradation, such as alkali-silica reaction, sulfate attack, or delayed ettringite formation

(d) Degradation due to cyclic freezing and thawing

(e) Degradation of stiffness and strength due to bar slip in cracked sections and joints damaged in seismic events

(f) Chloride penetration can cause steel reinforcement corrosion, which can lead to cracking and spalling

Other tests for material properties, including petrographic examination, are used.

The choice of tests depends on the structure, member type(s), and distress mechanism.

6.3.2 If available drawings, specifications, or other documents do not provide sufficient information to characterize the material properties, it shall be permitted to determine such properties without physical testing from the historical data provided in Tables 6.3.2a through 6.3.2c.

Table 6.3.2a—Default compressive strength of structural concrete, psi

Time frame	Footings	Beams	Slabs	Columns	Walls
1900-1919	1000	2000	1500	1500	1000
1920-1949	1500	2000	2000	2000	2000
1950-1969	2500	3000	3000	3000	2500
1970-present	3000	3000	3000	3000	3000

Note: Adopted from ASCE/SEI 41.

Table 6.3.2b—Default tensile and yield strength properties for steel reinforcing bars for various periods*

		Structural†	**Intermediate**†	**Hard**†				
	Grade	33	40	50	60	65	70	75
	Minimum yield, psi	33,000	40,000	50,000	60,000	65,000	70,000	75,000
Year	**Minimum tensile, psi**	55,000	70,000	80,000	90,000	75,000	80,000	100,000
1911-1959		X	X	X	—	X	—	—
1959-1966		X	X	X	X	X	X	X
1966-1972		—	X	X	X	X	X	—
1972-1974		—	X	X	X	X	X	—
1974-1987		—	X	X	X	X	X	—
1987-Present		—	X	X	X	X	X	—

Note: Adopted from ASCE/SEI 41.

*An entry of "X" indicates the grade was available in those years.

†The terms "structural," "intermediate," and "hard" became obsolete in 1968.

Table 6.3.2c—Default tensile and yield strength properties of steel reinforcement for various ASTM specifications and periods*

				Structural[†]	Intermediate[†]	Hard[†]				
		Grade		33	40	50	60	65	70	75
		Minimum yield, psi		33,000	40,000	50,000	60,000	65,000	70,000	75,000
ASTM Designation[‡]	**Steel type**	**Year range**	**Minimum tensile, psi**	55,000	70,000	80,000	90,000	75,000	80,000	100,000
A15	Billet	1911-1966		X	X	X	—	—		
A16	Rail[§]	1913-1966		—	—	X	—	—		
A61	Rail	1963-1966		—	—	—	X	—		
A160	Axle	1936-1964		X	X	X	—	—		
A160	Axle	1965-1966		X	X	X	X	—		
A185	WWF	1936-present		—	—	—	—	X		
A408	Billet	1957-1966		X	X	X	—	—		
A431	Billet	1959-1966		—	—	—	—	—		X

A432	Billet	1959-1966		—	—	—	X	—		—
A497	WWF	1964-present		—	—	—	—	—	X	—
A615	Billet	1968-1972		—	X	—		—	—	X
A615	Billet	1974-1986		—	X	—	X	—		—
A615	Billet	1987-present		—	X	—	X	—		X
A616-96[‖]	Rail	1968-present		—	—	—	X	—		—
A617	Axle	1968-present		—	X	—	—	—		—
A706[#]	Low-alloy	1974-present		—	—	—	X	—	X	—
A955	Stainless	1996-present		—	X	—	X	—		X

Note: Adopted from ASCE/SEI 41.

*An entry of “X” indicates the grade was available in those years.

[†]The terms structural, intermediate, and hard became obsolete in 1968. Hard grade does not correspond to hardness.

[‡]ASTM steel is marked with the letter W.

[§]Rail bars are marked with the letter R.

[‖]Bars marked with “s!” (ASTM A616-96) have supplementary requirements for bend tests.

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Letter Concept for Support Reference to the ACI Repair Code

February 15, 2019

Florida Building Commission
Florida Department of Business and Professional Development
2601 Blair Stone Road
Tallahassee, FL 32399

Subject: Proposed Modification 7840
Reference ACI 562-19

Dear Florida Building Commissioners:

DeSimone Consulting Engineers recommends the adoption by reference of ACI 562: *Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures* in the *Florida Building Code* as presented in the subject code change proposal submitted by the American Concrete Institute.

DeSimone Consulting Engineers provides structural engineering, façade consulting, and forensic engineering services for all types of buildings. The firm is organized to support clients around the country and around the globe with offices in the United States, South America, and the Middle East. To date, DeSimone has designed over 10,000 projects in 44 states and 54 countries. The Miami office has provided structural engineering services for some of the most notable projects in Florida and the Caribbean. In Miami-Dade County alone, DeSimone has designed over 68 million square feet of new building construction at a project cost of over $15 billion.

As design engineers concerned with the evaluation of existing buildings, it is critically important for us to work within a clear and robust framework of regulations and requirements for evaluation and repair of structural concrete in buildings that require alternations, additions, renovations, or changes in occupancy. The additional provisions of ACI 562 establish such a framework that can clarify the perspective of building owners and building officials and standardize and enhance the technical procedures followed by design engineers, contractors and material suppliers involved in the repair and rehabilitation of structural concrete.

The ambiguity in expectations and scopes of work can also prove very costly. The absence of a unified guideline has increased the likelihood of two opposite outcomes for repair efforts: Insufficient scope of repair and inspection results in increased repair frequency, unsafe conditions and short life cycles. Conversely, exaggerated expectations that demand a repaired structure conform to the codes of new design can result in decisions to demolish and rebuild entire structures. ACI 562 addresses both problems. It elevates the anticipated outcome of repair to ensure a lasting rehabilitation. It also utilizes the information available for an existing structure to unburden the design engineers and building officials of those provisions that are intended to tackle the unknowns of new designs. We believe this approach will tangibly improve the cost-effectiveness of restoration efforts.

Finally, adoption of ACI 562 is rendered even more pressing when considering that the corrosive and concrete-hostile environment of Florida is unmatched by that of other jurisdictions that have

DESIMONE CONSULTING ENGINEERS 800 BRICKELL AVENUE 6TH FLOOR MIAMI, FLORIDA 33131 P. 305.441.0755 F. 212.481.6108

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already recognized the code. To protect buildings against this environment, a stand-alone concrete repair standard is needed in Florida, perhaps more than anywhere else in the US.

DeSimone Consulting Engineers recommends that the Commission adopt the modification discussed above for the development of the 7th Edition of the Florida Building Code. Thank you in advance for your consideration of this recommendation.

Respectfully submitted.

VECTOR CORROSION SERVICES, INC.
8413 Laurel Fair Circle, Ste 200B, Tampa, FL 33610
Main: 813-501-0050 | Fax: 813-501-1412
eMail: Info@VCServices.com

February 16, 2019

Florida Building Commission
Florida Department of Business and Professional Development
2601 Blair Stone Road
Tallahassee, FL 32399

Subject: Proposed Modification 7840
Reference ACI 562-19

Dear Florida Building Commissioners:

This letter is to recommend approval of adoption by reference of ACI 562 *Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures* in the *Florida Building Code* as presented in the subject code change proposal submitted by the American Concrete Institute.

Vector Corrosion Services Inc. performs investigations and evaluations of reinforced concrete structures. Clearer requirements for investigation are outlined in the code which will improve quality and improve the industry.

We find that it is increasingly more important to add additional minimum requirements for evaluation, repair, and rehabilitation of structural concrete in existing buildings undergoing alternations, additions, renovations, or changes in occupancy. The additional requirements provided in ACI 562 improve the clarity of expectations by owners, designers, contractors, officials, material providers, and other relevant parties regarding repairs and rehabilitation of structural concrete.

Most importantly, the use of ACI 562 provides an increased level of anticipated outcome associated with repairs and rehabilitation regarding the ability to satisfy the intent of the code and provides information that can facilitate the efforts of officials involved in the project.

Other jurisdictions have adopted ACI 562. This standard is especially important in Florida where the environmental exposure corrodes and otherwise deteriorates concrete more rapidly than in other areas of the country.

We recommend that the Commission adopt this modification for the development of the 7th Edition of the Florida Building Code. Thank you in advance for your consideration of this recommendation.

Respectfully submitted,

Matt Miltenberger
President
Vector Corrosion Services Inc.

We Save Structures™

VCSERVICES.COM

VECTOR CONSTRUCTION INC.
2504 Main Avenue West, West Fargo, ND 58078
Main: 701-280-9697 | Fax: 701-232-2763
Fargo@Vector-Construction.com

February 16, 2019

Florida Building Commission
Florida Department of Business and Professional Development
2601 Blair Stone Road
Tallahassee, FL 32399

Subject: Proposed Modification 7840
Reference ACI 562-19

Dear Florida Building Commissioners:

This letter is to recommend approval of adoption by reference of ACI 562 *Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures* in the *Florida Building Code* as presented in the subject code change proposal submitted by the American Concrete Institute.

As a concrete repair contractor, Vector Construction Inc. recommends the adoption of the repair code to help standardize expectations and requirements for the repair of concrete structures. This will lead to better quality and longer lasting repairs and ultimately extend the life of existing buildings in Florida.

We find that it is increasingly more important to add additional minimum requirements for evaluation, repair, and rehabilitation of structural concrete in existing buildings undergoing alternations, additions, renovations, or changes in occupancy. The additional requirements provided in ACI 562 improve the clarity of expectations by owners, designers, contractors, officials, material providers, and other relevant parties regarding repairs and rehabilitation of structural concrete.

Most importantly, the use of ACI 562 provides an increased level of anticipated outcome associated with repairs and rehabilitation regarding the ability to satisfy the intent of the code and provides information that can facilitate the efforts of officials involved in the project.

Other jurisdictions have adopted ACI 562. This standard is especially important in Florida where the environmental exposure corrodes and otherwise deteriorates concrete more rapidly than in other areas of the country.

We recommend that the Commission adopt this modification for the development of the 7th Edition of the Florida Building Code. Thank you in advance for your consideration of this recommendation.

Respectfully submitted,

Garth Fallis
VP Construction Technologies
Vector Construction Inc.

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VECTOR-CONSTRUCTION.COM

NDT CORPORATION
Concrete & Geophysical Testing

NDT CORPORATION
153 Clinton Road, Sterling, MA 01564
Main: 978-563-1327 | Fax: 978-563-1340
Email: Info@NDTCorporation.com

February 16, 2019

Florida Building Commission
Florida Department of Business and Professional Development
2601 Blair Stone Road
Tallahassee, FL 32399

Subject: Proposed Modification 7840
Reference ACI 562-19

Dear Florida Building Commissioners:

This letter is to recommend approval of adoption by reference of ACI 562 *Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures* in the *Florida Building Code* as presented in the subject code change proposal submitted by the American Concrete Institute.

NDT Corporation performs investigations of pos-tensioned concrete structures and recommends the adoption of the repair code to help standard expectations and requirements for the repair of concrete structures.

We find that it is increasingly more important to add additional minimum requirements for evaluation, repair, and rehabilitation of structural concrete in existing buildings undergoing alternations, additions, renovations, or changes in occupancy. The additional requirements provided in ACI 562 improve the clarity of expectations by owners, designers, contractors, officials, material providers, and other relevant parties regarding repairs and rehabilitation of structural concrete.

Most importantly, the use of ACI 562 provides an increased level of anticipated outcome associated with repairs and rehabilitation regarding the ability to satisfy the intent of the code and provides information that can facilitate the efforts of officials involved in the project.

Other jurisdictions have adopted ACI 562. This standard is especially important in Florida where the environmental exposure corrodes and otherwise deteriorates concrete more rapidly than in other areas of the country.

We recommend that the Commission adopt this modification for the development of the 7th Edition of the Florida Building Code. Thank you in advance for your consideration of this recommendation.

Respectfully submitted,

Bill Horne
President
NDT Corporation

We Save Structures™

NDTCORPORATION.COM

VECTOR CORROSION TECHNOLOGIES, INC.
8413 Laurel Fair Circle, Ste 200A, Tampa, FL 33610
Main: 813-830-7566 | Fax: 813-830-7565
Info@Vector-Corrosion.com

February 16, 2019

Florida Building Commission
Florida Department of Business and Professional Development
2601 Blair Stone Road
Tallahassee, FL 32399

Subject: Proposed Modification 7840
Reference ACI 562-19

Dear Florida Building Commissioners:

This letter is to recommend approval of adoption by reference of ACI 562 *Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures* in the *Florida Building Code* as presented in the subject code change proposal submitted by the American Concrete Institute.

Vector Corrosion Technologies Inc. is a supplier of corrosion protection products to the concrete repair industry.

We find that it is increasingly more important to add additional minimum requirements for evaluation, repair, and rehabilitation of structural concrete in existing buildings undergoing alternations, additions, renovations, or changes in occupancy. The additional requirements provided in ACI 562 improve the clarity of expectations by owners, designers, contractors, officials, material providers, and other relevant parties regarding repairs and rehabilitation of structural concrete.

Most importantly, the use of ACI 562 provides an increased level of anticipated outcome associated with repairs and rehabilitation regarding the ability to satisfy the intent of the code and provides information that can facilitate the efforts of officials involved in the project.

Other jurisdictions have adopted ACI 562. This standard is especially important in Florida where the environmental exposure corrodes and otherwise deteriorates concrete more rapidly than in other areas of the country.

We recommend that the Commission adopt this modification for the development of the 7th Edition of the Florida Building Code. Thank you in advance for your consideration of this recommendation.

Respectfully submitted,

David Whitmore
President
Vector Corrosion Technologies Inc.

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An ACI Standard

Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures (ACI 562-19) and Commentary

Reported by ACI Committee 562

ACI 562-19

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Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures and Commentary

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American Concrete Institute
38800 Country Club Drive
Farmington Hills, MI 48331
Phone: +1.248.848.3700
Fax: +1.248.848.3701

www.concrete.org

ACI 562-19

Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures (ACI 562-19) and Commentary

An ACI Standard

Reported by ACI Committee 562

Keith E. Kesner, Chair | Kevin Conroy, Secretary

VOTING MEMBERS

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Anton Gueorguiev
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Jose Pacheco

ACI 562-19, "Code Requirements for Assessment, Repair and Rehabilitation of Existing Concrete Structures," was developed to provide design professionals a code for the assessment of the damage and deterioration, and the design of appropriate repair and rehabilitation strategies. The code provides minimum requirements for assessment, repair, and rehabilitation of existing structural concrete buildings, members, systems and where applicable, nonbuilding structures. ACI 562-19 was specifically developed to work with the International Existing Building Code (IEBC) or to be adopted as a stand-alone code.

Keywords: assessment; bond; corrosion; damage; durability; evaluation; existing structure; fiber-reinforced polymer (FRP); interface bond; licensed design professional; maintenance; rehabilitation; reliability; repair; strengthening.

CONTENTS

ACI 562-19 supersedes ACI 562-16, was adopted May 1, 2019, and was published May 2019.

PREFACE

This code provides minimum requirements for assessment, repair, and rehabilitation of existing structural concrete buildings, members, systems and where applicable, nonbuilding structures. This code was developed by an ANSI-approved consensus process. This code can supplement the International Existing Building Code (IEBC), supplement the code governing existing structures of an authority having jurisdiction, or act as a stand-alone code in a locality that has not adopted an existing-building code. When this code is adopted as a stand-alone code, Appendix A should be used in place of Chapter 4.

The Code is specifically written for use by a licensed design professional. This code provides minimum requirements for assessment, design and construction, or implementation of repairs and rehabilitation, including quality assurance requirements, for structural concrete in service. This code has no legal status unless it is adopted by the authority having jurisdiction. Where the code has not been adopted, it serves as a standard to provide minimum requirements for assessment, and design and construction of repair and rehabilitation of existing structural concrete. ACI 318 provides minimum requirements for the materials, design, and detailing of structural concrete buildings and, where applicable, nonbuilding structures, and for new construction within existing structures where noted herein.

Key changes from ACI 562-16 to ACI 562-19 include:

(a) Text was added to simplify use of new materials that have the equivalent of an ICC-ES evaluation report in Chapter 1.

(b) The requirements for the basis of design report were simplified in Chapter 1.

(c) Requirements related to detailing of existing reinforcing steel in Chapter 4 have been clarified.

(d) The commentary in Chapter 8 was updated to include a listing of exposure categories that may affect durability.

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CODE

CHAPTER 1—GENERAL REQUIREMENTS

1.1—General

1.1.1 ACI 562, "Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures," is hereafter referred to as "this Code."

1.1.2 *Scope*—This code shall apply to assessment, repair, and rehabilitation of existing concrete structures as:

1. A code supplementing the International Existing Building Code (IEBC)
2. As part of a locally adopted code governing existing buildings or structures
3. Or as a stand-alone code for existing concrete structures

1.1.3 The intent of this Code is to safeguard the public by providing minimum structural requirements for existing structural concrete members, systems, and buildings.

1.1.4 All references in this code to the licensed design professional shall be understood to mean persons who possess the knowledge, judgment, and skills to interpret and properly use this code and are licensed in the jurisdiction where this code is being used. The licensed design professional for the project is responsible for, and in charge of, the assessment or rehabilitation design, or both.

COMMENTARY

R1—GENERAL REQUIREMENTS

R1.1—General

R1.1.2 This code defines assessment, design, construction and durability requirements for repair and rehabilitation of existing concrete structures. Throughout this code, the term "structure" means an existing building, member, system, and, where applicable, nonbuilding structures where the construction is concrete or mixed construction with concrete and other materials.

Chapter 4 provides assessment, repair, and rehabilitation criteria if this code is used as a supplement to the International Existing Building Code (IEBC) for concrete members and systems.

Appendix A provides assessment, repair, and rehabilitation criteria when this Code is adopted, including Appendix A, as a stand-alone code for repair of existing concrete structures.

R1.1.3 The intent of this code is to address the safety of existing structures through assessment requirements that demonstrate an approximation of the structural reliability using demand-capacity ratio limits of Chapter 4 or Appendix A and, if necessary as determined by the assessment, increase the structural capacity by repair or rehabilitation.

Unless prohibited by the authority having jurisdiction, if an existing structure is shown to be potentially dangerous in accordance with 4.3 or A.3, the structure should be rehabilitated using 4.3 or A.3.

Using the demand-capacity ratio limits of 4.5.1 or A.5.1, repair of the existing structural concrete to its predeteriorated state is permitted based on material properties specified in the original construction (per Chapter 6), and substantiated engineering principles of the original design. Where requirements of the original building code are appreciably changed in the current building code, the licensed design professional may consider using 4.5.2 or A.5.2.

Beyond the restoration assessment requirements of 4.5.1 and 4.5.3 or A.5.1 and A.5.3, the structural reliability principles of 4.5.2 or A.5.2 are permitted. These alternative requirements provide acceptable safety if the current building code demand exceeds the original building code demand or if the regulations of the original building code provide an unacceptable level of structural reliability.

CODE

1.1.5 The requirements of this code are provided using strength design provisions for demands and capacities, unless otherwise noted.

1.2—Criteria for the assessment and design of repair and rehabilitation of existing concrete structures

1.2.1 The "existing building code" refers to the code adopted by a jurisdiction that regulates existing buildings or structures.

1.2.2 The "current building code" refers to the general building code adopted by a jurisdiction that regulates new building design and construction.

1.2.3 The "original building code" refers to the general building code applied by the authority having jurisdiction to the structure in question at the time the existing structure was permitted for construction.

COMMENTARY

R1.1.5 When this code permits the original building code regulations to be used and that code uses allowable stress design, the following should be considered: those provisions should be substituted for strength design as noted in 4.5.3 or A.5.3; the licensed design professional is not required to use, but should consider using strength design provisions of this code as a check in the assessment of existing structures originally designed with allowable stress methods.

R1.2—Criteria for the assessment and design of repair and rehabilitation of existing concrete structures

R1.2.1 The code governing existing buildings in the United States is commonly the IEBC developed by the International Code Council (ICC). The IEBC provides regulations for evaluations of damage and the limit for damage to be repaired using the original building code.

R1.2.2 The current building code establishes the design and construction regulations for new construction. Strength design regulations of the current building code include:

(a) Required strengths computed using combinations of factored loads (strength design demands)

(b) Design strengths (capacities) based on testing of materials, members, and systems

(c) Analytical methods used to calculate member and system capacity

(d) Strength reduction factors, which have been established to be consistent with reliability indices used with the strength design demands

The load factors and strength reduction factors in the current building code are obtained through rational design code calibration procedures to achieve the targeted reliability indices which produce historically acceptable structural safety for new structures. The targeted reliability indices are generally based on past structural behavior, engineering experiences, costs and consequences of loss, among other criteria. The resulting demand-capacity ratios for new structures provide the limits that are not to be exceeded if designing new construction, but these demand-capacity ratio limits need not to be the same as those for existing structures as noted in sections 4.5.2 and A.5.2.

The general building code in the United States is usually based on the International Building Code (IBC) published by the ICC. Prior to 2015, Chapter 34 of the IBC included provisions for existing structures. For the design and construction of new concrete structures, the IBC and most other older general building codes often reference ACI 318, Building Code Requirements for Structural Concrete and Commentary, with exceptions and additions.

R1.2.3 This definition of "original building code" is consistent with the building code in effect at the time of original permitted construction per the IEBC. In assessing existing structures, the licensed design professional may need to consider changes in the codes enforced by the local authority

CODE

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having jurisdiction for the structure from the time of the original design through the time of the completion of construction. For buildings with major alterations or additions, the original building code should refer to the code in effect when the subject portion of the building was permitted, and different portions of a building may have different original building codes.

Reference to design requirements of the original building code should include: demands determined using either nominal loads, load factors, and load combinations of the original building code, or using allowable design loads and load combinations of the original building code; capacities determined using either strength design and reinforcement detailing provisions, and strength reduction factors of the original building code or using allowable stress design provisions of the original building code; and construction materials. Requirements for concrete design and construction include previous versions of ACI 318, concrete codes predating ACI 318, or concrete provisions within the original building code. A structural assessment using allowable stress design provisions of the original building code should be coupled with an evaluation using current standards or the strength design and reinforcement detailing provisions of this code to increase the understanding of structural behavior.

For a structure constructed prior to the adoption of a building code, the licensed design professional should research available standards and practices in effect at the time of construction. The Historic American Engineering Record, a program of the United States Park Service, has information on construction and preservation of historic structures (https://www.nps.gov/hdp/haer/).

1.2.4 *Design-basis code criteria*

1.2.4.1 The design-basis code criteria in this Code shall be used to assess and design repairs of existing members, systems, and structures.

R1.2.4 *Design-basis code criteria*

R1.2.4.1 The design-basis code criteria include requirements for assessment of the existing structure and for design when repairs are required based upon assessment results.

If a jurisdiction has adopted the IEBC and ACI 562 is used, then the design-basis code criteria are based on the IEBC with supplemental requirements of this code for potentially dangerous structural conditions, damage less than substantial structural damage, deterioration of concrete and reinforcement, faulty construction, serviceability issues, and durability of existing concrete.

For substantial structural damage, additions, alterations, and changes in occupancy, the IEBC establishes limits to which an assessment and design of repair and rehabilitation can occur in accordance with the original building code. Above these limits, an assessment and design of the repair and rehabilitation is in accordance with the current building code. Current and original building code provisions are supplemented by this code to address existing concrete members, systems, and structures.

Appendix A applies if a jurisdiction has not adopted the IEBC and has adopted this code. Appendix A of this code can provide design-basis code criteria for potentially dangerous

CODE

COMMENTARY

structural conditions, substantial structural damage, damage less than substantial structural damage, deterioration of concrete and reinforcement, faulty construction, additions, alternations, changes in occupancy, serviceability issues, and durability of existing concrete.

1.2.4.2 Assessment and design-basis criteria and the requirements for applying these criteria are provided in Chapter 4 and Appendix A. Chapter 4 applies if a jurisdiction has adopted the International Existing Building Code (IEBC) as the existing building code. Appendix A applies if a jurisdiction has not adopted the IEBC or if a jurisdiction has adopted this code.

R1.2.4.2 Classifying the work category using criteria and requirements of Chapter 4 or Appendix A defines the design-basis criteria, which is used to design the repair or rehabilitation work.

1.2.4.3 Assessment criteria shall be used to classify the work and to establish the design-basis criteria.

1.2.4.3.1 It shall be permitted to use the current building code as the assessment criteria for all existing structures.

R1.2.4.3.1 Use of the current building code for assessment criteria may result in a conservative assessment of an older structure. The design professional should review use of the current building code with the Owner at the start of the project (refer to R1.3.1).

1.2.4.4 Design-basis criteria shall be used to establish the applicable building code for repair and rehabilitation design.

1.2.4.5 The current building code shall be the design-basis code for new members and for connection of new members to existing structures.

1.2.4.5.1 The exceptions to 1.2.4.5 occur for the following: 1) when seismic retrofits are designed using the alternate design criteria of ASCE 41, or 2) when new members are added within the work area using the original building code as the design-basis code criteria for the repair.

R1.2.4.5.1 The performance-based criteria in ASCE 41 may result in new member design that will not satisfy current code requirements for strength, stiffness, or detailing. New concrete members and reinforcement may be designed by the original building code if integrated with the work area repair construction of the existing structure when the repair design-basis criteria for the existing structure is the original building code. The detailing of these new members and the connection of these members to the existing concrete should be according to the current building code.

1.3—Applicability of this code

1.3.1 This code provides minimum requirements when performing an assessment, repair or rehabilitation design and remedial construction of the structural components of existing concrete structures, including buildings and nonbuilding structures.

1.3.1.1 Regulations of the current building code need not be exceeded when assessing, designing repair and rehabilitation work, or installing remedial work of existing structures.

R1.3—Applicability of this code

R1.3.1 In typical U.S. practice, Owners are required to maintain existing structures to prevent unsafe conditions from occurring, or repair an existing structure when unsafe conditions are present. The minimum level of repair for an existing building will typically address these unsafe and potentially unsafe conditions.

The licensed design professional is permitted to perform assessment, design, and quality assurance activities that exceed the minimum requirements of this Code. Considerations beyond the minimum requirements of this Code, such as those for progressive collapse resistance, redundancy, or integrity provisions are permitted. Exceeding the code minimum requirements is not a violation of this Code.

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The Owner and the design professional should agree on the intent of the repair and rehabilitation program and desired outcome at the onset of the project. The desired repair outcome may include consideration of the design service life of the repairs, structural reliability, serviceability considerations, and other factors. Due to the uncertain remaining service life of existing structures and the technical requirements of repair construction, quality assurance and construction observations in excess of that required by general building code is commonly required. The desired outcome of the repair and rehabilitation program, quality assurance, and construction observation requirements should be documented in the basis of design (Section 1.5.3).

1.3.2 This Code is applicable to existing nonbuilding concrete structures.

R1.3.2 Nonbuilding concrete structures can include, but are not limited to arches, tanks, reservoirs, bins and silos, blast- and impact-resistant structures, and chimneys.

1.3.3 *Foundations*

R1.3.3 *Foundations*

1.3.3.1 This code shall apply to the assessment and repair or rehabilitation of existing structural concrete foundation members.

R1.3.3.1 Foundation members and systems should include those constructed using plain or reinforced concrete including but not limited to spread footings, mat foundations, concrete piles, drilled piers, grade beams, pile and pier caps, and caissons embedded in the ground. The design and installation of new pilings fully embedded in the ground are regulated by the current building code. For repair of existing foundation members and systems, the provisions of this code apply if not in conflict with the code governing existing building. For the portions of concrete piling in air or water, or in soil not capable of providing adequate lateral restraint throughout the piling to prevent buckling, the provisions of this code govern.

1.3.4 *Soil-supported slabs*

1.3.4.1 This code shall apply to the assessment and repair or rehabilitation of soil-supported structural slabs that transmit vertical loads or lateral forces from the structure to the soil.

1.3.5 *Composite members*

1.3.5.1 This code shall apply to the assessment and repair or rehabilitation of the concrete portions of composite members.

1.3.6 *Precast and prestressed concrete*

1.3.6.1 The code shall apply to the assessment and repair or rehabilitation of structural precast and prestressed concrete members, systems, and connections. The code shall apply to cladding transmitting vertical loads to supporting members or lateral loads to diaphragms or bracing members.

1.3.7 *Nonstructural concrete*

R1.3.7 *Nonstructural concrete*

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1.3.7.1 This code is not intended for repair of nonstructural concrete or for aesthetic improvements, except if failure of such repairs would result in an potentially dangerous condition.

1.3.8 *Seismic resistance*

1.3.8.1 Evaluation of seismic resistance and design of retrofit shall be in accordance with the code governing existing buildings if one has been adopted or this code if a code governing existing buildings has not been adopted. If using this code for evaluation of seismic resistance and retrofit design, ASCE/SEI 41 shall apply.

1.3.8.2 If retrofit for seismic resistance is not required by the code governing existing buildings or by this code, voluntary seismic retrofit shall be permitted.

1.3.8.2.1 When this code is used without the IEBC, the licensed design professional shall use the current building code supplemented by ASCE/SEI 41 and ASCE/SEI 7 to design voluntary seismic retrofits.

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R1.3.7.1 Where nonstructural concrete requires repair, that repair is not required to comply with or satisfy the requirements of this code. The licensed design professional designing repairs to nonstructural concrete should consider the consequence of repair failure to determine if there are provisions of this code that are applicable.

R1.3.8 *Seismic resistance*

R1.3.8.1 Provisions in Chapter 10 of ASCE/SEI 41 are based on ACI 369.1-17, which provides specific guidance on evaluation, repair and rehabilitation for existing concrete structures.

R1.3.8.2 Conditions for evaluation of seismic resistance and design of retrofits are provided in Chapter 3 of ACI 369R, Chapter A2 of Appendix A of IEBC, and ASCE/SEI 41.

Critical conditions requiring engineering review include, but are not limited to: irregular building configurations; nonductile or strong-beam-weak-column frames; and anchorage of walls to diaphragms. Significant improvements to the seismic resistance of a building can be made using repair techniques that provide less than those detailing and reinforcement methods required for new construction. As an example, providing additional reinforcement to confine concrete in flexural hinging regions will increase the energy dissipation and seismic performance even though the amount of confinement reinforcement may not satisfy the confinement requirements for new structures (Kahn 1980; Priestley et al. 1996; Harris and Stevens 1991). Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook (FEMA P-154), Mitigation of Nonductile Concrete Buildings (ATC-78 Project), Seismic Performance Assessment of Buildings (ATC-58), Quantification of Building Seismic Performance Factors (FEMA P-695 Report), and Identification and Mitigation of Nonductile Concrete Buildings (ATC-78-1) address seismic assessment and resistance in existing concrete structures.

Components of the seismic-force-resisting system that require strength and ductility should be identified. Force-controlled (nonductile) action is acceptable for some classifications of components of the seismic-force-resisting system (ASCE/SEI 41). The strength requirement of this code, Section 7.1 is applicable to these force-controlled components. ASCE/SEI 41 and ACI 369R provide information on rehabilitation for seismic resistance. Seismic-resisting components requiring energy-dissipating capability should maintain the ability to dissipate energy after repair. Design and detailing requirements for seismic resistance of cast-in-place or precast concrete structures are addressed in ACI 318 and ACI 369R.

1.4—Administration

1.4.1 Whenever this code is in conflict with the regulations of the authority having jurisdiction or code governing

R1.4—Administration

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existing buildings, the authority having jurisdiction or code governing existing buildings shall govern.

1.4.2 Whenever this code is in conflict with requirements in other referenced standards, this code shall govern.

1.4.3 *Approval of special systems of design or construction*—Systems that are approved by the authority having jurisdiction through alternative means and methods clauses in the building design-basis code shall be permitted.

1.4.4 Materials that are evaluated in a process equivalent to the requirements of the IBC shall be used in accordance with the requirements of the written evaluation report for the material. Material use shall satisfy requirements of this code.

1.5—Responsibilities of the licensed design professional

1.5.1 The licensed design professional for the project is responsible for 1) assessing; 2) designing, detailing, and specifying the work proposed and material requirements; 3) consideration of load paths for the work proposed; and 4) preparing construction documents of the work proposed and specifying a quality assurance program. Construction documents shall indicate the location, nature, and extent of the work proposed.

1.5.2 *Potentially dangerous structural conditions*—The licensed design professional for the project shall report observations of exposed structural defects in the existing construction within the work area representing visible potentially dangerous structural conditions requiring evaluation and possible mitigation to the Owner.

1.5.2.1 When required by the authority having jurisdiction, visible potentially dangerous conditions shall be reported by the licensed design professional to the authority having jurisdiction.

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R1.4.3 New methods of design, new materials, and new uses of materials for repair and rehabilitation usually undergo a period of development before being specifically covered in a code. Hence, good systems or components might be excluded from use by implication if means are not available to obtain acceptance. For systems considered under this section, specific tests, load factors, strength reduction factors, deflection limits, and other pertinent requirements should be set by the authority having jurisdiction and should be consistent with the intent of this code. Provisions of this section do not apply to model analysis used to supplement calculations or to strength evaluation of existing structures.

R1.4.4 The IBC (Section 1703 in IBC 2018) includes provisions for approval of alternate materials in new construction. The approval process requires the evaluation to be completed by an approved agency, and the material properties and use requirements be summarized in a written evaluation report. The same process may be used for materials in repair applications, provided the materials satisfy the provisions of this code. This process is intended to allow for use of new materials and new classes of materials that do not have approved design or material standards.

R1.5—Responsibilities of the licensed design professional

R1.5.1 During the assessment part of the investigation, the licensed design professional should request that the Owner provide all available information regarding the condition of the building, construction documents, previous engineering reports, disclose the presence of any known hazardous materials in the work area, and any other pertinent information to the parties involved in the work. This information may require that remedial measures be taken before or during the construction process and should be considered in the scope of work.

R1.5.2 During investigation or repair construction, potentially dangerous structural conditions in the work area may be revealed. To protect the public safety, an observed potentially dangerous structural condition should be reported to the contractor and Owner to initiate mitigation of the condition. Mitigation may include temporary shoring or construction as part of the remedial work

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1.5.3 The licensed design professional for the project shall document the basis of design. The basis of design shall address work categories and repair construction within the work area for each structural element and include:

(a) A description of the building

(b) Modifications such as additions, alterations, or changes in occupancy

(c) Elements of existing structure to be shored

(d) Quality assurance and quality control (QA/QC) requirements

(e) Conditions and details of the proposed rehabilitation work

(f) Assessment criteria and findings

(g) Repair material requirements

(h) Known history of repairs and rehabilitation

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R1.5.3 The basis of design provides a summary of the assessment of the existing structure, and a summary of the construction documents from original construction or prior rehabilitation used in developing the basis of design. The basis of design can be documented in a written report or included in construction documents. Information on some structures may be unavailable or unnecessary if strengthening is not required and should be so documented in the basis of design. The licensed design professional should review requirements of the authority having jurisdiction to determine the information to include in the basis of design documentation and filing requirements for the basis of design.

Additional materials that may be documented in the basis of design include:

(a) Detailed building description, including age of construction, structural systems, identified original building code, and past and current uses

(b) Documentation of potentially dangerous structural conditions in the work area of the structure determined in the assessment

(c) Documentation of substantial structural damage in the work area

(d) Members and systems of the work area requiring increase in capacity beyond the demand of the original building code

(e) Conditions and details of the proposed rehabilitation work

(f) Assessment criteria and findings

(g) Design-basis code criteria and basis of rehabilitation design

(h) Shoring requirements such as loads and spacing of shoring members

(i) Quality assurance and quality control (QA/QC) requirements

(j) Types and frequency of future inspection

(k) Types and frequency of future maintenance

(l) Recommendations to address serviceability conditions as discussed in Section 6.6

A maintenance protocol that addresses project-specific conditions provides the most effective method to ensure durability and should be established as part of the repair or rehabilitation design that includes inspections and period of time between inspections, after completion of the repair installation. Maintenance and frequent preventative approaches that occur early in the service life of the structure generally result in improved service life with less interruption and a lower life-cycle cost (Tuutti 1980; ACI 365.1R). Recommendations should be provided to the Owner on inspection and maintenance to be undertaken during the remaining design service life of the repair material or the repaired part of the structure.

A maintenance protocol should be provided in the basis of design, or in as-built or close-out documents. Maintenance of the repair can be incorporated in the instruction manuals from the licensed design professional, contractor, or product manufacturers. Documents and records of observations,

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inspections and tests should be provided to the Owner as necessary for future work.

1.6—Construction documents

1.6.1 The construction documents for rehabilitation work proposed shall provide sufficient detail and clarity to convey the location, nature and extent of the work, and the necessary information to perform the work in conformance with the requirements of this code and the local authority having jurisdiction. Specifications shall require that materials used for repair and rehabilitation construction satisfy this code and governing regulatory requirements at the time the work is implemented.

R1.6—Construction documents

R1.6.1 As necessary, the construction documents should indicate:

(a) Name and date of issue of the building code and supplements to which the assessment, repairs, or rehabilitation conforms

(b) Design-basis code criteria used for conditions addressed by the documents

(c) Design assumptions and construction requirements including specified properties of existing and remedial materials used for the project and the strength requirements at stated ages or stages of the construction

(d) Details, locations and notes indicating the size, configuration, reinforcement, anchors, repair materials, preparation requirements, and other pertinent information to implement the repairs, strengthening, or rehabilitation of the structure

(e) Magnitude and location of prestressing forces

(f) Anchorage details for prestressing reinforcement

(g) Development length of reinforcement and length of lap splices

(h) Type and location of mechanical or welded splices of reinforcement

(i) Shoring or bracing criteria necessary before, during, and at completion of the assessment, repair, or rehabilitation projects

(j) Quality assurance program including specific inspections and testing requirements

ACI 563 is a reference specification that is written to be consistent with the requirements of this Code.

1.6.2 Calculations pertinent to design shall be submitted with the construction documents if required by the authority having jurisdiction. Scale-model testing and analysis shall be permitted to supplement calculations.

R1.6.2 Analyses and designs should include calculations, evaluation and design assumptions. If computer-based analyses and designs, such as finite element methods are used, they should include input, and computer-generated output.

1.6.3 To the extent required by the contract between the licensed design professional and Owner, the licensed design professional shall provide the Owner with copies of the basis of design report, assessment reports, project documents, field reports, locations of completed repairs, and other project documents.

R1.6.3 Documentation of the project and repairs that have been carried out, including structural observations, inspection reports by others, test results, and recommendations on inspection and maintenance to be undertaken during the remaining design service life of the repaired part of the concrete structure, should be provided to the Owner. The extent and type of quality assurance records should include those required in the construction documents. It is good practice for the Owner to keep documentation of repairs, inspections, testing, monitoring, and investigations for future reference.

1.7—Preliminary assessment

1.7.1 Preliminary assessment of an existing structure shall include investigation and review of the structure, construction documents, reports, local jurisdictional codes, and other available documents of the existing structure. Existing in-place conditions shall be visually or otherwise investigated to verify existing geometry and structural conditions.

R1.7—Preliminary assessment

R1.7.1 The goal of the preliminary assessment is to examine available information about the structure within the work area, and to make an initial determination of its adequacy to withstand in-place environmental conditions and design loads. The results of the preliminary assessment should be used to make decisions regarding the current

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in-place condition, need for additional information, work items necessary as part of the assessment, possible rehabilitation design and construction work to consider, and if there is a need for temporary shoring for safety of the existing structure. The preliminary assessment results should be updated as additional data regarding the examined structure become available.

The licensed design professional may determine that 4.6 or A.6 applies in a preliminary assessment based on engineering judgment and without analysis if all of the following are confirmed:

(a) Historical performance of the structure and visual observation of the structural condition of members and systems indicate acceptable behavior precluding assessment by 4.3 or A.3

(b) Review of construction documents and observation of current structural conditions indicate damage or deterioration of the structure below the level requiring assessment by 4.4 and 4.5 or A.4 and A.5

(c) Modifications for additions, alterations, and changes in occupancy are not planned.

Repairs are permitted that address durability and serviceability of 4.6 or A.6 without analyzing members and systems and checking the demand-capacity ratio limits of 4.3 through 4.5 or A.3 through A.5 if the structure is determined to be structurally acceptable. Structural performance should be considered acceptable if past and present performance has been satisfactory and observations do not indicate structural distress beyond levels expected.

The extent of damage or deterioration should be limited and the licensed design professional should not have a concern about the capacity of the structure if repairs are completed using the provisions of 4.6 with verifying the demand to capacity limits of 4.4 and 4.5 or A.4 and A.5.

1.7.2 The preliminary assessment shall determine if visibly potentially dangerous structural conditions are present. If present, they shall be reported in accordance with 1.5.2.

R1.7.2 Potentially dangerous structural conditions may require the Owner to install shoring, limit access, or take other measures to mitigate these conditions.

1.7.3 For the purpose of performing a preliminary assessment, it is permitted to use the criteria of the original or current building code for assessment criteria of Chapter 4 or Appendix A.

R1.7.3 The assumed preliminary assessment criteria should be substantiated or modified in accordance with the assessment details of Chapter 6.

1.7.4 The in-place strength of the existing structure shall be determined considering in-place geometric dimensions and material properties including effects of material deterioration and other deficiencies. If material properties are not immediately available, a preliminary assessment is permitted to be completed using material properties as described in Section 6.3.2.

R1.7.4 When required as a part of the preliminary assessment, strength calculations should be based on in-place conditions and should include an assessment of the loss of strength due to deterioration mechanisms. Guidelines for assessing in-place conditions include ACI 201.2R, ACI 214.4R, ACI 228.1R, ACI 228.2R, ACI 364.1R, ACI 437.1R, FEMA P-58, FEMA P-154, FEMA 306, FEMA 307, ASCE/SEI 11, ASCE/SEI 41, ATC-20, ATC-45, and ATC-78 as well as The Concrete Society *Technical Report 68* (2008). When material test results are initially unavailable, historical properties based on typical values used at the time of

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1.7.5 A structural assessment in accordance with Chapter 6 shall be performed when a member or structure exhibits damage, displacements, deterioration, or structural deficiencies, or behavior is observed during the preliminary assessment that is unexpected or inconsistent with available design and construction documents or code requirements in effect at the time of construction.

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construction can be used in preliminary evaluation. If available, material properties from construction documents can also be used in a preliminary evaluation.

The assessment of existing structures should initially focus on critical gravity-load-resisting members such as columns, walls, and members that are expected to have limited ductility, followed by an assessment of the lateral-load-resisting system.

Assessing fire damage and other deterioration mechanisms that result in a change in material properties (such as compressive strength or modulus of elasticity) should include an evaluation of the effect of the damage on the material properties and the impact of the damage on the performance of the existing structure. Examples of deterioration mechanisms that result in possible changes in material properties include corrosion of steel reinforcement, thermal damage, concrete reactions such as alkali-aggregate, and freezing and thawing.

Conditions to be documented include cracking, spalls, member deflection, cross-section dimensions different than specified on the original construction drawings, and construction deviating from tolerances permitted under the original design criteria.

R1.7.5 The preliminary assessment is generally the first portion of the work necessary to determine the rehabilitation category. Based upon preliminary assessment results, a structural assessment may be required to determine the extent of damage or if potentially dangerous structural conditions are present. However, in some cases the licensed design professional may deem that a structural assessment is not required based on judgement in accordance with 1.7.1 and R1.7.1.

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CHAPTER 2—NOTATION AND DEFINITIONS

2.1—Notation

This chapter defines notation and terminology used in this code.

c = depth of neutral axis, in.
D = dead load acting on the structure
d_t = distance from extreme compression fiber to centroid of extreme tension reinforcement, in.
$\bar{f}_c$ = average core strength modified to account for the diameter and moisture condition of the core, psi
f_c' = specified concrete compressive strength, psi
f_{ceq} = equivalent specified concrete strength used for evaluation, psi
f_y = specified yield strength of steel reinforcement, psi
$\bar{f}_y$ = average yield strength value for steel reinforcement, psi
f_{yeq} = equivalent yield strength of steel reinforcement used for evaluation, psi
k_c = coefficient of variation modification factor for concrete testing sample sizes
k_s = coefficient of variation modification factor for steel testing sample sizes
L = live load acting on the structure
ℓ_t = span of member under load test and taken as the smaller of: (a) distance between centers of supports; and (b) clear distance between supports plus thickness h of member; for a cantilever, it shall be taken as twice the distance from face of support to cantilever end, in.
n = number of sample tests
R_a = service load capacity of structural member, system, or connection including effects of damage, deterioration of concrete and reinforcement, and faulty construction determined using allowable stresses according to the original building code.
R_{cn} = current in-place nominal capacity of structural member, system, or connection including the effects of damage, deterioration of concrete and reinforcement, and faulty construction
R_{ex} = nominal resistance of the structure during an extraordinary (that is, low-probability) event computed using the probable material properties
R_n = nominal capacity of structural member, system, or connection excluding the effects of damage, deterioration of concrete and reinforcement, and faulty construction
S = snow load acting on the structure
T_g = glass transition temperature, °F
U = demand using nominal loads and factored load combinations for strength design provisions (LRFD)
U_c = demand using nominal loads of the current building code and factored load combinations of ASCE/SEI 7 for strength design provisions (LRFD)

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U_o = demand using nominal loads and factored load combinations of the original building code for strength design provisions (LRFD)

U_o^* = demand using nominal loads of the original building code and factored load combinations of ASCE/SEI 7 for strength design provisions (LRFD)

U_s = demand using service loads of the original building code and load combinations of the original building code

V = coefficient of variation (a dimensionless quantity equal to the sample standard deviation divided by the mean) determined from testing of concrete or steel samples from structures

v_{ni} = nominal interface shear stress capacity

v_u = resultant interface stress demand from the transfer of tension and shear

ε_t = net tensile strain in the extreme tension reinforcement at nominal strength

ε_y = yield strain of steel reinforcement

ϕ = strength reduction factor

ϕ_{ex} = strength reduction factor used to check strength of the structure without external reinforcement after an extraordinary event

ϕ_o = strength reduction factor from the original building code used in the design of an existing structure

2.2—Definitions

ACI provides a comprehensive list of definitions through an online resource, "ACI Concrete Terminology." Definitions provided here complement that resource.

assessment—refer to **structural assessment**.

assessment criteria—codes, standards, loads, demands, capacities, strength reduction factors, materials, material properties, connections, details, and protections used in the evaluation.

authority having jurisdiction—person or entity that has legal control over the applicable building code and permitting procedures for a structure.

bond—(1) adhesion of applied materials to reinforcement or other surfaces against which they are placed, including friction due to shrinkage and longitudinal shear in the concrete and repair materials engaged by the bar deformations; (2) adhesion or cohesion between layers of a repair area or between a repair material and a substrate produced by adhesive or cohesive properties of the repair material or other supplemental materials throughout the service life of the repair.

bond-critical application—strengthening or repair system that relies on load transfer from the substrate to the system material achieved through shear and tension transfer at the interface, where bond rather than mechanical attachment is used as the primary load transfer mechanism.

capacity—the strength, stiffness, ductility, energy dissipation and durability, of a material, member or system as determined by analysis or testing.

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R2.2—Definitions

Additional repair-related definitions are provided by "ICRI Concrete Repair Terminology".

An example of an authority having jurisdiction is the local building official.

This definition has been expanded from "ACI Concrete Terminology" for this code.

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compatible—the ability of two or more materials to be placed in contact or in sufficiently close proximity to interact with no significant detrimental results with respect to the intended service life.

connector steel—steel elements, such as reinforcing bars, shapes, or plates, embedded in concrete or connected to embedded elements to transfer load, restrain movement, or provide stability.

contact-critical application—strengthening or repair system that relies on load transfer from the substrate to the system material achieved through bearing perpendicular to the interface.

construction documents—written and graphic documents and specifications prepared or assembled that describe the location, design, materials, and physical characteristics of the elements of a project necessary for obtaining a building permit and for construction of the project.

damage—a decrease in the capacity of an existing member or structure resulting from events, such as loads and displacements, or as a result of deterioration of the structure.

dangerous—any building, structure, or portion thereof that meets any of the conditions described below shall be deemed dangerous:

1. The building or structure has collapsed, has partially collapsed, has moved off its foundation, or lacks the necessary support of the ground.
2. There exists a significant risk of collapse, detachment or dislodgement of any portion, member, appurtenance, or ornamentation of the concrete building or structure under service loads.

demand—the force, deformation, energy input, and chemical or physical attack imposed on a material, member, or system which is to be resisted.

design-basis code—legally adopted code requirements under which the assessments, repairs, and rehabilitations are designed and constructed.

design-basis criteria—codes, standards, loads, displacement limits, material properties, connections, details, and protections used in the design of mandated or voluntary work.

design service life (of a building, component, or material)—the period of time after installation or repair during which the performance satisfies the specified requirements if routinely maintained but without being subjected to an overload or extreme event.

deterioration—(1) physical manifestation of failure of a material (for example, cracking, delamination, flaking, pitting, scaling, spalling, and staining) caused by environmental or internal autogenous influences on rock and hardened concrete as well as other materials; (2) decomposition of material during either testing or exposure to service. (See also **disintegration** and **weathering** in ACI CT.)

durability—ability of a material or structure to resist weathering action, chemical attack, abrasion, and other conditions of service and maintain serviceability over a specified time or service life.

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An example of a contact-critical application is the addition of a confinement jacket around a column.

This definition has been adopted from the IEBC. Potentially dangerous conditions of an existing concrete member, system, or structure may include those defined as dangerous from the IEBC. Circumstances may render some conditions defined as dangerous to be potentially dangerous within a limited period of time or may be concluded to be less of an imminent hazard.

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equivalent cover—a system to supplement insufficient concrete cover to improve durability or fire protection to that equivalent to the minimum cover specified in the design-basis code.

evaluation—refer to **structural evaluation**.

existing structure—structure for which a legal certificate of occupancy has been issued. For structures that are not covered by a certificate of occupancy, existing structures are those that are complete and permitted for use or otherwise legally defined as an existing structure or building.

factored load—product of the nominal load and load factor.

faulty construction—deficient construction resulting from errors or omissions in design or improper construction causing displacement of supporting portions of the structure or resulting in deficient materials, geometry, size or location of concrete members, reinforcement or connections that result in a decrease in the capacity of an existing structure or an adverse impact on the long-term durability or serviceability of the structure.

in-place condition—current condition of an existing structure, system, member, connection including component sizes and geometry, material properties, faulty construction, deterioration, and damage from an event.

interface reinforcement—(1) existing or supplemental reinforcement that is properly anchored on both sides of an interface; (2) post-installed reinforcement such as adhesive anchors or mechanical anchors, or other mechanical connections providing a method of force transfer across an interface.

interface shear stress—shear stress resulting from transfer of forces at bonded interfaces between repair material and existing substrate used to achieve composite behavior.

licensed design professional—(1) an engineer or architect who is licensed to practice structural design as defined by the statutory requirements of the professional licensing laws of a state or jurisdiction; (2) the engineer or architect, licensed as described, who is responsible for the structural design of a particular project (also historically engineer of record).

nominal load—magnitude of load specified by the design-basis code before application of any load factor.

nonstructural concrete—any element or portion thereof made of plain or reinforced concrete that is not required to transfer gravity load, lateral load, or both, along a load path of a structural system to the ground.

Owner—corporation, association, partnership, individual, or public body or authority with whom the contractor enters into an agreement and for whom the work is provided. The Owner is the party in legal possession of the structure.

potentially dangerous—(1) structural state of existing concrete within a work area for an individual structural member, structural system, or structure meets the definition of dangerous or unsafe, is unstable, has potential of collapse of overhead components or pieces (falling hazards), has

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The definition is different from the IEBC definition of an existing building. The IEBC definition is "A building erected prior to the date of adoption of the appropriate code, or one for which a legal building permit has been issued." When using this code with the IEBC, use of the IEBC definition is appropriate.

This definition is adopted from "ACI Concrete Terminology."

Potentially dangerous conditions of an existing concrete member, system, or structure include conditions that may be defined as dangerous or unsafe in the IEBC. These conditions may be overtly hazardous, dangerous, or unsafe depending

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been determined to have demand/capacity ratio exceeding the limit of Section 4.3.2.2 or has potentially hazardous resistance for seismic events. (2) A limit state of unacceptably low margin of safety against collapse without supplemental resistance.

rehabilitation—repairing or modifying an existing structure to a desired useful condition.

repair—the reconstruction or renewal of concrete parts of an existing structure for the purpose of its maintenance or to correct deterioration, damage, or faulty construction of members or systems of a structure.

repair reinforcement—reinforcement used to provide additional strength, ductility, confinement, or any combination of the three, to the repaired member.

repair, structural—restoring a damaged or deteriorated structure or increasing the capacity of a structure.

repair system—the combination of existing and new components, which may include existing reinforcement, repair materials, supplementary reinforcement and supplemental structural members.

retrofit—modification of an existing member, system, or structure to increase its strength, ductility, or both as a means of improving the seismic performance of the structure.

serviceability—structural performance under service conditions.

shoring—props or posts of timber, steel, or other material used for the temporary support of excavations, formwork, members during repairs, or potentially dangerous structures; the process of erecting shores.

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on the circumstances or load probability between the time of determination and repair.

This definition is adapted from ACI Concrete Terminology – "the process of repairing or modifying a structure to a desired useful condition." The definition is specific for concrete rehabilitation and is inclusive of the IEBC definition – "Any work, as described by the categories of work defined herein, undertaken in an existing building." Herein, concrete rehabilitations include: repair to restore original capacity; strengthening to increase the capacity to the current building code requirements; seismic retrofits per ASCE/SEI 41; and modifications addressing additions, alterations, and change of occupancy.

The definition of repair from ACI Concrete Terminology is "to replace or correct deteriorated, damaged, or faulty materials, components, or elements of a structure." The definition of repair from IEBC is "The reconstruction or renewal of any part of an existing building for the purpose of its maintenance or to correct damage." The definition herein is adapted from the IEBC and is specific for repair of materials, components, or elements of existing concrete structures where structural repair or durability is addressed. Faulty materials, components, or elements of a structure are interpreted to be faulty construction resulting from errors or omissions in design or construction.

This definition is adapted from ACI Concrete Terminology – "increasing the load-carrying capacity of a structural component beyond its current capacity or restoring a damaged structural component to its original design capacity." Herein, the definition addresses increasing the capacity to include enhancements such as ductility of existing concrete members. Repairs to nonstructural members, whose failure would cause or result in potentially dangerous structural conditions are considered structural repairs.

Typically used to refer to seismic modifications to increase resistance in an existing structure per ASCE/SEI 41. The definition is adapted from ASCE/SEI 41 – "Improving the seismic performance of structural or nonstructural components of a building."

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specialty engineer—a licensed design professional retained by a contractor to design a delegated portion of the project.

stability, global—stability of the overall existing structure with respect to vertical support, uplift, overturning, sway instability, or sliding failure.

stability, local—the stability of an individual member or part of an individual member.

strengthening—process of increasing the capacity of an existing structure or a portion thereof.

structural analysis—process of using engineering mechanics to determine internal demands on, and capacities of a structure, member, or system.

structural assessment—the process of investigating by systematically collecting information regarding the performance of an existing structure; and evaluating the collected information to make informed decisions regarding the need for repair or rehabilitation; and detailing of findings as conclusions and reporting recommendations for the examined structural concrete work area (member, system, or structure).

COMMENTARY

The term "specialty engineer" is used in Chapter 9. In this code, the specialty engineer will typically be a licensed design professional that is retained by the contractor to design specific types of components such as precast concrete or shoring members.

This definition with specific details for existing concrete is adapted from ASCE/SEI 11 – "Systematic collection and analysis of data, evaluation, and recommendations regarding the portions of an existing structure which would be affected by its proposed use."

A structural assessment is the process of acquiring knowledge of the existing structure used for the purpose of judging the future performance. The results of the investigation and evaluation are used to make decisions on the appropriate course of action regarding the future use of the structure and the suitability of the structure to continue in service.

Herein, assessments should be limited to the work area and may include:

(a) Investigation of the in-place condition of the existing structure by:

- i. Collection and review of field data for the structure, such as geometry, material strengths, conditions, symptoms of distress, extent of damage, measurement of displacements, environmental factors and reinforcement sizes, and placement
- ii. Collection of background data, such as construction plans, construction records, original, current, and code governing existing buildings, and historical events

(b) Evaluation of an existing structure, member or system of the work area (refer to commentary for structural evaluation)

(c) Findings and conclusions of the investigation and evaluation include:

- i. Define the existing structure, member, or system rehabilitation category using the assessment criteria of this code
- ii. Identify the work area, scope of work and likely cause or mechanism of damage, distress and deterioration
- iii. Identify faulty construction limitations
- iv. Evaluate test results to determine cause of failure and predict future performance.

(d) Determine repair and rehabilitation concepts, strategies, alternates and recommendations

- i. Develop cost-impact or economic study as necessary to appraise remedial work and maintenance
- ii. Describe repair and rehabilitation work recommendations

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COMMENTARY

(e) Report conclusions and recommendations include:

i. Work area limits and limitations of information collected and evaluated

ii. Assessment criteria and work of the evaluation such as calculations, tests and analyses

iii. Details of findings (conclusions) and recommendations

iv. Safety issue requirements (for example, recommendation for any temporary shoring)

structural concrete—plain or reinforced concrete in a member that is part of a structural system required to transfer gravity loads, lateral loads, or both, along a load path to the ground.

structural evaluation—the process of determining and judging the structural adequacy of a structure, member, or system for its current intended use or performance objective.

This definition is adapted from ASCE/SEI 11 – "The process of determining the structural adequacy of the structure or component for its intended use, performance, or both. Evaluation by its nature implies the use of personal and subjective judgment by those functioning in the capacity of experts." An evaluation should determine, to the best of the license design professional's knowledge, the level of quality (structural adequacy, serviceability, or durability) of an existing structure based upon a measured criteria and the judgment of the licensed design professional. An evaluation may require professional judgment to gage structural adequacy. Structural analyses may be required to determine possible ranges of existing structure capacities and variations in demands. The goal of the evaluation process is to appraise the in-place condition to determine adequacy for current or proposed future use. Structural evaluation requires determining capacity and demand, which may vary widely depending on the acquired information, tests, models, and analyses; determining the demand-capacity ratios; and judging structural reliability limits, which may be open to interpretation based on project requirements, structural experience, knowledge, and past performance.

Evaluation activities may include:

(a) Tests to confirm reinforcement location, strength of material properties or structural capacity of existing members or systems or for presence of contaminants.

(b) Analysis of test results to establish reinforcement, statistical equivalent material properties, limits of faulty construction, and structural capacity

(c) Screening of observations and tests for mechanisms and causes of damage, distress, and deterioration

(d) Establishing the assessment criteria

(e) Calculating demand loadings, serviceability limits, lateral displacements, and durability requirements

(f) Analysis of the structure to determine the capacity of the structure to withstand current or future load demands and comply with serviceability limits

i. Determination of demand-capacity ratios to appraise structural adequacy, ascertain classifications, and judge the need for repair and rehabilitation

ii. determination of maintenance requirements necessary for the service life of the structure

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substantial structural damage—except when using Appendix A, substantial structural damage shall be as defined in the IEBC.

When using this code as a stand-alone code, substantial structural damage shall be as defined in A.4.

temporary bracing—non-permanent supplemental members added to an existing structure to prevent local or global instability during assessment and repair construction.

undercutting—concrete removal around the reinforcement circumference to allow for existing reinforcement to be encapsulated in repair material.

COMMENTARY

The definition of substantial structural damage is from the IEBC. The definition has been modified, as noted in A.4, when using this code as a stand-alone code.

CODE

CHAPTER 3—REFERENCED STANDARDS

American Concrete Institute

ACI 216.1-14—Code Requirements for Determining Fire Resistance of Concrete and Masonry Construction Assemblies

ACI 318-19—Building Code Requirements for Structural Concrete and Commentary

ACI 369.1-17—Standard Requirements for Seismic Evaluation and Retrofit of Existing Concrete Buildings

ACI 437.2-13—Code Requirements for Load Testing of Existing Concrete Structures and Commentary

ACI 440.6-08—Specification for Carbon and Glass Fiber-Reinforced Polymer Bar Materials for Concrete Reinforcement

ACI 440.8-13—Specification for Carbon and Glass Fiber-Reinforced Polymer (FRP) Materials Made by Wet Layup for External Strengthening of Concrete and Masonry Structures

American Institute of Steel Construction

ANSI/AISC 360-16—Specification for Structural Steel Buildings

American Society of Civil Engineers

ASCE/SEI 7—Minimum Design Loads for Buildings and Other Structures

ASCE/SEI 37—Design Loads on Structures during Construction

ASCE/SEI 41—Seismic Evaluation and Retrofit of Existing Buildings

American Welding Society

AWS D1.4/D1.4M:2011—Structural Welding Code—Reinforcing Steel

ASTM International

ASTM A15—Specification for Billet-Steel Bars for Concrete Reinforcement (withdrawn 1969)

ASTM A16—Specification for Rail-Steel Bars of Concrete Reinforcement (withdrawn 1969)

ASTM A61—Specification for Deformed Rail Steel Bars for Concrete Reinforcement with 60,000 psi Minimum Yield Strength (withdrawn 1969)

ASTM A160—Specification for Axle-Steel Bars for Concrete Reinforcement (withdrawn 1969)

ASTM A185/A185M-18—Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete (withdrawn 2013)

ASTM A370-14—Standard Test Methods and Definitions for Mechanical Testing of Steel Products

ASTM A408—Specification for Special Large Size Deformed Billet-Steel Bars for Concrete Reinforcement (withdrawn 1968)

ASTM A431—Specification for High-Strength Deformed Billet-Steel Bars for Concrete Reinforcement with 75,000 psi Minimum Yield Strength (withdrawn 1968)

COMMENTARY

R3—REFERENCED STANDARDS

Both current and withdrawn standards are referenced. Standards that are referenced in the design-basis code are applicable for the assessment of existing structures. These standards may have been withdrawn by the developing organization; however, they provide information on the materials used at the time of original construction. Refer to 4.3.3 and Chapter 6.

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COMMENTARY

ASTM A432—Specification for Deformed Billet Steel Bars for Concrete Reinforcement with 60,000 psi Minimum Yield Point (withdrawn 1968)

ASTM A497/A497M—Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete (withdrawn 2013)

ASTM A615/A615M-14—Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

ASTM A616/A616M-96a—Standard Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement (withdrawn 1999)

ASTM A617/A617M-96a—Standard Specification for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement (withdrawn 1999)

ASTM A706/A706M-14—Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement

ASTM A955/A955M-15—Standard Specification for Deformed and Plain Stainless Steel Bars for Concrete Reinforcement

ASTM A1061/A1061M-09—Standard Test Methods for Testing Multi-Wire Steel Strand

ASTM C42/C42M-13—Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

ASTM C823/C823M-12—Standard Practice for Examination and Sampling of Hardened Concrete in Constructions

ASTM C1580-15—Standard Test Method for Water-Soluble Sulfate in Soil

ASTM C1583/C1583M-13—Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)

ASTM D516-16—Standard Test Method for Sulfate Ion in Water

ASTM D4065-12—Standard Practice for Plastics: Dynamic Mechanical Properties: Determination and Report of Procedures

ASTM D4130-15—Standard Test Method for Sulfate Ion in Brackish Water, Seawater, and Brines

ASTM E329-14a—Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

BSI Group

BS EN 1504-10:2017—Products and systems for the protection and repair of concrete structures. Definition, requirements, quality control and evaluation of conformity. Site application of products and systems and quality control of the works

International Code Council

IBC—International Building Code

IEBC—International Existing Building Code

CODE

CHAPTER 4—CRITERIA WHEN USING THIS CODE WITH THE INTERNATIONAL EXISTING BUILDING CODE (IEBC)

4.1—General

4.1.1 This chapter applies if a jurisdiction has adopted the International Existing Building Code (IEBC) as the existing building code. When this chapter is used, Appendix A does not apply.

4.1.2 The design-basis code criteria of the project shall be determined based upon the results of the preliminary assessment (1.7) and the detailed assessment (Chapter 6), if performed, using the requirements set forth in this chapter.

4.1.3 It shall be permitted to use the current building code in place of the original building code as the design-basis criteria for all damage states, deterioration, faulty design, or faulty construction.

4.1.4 It shall be permitted to use this code in conjunction with the IEBC to determine the work category as shown in Table 4.1.4.

COMMENTARY

R4—CRITERIA WHEN USING THIS CODE WITH THE INTERNATIONAL EXISTING BUILDING CODE (IEBC)

R4.1—General

R4.1.1 Appendix A is used when this code is used for existing concrete structures as a stand-alone code without the IEBC and may be used to supplement provisions of Chapter 34 in 2012 and previous versions of the IBC.

R4.1.2 Structures constructed under previously adopted codes or before the adoption of a building code may not satisfy all current building code requirements. This Code and the IEBC contain specific requirements that determine if existing structures should be repaired, rehabilitated, or retrofitted to satisfy the requirements of the design-basis code. Local ordinances may also require that a structure be rehabilitated to satisfy the current codes. These requirements should be reviewed at the start of a project.

In the absence of mandatory local ordinances, the licensed design professional should determine if a seismic evaluation is necessary for potentially hazardous conditions using Section 4.3.3. Section 4.3.3 provides minimum assessment criteria for potentially hazardous seismic conditions. Provisions of ASCE/SEI 41 may be applicable to nonbuilding structures being assessed.

R4.1.3 Refer to Section R1.2.4.3.1 for additional commentary on use of current building code as the design-basis criteria.

R4.1.4 Unless the local jurisdiction provides more restrictive requirements, this chapter with the IEBC should be used to determine the assessment and design-basis criteria based on the work category of Table 4.1.4.

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Table 4.1.4—Design-basis code criteria references for work categories

Work category	Design-basis code criteria reference
Potentially dangerous structural conditions for gravity and wind loads	4.3.2
Potentially hazardous structural conditions for seismic resistance in regions of high seismicity	4.3.3
Substantial structural damage, definition	IEBC
Substantial structural damage to vertical elements of the lateral-force-resisting system	IEBC
Substantial structural damage to vertical elements of the gravity-load-resisting system	IEBC
Damage less than substantial structural damage with strengthening	4.5
Damage less than substantial structural damage without strengthening	4.6
Deterioration and faulty construction with strengthening	4.5
Deterioration and faulty construction without strengthening	4.6
Additions	IEBC
Alterations	IEBC
Changes in occupancy	IEBC

4.1.5 This code shall be used to assess and design repairs of existing structures. The current building code shall be used to detail new concrete members and connections between new concrete members and existing construction. When the original building code is used as the design-basis criteria for repairs and new concrete or reinforcing members are integrated with the repairs, the original building code shall be used for design; otherwise, these new members shall be designed using the current building code.

4.1.6 In design of repair to existing structures using the original building code, detailing of the existing reinforcement within the work area need not comply with the current building code, if both of the following conditions are satisfied:

(a) The damage or deterioration to the existing reinforcement is addressed

(b) The repaired work area of the structure has capacity equal to or greater than demand per 5.2.2 using the original building code requirements or satisfies the requirements of 4.5.3 when using allowable stress design

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R4.1.5 New member or reinforcement that is part of the work area repairs and built jointly with the existing structure should be designed using the same criteria as other repairs to the structure. However, the detailing of new members and detailing of added reinforcement, including connections to the existing structure, should comply with the current building code.

R4.1.6 The licensed design professional should review the development of existing reinforcing steel, when cracking damage is evident near the ends of reinforcement, to determine if the cracking is indicative of potential development failure beyond the restrictions of this section. Research has shown that development length equations from previous versions of ACI 318 may be unconservative for top cast plain reinforcing steel bars (Feldman and Cairns 2017). Significant changes have occurred in the building code requirements increasing the development of reinforcing steel.

When the basis of design is the current building code, the licensed design professional should consider the following:

(a) Assessing demand/capacity ratios for the existing reinforcing steel with current development length provisions

(b) Confinement details of the reinforcement when assessing seismic resistance

The licensed design professional should determine if structural behavior indicates adequate performance. ACI

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COMMENTARY

224.1R, ACI 437R, and ACI 437.1R provide guidance in judging acceptable performance.

4.2—Compliance method

4.2.1 The compliance method selected and the design-basis criteria shall be used consistently for all assessment and rehabilitation design, excluding other options.

R4.2—Compliance method

R4.2.1 For all existing structures, only one of the compliance methods listed in the IEBC should be used and these should not be used in combination with each other.

4.3—Potentially dangerous structural conditions

4.3.1 A structural assessment shall be performed in the work area to determine if potentially dangerous structural conditions are present when there is a reason for the licensed design professional to question the capacity of the structure or when potentially dangerous structural conditions are observed as a part of the preliminary assessment.

4.3.1.1 Potentially dangerous structural conditions shall be reported in accordance with 1.5.2.

R4.3—Potentially dangerous structural conditions

R4.3.1 Structural assessments are required when damage, deterioration, structural deficiencies or behavior are observed during the preliminary assessment that are unexpected or inconsistent with available construction documents. The structural condition assessment will be performed in accordance with 1.7 or Chapter 6, or both. The commentary to 1.7.4 has information on methods to determine if there is a reason to question the capacity of the structure. Results of the condition assessment should also be reviewed to identify if potentially dangerous structural conditions are present. Potentially dangerous structural conditions include any instability, the potential for collapse of overhead components or pieces (falling hazards), or a significant risk of collapse exists under service load conditions.

4.3.2 For gravity, fluid, soil, and wind loads, potentially dangerous structural conditions exist in members or structures where the demand/capacity ratio is greater than 1.5, as shown in Eq. (4.3.2).

$$U_c/\phi R_{cn} > 1.5 \qquad (4.3.2)$$

In Eq. (4.3.2), U_c is the strength design demand determined by using the nominal loads identified in the current building code and the factored load combinations of ASCE/SEI 7, excluding seismic forces; and ϕR_{cn} is the capacity adjusted by the strength reduction factor ϕ in Section 5.3 or 5.4 of this code.

4.3.2.1 If the demand/capacity ratio exceeds 1.5 for the work area, the design-basis criteria shall be the current building code.

4.3.2.2 For structures with no potentially dangerous conditions, Sections 4.4 through 4.9 shall be used to determine the design-basis criteria.

R4.3.2 Demand/capacity ratios are used to quantify the adequacy of the member or structure. The threshold demand/capacity ratios determine when different levels of intervention may be required. For each demand/capacity ratio, this code provides direction on how the demand and capacity are determined. Demands may be determined based upon loads associated with current building codes (U_c as defined above) or loads specified during the original design of the structure (U_o as defined in Section 4.5.1). The calculated capacity of the structure will vary depending upon the condition of the structure and extent of evaluation used to confirm as-built properties of the structure.

In assessing potentially dangerous structural conditions, the demand of Eq. (4.3.2) combines current building code nominal gravity loads (dead, live and snow) with lateral loads from fluid, soil and wind (excluding seismic forces), using the factored load combinations of ASCE/SEI 7. A demand/capacity ratio greater than 1.5, calculated using Eq. (4.3.2), represents a condition with limited to potentially no margin of safety against failure for ASCE/SEI 7 loads (Stevens and Kesner 2016).

In the assessment of potentially dangerous structural conditions, the licensed design professional should determine if it may be appropriate to include structural redundancies, alternate load paths, primary and secondary supporting elements, redistribution of loads, collapse mechanisms, reduced live loads, measured displacements (sagging, listing, leaning and tilting), second-order effects, and other loads specific to the structure, such as drifting snow, self-straining loads, ice, and floods. References for potentially dangerous structural conditions are Galambos et al. (1982), Ellingwood et al. (1982), and Ellingwood and Ang (1972). These references

CODE

4.3.3 Assessment criteria for potentially hazardous structural conditions of concrete structures for seismic loads, unless addressed by the authority having jurisdiction, are limited to potentially harzardous conditions associated with Structural Performance Level, Collapse Prevention of structures in Seismic Design Category D, E, and F of ASCE/SEI 7 using Earthquake Hazard Level, BSE-1E, and shall be determined using ASCE/SEI 41 and this Code. The design-basis criteria for retrofit design and construction to address potentially hazardous seismic conditions in concrete structures shall be this Code and ASCE/SEI 41.

4.4—Substantial structural damage

4.4.1 Substantial structural damage shall be assessed and rehabilitated as referenced in Table 4.1.4.

4.5—Conditions of deterioration, faulty construction, or damage less than substantial structural damage with strengthening

If a work area of a structure has damage less than substantial structural damage, deterioration, or contains faulty construction, and there is a reason for the licensed design professional to question the capacity of the member, system, or structure of the work area, it shall be assessed by checking one of the criteria in sections 4.5.1, 4.5.2, or 4.5.3 as selected by the licensed design professional. Sections 4.5.1 through 4.5.3 shall not be applied in combination with each other.

4.5.1 The demand/capacity ratio of the member, system, or structure of the work area shall be evaluated using the original building code demand (U_o) with nominal loads, factored load combinations, and capacities of the original building code to determine if the demand/capacity ratio exceeds 1.0, as shown in Eq. (4.5.1).

$$U_o/\phi_o R_{cn} > 1.0 \tag{4.5.1}$$

In Eq. (4.5.1), U_o is the strength design demand determined by using the nominal loads and factored load combinations of the original building code. ϕR_{cn} is the capacity adjusted by the reduction factor (ϕ_o) of the original building code.

If $U_o/\phi_o R_{cn}$ is greater than 1.0, then strengthening repairs are required and shall be permitted to restore the structural capacity required by the original building code.

Repair of the existing concrete structure shall be permitted to restore a member, system, or structure of the work area to the capacity of the original building code based on the material properties of the original construction. New concrete members and connections to existing construction shall

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provide basic probability theory and concepts for an evaluation using the specific details of the demand as it relates to the capacity with the strength reduction factors of Section 5.3 for new concrete structures.

R4.3.3 Compliance with ASCE/SEI 41 for Structural Performance Level, Collapse Prevention using an applicable Earthquake Hazard Level, BSE-1E should be reviewed and approved by the local authority having jurisdiction for the assessment of potentially harzardous seismic conditions of concrete structures. Assessment of potentially hazardous seismic conditions for concrete structures is not required for structures in regions of low or moderate seismicity. If no requirements for potentially hazardous seismic structural conditions are provided by the local authority having jurisdiction, the licensed design professional should refer to ATC-78, the IEBC and ASCE/SEI 41 appendices for guidance.

R4.5—Conditions of deterioration, faulty construction, or damage less than substantial structural damage with strengthening

R4.5.1 Concrete structures with damage less than substantial structural damage, deterioration, or containing faulty construction have historically been restored to the strength of the original building code.

The demand/capacity ratio limit of 1.0 as provided in this section allows strengthening repair that restores the structural reliability of the existing structure to the level prior to damage and deterioration when that repair is greater than that intended in the original building code.

Historical performance is often an acceptable indicator of adequate safety if the structure has been subjected to known loads even if the demand in the original building code was significantly different from the current building code.

If the capacity of the structure is not in question, such as indicated by the commentary provisions of R1.7, assessment checks are not required.

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comply with provisions of 4.1.5. If $U_o/\phi_o R_{cn}$ is 1.0 or less, then strengthening repairs are not required.

4.5.2 An alternative assessment criteria shall be permitted when approved by authority having jurisdiction using engineering principles for the member, system, or structure of the work area of the existing structure.

COMMENTARY

R4.5.2 An assessment criterion other than the current building code or ASCE/SEI 41 may be used. The references of R4.3.2 should be considered in the selection of applicable assessment criterion. Beyond using the current building code, the assessment criteria should address if the demand or capacity of the original structure or member is significantly inconsistent with current standards resulting in unacceptable structural safety. An increase in load intensity; added loads; changes in load factors, strength reduction factors, or load combinations; modification of analytical procedures; or changes in the determined capacity between the original and current building code (such as a change from allowable stress design [ASD] to strength design) should lead the licensed design professional to question the applicability of using the original building code for the assessment of an existing structure. Engineering principles used to determine acceptable structural safety are to use either a probabilistic evaluation of loads and capacities to show adequate structural reliability indices or an evaluation procedure using demand/capacity ratios that are derived from the basic engineering principles as presented in current standards.

An assessment criterion for a structure that has damage less than substantial structural damage, deterioration, or faulty construction that is based on the demand/capacity ratio threshold of 1.05 using the original building code or 1.1 using the current building code is the following:

a) If the current building code demand (U_c) exceeds the original building code demand (U_o^*) increased by 5 percent ($U_c > 1.05U_o^*$), check the demand/capacity ratio using the current building code demand (U_c) to determine if it exceeds 1.1, as shown in Eq. (R4.5.2a).

$$U_c/\phi R_{cn} > 1.1 \qquad \text{(R4.5.2a)}$$

If the demand/capacity ratio exceeds 1.1, then that system or member should be strengthened using the current building code demand. If the demand/capacity ratio does not exceed 1.1, then no strengthening is required.

b) If the current building code demand (U_c) does not exceed the original building code demand (U_o^*) increased by 5 percent ($U_c \leq 1.05U_o^*$), check the demand/capacity ratio using the original building code demand (U_o^*) to determine if it exceeds 1.05, as shown in Eq. (R4.5.2b).

$$U_o^*/\phi R_{cn} > 1.05 \qquad \text{(R4.5.2b)}$$

If the demand/capacity ratio exceeds 1.05, then that system or member strength should be restored using the original building code demand. If the demand/capacity ratio does not exceed 1.05, then strengthening is not required.

In this assessment criterion, the strength reduction factors (ϕ) of Section 5.3 or 5.4 shall be applied in both Eq. (R4.5.2a) and (R4.5.2b).

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The current building code strength design demand (U_c) combines current building code nominal gravity loads (dead, live, and snow) with lateral loads from fluid, soil, wind, and seismic using the factored load combinations of ASCE/SEI 7. The original building code strength design demand (U_o^*) combines original building code nominal gravity loads (dead, live, and snow) and lateral loads from fluid, soil, wind, and seismic using the factored load combinations of ASCE/SEI 7.

It may be appropriate to consider detailing requirements for ductility when considering seismic resistance, redistribution of internal member forces, reduced live loads, measured displacements (sagging, listing, leaning, and tilting), second-order effects, and other loads specific to the work area of the structure, such as drifting snow, lateral earth and fluid pressures, self-straining loads, ice, and floods.

The use of structure-specific data is acceptable, if substantiated by the licensed design professional. For these assessment criteria, the demand/capacity ratio provisions in R4.5.2a may be used in the assessment, whether the current building code demand does or does not exceed the original building code demand increased by 5 percent.

4.5.3 If the concrete design criteria of the original building code only used allowable stress design, an alternate to using 4.5.2 strength design criteria is to evaluate the demand/capacity ratio of the member, system, or structure of the work area based on allowable stress design load combinations for demand (U_s) and resistance calculated using allowable stresses (R_a) as shown in Eq. (4.5.3).

$$U_s/R_a > 1.0 \tag{4.5.3}$$

If the demand/capacity ratio exceeds 1.0, then strengthening repairs are required and shall be permitted to restore the structural capacity as required by the original building code. If the demand/capacity ratio is 1.0 or less, then strengthening repairs are not required.

Repair of the existing concrete structure shall be permitted to restore a member or system of the work area to the capacity of the original building code based on the material properties of the original construction. New concrete members and connections to existing construction are part of the repair and shall comply with provisions of 4.1.5.

R4.5.3 Before the "Building Code Requirements for Reinforced Concrete (ACI 318-63)" in 1963, the design of reinforced concrete structures was based upon allowable stress or working stress design principles. Original building code demands should include nominal gravity loads (dead, live, and snow) and lateral wind forces or seismic forces using the load combinations of original building code. Displacements (sagging, listing, leaning, and tilting), second-order effects, and other loads specific to the work area of the structure, such as drifting snow, lateral earth pressures, self-straining loads, ice, and floods should be considered.

Using allowable stress design is inconsistent with the reliability principles of current strength design provisions. To adequately address current safety levels, consideration should be given to verification using strength design provisions of 4.5.2. It may be appropriate to consider detailing requirements for ductility when considering seismic resistance.

4.5.4 Existing structures other than those to be strengthened per 4.3 through 4.5 shall use 4.6 through 4.9 to determine the design-basis criteria.

4.6—Conditions of deterioration, faulty construction, or damage less than substantial structural damage without strengthening

4.6.1 If less-than-substantial structural damage is present, structures damaged, deteriorated, or containing faulty construction that do not require strengthening in accordance

R4.6—Conditions of deterioration, faulty construction, or damage less than substantial structural damage without strengthening

R4.6.1 Serviceability requirements including deflection limits and crack control reinforcement in the current building code are not requirements of this code, but should be considered in the assessment and repair of existing structures.

CODE

with 4.5 shall use Chapters 7 through 10 of this code as the design-basis criteria.

4.7—Additions

4.7.1 The existing structure shall be assessed and rehabilitated in accordance with structural requirements of the IEBC per Table 4.1.4 for Additions.

4.8—Alterations

4.8.1 The existing structure shall be assessed and rehabilitated in accordance with structural requirements of the IEBC per Table 4.1.4 according to Alteration level 1, 2, or 3.

4.9—Change of occupancy

4.9.1 The existing structure shall be assessed and rehabilitated in accordance with structural requirements of the IEBC per Table 4.1.4 for changes of occupancy.

COMMENTARY

R4.8—Alterations

R4.8.1 Alterations in this section exclude the remedial work of 4.3 through 4.6.

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CHAPTER 5—LOADS, FACTORED LOAD COMBINATIONS, AND STRENGTH REDUCTION FACTORS

5.1—General

5.1.1 If this code is part of the design-basis code, the load factors, load combinations, and strength reduction factors in this chapter shall be used for the assessment of the existing structure and the design of rehabilitation.

5.1.2 It shall not be permitted to use load factors and load combinations from the original building code with strength reduction factors from this chapter. It shall not be permitted to use load factors and load combinations from this chapter with strength reduction factors from the original building code.

5.1.3 For work areas subjected only to construction activity and not subjected to design occupancies, it shall be permitted to determine factored loads on only those areas in accordance with ASCE/SEI 37.

5.1.4 When assessing an existing structure, consideration shall be given to effects caused by loads or imposed deformations that the structure is subjected to, if required by the authority having jurisdiction, even if such effects may not have been specified in the original building code.

5.2—Load factors and load combinations

5.2.1 Design of rehabilitation shall account for existing loads and imposed deformations of the structure; the effects of load redistribution due to damage, deterioration, or load removal; and the sequencing of load application, including construction and shoring loads, during the rehabilitation process.

5.2.2 Structural assessment shall consider whether the design strengths of members and connections in the work area are sufficient to resist the factored load combinations required by this Code. In the rehabilitation design, the structural members and connections shall have design strengths at least equal to the required strengths calculated for the factored load combinations as required by this Code.

5.2.3 Required strength U shall be at least equal to the effects of factored load combinations as specified in the design-basis code.

5.2.4 Required strength U shall include internal load effects due to reactions induced by prestressing with a load factor of 1.0.

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R5—LOADS, FACTORED LOAD COMBINATIONS, AND STRENGTH REDUCTION FACTORS

R5.1—General

R5.1.1 Load factors, load combinations, and strength reduction factors are intended to achieve consistent acceptable levels of safety among all the structural elements in a system. They are obtained through rational design code calibration procedures that consider the accuracy of the strength prediction models and on the expected loads during the design service life of the structure.

R5.1.2 Mixing of load factors and load combinations from one code with strength reduction factors from a different code may result in an inconsistent level of safety.

R5.1.3 This provision permits the less stringent loads and load factors in ASCE/SEI 37 to be applied for areas designated for construction activity and not subjected to design occupancies.

R5.1.4 Examples of such loads include vibration or impact loads. Examples of such imposed deformations include unequal settlement of supports, sagging, and listing, leaning and tilting, and those due to prestressing, shrinkage, temperature changes, and creep.

R5.2—Load factors and load combinations

R5.2.2 The basic requirement for strength design or assessment is expressed as:

design strength (for example, capacity) ≥ required strength (for example, demand)

$$\phi(R_n) \geq U$$

The design strength is the nominal strength multiplied by the strength reduction factor ϕ.

R5.2.3 The required strength U is expressed in terms of factored loads, which are the product of specified nominal loads multiplied by load factors.

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5.2.5 For post-tensioned anchorage zone design or evaluation, a load factor of 1.2 shall be applied to the maximum prestressing reinforcement jacking force.

5.3—Strength reduction factors for rehabilitation design

5.3.1 Design strength provided by a member, its connections to other members, and its cross sections, in terms of flexure, axial load, shear, and torsion, shall be taken as the nominal strength calculated in accordance with requirements and assumptions of this code, multiplied by the strength reduction factors ϕ in 5.3.2 and 5.3.4.

5.3.2 The strength reduction factor ϕ shall be shown in Table 5.3.2.

Table 5.3.2—Maximum strength reduction factors for rehabilitation design

Strength	Classification	Transverse reinforcement	ϕ
Flexure, axial, or both	Tension-controlled*		0.90
	Compression-controlled†	Spirals‡	0.75
		Other	0.65
Shear, torsion, or both			0.75
Interface shear			0.75
Bearing on concrete§			0.65
Post-tensioned anchorage zones			0.85
Struts, ties, nodal zones and bearing areas in strut-and-tie models			0.75

*Applies when the steel tensile strain at member failure exceeds $2.5\varepsilon_y$, where ε_y is the yield strain of the tensile reinforcement.

†Applies when the steel tensile strain at member failure does not exceed ε_y. For sections in which the net tensile strain in the extreme tension steel at nominal strength is between the limits for compression-controlled and tension-controlled sections, linear interpolations of ϕ shall be permitted.

‡Spirals shall satisfy 10.7.6.3, 20.2.2, and 25.7.3 of ACI 318-14.

§Does not apply to post-tensioned anchorage zones or elements of strut-and-tie models.

5.3.3 Computation of development lengths do not require a ϕ-factor.

5.3.4 For flexure, compression, shear, and bearing of structural plain concrete, ϕ shall be 0.60.

5.4—Strength reduction factors for assessment

5.4.1 If the required structural element dimensions and location of reinforcement are determined in accordance with

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R5.2.5 The load factor of 1.2 applied to the maximum tendon jacking force results in a design load that exceeds the typical prestressing yield strength. This compares well with the maximum attainable jacking force. For jacking loads less than the maximum tendon jacking force, or for jacking loads applied to nonmetallic prestressing tendons, design of the anchorage for 1.2 times the anticipated jacking force is appropriate given that the jacking load is controlled better than typical dead loads.

R5.3—Strength reduction factors for rehabilitation design

R5.3.2 For a steel yield strength of 60 ksi, the steel tensile strains corresponding to the tension- and compression-controlled limits are 0.005 and 0.002, respectively. Because the compressive strain in the concrete at nominal strength is typically assumed to be 0.003, the net tensile strain limits for compression-controlled members may also be stated in terms of the ratio c/d_t, where c is the depth of the neutral axis at nominal strength, and d_t is the distance from the extreme compression fiber to the centroid of extreme tension reinforcement. The c/d_t limits for tension- and compression-controlled sections are 0.375 and 0.6, respectively. The 0.6 limit for compression-controlled sections applies to sections reinforced with Grade 60 steel and to prestressed sections. For other grades of steel reinforcement, the term c/d_t is a function of the yield strain of the steel reinforcement (ε_y). The c/d_t ratio is calculated as $c/d_t = 0.003/(0.003 + \varepsilon_y)$.

R5.4—Strength reduction factors for assessment

R5.4.1 Strength reduction factors given in 5.4.1 are larger than those in 5.3.1. These increased values are justified by the

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Chapter 6, and material properties are determined in accordance with 6.4, it shall be permitted to increase ϕ from those specified in 5.3, but ϕ shall not exceed the values shown in Table 5.4.1.

Table 5.4.1—Maximum strength reduction factors for assessment

Strength	Classification	Transverse reinforcement	ϕ
Flexure, axial, or both	Tension-controlled*		1.00
	Compression-controlled†	Spirals‡	0.90
		Other	0.80
Shear, torsion, or both			0.80
Interface shear			0.80
Bearing on concrete§			0.80
Struts, ties, nodal zones, and bearing areas in strut-and-tie models			0.80

*Applies when the steel tensile strain at member failure exceeds $2.5\varepsilon_y$, where ε_y is the yield strain of the tensile reinforcement.

†Applies when the steel tensile strain at member failure does not exceed ε_y. For sections in which the net tensile strain in the extreme tension steel at nominal strength is between the limits for compression-controlled and tension-controlled sections, linear interpolations of ϕ shall be permitted.

‡Spirals shall satisfy 10.7.6.3, 20.2.2, and 25.7.3 of ACI 318-14.

§Does not apply to post-tensioned anchorage zones or elements of strut-and-tie models.

5.4.2 If an evaluation of members is based on historical material properties as given in Tables 6.3.2a through 6.3.2c, the ϕ-factors not exceeding those in 5.3 shall apply.

5.4.3 For flexure, compression, shear, and bearing of structural plain concrete, ϕ shall be 0.60.

5.5—Additional load combinations for structures rehabilitated with external reinforcing systems

5.5.1 For rehabilitation achieved with external reinforcing systems that are susceptible to damage by vandalism or impact, the required strength of the structure without rehabilitation shall equal or exceed the effects of the load combinations specified in 5.5.2. The performance of externally reinforced elements subjected to fire shall be evaluated using the load combinations specified in 5.5.3.

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improved reliability due to the use of accurate field-obtained material properties, and actual in-place dimensions. They have been deemed appropriate for use in ACI 318 and have had a lengthy history of satisfactory performance.

R5.4.3 The resistance factor for assessment of plain concrete is the same as that specified for design in 5.3.4. Material properties for plain concrete determined in accordance with 6.3.5 may increase its nominal resistance, but the strength reduction factor remains unchanged because plain concrete failures are usually brittle.

R5.5—Additional load combinations for structures rehabilitated with external reinforcing systems

R5.5.1 The additional load combinations specified in this section are intended to ensure adequate strength should the external reinforcing system be sufficiently damaged to become ineffective. External reinforcing systems should be evaluated to determine if they are susceptible to damage from accidental vehicular impact or vandalism. Alternately, the rehabilitation measures may include physical design features that protect the external reinforcing system from these types of damage. The requirements of this section are not intended for the assessment of the effect of blast loadings, blast effects or a generalized assessment of extraordinary events on structures.

The requirements of this section are not intended for the design of structures that are exposed to elevated tempera-

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5.5.2 For external reinforcing systems susceptible to damage, the required strength of the structure without such external reinforcement shall satisfy Eq. (5.5.2a) and (5.5.2b)

$$\phi R_n \geq 1.1D + 0.5L + 0.2S \qquad (5.5.2a)$$

$$\phi R_n \geq 1.1D + 0.75L \qquad (5.5.2b)$$

where D, L and S are the effects due to the dead, live, and snow loads, respectively, calculated for the rehabilitated structure; ϕ is the strength reduction factor in 5.3 or 5.4, as applicable; and R_n is the nominal strength of the structural member computed using the material properties determined from Chapter 6, without the contribution of the external reinforcing system.

5.5.2.1 If the live load has a high likelihood of being a sustained load, the live load factor in Eq. (5.5.2a) and (5.5.2b) shall be increased to 1.0.

5.5.3 Structural members with external reinforcement shall satisfy Eq. (5.5.3)

$$\phi_{ex} R \geq (0.9 \text{ or } 1.2)D + 0.5L + 0.2S \qquad (5.5.3)$$

where ϕ_{ex} = 1.0; R is the nominal resistance of the structural member, computed using the probable material properties during the fire event and considering the contribution of external reinforcement in accordance with Section 5.5.3.3; and S is the specified snow load. The dead load factor of 0.9 shall be applied when the dead load effect counteracts the total load effect.

5.5.3.1 Additional live loads incurred during a fire shall be considered, with a load factor of 1.0.

5.5.3.2 Internal forces and imposed deformations due to thermal expansion during the fire event shall be considered, with a load factor of 1.0, in determining the demands on the structural system.

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tures during routine service, such as manufacturing facilities and other industrial environments. Refer to Section 7.9.4.

R5.5.2 These load combinations are intended to minimize the risk of failure of the strengthened structural member in the case where, during normal operating conditions, the external reinforcement is damaged. Such damage may not be detected immediately and so the structure (or structural component) may remain in service until the damage is identified and addressed. The load factors for live and snow loads in Eq. (5.5.2a) correspond to the arbitrary point-in-time loadings specified in ASCE/SEI 7. Equation (5.5.2b) is compatible with ACI 440.2R.

R5.5.2.1 Examples include library stack areas, heavy storage areas, warehouses, and other storage occupancies with a live load exceeding 100 lb/ft^2.

R5.5.3 Equation (5.5.3) is intended to ensure that the repaired element will maintain sufficient strength, accounting for its probable reduced material properties due to elevated temperatures, during a fire event. If fire protection is applied to the repaired element, its effect on the external reinforcement and existing elements should be considered.

The design-basis code and ACI 216.1 should be reviewed to determine the required duration of the fire event.

Equation (5.5.3) was developed from Eq. (2.5.1) of ASCE/SEI 7-10 and is limited to the evaluation of fire effects on structures with external reinforcement. Guidance on computing the structural effects caused by the fire event is provided in 5.5.3.1 and R5.5.3.1.

Strength of the affected portion of the structure during a fire event should be based on reduced steel and concrete strengths. Guidance concerning probable material properties during a fire event may be obtained from ACI 216.1.

R5.5.3.1 Live loads associated with firefighting operations may include wetting of the building contents, which can be idealized as a live load of 20 lb/ft^2.

R5.5.3.2 Thermal expansion of a member during a fire event will generate internal thrust forces if that expansion is restrained. The generated thrust force, while potentially large, is considerably less than that computed using conventional elastic properties and thermal expansion coefficients. This thrust may increase the moment capacity and the corresponding fire endurance of the restrained member.

Procedures for calculating thermal induced thrust forces can be found in NIST (2010) and Buchanan (2001). PCI (2010) provides methods for determining (a) the magnitude and location of the thrust generated by a given fire tempera-

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	ture and duration, and (b) the increase in moment capacity caused by a known thrust force.
5.5.3.3 Any contribution of external reinforcement that is not protected using a fireproofing system shall be neglected during a fire event. The contribution of any adhesively bonded external reinforcement to the strength of a member during a fire shall be ignored.	**R5.5.3.3** Section 7.9 gives member strength requirements for protected and unprotected external reinforcing systems subjected to elevated temperatures during a fire event.
5.5.3.4 When the live load acting on the member to be strengthened has a high likelihood of being a sustained load, a live load factor of 1.0 shall be used in Eq. (5.5.3).	**R5.5.3.4** Refer to R5.5.2.1.

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CHAPTER 6—ASSESSMENT, EVALUATION, AND ANALYSIS

6.1—Structural assessment

6.1.1 A structural assessment shall be performed if required per 1.7.5. The structural assessment shall comprise 1) an investigation to establish the in-place condition of the structure in the work area, including environment, geometry, material strengths, reinforcing-steel sizes and placement, and signs of distress; 2) an evaluation to define the causes of distress and criteria for selection of rehabilitation solution(s); and 3) development of appropriate rehabilitation strategies.

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R6—ASSESSMENT, EVALUATION, AND ANALYSIS

R6.1—Structural assessment

R6.1.1 Field investigations in support of the structural assessment may include visual observations, destructive testing, and nondestructive testing (NDT). Areas of known deterioration and distress in the structural members should be identified, inspected, and recorded as to the type, location, and degree of severity. Investigation procedures are referenced in ACI 201.1R, ACI 228.1R, ACI 228.2R, ACI 364.1R, ACI 437R, ASCE/SEI 11, ASCE/SEI 41, and FEMA P-154. The affected structural members are not only members with obvious signs of distress but also contiguous members and connections in the structural system.

The data gathered to determine the existing capacity should include the following:

(1) The effects of material deterioration, such as loss of concrete strength from chemical attack; freezing and thawing

(2) Loss of steel area due to corrosion or other causes

(3) Missing or misplaced reinforcement

(4) Effects of damaging events, such earthquakes or fire

The effect of deterioration on the ductility of the member should be considered in the evaluation. The strength or serviceability of a member or structure may be compromised by spalling, excessive cracking, large deflections, or other forms of damage or deterioration. Seismic evaluation references for undamaged buildings include FEMA P-58, FEMA P-154 and ASCE/SEI 41 and for damaged buildings include FEMA 306 and FEMA 307.

Where the as-built conditions and properties of historical buildings require evaluation and rehabilitation, care should be taken to minimize the impact of repair design and investigation procedures (U.S. Department of the Interior 1995).

6.2—Investigation and structural evaluation

6.2.1 An investigation and structural evaluation shall be performed when there is a reason to question the capacity of the structure in the work area and insufficient information is available to determine if an existing structure is capable of resisting design demands.

R6.2—Investigation and structural evaluation

6.2.2 Where repairs are required to an individual member or connection in a structure, determine if similar conditions exist beyond the work area also require evaluation.

R6.2.2 If there is no evidence of damage, distress or deterioration of similar members or connections elsewhere in the work area that required repair, there is no need to perform an evaluation of similar members unless potentially dangerous conditions are present. Such conditions may be a concern if there are significant variances from the original design intent such as lower-strength concrete or insufficient reinforcement. In addition, if the similar members are in an environment that could foster deterioration, then evaluation of these members may be necessary to determine if strengthening or durability enhancements may be required.

6.2.3 An investigation shall document conditions as necessary to perform an evaluation of the structure in the work area.

R6.2.3 Conditions which may need to be documented include (a) through (g):

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(a) The physical condition of the structural members to examine the extent and location of deterioration or distress

(b) The adequacy of continuous load paths through the primary and secondary structural members to provide for life safety and structural integrity

(c) As-built information required to determine appropriate strength reduction factors in accordance with Chapter 5

(d) Structural members' orientation, displacements, construction deviations, and physical dimensions

(e) Properties of materials and components from available drawings, specifications, and other documents; or by testing of existing materials

(f) Additional considerations, such as proximity to adjacent buildings, load-bearing partition walls, and other limitations for rehabilitation

(g) Information needed to assess lateral-force-resisting systems, span lengths, support conditions, building use and type, and architectural features

The construction documents may not represent as-built conditions. Therefore, the licensed design professional is encouraged to research and verify that the material properties obtained from record documents are accurate. Material testing may be required to verify these values.

6.2.4 When an analysis is required, the analysis shall be performed in accordance with Section 6.5 and the structural evaluation shall consider the following items.

(a) As-measured structural member dimensions including the reinforcement configuration

(b) The presence and effect of alterations to the structural system

(c) Loads, occupancy, or usage different from the original design

(d) In-place material properties in accordance with 6.3

R6.2.4 The size, number, and location of the reinforcement may be needed to determine member strength. Nondestructive testing methods, including but not limited to ground-penetrating radar (GPR) and ferromagnetic testing, may be used to determine the location and spacing of reinforcement. These methods may require destructive confirmation. Additional guidance is provided in ACI 228.2R.

6.3—Material properties

6.3.1 Concrete compressive strength and steel reinforcement yield strength shall be determined for the structure if a structural evaluation is required. Nominal material properties shall be determined by (a), (b) or (c):

(a) Available drawings, specifications, and previous testing documentation

(b) Historical material properties in accordance with 6.3.2

(c) Physical testing in accordance with 6.4

R6.3—Material properties

R6.3.1 The construction documents may not represent as-built conditions. Therefore, the evaluation of material properties may require verification by material testing to confirm that the material properties obtained from record documents are representative.

Additional factors and characteristics affecting materials that may be required to be evaluated include:

(a) Ductility based on the mechanical characteristics of the component materials.

(b) Presence of corrosion of embedded steel reinforcement, including carbonation, chloride intrusion, corrosion-induced spalling

(c) Presence of other deterioration, such as alkali-silica reaction, sulfate attack, delayed ettringite formation, or other chemical attack

(d) Deterioration due to cyclic freezing and thawing

(e) Deterioration of stiffness and strength due to bar slip in cracked sections and joints damaged in seismic events

Other tests for material properties, including petrographic examination, are used.

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6.3.2 If available drawings, specifications, or other documents do not provide sufficient information to characterize the material properties, it shall be permitted to determine such properties without physical testing from the historical data provided in Tables 6.3.2a through 6.3.2c.

Table 6.3.2a—Default compressive strength of structural concrete, psi

Time frame	Footings	Beams	Slabs	Columns	Walls
1900-1919	1000	2000	1500	1500	1000
1920-1949	1500	2000	2000	2000	2000
1950-1969	2500	3000	3000	3000	2500
1970-present	3000	3000	3000	3000	3000

Note: Adopted from ASCE/SEI 41.

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The choice of tests depends on the structure, member type(s), and distress mechanism.

R6.3.2 Material properties required for seismic evaluation and rehabilitation are discussed in ASCE/SEI 41. The required material properties may include necessary physical and chemical properties of the concrete and reinforcement, and should include the required references to ASTM standards and other methods of determining physical and chemical properties.

Table 6.3.2b—Default tensile and yield strength properties for steel reinforcing bars for various periods*

		Structural†	Intermediate†	Hard†				
	Grade	33	40	50	60	65	70	75
	Minimum yield, psi	33,000	40,000	50,000	60,000	65,000	70,000	75,000
Year	Minimum tensile, psi	55,000	70,000	80,000	90,000	75,000	80,000	100,000
1911-1959		X	X	X	—	X	—	—
1959-1966		X	X	X	X	X	X	X
1966-1972		—	X	X	X	X	X	—
1972-1974		—	X	X	X	X	X	—
1974-1987		—	X	X	X	X	X	—
1987-Present		—	X	X	X	X	X	—

Note: Adopted from ASCE/SEI 41.

*An entry of "X" indicates the grade was available in those years.

†The terms "structural," "intermediate," and "hard" became obsolete in 1968. Hard grade does not correspond to metallurgical hardness.

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Table 6.3.2c—Default tensile and yield strength properties of steel reinforcement for various ASTM specifications and periods*

				Structural†	Intermediate†	Hard†				
			Grade	33	40	50	60	65	70	75
			Minimum yield, psi	33,000	40,000	50,000	60,000	65,000	70,000	75,000
ASTM designation‡	Steel type	Year range	Minimum tensile, psi	55,000	70,000	80,000	90,000	75,000	80,000	100,000
A15	Billet	1911-1966		X	X	X	—	—		
A16	Rail§	1913-1966		—	—	X	—	—		
A61	Rail	1963-1966		—	—	—	X	—		
A160	Axle	1936-1964		X	X	X	—	—		
A160	Axle	1965-1966		X	X	X	X	—		
A185	WWF	1936-present		—	—	—	—	X		
A408	Billet	1957-1966		X	X	X	—	—		
A431	Billet	1959-1966		—	—	—	—	—		X
A432	Billet	1959-1966		—	—	—	X	—		—
A497	WWF	1964-present		—	—	—	—	—	X	—
A615	Billet	1968-1972		—	X	—		—	—	X
A615	Billet	1974-1986		—	X	—	X	—		—
A615	Billet	1987-present		—	X	—	X	—		X
A616-96‖	Rail	1968-present		—	—	—	X	—		—
A617	Axle	1968-present		—	X	—	—	—		—
A706#	Low-alloy	1974-present		—	—	—	X	—	X	—
A955	Stainless	1996-present		—	X	—	X	—		X

Note: Adopted from ASCE/SEI 41.

*An entry of "X" indicates the grade was available in those years.

†The terms structural, intermediate, and hard became obsolete in 1968. Hard grade does not correspond to metallurgical hardness.

‡ASTM steel is marked with the letter W.

§Rail bars are marked with the letter R.

‖Bars marked with "s!" (ASTM A616-96) have supplementary requirements for bend tests.

#ASTM A706 has a minimum tensile strength of 80 ksi, but not less than 1.25 times the actual yield strength.

6.3.3 It shall be permitted to determine material properties through testing in accordance with 6.4.

6.3.4 The material properties provided in the original construction documents or material test reports shall be permitted to be used unless known deterioration that can affect performance has occurred.

R6.3.4 If the results of material testing from original construction are available, these results may be used in the analysis. Additional testing could be required to confirm these material test results if deterioration has occurred.

6.3.5 If historic data are not given in either Table 6.3.2b or 6.3.2c, the historic default value for yield strength f_y shall be taken as 33,000 psi.

R6.3.5 Additional guidance regarding the use of the historic lower bound default value is given in R6.4.4.1.

6.4—Test methods to quantify material and member properties

6.4.1 *General*

6.4.1.1 Destructive and nondestructive test methods used to obtain in-place mechanical properties of materials and member properties shall be in accordance with this section. Compressive strength of sound concrete shall be determined

R6.4—Test methods to quantify material and member properties

R6.4.1 *General*

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by taking and testing core samples or by a combination of cores and by the use of site specific nondestructive testing. Steel reinforcement properties shall be determined by removal of reinforcement samples and destructive testing.

6.4.1.2 The locations and numbers of material samples shall be sufficient to define the material properties of the structural element of concern. The number of samples shall be determined during evaluation.

6.4.2 *Core sampling of concrete for testing*

6.4.2.1 It shall be permitted to determine the compressive strength of sound concrete by taking cores from the members being evaluated. Steel reinforcement shall be located before locating the cores to be extracted.

6.4.3 *Concrete*

6.4.3.1 The cores shall be selected, removed, and tested in accordance with ASTM C42 and ASTM C823. The equivalent specified concrete strength f_{ceq} shall be calculated by:

$$f_{ceq} = 0.9\overline{f_c}\left[1 - 1.28\sqrt{\frac{(k_c V)^2}{n} + 0.0015}\right] \quad (6.4.3.1)$$

where $\overline{f_c}$ is the average core strength, as modified to account for the diameter, length to diameter ratio and moisture condition of the core (following ASTM C42 procedures); V is the coefficient of variation of the core strengths (a dimensionless quantity equal to the sample standard deviation divided

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R6.4.1.2 Review of available records from the original construction may be used to guide testing. Evaluation, historical research, and documentation of the geometry, material properties, and detailing used in the construction are invaluable and may be used to reduce the amount of required in-place testing. The data gathered to determine strength should include any effects of material deterioration, such as loss of concrete strength from chemical attack and loss of steel area due to corrosion. The impact of deterioration on the expected strength and ductility of the section also should be considered in the evaluation.

The minimum number of tests is influenced by the data available from the original construction, the type of structural system, the desired accuracy, and the quality and condition of the in-place materials. The focus of the prescribed material testing should be on the principal structural members and specific properties needed for analysis. The licensed design professional should determine the appropriate number and type of testing needed to evaluate the existing conditions.

Care should be taken in selecting the location for sampling concrete. Core drilling should minimize damage of the existing reinforcement and should generally occur at locations where the coring will least affect the member strength.

R6.4.2 *Core sampling of concrete for testing*

R6.4.2.1 NDT may be used to locate existing reinforcement and to avoid damage to reinforcement during coring. Guidelines for core sampling and evaluating core strength data are given in ACI 214.4R. The presence of reinforcement or other foreign material, such as conduit or wood, may adversely affect the test strength of the concrete and cores containing such foreign material should not be used for strength determination. See ASTM C42/C42M Section 5.1.3 and Note 8 for additional information.

R6.4.3 *Concrete*

R6.4.3.1 The equivalent specified strength determined using this procedure can be used in strength equations with the strength reduction factors from Chapter 5. This approach is specified in the Canadian Highway Bridge Design Code (CAN/CSA S6-14) and is based on the approach proposed by Bartlett and MacGregor (1995). Equation (6.4.3.1) is a simplification of criteria given in ACI 214.4R that gives similar results because it includes the strength correction factors for length-to-diameter ratio, core diameter, and drilling damage. The strength value obtained using this procedure is an estimate of the 13 percent fractile of the in-place concrete strength at a confidence interval of 90 percent, based on the field data collected by Bartlett and

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by the mean); n is the number of cores taken; and k_c is the coefficient of variation modification factor, as obtained from Table 6.4.3.1.

Table 6.4.3.1—Concrete coefficient of variation modification factor k_c

n	k_c
2	2.4
3	1.47
4	1.28
5	1.20
6	1.15
8	1.10
10	1.08
12	1.06
16	1.05
20	1.03
25 or more	1.02

6.4.3.2 Nondestructive strength testing to evaluate in-place strength of concrete shall be permitted if a valid correlation is established with core sample compressive strength test results and nondestructive test results. Quantifications of concrete compressive strength by NDT alone shall not be permitted as a substitute for core sampling and testing.

6.4.4 *Steel reinforcement*

6.4.4.1 If the original construction documents are not available and if the properties of the reinforcing bars are unknown, historical values provided in 6.3.2b and 6.3.2c shall be permitted in place of testing. If the grade of material is unknown, the lowest grade provided in Table 6.3.2b for a given historic period shall be used.

6.4.5 *Reinforcement sampling and testing*

6.4.5.1 Coupon samples used for the determination of the yield and tensile strength for steel reinforcement shall be obtained in accordance with ASTM A370. A minimum of three sample coupons, taken from different segments of reinforcement shall be obtained from the members being evaluated.

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MacGregor (1995). When a different strength fractile or confidence interval is required, the methods presented in ACI 214.4R may be applicable.

The core samples, tested per ASTM C42/42M, are expected to be moisture conditioned following the procedure in the ASTM standard. The correction factors in ASTM C42/42M were developed for lightweight and normal weight concrete with a compressive strength between 2,000 and 6,000 psi (14 MPa to 42 MPa). Core samples are assumed to have a maximum length-to-diameter ratio of 2.1. Bartlett and MacGregor (1994a) discuss the effect of higher compressive strengths on the length-to-diameter ratio.

ASTM C42/42M procedures require a minimum core diameter of 3.70 in. (94 mm), smaller diameter cores are likely to have more variability and a lower strength (Bartlett and MacGregor 1994b).

When the testing requirements of ASTM C42/42M are not met, the user should consult ACI 214.4R.

R6.4.3.2 ACI 228.1R provides information on NDT methods for evaluation of concrete compressive strength and development of statistical correlations between NDT and core test results.

R6.4.4 *Steel reinforcement*

R6.4.4.1 The age of the structure may be known but the grade of reinforcement may not be known. In this case, the lowest grade of reinforcement corresponding to the structure's age should be used. If the date of original construction is unknown, the lower bound value of f_y equal to 33,000 psi may be used instead of testing, provided it is conservative. In some instances, assuming higher yield strengths may be more conservative. Where the demand on one member is governed by the capacity of a connected member, it is appropriate to assign higher yield strengths to the connected member. For example, in seismic analysis at beam column joints, the moment strength of the columns should exceed the moment strength of the beams. When assessing this requirement it is more conservative to assume a higher yield strength for the beam reinforcement than for the column reinforcement.

R6.4.5 *Reinforcement sampling and testing*

R6.4.5.1 Often, the steel reinforcement in a structure is of a common grade and strength. Occasionally, more than one grade of steel is used, for example, smaller diameter (No. 3 and 4) stirrups and other complex bent bars were often fabricated with lower strength material than the longitudinal bars.

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CRSI (2014): "Vintage Reinforcement in Concrete Structures," contains supplemental information on mechanical properties of the reinforcement used in different construction eras.

Steel reinforcement information includes square, rectangular, and round bars with and without deformations, prestressing wire, bars, multi-wire strands, and structural shapes. Historically, wire rope and chain have also been used as reinforcement.

6.4.6 The equivalent specified yield strength f_{yeq} of reinforcement used for analysis shall be calculated by

$$f_{yeq} = (\bar{f}_y - 3500)e^{(-1.3k_s V)} \quad (6.4.6)$$

where $\bar{f}_y$ is the average yield strength value from the tests, in psi; V is the coefficient of variation determined from testing; n is the number of strength tests; and k_s is the steel coefficient of variation modification factor, as obtained from Table 6.4.6.

Table 6.4.6—Steel coefficient of variation modification factor k_s

n	k_s
3	3.46
4	2.34
5	1.92
6	1.69
8	1.45
10	1.32
12	1.24
16	1.14
20	1.08
25	1.03
30 or more	1.00

R6.4.6 The equivalent specified yield strength determined using this procedure can be used in strength equations with the strength reduction factors from Chapter 5. The yield strength value obtained using this procedure is an estimate of the 10 percent fractile of the static steel strength. It is assumed that the yield strength measured during a coupon test exceeds the static yield strength by 3500 psi. This approach is specified in the Canadian Highway Bridge Design Code (CAN/CSA S6-14).

The factors in Table 6.4.6 reflect the uncertainty of the sample standard deviation for a small sample size. They are the 95 percent one-sided tolerance limits on the 10 percent fractile, and they have been reduced by a constant factor to be equal to 1.0 for $n = 30$ specimens.

6.4.7 If the properties of the connector steel are unknown, strength shall be determined by (a), (b), or (c):

(a) Testing of coupons taken from the connector steel.

(b) Documentation giving connector steel properties in the original construction documents.

(c) Use of historic default values in accordance with 6.3.6.

R6.4.7 The historic default value is obtained from ASCE/SEI 41.

6.4.8 Coupon specimens for the determination of yield and tensile strengths of structural steel shall be tested in accordance with ASTM A370. A minimum of three specimens shall be taken from representative elements.

The equivalent specified yield strength f_{yeq} of each specimen shall be its reported yield strength. The f_{yeq} used for analysis shall be calculated by

$$f_{yeq} = (\bar{f}_y - 4000)e^{(-1.3k_s V)} \quad (6.4.8)$$

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where $\bar{f}_y$ is the average yield strength value from tests, in psi; V is the coefficient of variation determined from testing; n is the number of strength tests; and k_s is the steel coefficient of variation modification factor, as obtained from Table 6.4.6.

6.4.9 The sampling of prestressing steel reinforcement for strength testing shall be required if strength and historical data are not available. Testing of the prestressing reinforcement shall be in accordance with ASTM A1061/1061M.

6.4.10 If welding of existing reinforcement is required, carbon equivalent shall be determined in accordance with AWS D1.4/D1.4M.

6.5—Structural analysis of existing structures

6.5.1 The gravity and lateral-force-resisting structural systems shall be analyzed when required using loads and load combinations determined in accordance with this code that produce the maximum effects on the existing members being evaluated.

6.5.2 Analysis of the structure shall use accepted engineering principles that satisfy force equilibrium and the principles of compatibility of deformations and strains.

6.5.3 Analysis shall consider material properties, member geometry and deformation, lateral drift, duration of loads, shrinkage and creep, and interaction with the supporting foundation.

6.5.4 Members shall be analyzed considering the effect of material deterioration, bond loss, and the redistribution of forces in members and in the structural system as a whole.

6.5.5 Analysis shall consider the load path from the load application through the structure to the foundation. Three-dimensional distribution of loads and forces in the complete structural system shall be considered unless a two-dimen-

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R6.5—Structural analysis of existing structures

R6.5.1 Structural evaluation and analyses are conducted to verify strength and serviceability. The analytical methods of 6.5 are used with factored loads to determine strength requirements for a combination of flexure, shear, torsion, and axial loads of pertinent structural members. A service-load analysis may be required to evaluate serviceability issues such as deflection and cracking.

R6.5.3 The licensed design professional is responsible for determining the appropriate method of analysis. Appropriate methods include linear elastic analysis, nonlinear analysis, and other traditionally accepted engineering analysis methods. If a linear elastic analysis method is used, the effects of cracking, second-order and other nonlinear effects should be included in the analysis.

The analysis may include the effects of the size and member geometry to determine the forces on individual members of a structure. The analysis should consider external effects, including prestressing, material volume changes, temperature variations, and differential foundation movement.

R6.5.4 Member deterioration and damage may result in distribution of internal forces different than the distribution of forces of the original structural design. The strength and integrity of prestressed structures with damaged prestressing reinforcement requires careful consideration to assess the impact of the damage. The state of the structure should be accurately modeled to determine the distribution of forces. Redistribution of forces may be determined using material nonlinear analysis, by load tests described in ACI 437.2, or by linear analysis, which bounds the limits of redistributed forces.

R6.5.5 The evaluation of load effects requires consideration of both the load paths through the structure and how the forces are distributed in members.

sional analysis adequately represents the part of the structure being evaluated.

6.5.6 Analysis shall consider the effects of previous repairs and of any previous structural modifications on the behavior of the structure.

R6.5.6 Modifications to structures in the form of repairs, alterations, or additions may affect the force distribution and load path in a structure.

6.5.7 The analysis shall be based on available documentation, as-built dimensions, and the in-place properties of the structure including section loss. The determination of in-place material properties shall be in accordance with 6.3.

R6.5.7 Available documentation may include original drawings, specifications, shop drawings, structural assessments, testing, and geotechnical reports. Deviations between the existing construction and construction documents are to be identified and recorded. If section loss has occurred, a more accurate analysis may be developed by direct measurement of the section, and by calculation of section properties based on actual conditions. Additional information may be obtained in ACI 364.10T.

6.6—Structural serviceability

6.6.1 If serviceability problems are identified during the preliminary evaluation or the structural assessment, the licensed design professional shall perform a serviceability evaluation based on the existing geometry and properties of the structure.

6.6.2 The serviceability evaluation shall evaluate the structure for the intended use considering the existing geometry and properties of the structure, and shall consider such effects as existing floor levelness, support displacements, vibrations, and deflections.

R6.6—Structural serviceability

R6.6.1 Structural serviceability problems may include deflections, floor levelness, vibrations, leakage, or cracking. The data gathered to determine serviceability should include the effects of material deterioration, such as loss of concrete strength from sulfate attack or loss of steel area due to corrosion. Reference ACI 224.1R for additional information on cracking, including causation and repair.

R6.6.2 When specific concerns are raised regarding the serviceability of the structure, the effect of floor levelness, vibrations, and deflections on the structural performance should be investigated by the licensed design professional. The floor levelness, vibrations, and deflections should indicate (or be assessed to determine) if the performance of the structure is acceptable. Acceptable performance criteria will need to be established for an individual structure based upon the intended use of the structure.

The specific performance criteria and the intended function of the structure should be considered. Floor deflection criteria for new structures can be found in ACI 318. Vibration criteria are given in Fanella and Mota (2014).

Information on construction tolerances for new concrete construction is presented in ACI 117.1R; however, some of the tolerances only apply to measurement made during construction and therefore may not be appropriate to be used for existing completed construction. Refer to ATC Design Guide 1 (1999), Fanella and Mota (2014), and Wilford and Young (2006) for information on evaluation of vibration problems in concrete structures.

6.7—Structural analysis for repair design

6.7.1 The structural analysis used for repair design shall consider the structural repair process. The analysis shall consider the effects of the sequence of load application and material removal during the anticipated phases of the evaluation and repair process.

R6.7—Structural analysis for repair design

R6.7.1 The construction process may involve the application, removal and replacement of loads. The analysis needs to consider the effects of the application and removal of construction loads to determine the maximum loading during anticipated construction phases. The additional applied loads may be due to prestressing, vibration, material volume changes (such as creep and shrinkage, or tempera-

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ture changes), effect of shoring, and unequal deformation of supports.

6.7.2 Structural analysis shall account for variations in material properties through member sections.

R6.7.2 The intent of this section is to address differences in stiffness between repair material and existing substrate. In these situations, localized deformation may occur in the material with the lower modulus of elasticity, affecting the force distribution in the repaired structure.

6.7.3 Section analysis shall use principles of mechanics and shall assume either (a), (b), or (c) as deemed appropriate by the licensed design professional:

(a) Full composite action with no slip at interfaces between repair materials and existing materials

(b) Separate action with full slip between repair and existing materials

(c) Partial composite action with friction at interfaces between repair and existing materials

R6.7.3 Depending on the repair construction process and the selection of repair materials, the repair materials and the existing concrete or reinforcement may not act compositely. The analysis should model the anticipated degree of composite action of the repaired structure. An example of partial composite behavior are beams that contain shear studs to develop nominal strength, yet lack bond between the overlay and substrate. In this situation, the overlay and substrate do not maintain strain compatibility.

6.7.4 *Seismic analysis of repaired structure*

R6.7.4 *Seismic analysis of repaired structure*

6.7.4.1 The interaction of structural members and nonstructural components that affect the response of the structure to seismic motions shall be considered in the analysis.

6.7.4.2 Existing, repaired, and added supplementary members assumed not to be a part of the seismic-force-resisting system shall be permitted, provided there is no adverse effect on the seismic-force-resisting system.

6.7.4.3 The analysis shall consider the structural configuration and material properties after repair.

R6.7.4.3 Procedures for seismic rehabilitation of concrete buildings, including analysis, are provided in ASCE/SEI 41, which incorporates ACI 369R. These references provide details for forces, rehabilitation methods, analysis and modeling procedures, and seismic rehabilitation design. Additional references for repair of building damage by a seismic event and rehabilitation of concrete buildings include FEMA 308, FEMA 395 through FEMA 400, and FEMA 547.

6.8—Strength evaluation by load testing

6.8.1 Load testing in accordance with ACI 437.2 shall be permitted to supplement an analysis or to demonstrate the strength of the original or repaired structure.

R6.8—Strength evaluation by load testing

R6.8.1 Information obtained during a structural assessment may be insufficient to determine the strength or serviceability of deteriorated or repaired structural members. Structural condition assessments, including destructive testing, can provide some of the information required, but the costs for these assessments can be significant. Further, the results of a structural evaluation may still be inconclusive due to unknown effects of existing conditions or interaction with the repair. In such cases, load testing may provide the most effective means of verifying the strength of a structure or member. Load testing can also be a valuable tool for evaluating the effectiveness of structural repairs. For example, load testing, as defined in ACI 437.2, can be performed to determine if the service load deflection and cracking are acceptable.

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6.8.2 Load tests shall be conducted in accordance with the monotonic or cyclic procedures in ACI 437.2.

6.8.3 The design professional is permitted to waive the ℓ_t/180 deflection criteria in ACI 437.2.

6.8.4 If a member fails a cyclic load test, it shall be permitted to retest the member or structure in accordance with ACI 437.2. It shall be permitted to waive the maximum deflection limit (ℓ_t/180) in ACI 437.2 that precludes a retest.

6.8.5 Model analysis shall be permitted to supplement calculations.

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R6.8.2 If the strength of the structure being evaluated is limited by the strength of concrete, or the expected failure of the structure is controlled by shear or development of the reinforcement, the sustained load applied using the monotonic test allows greater time for widening and propagation of cracks, creep, and slip of reinforcement compared with the cyclic procedure.

R6.8.3 The ℓ_t/180 deflection limit was included to provide an upper limit on the deflection of a member during a load test. The deflection limit may be waived by the design professional when the tested member is not damaged by large deflections or when the residual deflection criteria is satisfied.

R6.8.4 ACI 437.2 precludes a retest if the member exceeds a maximum deflection limit of ℓ_t/180 (Section 6.4.4.2 in ACI 437.2). For consistency with the monotonic testing protocol, this ℓ_t/180 limit is waived.

R6.8.5 This code permits model analysis to be used to supplement structural analysis and design calculations. Model analysis involves the construction and experimental testing of full or scale models of structure components, assemblages, or systems. Documentation of the model tests and subsequent interpretation should be provided with the related calculations. Model analysis should be performed by an individual having experience in this technique. References are provided in Harris and Sabnis (1999) and White (1970).

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CHAPTER 7—DESIGN OF STRUCTURAL REPAIRS

7.1—General

7.1.1 Repaired structural elements and connections within the work area shall have design strengths at all sections at least equal to the required strengths calculated using the applied factored loads and internal forces in such combinations as required by this code.

7.2—Strength and serviceability

7.2.1 Repaired structures shall be designed to meet the strength requirements of the design-basis code.

7.2.2 Repair design and construction procedures shall consider loading, internal forces, and deformations in both the existing and repaired structure during the repair process.

7.2.3 When serviceability issues are identified consistent with Section 6.6, repairs to address serviceability issues shall be considered.

7.3—Behavior of repaired systems

7.3.1 Repairs to sections, components, reinforcement, connections of members, or systems shall be designed to be integrated with the existing structure, creating a structural system capable of resisting the design loads by sharing and transferring loads between repaired and existing elements.

7.3.1.1 Repairs incorporating new members shall be designed to be integrated with the existing structure, creating

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R7—DESIGN OF STRUCTURAL REPAIRS

R7.1—General

Repair and rehabilitation, as defined in Chapter 2, are processes in which deficiencies and damage in a structure or member are corrected. The methods used to correct deficiencies and damage in structures will be the same for both repair and rehabilitation projects. For the purposes of this chapter, design requirements for repair and rehabilitation can be considered to be equivalent.

Durability requirements for repairs are in Chapter 8.

R7.1.1 Internal forces include those from externally applied loads and those from imposed deformations, from such actions as prestressing, shrinkage of repair materials, temperature changes, creep, unequal settlement of supports, and listing, leaning and tilting displacements.

R7.2—Strength and serviceability

R7.2.2 During the repair process, it may not be possible or practical to relieve existing stresses or deformations. Consideration should be given to the in-place internal forces and deformations present in the structure during the repair and the subsequent internal forces from the design loads that the repaired section will resist. Internal forces and deformations caused by existing loads may be locked in by the repair.

Analysis to evaluate the effects of structural modifications should verify that the strength is adequate and that serviceability conditions are met. As an example, creating a large opening in structural slabs may necessitate cutting reinforcement, which can significantly influence the global behavior of the structure. Supplementary strengthening may be required to address force redistribution that can exceed the existing strength of the affected elements. Slab punching shear strength should be evaluated for openings at the intersection of column strips to verify that the slab is adequate. This is especially critical near corner and edge columns where the slab shear stress is typically highest.

R7.2.3 Adequate stiffness needs to be determined on a project-specific basis and is a function of the structure type, the desired performance of the structure, and loading conditions and use.

R7.3—Behavior of repaired systems

R7.3.1.1 Repair of a structure may be achieved by improving the global behavior of the structure by adding

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a structural system capable of resisting the design loads by sharing and transferring loads between new members and existing elements.The effect of the new members on the structure shall be evaluated according to the design-basis code.

7.3.2 Repairs to members shall account for force transfer at the interface between the member and the repair material or repair system. It shall be permitted to use ACI 318 to design the force transfer mechanism between new and existing concrete.

7.3.3 Structural repairs required for strength or stiffness shall maintain composite behavior under service load. The repaired system shall be designed to mitigate potentially dangerous conditions if bond between the repair and the substrate is lost.

7.4—Interface bond of cementitious repair materials

7.4.1 Repair design shall include an analysis to determine the interface shear and tension stresses across bonded interfaces between cementitious repair materials and the existing substrate. The interface analysis shall use factored loads in

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new structural members that act integrally with the existing structural system or improving the behavior of the existing members. The design of the repair should consider connections of new members to the structure. Connections of new members should be designed to transfer design forces between new members and the structure.

Load sharing and load transfer should exist between the structure and the new members so that the assumed load path and force distribution can occur. The effects of adding new members on the global stiffness and force distribution should be considered.

New members may need to be separated from adjacent members to prevent or minimize interaction that may result in damage to adjacent portions of the structure. Transfer of forces between new and existing members should not compromise the performance of the structural system.

R7.3.2 Induced forces on the repaired member are shared between the existing member and the repair material or system. The repair should be designed to allow for transfer of forces between the two components.

The requirements for composite behavior between the repair and the member may vary depending on the type of repair (structural or nonstructural), the performance criteria at service, and the required strength at the ultimate limit states. While certain designs require composite behavior up to an ultimate limit state, others may be limited to service conditions. Composite behavior can be achieved by chemical bonding, mechanical means, or a combination thereof. The design should specify the repair materials and techniques that will develop the level of composite behavior to achieve the intended performance of the repaired member. Specific reference is made to ACI 318-14, Sections 16.4 and 22.9, for force transfer requirements between new and existing concrete. Techniques other than shear-friction may be acceptable.

Design guidelines for bond of fiber-reinforced polymer (FRP) are provided in ACI 440.1R and 440.2R. Design provisions to achieve composite behavior with structural steel sections are provided in the "Specification for Structural Steel Buildings" (ANSI/AISC 360-16, Chapter I).

R7.3.3 Nonstructural repairs intended to improve durability or aesthetics may not require composite behavior under service loads. To prevent potentially dangerous conditions in the event of bond failure in a repair, the repair should encapsulate existing steel reinforcement. Alternately, the repair systems should be designed to provide redundant attachment of the repair material to the existing structure.

R7.4—Interface bond of cementitious repair materials

R7.4.1 The forces acting on the interface between cementitious repair materials and existing substrate can include tension, shear, or a combination of tension and shear depending on repair geometry and the applied loads. The

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addition to internal forces resulting from restrained volume change to calculate the resultant interface stress demand (v_u) from the transfer of tension and shear.

7.4.1.1 Interface shear stress shall be designed based on

$$v_u \leq \phi v_{ni} \tag{7.4.1.1}$$

where v_{ni} is nominal interface shear stress capacity and ϕ is the strength reduction factor determined in accordance with 5.3.2.

7.4.1.2 Testing requirements for interface bond shall be in accordance with Table 7.4.1.2.

Table 7.4.1.2—Testing requirements where v_u is partially or totally resisted by the concrete

v_u	Testing requirements
Less than or equal to 30 psi	Bond integrity testing
Greater than 30 psi	Quantitative bond strength testing unless design satisfies 7.4.5

7.4.2 If v_u does not exceed 30 psi, interface reinforcement shall not be required. Bond integrity testing as specified in the construction documents shall be performed.

7.4.3 If v_u is between 30 psi and 60 psi, interface reinforcement is not required. Quantitative bond strength testing shall be performed to verify performance. Direct tension pull-off tests (ASTM C1583/C1583M) or other similar quantitative test methods shall be specified. The frequency of tests and acceptance criteria shall be specified, but the number of tests on a project shall be at least three (3).

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tensile and shear demand at an interface between a cementitious repair material and the substrate from applied loads and from volume changes that occur as a result of shrinkage or thermal movement can be calculated using principles of structural mechanics, but these calculations can be complex. Guidance on designing the interface for horizontal shear can be found in Chapter 16 of ACI 318-14, Chapter I of ANSI/AISC 360-16, and Bakhsh (2010).

Where the required nominal interface shear stress is lower than 80 psi, and where good surface preparation, placement, repair materials, and curing techniques are employed, satisfactory composite behavior will likely be achieved without interface reinforcement.

R7.4.2 The 30 psi bond stress specified by this code is based on half of a nominal shear stress of 80 psi multiplied by the strength reduction factor in 5.3.2.

A properly prepared substrate is achieved by removing existing deteriorated, damaged, or contaminated concrete. The exposed sound concrete is then roughened and cleaned to allow for adequate bond of a repair material. ICRI Guideline No. 210.3 presents a discussion of achievable tensile bond strengths, suggests a minimum value of 100 psi for less critical applications, and indicates that tensile bond test values less than 175 psi that fail at the bond interface or superficially within the existing concrete substrate may indicate a partially damaged, contaminated, or otherwise inadequate bond surface. BS EN 1504-10 suggests minimum direct tension strengths of 100 psi for nonstructural repair and 175 to 215 psi for structural repairs. Interface reinforcement may be needed if sufficient interface capacity cannot be achieved through bond.

Bond integrity testing can consist of various nondestructive qualitative test methods such as sounding in accordance with ASTM D4580/D4580M, ground-penetrating radar or impact-echo described in ACI 228.2R or ICRI Guideline No. 210.4.

R7.4.3 The 60-psi bond stress is based on a nominal shear stress of 80 psi multiplied by the strength reduction in 5.3.2

On most concrete repair projects, testing to verify the bond of cementitious repair materials to the substrate is recommended as part of a quality assurance program. Quantitative bond strength testing is required when the bond stress exceeds 30 psi and interface reinforcement is not provided. ICRI Guideline No. 210.3 provides guidance on the number

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of tests that should be performed based upon the repair area and acceptance criteria.

Bond capacity has primarily been evaluated using direct tension pull-off tests, as defined in ASTM C1583/C1583M and as described in ICRI Guideline No. 210.3. In some instances, laboratory slant shear tests in accordance with ASTM C882/C882M of cores made in the lab or cores taken from mockups in the field have been used to assist the licensed design professional to make informed design decisions. Slant shear test results typically exceed direct tension pull-off test results, but the slant shear strength is greatly influenced by the compressive stress the test setup introduces across the interface and may not be directly comparable to field conditions. Typically direct shear strengths are larger than direct tension strengths. Comparisons of these tests and other tests, for the purpose of achieving adequate bond is discussed in Bakhsh (2010). It generally is adequate to assume that the repair to substrate bond will resist an interfacial shear equal to the direct tensile pull-off test result.

If failure during direct pull-off testing occurs at the bond line, it may indicate inadequate surface preparation of the concrete substrate or the substrate surface was damaged by the surface preparation method (bruising of the substrate). Modifications to the surface preparation procedures may improve the tensile bond strength. Discussion of proper methods for surface preparation can be found in ACI 546R and ICRI Guideline No. 310.2R.

7.4.4 If v_u exceeds 60 psi, interface reinforcement shall be provided.

7.4.5 If v_u is completely resisted by interface reinforcement, quantitative bond strength testing is not required.

R7.4.5 This provision provides an alternative to bond strength testing.

7.4.6 Interface reinforcement shall be designed in accordance with ACI 318.

R7.4.6 ACI 318 provides design provisions for horizontal shear transfer in composite concrete flexural members. Minimum reinforcement is required between horizontal shear stress of 60 and 375 psi (500 psi multiplied by strength reduction factor of 0.75). Where the required design horizontal shear stress is greater than 375 psi, Section 16.4.4.1 of ACI 318-14 requires design per Section 22.9 of ACI 318-14. For cases where there is a net factored tension across the interface, reinforcement should be provided and designed in accordance with ACI 318.

7.4.7 Construction documents shall specify testing requirements for interface reinforcement in the repair applications.

R7.4.7 Testing to verify the performance of the interface reinforcement to transfer horizontal shear can be performed in accordance with the recommendations contained in ACI 355.2 and 355.4. Specific requirements for testing of ties should be included in a quality assurance plan.

Direct tension testing of post-installed interface reinforcement is recommended to provide verification of the installation. Guidance for determining the number of tests and acceptance criteria of the direct tension testing is similar to principles used in developing direct tension pull-off testing requirements described in ICRI Guideline No. 210.3.

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7.5—Materials

7.5.1 Materials in a structure shall be permitted to remain if such materials are performing satisfactorily.

7.5.2 Except as permitted by this code, materials permitted by the current building code for new construction shall be used. Like materials shall be permitted, provided they do not contain hazardous materials or other materials not permitted by the code for new construction.

7.5.3 Alternate materials shall be permitted following approval in accordance with 1.4.

7.5.4 Design of the repair system shall consider the properties and installation of the repair materials and systems. These include, but are not limited to: physical properties of the repair materials, type of application, adhesion, volume stability, thermal movement, durability, corrosion resistance, installation methods, curing requirements, and environmental conditions.

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R7.5—Materials

R7.5.2 Hazardous materials include asbestos or other materials specifically prohibited by the current building code.

R7.5.4 Physical properties of repair materials include mechanical, chemical, and electrical properties. Documentation should be obtained for properties of each repair material. The stated properties should be verified that they satisfy the project requirements. ACI and ICRI provide guidelines for the selection of repair materials (ACI 301, ACI 318, ACI 503R, ACI 503.5R, ACI 503.6R, ACI 506R, ACI 546.3R, ACI 549.1R, ICRI Guideline No. 320.2R, ICRI Guideline No. 320.3R, ICRI Guideline No. 330.1, and ICRI Guideline No. 340.1).

The design of a repair should consider the compatibility of the repair materials with the materials of the existing structure. Compatibility of repair materials and systems include volume stability, bond compatibility and durability, mechanical compatibility, and electrochemical and permeability compatibility. Generally, the intent is to use a repair material or repair system that has physical, mechanical, and other properties that are as close as possible to those of the parent material to provide long-term performance.

Individual repair materials may have different properties yet will perform satisfactorily when combined in a repair system. An example of this is where materials with differing thermal coefficients of expansion may be used, provided that the overall performance of the system is not affected by thermal changes.

Volume stability is often estimated as a change in the linear dimensions of the repair and should be considered in the design of a repair system. Autogenous shrinkage, chemical shrinkage, degree of restraint, environmental conditions, drying shrinkage, creep, thermal changes, moisture absorption, and other factors all affect volume stability. Experience has shown that volume change of repair materials has often been the cause of poor performance of repairs. Properties of repair materials should be selected considering volume stability relative to the volume stability of the existing concrete in order to reduce the probability of cracking caused by relative volume changes.

Volume stability is discussed in ACI 209R, ACI 209.1R, ACI 546.3R, and ICRI Guideline No. 320.2R.

Repair materials such as portland-cement concrete, portland-cement mortar, polymer-cement concrete, polymer concrete, shotcrete, fiber-reinforced concrete, resin-based materials, and similar products are commonly used. Repair

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materials might not necessarily contain portland cement, but should be selected to achieve the necessary service, strength, and durability requirements.

The selection of reinforcement material should consider the durability, performance at elevated temperatures, and ductility. Electrical and chemical reactivity between the reinforcement, the repair material, and the existing reinforcement should also be considered.

Refer to ACI 440.1R for internal FRP reinforcement, ACI 440.2R for externally bonded FRP reinforcement, and ICRI Guideline No. 330.1 and ACI SP-66 for steel reinforcement.

Required properties of the repair reinforcement should be specified in the construction documents. Specified reinforcement properties are dependent on the requirements of the repair and may include physio-chemical (for example, glass transition temperature, and coefficient of thermal expansion) as well as mechanical properties (for example, ultimate strength, tensile modulus, and ultimate elongation).

7.6—Design and detailing considerations

7.6.1 Repair design shall be based upon the member conditions in Chapter 6.

7.6.2 *Concrete*—The in-place properties of the concrete, in accordance with Chapter 6, shall be used in the repair design.

7.6.3 *Reinforcement*

7.6.3.1 Reinforcement that is damaged or corroded shall be permitted to remain. The effective cross-sectional area of remaining reinforcement shall be permitted to be used in the repair design in accordance with the design-basis code. The effect of corrosion damage on development of steel reinforcement shall be considered. Where original deformations are no longer effective, reinforcing bars shall be considered as smooth bars.

7.6.3.2 Repair design shall consider the location and detailing of the reinforcement in accordance with the assessment requirements of Chapter 6.

R7.6—Design and detailing considerations

R7.6.2 The extent and cause of deterioration and the concrete strength and quality should be assessed, including compressive strength, chlorides, carbonation, sulfate attack, alkali-silica reaction, physical damage, corrosion-induced spalling, and cracking.

Chloride penetration can cause corrosion that can lead to cracking and spalling. The depth of a spall reduces the effective area of concrete section. Degradation of the concrete affects the concrete compressive strength.

R7.6.3 *Reinforcement*

R7.6.3.1 Repair design should consider the in-place condition of the reinforcement, including the effective cross-sectional area of the reinforcing bars. The effective area is calculated using the remaining effective diameter of the reinforcing bar accounting for the loss of section due to corrosion. Further considerations may also include the location of the corroded areas, loss of confinement, the loss of bond, and the effect of corrosion on member strength. If the structure is fire damaged, steel reinforcement may be annealed, and the yield strength reduced. Refer to ACI 216.1 for additional guidance. Durability requirements related to corroded reinforcement are addressed in 8.4 and ACI 364.1R. CRSI (2014) provides information on older reinforcement systems.

R7.6.3.2 The location and detailing includes the horizontal and vertical positions, orientation, geometry of the reinforcement, development of reinforcement, and the presence of hooks and crossties. Field examination to locate reinforcement may be required. Guidance on evaluation techniques for reinforcement location is provided in Chapter 6.

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7.6.3.3 Both existing and new reinforcement shall be adequately developed. Development length shall be permitted to be calculated based upon development in both the existing concrete and new materials and in accordance with the design-basis code.

7.6.4 *Prestressed structures*

7.6.4.1 The effects of prestressing shall be considered in the repair design.

7.6.4.2 The effects of modifications to existing structure geometry, damage conditions, loss of prestressing force, and repair sequence shall be considered in the repair design.

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R7.6.3.3 Reinforcement development may be inadequate due to corrosion, mechanical damage, insufficient or loss of concrete cover, delaminated concrete, concrete strength, or other conditions. Equations to calculate the development length have also changed over time and current equations may require longer development lengths than earlier equations. The design of the repair should evaluate the required development length. Detailing of the repair should include the proper development of new reinforcement to achieve the design force. ACI 318 provides development equations and requirements for detailing of steel reinforcement. ACI 369.1 (or ASCE/SEI 41) provides an equation when development length of existing reinforcement does not meet ACI 318. ACI 440.1R and ACI 440.2R provide detailing guidance for internal FRP reinforcement and externally bonded FRP reinforcement, respectively. Additional information can be found in *fib* Bulletin No. 10.

R7.6.4 *Prestressed structures*

R7.6.4.1 Requirements for repair of structures with bonded and unbonded prestressing are different. Post-tensioned structures (with bonded and unbonded tendons) are often cast-in-place monolithic structures, whereas pretensioned structures (with bonded strands) are often single-span precast structures. Each system is unique and should be individually considered. The repair of prestressed structures requires a condition assessment of the existing tendons. Repair of unbonded tendons may require tendon detensioning. Guidance for analysis, evaluation methods and repair techniques of unbonded post-tensioned structures is provided in ACI 423.4R, ACI 222.2R, ICRI Guideline No. 210.2, PTI DC80.2-10, and PTI DC 80.3/ICRI 320.6.

R7.6.4.2 Analysis to evaluate the effects of structural modifications should verify that strength is adequate and that all serviceability conditions (for example, deflection limits) are satisfied.

Analysis of prestressed structures is required to evaluate the effect of damaged or severed prestressing reinforcement on structural strength and performance. The effect of a severed bonded tendon is typically localized because the severed tendon is effective after a development length is achieved and the full strength of the tendon is reestablished. For structures with bonded tendons, shoring, if necessary, may only be required locally at the repair area.

Review of grouting quality assurance and supervision documents should be performed to evaluate grouted tendons in advance of any repair or rehabilitation of bonded post-tensioning systems. The presence of voids, moisture in ducts, chlorides and the extent of carbonation in the existing grout need to be identified. Methods for evaluation of chloride-ion content are listed in ASTM C1152M, ASTM C1218, and AASHTO T260. Field evaluation of grout may be required even if documentation of the original construction is available.

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Unbonded tendons are designed to be permanently debonded from the member and often extend over multiple spans. As a result, damage or discontinuity of a tendon at one location will reduce the strength for the entire length of the tendon.

If unbonded tendons are severed, the prestressing force is assumed to be lost for the full length of the tendon. Releasing or cutting tendons may affect multiple spans and may require shoring beyond the area where cutting or releasing of tendons occurs. Adjacent spans may require temporary shoring depending on the number of tendons severed at one time and the applied loads. Analysis based on actual loading at the time of the modification may show shoring to be unnecessary.

Repair and structural modification may require detensioning of prestressing tendons. Unbonded tendons should be detensioned in a controlled manner to ensure performance and safety. Unless not needed based on analysis, unbonded tendons should be reanchored and restressed to restore required structural strength. Cut or damaged unbonded tendons can be restored by splicing or by installing new tendons with anchors at intermediate locations, at the end of the structural member or the edge of any new openings.

The stressing force in a repaired tendon depends on the condition and type of the repaired post-tensioned system and in certain cases this force can be less than the original force if determined to be acceptable by structural analysis. Further discussion of this topic can be found in PTI DC 80.3/ICRI 320.6.

Corrosion on prestressing strands for bonded and unbonded post-tensioned systems may have an effect on strand integrity and strength. Prestressing strands require examination for conditions such as corrosion pitting and hydrogen embrittlement (refer to ICRI Guideline No. 210.2 and ACI 222.2R).

If repairs to prestressed slabs or beams result in increased concrete tensile stress (that is, changing the classification of the prestressed flexural member as defined in ACI 318), impacts of the repair scheme on serviceability should be evaluated.

7.6.4.3 Stresses in remaining section after concrete removal during repair shall not exceed the limits established in the design-basis code.

R7.6.4.3 Removing surface concrete from a prestressed member may cause excessive compressive and tensile stress in the remaining concrete section and may alter secondary forces and moments due to prestressing in indeterminate structures. This condition is more critical for prestressed joists and girders that have a relatively small section and large prestressing force. Slabs are less critical due to the relatively small initial precompression. This change is acceptable as long as durability and strength are addressed as part of the repair design. The impact of removing concrete from a post-tensioned structure is addressed in Scollard and Bartlett (2004). PTI DC 80.3/ICRI 320.6 provides guidance for removing concrete around anchors and splices to prevent catastrophic anchorage failure.

7.6.5 *Anchoring to concrete*—Post-installed anchors shall be designed in accordance with ACI 318 to transfer design

R7.6.5 The design of post-installed anchors requires careful consideration of the loads to be resisted. Anchors

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forces to the substrate considering possible anchor failure modes and the condition of the substrate into which the anchor is installed.

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should have adequate strength to transfer design forces across all interfaces and into the existing member. All possible anchor failure modes should be considered to determine the design strength. Anchors should be selected considering the expected concrete substrate cracking condition. For example, post-installed anchors used in the tension zone of concrete members and in structures located in regions of moderate or high seismic hazard should be able to transfer the design seismic forces assuming a cracked concrete condition.

Design of post-installed anchors is provided in ACI 318, which includes provisions that require performance of post-installed anchors in both cracked and uncracked concrete. ACI 355.2 and 355.4 provide the standard required for qualifying post-installed anchors in cracked and uncracked concrete. Specifications for post-installed anchors should include installation, testing, and inspection procedures.

For post-installed expansion or undercut anchors, manufacturer's installation instructions specify procedures for drilling, hole cleaning, installation, torque magnitude, and procedures to engage the anchor.

For adhesive anchors and dowels, hole cleaning and moisture conditions are critically important. Manufacturer's printed installation instructions should specify procedures for drilling, hole cleaning, installation, and the care to be taken until the adhesive has cured.

Testing and inspection of post-installed anchors should be specified in the construction documents. Many building codes require that adhesive anchors be installed under special inspection procedures to ensure that the installation is correctly performed in accordance with the design and manufacturer's procedure. Refer to ACI 318 for specific inspection requirements for post-installed anchors.

7.6.6 *Repair geometry*—Configuration of repairs shall consider the potential for stress concentrations and cracking in both the existing structure and the repair area.

R7.6.6 Repair shapes with sharp reentrant corners can cause stress concentrations that may result in cracking. Long, slender (high aspect ratio) repair areas also may result in transverse cracking. The shape of the repair should be considered to reduce stress concentrations and possible cracking. Methods discussed in ICRI Guideline No. 310.1R provide guidance to reduce cracking in concrete repairs including providing a uniform depth of edges and substrate, repair geometry, surface preparation, concrete removal below reinforcement (undercutting) and elimination of feather edge repairs.

7.6.7 *Expansion joint materials*—Selection of expansion joint materials shall consider the anticipated movement of the structure and facility maintenance procedures.

R7.6.7 Repairs to expansion joint materials are common, particularly those subjected to snow removal operations.

Design and selection of the expansion joints should consider the total anticipated movement of the expansion joint. Typically, expansion joint capacities listed in manufacturer's literature are based on total movement from minimum installation width to maximum installation width and assume the joint will be installed when the joint is at the midpoint of this movement range. Joints installed in the summer or winter months will experience movement

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primarily in one direction only, and so may require a larger capacity. Additional guidance can be found in the Parking Facility Maintenance Manual published by the National Parking Association (2016).

7.7—Repair using supplemental post-tensioning

7.7.1 Supplemental post-tensioning shall be permitted for repair of structures.

7.7.2 The effects of the supplemental post-tensioning on the behavior of the structure shall be considered in the repair design.

7.7.2.1 Stresses due to supplemental post-tensioning shall be combined with existing stresses and the total shall not exceed the limits in the design-basis code.

7.7.2.2 Design of supplemental post-tensioning shall provide for the transfer of post-tensioning forces between the post-tensioning system and the structure. Design of concrete supplemental post-tensioning anchor zones shall be in accordance with ACI 318. Design of steel brackets and supplementary structural steel shall be in accordance with ANSI/AISC 360.

7.7.3 Provisions shall be made for effects of post-tensioning, temperature, and shrinkage on adjoining construction, including immediate and long-term deformations, deflections, changes in length, and rotations due to prestressing.

7.7.4 Post-tensioning losses shall be included in the design of supplemental post-tensioning systems.

7.7.5 Construction documents shall specify the repair sequence, including tendon placement, anchors, and stressing of the post-tensioned system.

R7.7—Repair using supplemental post-tensioning

R7.7.1 Supplemental post-tensioning can be applied to the structure externally, internally, or both.

R7.7.2 Supplemental post-tensioning can introduce moment, shear, and axial forces within the structure that should be considered in the design and detailing of the repair. The internal forces induced by the supplemental post-tensioning can be significant. For statically indeterminate structures, restraint to post-tensioning deformations can result in significant internal forces. Refer to ICRI Guideline No. 330.1 for selecting strengthening systems for concrete structures.

R7.7.2.1 Adding supplemental post-tensioning to a prestressed member may cause excessive compressive and tensile stress and may alter secondary forces and moments. External post-tensioning may result in changing the classification of prestressed flexural members as defined in ACI 318 Section 24.5.2. This change is acceptable as long as durability and strength are addressed as part of the repair design.

R7.7.2.2 Anchors for new post-tensioned reinforcement should be designed and detailed for the transfer of post-tensioning forces to the existing structure. Bearing, spalling, and bursting forces created at anchor zones should be considered. Strut-and-tie modeling, as given in ACI 318, may be used to design post-tensioning anchor zones.

R7.7.3 The post-tensioning forces may be restrained by adjacent stiff members such as walls, and reduce the effect of the prestressing on the intended member or have unintended effects on the adjacent construction.

R7.7.4 Losses include wedge seating in the anchor; elastic shortening; creep of original concrete; shrinkage of original concrete following installation of the supplemental prestressing; creep of repair material; shrinkage of repair material; prestressing relaxation; and friction and wobble between the post-tensioning reinforcement and ducts, bearings, or deviators. Assessment of losses of supplemental post-tensioning force should consider the existing conditions of the repaired elements, as the members may have already experienced time-dependent creep and shrinkage.

R7.7.5 Repair design using supplemental post-tensioning systems should include construction documents for installation sequence including shoring, removal of concrete, placement of new material and reinforcement, additional anchor requirements, horizontal shear transfer requirements, curing, and stressing. Installation of supplementary post-tensioning

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involves application of significant forces, which may require project safety and protection procedures by the installer. Refer to 8.4.1 for corrosion protection requirements.

7.7.6 Structural members repaired or modified with externally installed unprotected post-tensioning shall have adequate unrepaired strength, in accordance with 5.5.

R7.7.6 Unless protection of the post-tensioning strengthening system is provided to prevent sudden failure of the member in case the external post tensioning reinforcement is damaged or becomes ineffective (such as fire or impact), the structural member should have adequate strength without the post-tensioning reinforcement to support factored loads, as defined in Chapter 5.

7.8—Repair using fiber-reinforced polymer (FRP) composites

7.8.1 Fiber-reinforced polymer composites in conformance with ACI 440.6 and ACI 440.8 shall be permitted to repair concrete structures.

R7.8—Repair using fiber-reinforced polymer (FRP) composites

R7.8.1 Fiber-reinforced polymer fabrics, bars, or shapes can be used as externally bonded reinforcement, internal reinforcement, and as internal or external prestressed reinforcement. FRP shapes may be used as additional standalone structural members. Design and detailing of externally bonded FRP systems should be consistent with ACI 440.2R. Particular attention should be given to strength increase limits, service limits, and determination of FRP material design properties.

Design and detailing of internal FRP reinforcement should be consistent with ACI 440.1R. Particular attention should be given to service limits and determination of FRP material design properties.

If internal prestressed FRP reinforcement is used, the design and detailing should be consistent with ACI 440.4R.

FRP systems should only be installed in or on sound concrete. Concrete distress, deterioration, and corrosion of reinforcement should be evaluated and addressed before the application of the FRP system. Surface preparation requirements should be based on the intended application of the FRP system. FRP applications can be categorized as bond-critical or contact-critical. Bond-critical applications, such as flexural or shear strengthening of beams, slabs, columns, or walls, require an adhesive bond between the FRP system and the concrete. Contact-critical applications, such as confinement of columns, only require intimate contact between the FRP system and the concrete. Contact-critical applications do not require an adhesive bond between the FRP system and the concrete substrate, although one is often provided to facilitate installation. ACI 440.2R provides descriptions of FRP applications and surface preparation and repair requirements.

For bond-critical applications, the concrete substrate should possess the necessary strength to develop the design forces of the FRP system through bond. The substrate, including all bond surfaces between repaired areas and the original concrete, should have sufficient direct tensile and shear strength to transfer force between the existing substrate and FRP system. The tensile strength of the substrate should be at least 200 psi as determined by a pull-off type adhesion test per ASTM D7522/D7522M. Contact-critical applications are not required to meet this minimum bond value as

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the design forces of the FRP are developed by deformation or dilation of the concrete section.

For bond-critical applications, the concrete surface should be prepared to a minimum concrete surface profile (CSP) 3 as defined by the ICRI Guideline No. 310.2R. In contact-critical applications, surface preparation should promote continuous intimate contact between the concrete surface and the FRP system. Surfaces to be wrapped should, at a minimum, be flat or convex to promote proper loading of the FRP system.

FRP systems should not be applied to damp or wet surfaces unless the epoxies are formulated by the manufacturer for such applications. Moisture content of the concrete substrate should be evaluated before application of the FRP system as it may inhibit bonding between the concrete substrate and epoxy polymer. Surface moisture should not exceed the limits established by the manufacturer. Testing for presence of moisture should be done in accordance with manufacturer's written recommendations or one of the following: ASTM D4263 – "Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method;" AASHTO FRPS-1-UL – "Guide Specifications for Design of Bonded FRP Systems for Repair and Strengthening of Concrete Bridge Elements," first edition; ACI 548.1R; ASTM F1869 – "Standard Test Method for Measuring Moisture Vapor Emission Rate (MVER) of Concrete Subfloor Using Anhydrous Calcium Chloride;" ASTM F2170 – "Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using In Situ Probes;" or ASTM F2420 – "Standard Test Method for Determining Relative Humidity on the Surface of Concrete Floor Slabs Using Relative Humidity Probe Measurements and Insulated Hood."

The surfaces to receive moisture testing and the testing equipment should be acclimated near the relative humidity levels and temperatures that the design is anticipated to have in service. Variation between testing and in-service conditions may provide inaccurate or misleading testing results.

7.8.2 Structural members repaired or modified with externally-applied FRP composites shall have adequate unrepaired strength, in accordance with 5.5.

7.9—Performance under fire and elevated temperatures

7.9.1 Design of the repair system shall consider elevated temperature performance and shall comply with the fire resistance ratings of the structural members and other fire safety requirements in accordance with the design-basis code.

R7.9—Performance under fire and elevated temperatures

R7.9.1 Regardless of the repair system used, performance of the repaired element under fire and elevated temperatures should be evaluated and the system should be detailed and materials selected to provide adequate performance. The repaired elements should comply with applicable building code requirements and relevant fire regulations valid at the project location. Structures renovated for different use or strengthened to support higher loads may require a more stringent fire rating than the original structure. Other requirements such as flame spread and smoke density should also be considered in accordance with the general existing building code and ASTM E84.

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7.9.2 It shall be permitted to design a repair without supplemental fire protection if the unrepaired member has adequate strength during a fire event considering the reduced material properties due to fire exposure in accordance with 5.5.3.

7.9.3 The properties of the specified repair materials at elevated temperatures shall be considered.

7.9.4 Repairs using adhesives shall consider their performance at elevated temperatures.

7.9.5 Supplemental fire protection to improve the fire rating of repaired systems shall be permitted.

7.9.6 Fire rating of repaired systems, based on ACI 216.1, shall be permitted.

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R7.9.2 A repair system can be selected without additional fire protection provided that the existing unrepaired member has adequate strength during a fire event to support the loads, as defined in 5.5.3. Fire performance requirements and evaluation procedures for a structure during a fire event are outlined in ACI 216.1, ASCE/SEI/SFPE 29, and AISC Design Guide 19.

R7.9.3 Repair material specifications should comply with the requirements of relevant fire regulations valid at the project location. If there is a conflict between the properties of specific products or systems and fire regulations, alternative repair principles or methods should be used to avoid such a conflict. In general, polymer mortar and polymer concrete have higher coefficients of thermal expansion and higher resistance to water vapor transmission and lower resistance to fire and elevated temperatures compared to cementitious alternatives.

R7.9.4 ACI 440.2R reports that the physical and mechanical properties of the resin components of FRP systems are influenced by temperature and can degrade at temperatures close to and above their glass-transition temperature T_g. An acceptable service temperature for FRP is established by ACI 440.2R as T_g – 27°F. This value accounts for typical variation in test data for dry environment exposures. Adhesive-bonded FRP reinforcement should not be used if the maximum service temperature exceeds T_g – 27°F. A service temperature exceeding this limit temperature should be addressed using an adhesive system with a higher T_g value, using heat protection or insulation systems or using alternate repair systems. Similar service temperature considerations apply to adhesive-bonded steel reinforcement.

Adhesive-based repair systems can be considered effective during a fire event if a fire protection system with an established fire rating is used that maintains the temperature of the adhesive-based system below its glass transition temperature. In the absence of an established fire rating, detailed fire analysis may be used to establish a fire rating of the repaired system.

R7.9.5 Standard fire protection systems can be used to increase the fire rating of repaired systems. National codes and professional organizations list generic ratings for concrete structural members, giving the minimum thickness of concrete cover needed to protect the main steel reinforcement from fire effects (IBC; NFPA 5000 2015; PCA 1985, 1994). In addition to increasing the cover thickness, fire performance of reinforced and prestressed concrete members may be enhanced by fire protection systems as proven by fire testing or analytical methods (ACI 216.1). Concrete cover for nonmetallic reinforcement may need to exceed cover for steel reinforcement to achieve the same fire resistance rating.

R7.9.6 The fire rating of a repaired system or assembly can be determined in accordance with ACI 216.1, which requires

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the use of reduced material strength due to fire exposure and a strength reduction factor during fire of 1.0.

The criteria for evaluating a structure for fire safety are different than those for strength design and typically incorporate lower material strengths and required strength, and may not require the use of strength reduction factors (refer to Section 5.5.3). The licensed design professional should verify that the fire-reduced strength of the member exceeds the force demand due to expected service loads during the fire event. The fire-reduced strength should be based on reduced material strengths for the maximum expected temperature in a fire event, which can be determined in accordance with ASTM E119 and ACI 216.1.

Section 1.2 of ACI 216.1 allows alternative methods to assess the fire resistance of assemblies. The fire reduced strength as well as the effect of fire protection system on the overall performance and fire rating of an existing and repaired element can also be determined utilizing available design models and finite element numerical procedures. Descriptions of the detailed analytical methods can be found in Buchanan (2001) and *Technical Report 68* (2008) by the Concrete Society.

The fire resistance or rating of a repaired system or assembly can be determined through full scale testing in accordance with ASTM E119, which requires the application of the expected service load to the test specimen during the full-scale fire test.

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CHAPTER 8—DURABILITY

8.1—General

8.1.1 Durability of individual repairs, the repaired structure, and the interaction between the repaired areas and the remaining structure shall be considered.

8.1.2 Cause(s) of current conditions, defects, and potential future deterioration of repairs shall be assessed as part of the repair design.

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R8—DURABILITY

R8.1—General

R8.1.1 The durability of materials incorporated into a repair depends on the ability of the materials to withstand the environment where they are installed. A repaired section is considered to be the combination of the installed repair material(s) and the substrate material(s). The durability of repairs is dependent on the compatibility between repair materials, the structure, and the surrounding environment. To achieve compatibility, the repair and structure need to interact on several levels without detriment, including chemical, electrochemical, and physical behavior.

For repair durability design, the design service life is the time frame for which durability should be considered. The design service life requirements for a repaired structure are established by the licensed design professional in consultation with the Owner to achieve a repair that satisfies project requirements including strength, safety and serviceability. Such design service life should be reflected in the repair design and maintenance requirements, as well as incorporated into the construction documents. Design service life may be achieved through satisfactory repair construction practices, including the material selection, surface preparation and application of the repair materials. The design service life of the structure and repaired members, including maintenance requirements, may be estimated by considering the durability of the repair materials and their interaction with the structure. Service life and the parameters to be considered, the limitations, and methods available for conducting a service life prediction are presented in ACI 365.1R. Some examples of end of service life where durability parameters are not met include:

(a) Unacceptable reduction in structural performance

(b) Unacceptable frequency of maintenance cycles and associated activities

(c) Exceeding maximum crack width or crack frequency from corrosion, shear, torsion, flexure

(d) Exceeding maximum permissible chloride level at the interface of the steel in the repair area, or in adjacent areas

(e) Depth of carbonation leading to corrosion of reinforcement

(f) Unacceptable reinforcement section loss due to corrosion

(g) Exceeding maximum concrete deterioration level, mass loss or unacceptable surface conditions due to deterioration mechanisms, such as corrosion, freeze-thaw, chemical attack, abrasion, sulfate attack, alkali-silica reaction (ACI 221.1R, ACI 364.11T), or delayed ettringite formation

(h) Loss of watertightness or excessive/unacceptable leakage

R8.1.2 The presence of deterioration and its cause(s) should be determined as a first step in repair durability design. Causes of deterioration include:

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(a) Mechanical (abrasion, cavitation, fatigue, impact, overload, settlement, explosion, vibration, excessive displacement, loads, or ground motion from a seismic event)

(b) Chemical (alkali-aggregate reaction, sulfate attack, acid dissolution, soft water leaching, or biological action)

(c) Physical (freezing and thawing cycles, scaling, humidity gradients, temperature gradients, differing coefficients of thermal expansion, salt crystallization, radiation exposure, ultraviolet light, fire, or differences in permeability between materials)

(d) Reinforcement corrosion (carbonation, corrosive contaminants, dissimilar metals, stray currents, or stress corrosion cracking, location of reinforcement)

(e) Defects

8.1.3 Repair materials and methods shall be selected to be compatible with the structure, and within the service environment. Anticipated maintenance shall be considered in the selection of repair materials and methods.

R8.1.3 Compatibility in concrete repair systems can be defined as the balance of physical, chemical and electrochemical properties, as well as volume changes between the repair, the reinforcement, and the existing substrate. This balance ensures that the composite repair system withstands stresses induced by loads, chemical and electrochemical effects, and restrained volume changes without distress and deterioration over a designed period of time (Vaysburd and Emmons 2006).

Repaired sections should be resistant to expected service conditions that can result in deterioration during the design service life, including the causes of deterioration listed previously, and combinations of these causes.

Repaired sections should be resistant to:

(a) The ingress of chlorides and other corrosive contaminants that are present in the remaining concrete or the ingressof corrosive contaminants into the concrete that lead to corrosion of reinforcement or other embedments (8.4).

(b) The effects of thermal exposure and cycles.

(c) Freezing-and-thawing damage if critically saturated and subject to a freezing-and-thawing environment.

(d) Scaling if exposed to salts.

(e) Deterioration due to exposure to ultraviolet or other radiation deterioration within the repair environment unless other means are provided to address such deterioration.

(f) Fatigue deterioration resulting from loading cycles and load reversal. For example, fatigue resistance may be needed in repair areas subject to many cycles of repeated loading.

(g) Impact, erosion, and vibration effects if exposed to conditions causing deterioration by these mechanisms.

(h) Abrasion due to heavy traffic, impingement of abrasive particles, or similar conditions.

(i) Chemical deterioration which may result from sulfate attack, acids, alkalis, solvents, leaching of cementitious materials due to soft water, salt crystallization, and other factors that are known to attack or deteriorate the repair material or concrete substrate. Water penetration into concrete is associated with many types of chemical attack and other deterioration mechanisms.

(j) Carbonation-induced corrosion. Carbonation of concrete and repair materials reduces their pH and dimin-

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ishes the passivation effect which may lead to corrosion of embedded reinforcement (refer to 8.4).

(k) Deterioration resulting from deleterious aggregate, alkali-aggregate reactions or other aggregate durability concerns.

(l) Deterioration due to trapped moisture as a result of differential permeability between the repair and existing concrete, leading to freezing-and-thawing damage of critically saturated concrete, corrosion of embedded steel reinforcement, alkali-aggregate reaction, or sulfate attack of either the repair concrete or existing concrete.

Appropriate materials selection for concrete repair is discussed in ACI 546.3R.

Environmental classes that may affect durability performance are shown in Table R8.1.3.

Table R8.1.3—Exposure categories and classes (adopted from ACI 318-14)

Category	Class	Condition	
Freezing and thawing (F)	F0	Concrete not exposed to freezing-and-thawing cycles	
	F1	Concrete exposed to freezing-and-thawing cycles with limited exposure to water	
	F2	Concrete exposed to freezing-and-thawing cycles with frequent exposure to water	
	F3	Concrete exposed to freezing-and-thawing cycles with frequent exposure to water and exposure to deicing chemicals	
Sulfate (S)		Water-soluble sulfate (SO_4^{2-}) in soil, percent by mass [1]	Dissolved sulfate (SO_4^{2-}) in water, ppm[2]
	S0	$SO_4^{2-} < 0.10$	$SO_4^{2-} < 150$
	S1	$0.10 \leq SO_4^{2-} < 0.20$	$150 \leq SO_4^{2-} < 1500$ or seawater
	S2	$0.20 \leq SO_4^{2-} \leq 2.00$	$1500 \leq SO_4^{2-} \leq 10{,}000$
	S3	$SO_4^{2-} > 2.00$	$SO_4^{2-} > 10{,}000$
In contact with water (W)	W0	Concrete dry in service, concrete in contact with water and low permeability is not required	
	W1	Concrete in contact with water and low permeability is required	
Corrosion protection of reinforcement (C)	C0	Concrete dry or protected from moisture	
	C1	Concrete exposed to moisture but not to an external source of chlorides	
	C2	Concrete exposed to moisture and an external source of chlorides from deicing chemicals, salt, brackish water, seawater or spray from these sources	

[1] Percent sulfate by mass in soil shall be determined by ASTM C1580.

[2] Concentration of dissolved sulfates in water, in ppm, shall be determined by ASTM D516 or ASTM D4130.

8.2—Cover

8.2.1 Concrete cover shall be in accordance with the design-basis code, or an equivalent cover shall be used. An equivalent cover using alternative materials and methods shall be approved in accordance with 1.4.2.

8.2.2 Concrete cover over remaining and new reinforcement shall meet minimum requirements to provide sufficient (i) corrosion protection; (ii) fire protection; and (iii) anchorage and development.

R8.2—Cover

R8.2.2 Concrete cover protects reinforcement in concrete construction from corrosion until the concrete cover becomes contaminated, cracks or is compromised. The protection provided by the concrete cover is important in determining the service life of the structure. The minimum cover is typically required by the design-basis code. The effects of concrete cover on reinforcement corrosion, chloride contamination, and carbonation should be considered

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when evaluating the maintenance requirements and design service life of alternative methods for corrosion protection.

Adequate protection may be provided by increased section thickness, the appropriate coatings, such as sealers, or both; or electrochemical corrosion protection methods. Alternative means of protecting reinforcement include the application of waterproof membranes (ACI 515.2R), and various forms of cathodic protection. Active corrosion may create distress and deterioration beyond the limits of the repair area. The design service life should consider the existing conditions and potential distress in repairs areas and areas adjacent to the repair.

Concrete cover also provides fire protection. Fire protection requirements can be met by techniques such as increasing cover, spray-on fire protection or intumescent coatings.

8.3—Cracks

8.3.1 The cause(s) of cracks shall be assessed, and mitigation of cracking shall be considered in the repair design. As part of a repair design, cracking mitigation methods shall consider the causes, movement, size, orientation, width, and pattern of cracks. The characteristics of the substrate, location, and evidence of water transmission shall be determined to assess the appropriate method of repair. Active water infiltration shall be corrected as required for the durability of the structure.

8.3.2 The design of repairs shall consider the effects of cracks on the expected durability, performance, and design service life of the repair and structure as a whole.

R8.3—Cracks

R8.3.1 Cracks can reduce the protection provided by the effective cover over steel reinforcement and lead to water and deleterious material ingress, which accelerates the deterioration of embedded reinforcement and can cause other concrete deterioration issues such as freezing-and-thawing deterioration, alkali-aggregate deterioration, and chemical attack. Identification of their cause(s) and evaluation of their impact on a structure or a concrete component is described in ACI 224.1R. Guidance for the assessment of cracking caused by earthquakes is provided in FEMA 306.

R8.3.2 Not all cracks need to be repaired, however, all cracks have the potential to become active cracks. Cracks in concrete structures can be detrimental to the long-term performance of a structure if the cracks are of sufficient size to allow for the ingress of deleterious materials into the structure, and guidance for critical crack sizes is provided in ACI 224R, Table 4.1.

Consideration should be given to post-repair cracking and the need for protection of the existing concrete and repair material from the ingress of deleterious materials. ACI 224.1R provides guidance for the prevention and control of cracks.

There are a variety of different materials that have been used for crack repair, and the correct specification for a given application will affect the design service life of the repair. For cracks that are essentially acting as a joint or are active, one type of effective repair is to seal the crack with an elastomeric sealant at the concrete surface(s). Crack injection can be another effective repair approach. For repair by crack injection, the process and material should be appropriate to the site conditions. Dormant cracks can be repaired by injection using materials such as epoxy, polyurethane, latex in a cement matrix, microfine cement, and polymethacrylate. Crack injection should not be used to repair cracks caused by corrosion of steel reinforcement and alkali aggregate reaction unless supplemental means are employed to mitigate the cause of the cracks.

CODE

8.4—Corrosion and deterioration of reinforcement and metallic embedments

8.4.1 The corrosion and deterioration of reinforcement and embedded components shall be considered in the durability design. Repairs shall not contain intentionally-added constituents that are corrosive to reinforcement within the repair area.

8.4.2 The impact on the design service life of the repaired structure shall be considered if it is anticipated that corrosion products cannot be removed from the reinforcement during repair.

8.4.3 The quality of existing concrete and its ability to protect reinforcement from corrosion, fire and other forms of damage and deterioration shall be considered.

8.4.4 Galvanic corrosion between electrochemically dissimilar materials shall be considered.

COMMENTARY

R8.4—Corrosion and deterioration of reinforcement and metallic embedments

R8.4.1 Untreated reinforcement corrosion limits the life expectancy of repair areas, repair materials, and repaired structures. ICRI No. 310.1R provides guidelines on removal of damaged concrete and cleaning of reinforcement. Repairs that do not address reinforcement corrosion may negatively impact the design service life and require more intensive monitoring. The structural design considerations for corroding reinforcement on repairs are described in 7.6.3.1.

R8.4.2 Ideally corrosion products should be removed from reinforcement in repairs. In some situations, due to congestion of reinforcement, access limitations, load considerations, or other factors, it is not possible to remove corrosion products from the steel reinforcement. Situations exist where corroding reinforcement that cannot be adequately cleaned or repaired will remain in the repaired structure. The effects of uncleaned reinforcement on the long-term durability of the repaired structure should be considered in these situations. Supplemental corrosion mitigation strategies may be needed in these situations.

R8.4.3 Water and chemical penetration into the concrete can cause corrosion of metallic embedments and damage to nonmetallic reinforcement.

The corrosion of embedded metals adjacent to the repair may be accelerated due to differing electrical potential between electrically continuous reinforcement in the repair area and external to the repair area. This form of corrosion is commonly referred to as the "anodic ring" or "halo effect," and is discussed in ACI 364.3T, ACI 546R, and "ACI RAP Bulletin 8" (ACI Committee E706 2005). The rate of anodic ring corrosion depends upon the chloride content, internal relative humidity, and temperature.

The anodic ring effect, which may be induced by certain repairs, should be addressed by incorporating appropriate corrosion mitigation strategies such as cathodic protection or corrosion inhibitors. ACI 222R, ACI 222.3R, ACI 364.3T, ACI 546R, and *Technical Report 50* (The Concrete Society 1997) and FAQ sections from Concrete International (2002a,b,c) provide guidance for corrosion prevention, mitigation and inhibition. Both carbonation and chloride contamination may require consideration and are discussed in ACI 546R.

Aesthetics may be affected by different means of protection and may also require consideration. Damage due to fire and fire protection requirements are discussed in 7.9.

R8.4.4 Reinforcement or metallic embedments in the repair area with differing electrochemical potentials, environments, or both, should be isolated from the existing reinforcement, or the existing reinforcement and metal embedments should be protected to minimize galvanic corrosion. For example, rail or post-pocket repairs that use dissimilar

CODE | COMMENTARY

metals from conventional steel reinforcement could accelerate the deterioration of the installation (refer to ACI 222R).

8.4.5 Corrosion protection of bonded and unbonded prestressing materials and prestressing system components shall be addressed during the repair design.

R8.4.5 The presence of prestressing force in the steel and the need to transfer the prestressing force into the concrete makes corrosion damage in prestressed concrete members more critical than traditionally reinforced structures (refer to ACI 423.4R). Section 7.6.4 addresses the structural requirements for the repair.

The bonded or unbonded nature of the prestressing steel, the condition of the steel at the repair area, the attachment of the steel to the structure, the as-designed corrosion protection measures, the existing corrosion condition, the prestressing steel sheathing type and its risk for gaps and breaches that provide transmission pathways for contaminants, and the continuity of the prestressing steel need to be considered to address corrosion protection of the structure. Refer to PTI DC80.3-12/ICRI 320.6 and ACI 222.2R.

Hydrodemolition and other types of material removal methods should be used cautiously if the structure contains unbonded prestressing steel reinforcement. In these situations, water can be introduced into the sheathing surrounding the steel (refer to ICRI No. 310.3), affecting the long-term durability of the prestressing steel reinforcement.

8.4.6 If electrochemical protection systems are used to protect steel reinforcement in repair areas and structures, the interaction of the protection system with the repaired elements, the entire structure, and environment shall be considered.

R8.4.6 Structures using impressed current electrochemical protection or mitigation systems should have continuous reinforcement, separate zones, or provisions should be made to make the steel electrically continuous. Impressed current electrochemical protection systems should be designed and maintained to not promote an alkali-aggregate reaction (AAR) and to avoid embrittlement of prestressing steel.

Impressed current electrochemical protection systems should include a monitoring and maintenance plan developed by a licensed design professional specializing in the design of corrosion protection systems (refer to NACE 01101, NACE 01102, NACE 01104, NACE 01105, NACE SP0107, NACE SP0290, and NACE SP0390).

8.4.7 Repair materials and reinforcement shall be selected and detailed to be compatible such that the characteristics of each material do not adversely affect the durability of the other materials or of the existing concrete and reinforcement.

R8.4.7 Incompatibilities can arise from the use of inappropriate materials or components, or dissimilar electrochemical characteristics or physical properties, which can negatively impact the concrete and reinforcement. Some examples include:

(a) In certain situations such as exposure to high temperatures, polyvinyl chloride (PVC) and other polymer-based materials can deteriorate, releasing decomposition products found to cause corrosion.

(b) Even if the conventional steel reinforcement becomes more noble in electrical contact with a dissimilar metal (for example, embedded aluminum conduit in the presence of chlorides), considerable concrete damage can arise (Monfore and Ost 1965).

(c) Fiber-reinforced polymer (FRP) wrapping should not be used as a corrosion repair strategy on members experiencing corrosion of embedded reinforcement, unless the concrete is

CODE

COMMENTARY

repaired and corrosion mitigated. Appropriate sections within this code and referenced documents concerning FRP repairs should be consulted (refer to ACI 440.2R).

8.5—Surface treatments and coatings

8.5.1 Moisture transmission through the structure and the influence of the surface treatment on the durability of the structure shall be considered.

R8.5—Surface treatments and coatings

R8.5.1 Surface treatments, coatings, sealers, or membranes are commonly used to limit the ingress of deleterious materials and moisture into the structure to reduce future deterioration of the structure. Surface treatments, coatings, sealers, and membranes may have a shorter service life than the concrete and can be considered as consumable or requiring periodic replacement or repair to maintain effective protection of the concrete (ACI 515.1R).

In some situations, encapsulation of moisture and deleterious materials by a surface treatment has been found to cause or accelerate deterioration. The condition of the concrete should be appropriate to receive a specific surface treatment, coating, or membrane (ICRI No. 310.2R).

8.5.2 The selection of surface treatments applied to concrete surfaces shall consider the impact of abrasion, concrete cracks and their anticipated expansion and contraction, and anticipated movement of the structure on the repair system durability, the surface treatment, and the anticipated design service life of the structure.

R8.5.2 Crack development and propagation provide an accelerated mechanism for ingress of moisture and deleterious materials and may also cause a surface treatment to become ineffective.

CODE

CHAPTER 9—CONSTRUCTION

9.1—General

Construction documents shall specify that:

(a) The contractor has the responsibility to construct the project in accordance with the construction documents and with appropriate standards.

(b) The contractor has the responsibility to provide the necessary resources and access for inspection, testing, field observations, and quality control of the work.

(c) Specific temporary shoring and bracing requirements in accordance with Section 9.2.

(d) Specific jacking requirements.

(e) Project-specific inspection, testing, and construction observation requirements of Chapter 10.

9.2—Stability and temporary shoring requirements

9.2.1 Construction documents shall specify:

(a) Portions of the work that require temporary shoring and bracing during the period before the repair implementation for safety purposes and during construction

(b) Design loads and necessary spacing limitations for design of temporary shoring and bracing

(c) Contractor responsibilities to install, provide quality control, and properly maintain the temporary shoring and bracing

9.2.2 Temporary shoring and bracing design shall consider:

(a) Accommodation for in-place conditions and changes in conditions over the period of the repair phases, per 9.2.7

(b) Effects from measured lateral and vertical displacements, tilting or listing, secondary effects, and superimposed loads

(c) Impact of the temporary shoring and bracing on the structure

(d) Effects of deformation compatibility of the shoring system with the supported and supporting structural members and systems, in accordance with 9.2.6

(e) Structural stability of members, systems, and the structure in accordance with 9.2.5 and 9.2.6

(f) Effects of damage or deterioration of existing members and systems in accordance with 9.2.8

9.2.3 Shoring and bracing design shall be performed by a licensed design professional.

COMMENTARY

R9—CONSTRUCTION

R9.1—General

The information to be presented in construction documents is described in 1.6.1. Specific to the construction process, the construction documents should indicate that the contractor is responsible for construction consistent with the project plans and specifications, and convey project specific shoring, bracing and jacking requirements. During the work, the contractor should make the work available for inspection and observations by the licensed design professional, repair inspectors, and other quality assurance personnel.

R9.2—Stability and temporary shoring requirements

R9.2.1 Project-specific design criteria for the temporary shoring and bracing in the construction documents should include requirements for loading, displacement limits, spacing, placement, and quality control during construction. ACI 563 provides specifications for shoring of repairs.

R9.2.2 Temporary shoring and bracing members should be designed to consider changes in bracing and shoring conditions during repair construction and as required to support construction operations. Design of temporary shoring and bracing members should be based on the in-place loads on the structure, deformations of the structure, and anticipated superimposed loads during construction. Secondary effects that may need to be examined in shoring and bracing design include geometric and material nonlinear response, member and foundation displacement, and internal member forces developed due to placement and alignment of shoring and bracing elements.

Anticipated loads, such as snow, seismic, wind, and construction and occupancy live loads, should be considered in the design criteria of the temporary shoring and bracing. Design requirements for shoring are contained in ASCE/SEI 37. Shoring design guidelines are contained in AISC Steel Design Guide Series 10 (Fisher and West 2003) and ACI SP-4.

R9.2.3 Shoring and bracing design is not usually performed by the licensed design professional of record for the repair design. The contractor will usually retain a specialty engineer to prepare the temporary shoring design details and shoring-plans, showing loads, member type, spacing, and placement sequence for temporary shores and braces at the phases of planned repairs.

CODE

9.2.4 The licensed design professional for the repair design shall review temporary shoring and bracing design and details for compliance with the requirements of the project repair design and the temporary shoring and bracing criteria.

COMMENTARY

R9.2.4 Temporary shoring and bracing design and installation details should be reviewed by the licensed design professional for the repair project to assess the impact of the shoring on the structure, and to verify conformance of the proposed shoring with project-specific requirements. Refer to 5.1.4 for load requirements associated with shoring and temporary construction. Review of the shoring design by the licensed design professional for the repair design does not normally include a comprehensive review of the shoring design prepared by the specialty engineer and should not be considered a validation of the specialty engineer's design.

9.2.5 The shoring and bracing shall maintain the global structural stability of the structure before remedial construction and during the repair phases.

R9.2.5 The assessment of global structural stability includes the overall structure, members and systems affected by repair, and temporary lateral bracing elements that contribute to overall stability. Stability of these elements should be considered during the phases of the repair process. Temporary measures may be needed to provide lateral bracing and shoring of affected members and systems. If necessary, the criteria to temporarily preload members should be included in the construction documents. Review and redesign for variations in the construction proposed by the contractor with changes in temporary shoring and bracing design and detailing should be addressed in the construction documents.

The licensed design professional should be aware that compression-controlled columns with high axial loads in a structure with substantial structural damage may behave in a brittle manner, with little warning prior to localized failure or possible progressive collapse. Therefore, caution should be taken in the design and installation sequence for stabilization measures in these situations.

9.2.6 The shoring and temporary bracing shall maintain the structural stability of members and systems before construction and during the repair phases.

The lateral forces for temporary bracing design shall be determined using generally accepted engineering principles or as required by the design-basis code. Temporary shoring and bracing shall be designed to provide sufficient stiffness to prevent vertical and lateral displacement of the shored or braced members in excess of limits specified by the licensed design professional for the repair in the construction documents.

R9.2.6 Supplemental bracing for compression members may be required if the cross section or unbraced length of a compression member is modified during the repair process. Compression members include columns, walls, beam flanges, and other members, such as chords or diaphragms that resist compressive loads. The design of bracing members is described in various publications (AISC 2006; ANSI/AF&PA NDS 2014). The design load for a bracing member should be based on the existing dead and live loads, construction loads, and other loads that may be resisted by the compression member. A lateral force of 2 percent of the axial load in the member being braced is commonly used as a minimum load in the design of bracing members (ANSI/AISC 360-10).

9.2.7 The design of shoring and bracing members shall accommodate in-place conditions and changes in conditions during construction. The design shall, at a minimum, include consideration of (a) the changes in load paths, (b) construction loads, (c) unbraced lengths, and (d) the redistribution of loads and internal forces that result from removal of existing adjacent framing or changes in applied loads on structural members.

R9.2.7 Removal of column, beam, wall, and floor slab elements or parts thereof during repair construction and the placement of shoring and bracing can result in the redistribution of loads and internal forces within the building structure. The removal of framing members, diaphragms, or slabs can also affect the unbraced length of the framing members in the removal area. Effects of the removal of elements should be considered in assessing the structure and shoring and bracing design.

CODE

9.2.8 Where structural members are required to support the structure and superimposed loads before repair and during construction, the structural capacity of damaged or deteriorated members shall be evaluated. The evaluation shall consider the actual cross section of the member and reinforcing at the time of the repair including losses of capacity due to damage and deterioration. Structural members that require temporary shoring and bracing to be installed and maintained in place during construction until the member is repaired shall be identified on the construction drawings.

COMMENTARY

R9.2.8 Design of shoring and bracing members and the evaluation of members should be based on the member cross sections before and during the time of repair implementation. To account for unknown conditions, the evaluation by the licensed design professional should consider the importance of the member to the overall stability of the structure.

9.3—Temporary conditions

9.3.1 Load and load factors used during the assessment and construction processes shall be in accordance with 5.1.4.

R9.3—Temporary conditions

R9.3.1 During the assessment and repair process, a temporary reduction in design load may be allowed, except if prohibited by authorities having jurisdiction or local building codes. Reduction in the design load intensity should be determined using the in-place condition of the structure and the time required for the completion of stabilization measures or repairs. ASCE/SEI 37 provides information on reductions in loads based upon the duration of a project. If a change in the length of the project or a delay occurs, the reduced design loads may no longer be appropriate.

9.4—Environmental issues

9.4.1 Construction documents shall specify the contractor or other designated party is responsible for implementing environmental remediation measures, reporting new conditions encountered, and controlling construction debris, including environmentally hazardous materials and conditions.

R9.4—Environmental issues

R9.4.1 Assessment and repair of a structure can result in the exposure of workers and the public to potentially hazardous materials and conditions. Hazardous materials may be exposed, dislodged, carried into the air, or discharged as effluent into surface drainage during the assessment and repair process. Hazardous conditions include noise, nuisance dust, misdirected drainage, and falling debris. The Owner should have an environmental assessment performed during the structural assessment and repair process in the areas to be repaired before any work to identify hazardous materials with the potential to present health issues to the workers and public, unless the Owner can attest that the structure is free of hazardous materials.

During the repair project, the contractor normally is responsible for the implementation of repairs and, accordingly, the control of construction debris, dust, and other materials. Any new conditions uncovered during the repair process should be reported to the Owner and licensed design professional.

CHAPTER 10—QUALITY ASSURANCE

10.1—General

10.1.1 Quality assurance requirements of this chapter supplement the current and existing-building code provisions and shall be used for repair and rehabilitation construction.

10.2—Inspection

10.2.1 Concrete repair and rehabilitation construction shall be inspected as required by the building code and construction documents.

10.2.2 The construction documents shall include testing and inspection requirements applicable to the project.

COMMENTARY

R10—QUALITY ASSURANCE

R10.1—General

R10.1.1 The construction documents for repair and rehabilitation projects should include a project-specific quality assurance and inspection program. The quality assurance program should include:

(a) Review of the contractor's quality assurance program

(b) Quality control procedures during the repair process

(c) Review of conditions during the project

(d) Testing of materials used and material installation procedures

Usually, the quality control requirements are specified in the construction documents and the Owner retains the quality control personnel. The contractor is responsible for the work quality, including the quality of materials and workmanship.

R10.2—Inspection

R10.2.1 The quality of concrete repairs is largely dependent upon the workmanship during construction. Inspection is necessary to verify repairs and rehabilitation work are completed in accordance with construction documents. Most general building codes require special inspections for construction, which were developed for new construction. Typical repair construction is different from new construction in scope, and new construction testing requirements may not be sufficient for repair construction. Construction documents should specify inspection requirements for concrete repair and rehabilitation construction during the various work stages. The licensed design professional should recommend that the Owner retain a licensed design professional, a qualified inspector, a qualified individual, or some combination thereof for the necessary inspections.

R10.2.2 Required testing and inspections may include (a) through (j):

(a) Delivery, placement, and testing reports documenting the identity, quantity, location of placement, repair materials tests, and other tests as required

(b) Construction and removal of forms and reshoring

(c) Concrete removal and surface preparation of the concrete and reinforcement

(d) Placing of reinforcement and anchors

(e) Mixing, placing, and curing of repair materials

(f) Sequence of erection and connection of new members

(g) Tensioning of tendons

(h) Review and reporting of construction loads on floors, beams, columns, and walls

(i) General progress of work

(j) Installation and testing of post-installed anchors

Inspection and test results should be submitted to the licensed design professional and the Owner.

Repair construction should be inspected to verify the quality of materials, quality of workmanship, and for compliance with the intent of the construction documents. Inspection should be provided by either repair inspectors,

ACI 03-01-19
SEC 301 ADDS ACI 562 181209
ACI Proposed Code Change

Section 301.1.4 Add new Section and reference to Chapter 3 as follows and renumber subsequent Sections:

301.1.4 Concrete evaluation and design procedures. Evaluation and design of structural concrete in compliance with ACI 562 and this code shall be permitted.

Exception: ACI 562 shall not be used to comply with provisions of this code for seismic evaluation and design procedures.

303.1.~~4~~5 Seismic evaluation and design procedures. [No change to text, renumber Section and subsections]

ACI

American Concrete Institute
38800 Country Club Drive
Farmington Hills, MI 48331

562-19: Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures
303.3

Reason:
Concept – This code change proposal adds ACI 562: *Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures*, to establish minimum requirements for the design, construction, repair, and rehabilitation of concrete structural elements in buildings for various levels of desired performance as deemed appropriate for the project. In addition to improved life safety, the requirements clearly define objectives and anticipated performance for the code official, owners, designers, contractors and installers. The proposed language is permissive, allowing other methods to be used to comply with the intent of the building code.
The Exception provides language to appropriately exclude the use of ACI 562 for seismic evaluation, repair and rehabilitation, consistent with the scope of ACI 562. The language is provided so the user does not resort to the ACI 562 simply to discover that its scope excludes seismic resistance.

Background – In 2006, the repair industry approached ACI asking for a concrete repair and rehabilitation code that would improve the overall quality of concrete repairs by establishing common requirements and establishing clear responsibilities between owners, designers, and contractors. This code would also provide building code officials with a reference by which to evaluate rehabilitated concrete structures. ACI, following its rigorous American National Standards Institute accredited standards development process assembled a code committee with balanced representation and produced the first official code in 2012. The committee members reviewed and considered numerous reports and publications related to concrete repair and rehabilitation to identify and develop requirements consistent with current industry practice. The committee has received feedback from users of the code and are now completing their third version of this code, ACI 562-19.

Scope – ACI 562 complements the Florida EBC by providing specific direction on how to design concrete repairs and how to handle the unique construction problems associated with repair. This standard helps the designer assess the existing structure in accordance with the IEBC. The standard then provides the requirements that bridge the inconsistencies and gaps in acceptable criteria that occur from the two following situations that a designer must solve: one, repairing a structure according to the original building code used at the time it was built using today's construction methods and materials; or, repairing a structure built according to an older building code but repaired according to the latest building code. Note that ACI 562 does not address the evaluation of lateral-force resisting systems in high seismic areas. ASCE 41 is the appropriate standard for this situation as stated in the FL EBC and ACI 562.

Benefits – There are many benefits that ACI 562 provides for the designer, owner, contractor, materials providers, building code official and the public. A few of these benefits are:

- Provides a level of expectation of life safety to the public in buildings where repairs or rehabilitation is performed on concrete structural elements.
- Provides clearly defined, uniform requirements aimed at extending the service life of existing structures.
- Provides minimum requirements for efficiency, safety, and quality of concrete repair.
- Establishes clear responsibilities between owners, designers, and contractors.
- Provides building code officials with a means to evaluate rehabilitation designs.
- Provides specific repair requirements that often result in less costly repairs compared to repairs required to meet only new construction requirements.

Flexibility – ACI 562 permits flexibility in evaluation, design, construction and repair materials to provide economies while establishing expected performance for the service-life of the rehabilitation or repairs.

Resources – Also, there many resources that complement ACI 562. Among these are:

- *Concrete Repair Manual: Fourth Edition 2013*
- ACI 563-18, *Specifications for Repair of Structural Concrete in Buildings*
- MNL-3(16) *Guide to the Code for Assessment, Repair, and Rehabilitation of Existing Concrete Structures*

These resources are readily available to provide greater understanding of assessment, repair and rehabilitation of concrete structural elements. ACI MNL-3 provides case studies demonstrating the ease of use of ACI 562. Numerous technical notes, reports, guides, and specifications that provide background information and technical support are available through other organizations, such as American Society of Civil Engineers, British Research Establishment, Concrete Society, International Concrete Repair Institute, National Association of Corrosion Engineers, Post-Tensioning Institute, Society for Protective Coatings, and US Army Corps of Engineers. Many of these organizations publications related to concrete repair can be found in the Concrete Repair Manual.

Sustainability - Reference of ACI 562 in the IEBC will help improve the confidence of owners, builders, and developers regarding effective repairs, upgrades, and reuse of existing buildings in lieu of demolition and replacement. Typically, extending the life of existing buildings is substantially more sustainable than demolition and new construction. Adoption of ACI 562 by reference is needed to help facilitate efforts that conserve energy and resources while maintaining a minimum level of requirements to ensure reasonable levels of life safety, and welfare are afforded to the public.

Bibliography –

- Concrete Repair Manual - 4th Edition: 2-Volume Set, ACI and ICRI, 2013, 2093 pp.
- https://www.concrete.org/store/productdetail.aspx?ItemID=RPMN13PACK&Format=HARD_COPY
- Guide to the Code for Assessment, Repair, and Rehabilitation of Existing Concrete Buildings, ACI and ICRI, 2016, 176 pp. https://www.concrete.org/store/productdetail.aspx?ItemID=MNL316&Language=English

State and Local Adoptions – Several jurisdictions already addressed the need for these requirements. ACI 562 is already being used in several jurisdictions:

Hawaii: Hawaii was the first state to adopt ACI 562 by reference. The following provisions are included in the State Building Code Council HAWAII STATE BUILDING CODE, which became effective on January 1, 2018:

"3401.6 Alternative compliance.

1) Work performed in accordance with the International Existing Building Code shall be deemed to comply with the provisions of this chapter.

2) Work performed in accordance with the 2016 version of the American Concrete Institute Committee 562, "Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures" shall be deemed to comply with this chapter when used as a supplement to the requirements of this chapter or the International Existing Building Code. Wherever the term International Existing Building Code (IEBC) is used in ACI 562-16, it shall mean International Existing Building Code or Chapter 34 of the International Building Code."

Ohio: The Ohio Board of Building Standards Ohio adopted rule changes identified as Amendments Group 95. Included in this group is:

3401.6 Concrete evaluation and design procedures. Evaluation and design of structural concrete repairs and rehabilitation shall be in compliance with Chapter 34 and ACI 562.

ACI, a professional technical society, has developed this standard in response to industry needs and to help assure minimum levels of life safety results where repairs and rehabilitation are associated with concrete structural elements. For this reason and the other benefits identified in this reason statement, ACI recommends this code change proposal for committee approval as submitted.

New York City: The New York City Buildings Department issued *BUILDINGS BULLETIN 2015-017* in December 2017 Conditions of Acceptance for Fiber Reinforced Cementitious Matrix strengthening systems.

FRCM shall comply with the NYC Construction Codes and the following applicable provisions:
A. Design
1. FRCM system shall be designed in accordance with the ACI 549.4R-132 Guide for the Design and Construction of Externally Bonded Fabric-Reinforced Cementitious Matrix (FRCM) Systems for Repair and Strengthening Concrete and Masonry Structures with properties used for design obtained from tests performed in accordance with AC 434. Fire-resistance-rating and interior finish requirements shall be in accordance with the NYC Construction Codes, manufacturer's recommendations and the conditions of the required listing.

2. For repairs and upgrade achieved with unprotected external FRCM, the increase in flexural or shear strength provided by the external reinforcing system shall not exceed 50% of the existing structural capacity of the member prior to strengthening. This increase should be checked before applying the strength reduction factor.
3. Careful consideration should be given to determine reasonable strengthening limits. These limits are imposed to guard against collapse of the structure should bond or other failure of the FRCM system occur due to damage, vandalism, or other causes. The required strength of a structure without repair should be as specified in in accordance with ACI 562 *Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures* Section 5.5.

Recommendation – ACI, a professional technical society, has developed this ACI 562 in response to industry needs and to help assure minimum levels of life safety, health, and welfare for the public. For this reason and the other benefits identified in this reason statement, ACI recommends this code change proposal for committee approval as submitted.

Cost Impact: The use of this referenced standard should in many cases reduce the cost of repair. Too often in the process of repair, there is insufficient information to determine acceptance criteria that is amicable to both the owner and the building code official. The result is the determination that the repair must meet the latest building code requirements for new construction. This standard increases the options available for repair and provides the acceptance criteria necessary to permit these options. A case study that illustrates this point: "ACI 562 has been referenced in expert reports for litigation cases, resulting in significantly reduced financial settlements. Denver-based J. R. Harris & Company recently used the code as a standard in several litigation reports assessing damages in existing concrete structures. As an approved consensus standard, according to American National Standards Institute (ANSI) procedures, ACI 562-13 has been accepted as the source standard to use for damage assessment and repair on individual projects by Greenwood Village and Pikes Peak Regional Building Departments in Colorado. Based on this acceptance, the consulting engineer was able to cite the code in their recommendation for structural remediation and determination of damages. In one case involving rehabilitation work on four buildings with faulty construction, J.R. Harris was able to reduce the repair costs from $12 million to $3 million, with a repair plan based on the lesser of the demand-capacity ratio based on either the original or current building code per ACI 562."

Date Submitted 12/14/2018
Chapter 3
Section 301.1
Affects HVHZ No
Proponent Ann Russo4
Attachments No
TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes **Alternate Language** No

Related Modifications

301.1.4 301.1.4.1
Table 301.1.1.4.1
301.1.4.2
Table 301.1.1.4.2
303(New)

Summary of Modification

Moves the seismic evaluation and design procedures out of the same section and code hierarchy as the three compliance methods and places it in its own section.

Rationale

The topic is separate and distinct, this modification moves it to a separate section to ensure it is independent of the compliance method choice by the applicant and will eliminate possible confusion

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity as this is already a code requirement

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

No impact to building and property owners as this modification is only to clarify the existing code requirements through a relocation (reorganization) of code sections, so there is no intended increase or decrease expected by approving this proposal.

Impact to industry relative to the cost of compliance with code

No impact to industry as this is already a code requirement this is only to clarify the existing code requirements through a relocation (reorganization) of code sections, so there is no intended increase or decrease expected by approving this proposal.

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

No impact to small business as this is already a code requirement this is only to clarify the existing code requirements through a relocation (reorganization) of code sections, so there is no intended increase or decrease expected by approving this proposal.

Requirements

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

Doesn't change the health, safety, and welfare of the general public as is modification to move seismic evaluation and design procedures to its on section

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

Strengthens the code because the format of the chapter will be clearer. Section 301 is intended to describe the three compliance methods. The seismic criteria are to be applied to all three methods where referenced and needed to located in a standalaone section

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

Does not discriminate against material, products, methods, or systems of construction of demonstrated capabilities, this is a current code requirement that does not limit material, products, methods, or systems of construction

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code it makes the format of the chapter will be clearer

2nd Comment Period

S8169-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

SECTION
301
ADMINIS
TRATION

General. The *repair*, *alteration*, *change of occupancy*, *addition* or relocation of all *existing buildings* shall comply with one of the methods listed in Sections 301.1.1 through 301.1.3 as selected by the applicant. Sections 301.1.1 through 301.1.3 shall not be applied in combination with eachother.
Where this code requires consideration of the seismic force resisting system of an *existing building* subject to *repair*, *alteration*, *change of occupancy*, *addition* or relocation of *existing buildings,* the seismic evaluation and design shall be based on Section ~~301.1.4~~ 303.1 regardless of which compliance method is used.

Exception: Subject to the approval of the *code official, alterations* complying with the laws in existence at the time the building or the affected portion of the building was built shall be considered in compliance with the provisions of this code unless the building is undergoing more than a limited structural *alteration* as defined in Section 907.4.4. New structural members added as part of the *alteration* shall comply with the *Florida Building Code*. *Alterations* of *existing buildings* in *flood hazard areas* shall comply with Section 701.3.

Prescriptive compliance method. *Repairs*, *alterations*, *additions* and *changes of occupancy*complyingwithChapter4ofthiscodeinbuildingscomplyingwiththe*Florida Fire Code* shall be considered in compliance with the provisions of thiscode.

Work area compliance method. *Repairs*, *alterations*, *additions*, *changes in occupancy and relocatedbuildingscomplyingwiththeapplicablerequirementsofChapters5through13ofthiscode shall be considered in compliance with the provisions of thiscode.*

Performancecompliancemethod.*Repairs*,*alterations*,*additions*,changesinoccupancyand relocated buildings complying with Chapter 14 of this code shall be considered in compliance with the provisions of this code.

Add new section as follows:

SECTION 303

SEISMIC EVALUATION AND DESIGN PROCEDURES

Renumber subsequent sections:

[BS] ~~301.1.4~~303.1~~Seismic evaluation and design procedures~~General. *(No change to text)*

[BS] ~~301.1.4.1~~303.1.1 Compliance with Florida Building Code-level seismic forces. ***(No change to text)***

TABLE [BS] 3~~301.1.4.1~~ 303.1.1

PERFORMANCE OBJECTIVES FOR USE IN ASCE 41 FOR COMPLIANCE WITH FLORIDA BUILDING CODE-LEVEL SEISMIC FORCES

(No change to Table)

[BS] ~~301.1.4.2~~303.1.2 Compliance with reduced Florida Building Code-level seismic forces. ***(No change to text)***

TABLE [BS] ~~301.1.4.2~~ 303.1.2

PERFORMANCE OBJECTIVES FOR USE IN ASCE 41 FOR COMPLIANCE WITH REDUCED FLORIDA BUILDING CODE-LEVEL SEISMIC FORCES

S7970

Date Submitted 12/12/2018 **Section** 403.5 **Proponent** Harold Barrineau
Chapter 4 **Affects HVHZ** No **Attachments** Yes
TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes **Alternate Language** No

Related Modifications

Existing Building Section 907.5 EB23-16

Summary of Modification

This proposal simplifies and clarifies the wording of corresponding proposals in the Work Area and Prescriptive methods.Current 403.4.1:•Renumber to 403.5.

Rationale

This proposal simplifies and clarifies the wording of corresponding proposals in the Work Area and Prescriptive methods.Current 403.4.1:•Renumber to 403.5. This can and should be a stand-alone provision, independent of the basic alteration check and 10% rule in 403.4.•Use the defined terms "work area" and "building area."•Replace the "75% of code" wording with the simpler call out for reduced seismic loads.•Omit the sentence about "new structural members and connections," as this is now covered by the general provisions in Chapter 3.Current 907.4.3:•Renumber to 907.5. Each of the lateral system provisions in 907.4 should be independent to avoid confusion over the exceptions in 907.4. A more complete reorganization of 907.4 is being proposed separately.•Simplify the call out for reduced seismic loads. Note that the current Work Area provision triggers a wind evaluation/retrofit, while the Prescriptive provision does not. Because this is an editorial proposal, reconciliation, while recommended, will be left to a separate proposal.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity. This proposal is editorial, therefore there is no change in construction requirements.

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

No impact to building and property owners. This proposal is editorial, therefore there is no change in construction requirements.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction. This proposal is editorial, therefore there is no change in construction requirements.

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

No impact to small business. This proposal is editorial, therefore there is no change in construction requirements.

Requirements

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

Improves the health, safety, and welfare of the general public by clarification of code.

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

Strengthens and improves the code with clarification.

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

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

Does not degrade the effectiveness of the code

Increases the effectiveness of the code with clarification.

2nd Comment Period

S7970-G1

Proponent Robert Couch **Submitted** 5/13/2019 **Attachments** No

Comment:

I believe this is good for Florida

2nd Comment Period

S7970-G2

Proponent Michael Savage **Submitted** 5/14/2019 **Attachments** No

Comment:

I agree with the proposed modification.

2nd Comment Period

S7970-G3

Proponent	Jennifer Privateer	**Submitted**	5/20/2019	**Attachments**	No

Comment:

agreed

[BS] ~~403.4.1~~403.5Seismic Design Category F.

Where the~~portion of the building undergoing the intended alteration~~ work area exceeds 50 percent of the ~~aggregate~~buildingarea~~of the building~~, and where the building is assigned to Seismic Design Category F, the structure of the altered building shall~~be shown to~~meet the~~earthquake design provisions~~requirements of~~theInternational Building Code. For purposes of this section, the earthquake loads need not be taken greater than 75 percent of those prescribed in~~ Section 1613 of theInternational Building Code~~for new buildings of similar occupancy, purpose and location.New structural members and connections required by this section~~

ReducedInternational Building Code-level seismic forcesshall~~comply with the detailing provisions of this code for new buildings of similar structure, purpose and location~~be permitted.

[BS]~~907.4.3~~ 907.5Seismic Design Category F.

Where the building is assigned to Seismic Design Category F, the~~evaluation and analysis shall demonstrate that the lateral load-resisting systemstructure~~of the altered building~~or structure complies with reduced~~shall meet the requirements of Sections 1609 and 1613 of theInternational Building Code. ReducedInternational Building Code-level seismic forces~~in accordance with Section 301.1.4.2 and with the wind provisions applicable to a limited structural alteration~~ shall be permitted.

[BS] ~~403.4.1~~ 403.5 Seismic Design Category F.
Where the ~~portion of the building undergoing the intended alteration~~ work area exceeds 50 percent of the ~~aggregate~~ building area ~~of the building~~, and where the building is assigned to Seismic Design Category F, the structure of the altered building shall ~~be shown to~~ meet the ~~earthquake design provisions~~ requirements of ~~the International Building Code. For purposes of this section, the earthquake loads need not be taken greater than 75 percent of those prescribed in~~ Section 1613 of the International Building Code ~~for new buildings of similar occupancy, purpose and location~~. ~~New structural members and connections required by this section~~
Reduced International Building Code-level seismic forces shall ~~comply with the detailing provisions of this code for new buildings of similar structure, purpose and location~~ be permitted.

[BS] ~~907.4.3~~ 907.5 Seismic Design Category F.
Where the building is assigned to Seismic Design Category F, the ~~evaluation and analysis shall demonstrate that the lateral load-resisting system structure~~ of the altered building ~~or structure complies with reduced~~ shall meet the requirements of Sections 1609 and 1613 of the International Building Code. Reduced International Building Code-level seismic forces ~~in accordance with Section 301.1.4.2 and with the wind provisions applicable to a limited structural alteration~~ shall be permitted.

S8016

Date Submitted	12/12/2018	**Section**	403.6	**Proponent**	Harold Barrineau
Chapter	4	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	No Affirmative Recommendation				
Commission Action	Pending Review				

Comments

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

Related Modifications

Section 907.4.5 EB27-16

Summary of Modification

[BS] 403.6 Wall anchorage for unreinforced masonry walls in major alterations. [BS] 907.4.5 Wall anchors for concrete and masonry buildings.

Rationale

This proposal extends the URM mitigation requirement for Level 3 alteration projects. Currently, Level 3 alterations trigger URM parapet bracing and anchors at the roof line in both the Work Area and Prescriptive methods. However, experience in Christchurch and standard, feasible practice in Massachusetts and California indicate that URM walls should be anchored at floor levels as well, in order to achieve even basic collapse prevention performance. (IEBC AppendixA1 and ASCE 41 Chapter 15 say the same.)An alteration that already involves more than half of the building (a Level 3 Alteration in WAM terms) justifies this proactive mitigation, which not only protects the subject building and adjacent spaces and property, but also makes the essential parapet and roof level work more reliable.Note: A separate proposal would split 907.4.5 into two sections for editorial clarity. If that proposal is approved, this proposal can be effected simply by changing "roof line" to "floor and roof lines" in the new URM section, to match proposed 403.6 shown here.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will increase the cost of construction. A small additional cost with a high benefit-cost ratio for URM buildings with major alterations. No additional cost for lesser alterations.

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

Will increase the cost of construction. A small additional cost with a high benefit-cost ratio for URM buildings with major alterations. No additional cost for lesser alterations.

Impact to industry relative to the cost of compliance with code

Will increase the cost of construction. A small additional cost with a high benefit-cost ratio for URM buildings with major alterations. No additional cost for lesser alterations.

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

Will increase the cost of construction. A small additional cost with a high benefit-cost ratio for URM buildings with major alterations. No additional cost for lesser alterations.

Requirements

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

Improves the health, safety, and welfare of the general public by improving the performance of unreinforced masonry structures.

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

Strengthens or improves the code by improving the performance of unreinforced masonry structures.

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

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

Does not degrade the effectiveness of the code

Increases the effectiveness of the code by improving the performance of unreinforced masonry structures.

2nd Comment Period

S8016-G1

Proponent Robert Couch **Submitted** 5/13/2019 **Attachments** No

Comment:

This is a good modification

2nd Comment Period

S8016-G2

Proponent	Michael Savage	Submitted	5/14/2019	Attachments	No

Comment:

I agree with the proposed modification.

2nd Comment Period

S8016-G3

Proponent	Michael Savage	Submitted	5/14/2019	Attachments	No

Comment:

I agree with the proposed modification.

2nd Comment Period

S8016-G4

Proponent	Jennifer Privateer	Submitted	5/20/2019	Attachments	No

Comment:

agreed

[BS] 403.6 Wall anchorage for unreinforced masonry walls in major alterations.

Where the portion of the building undergoing the intended alteration exceeds 50 percent of the aggregate area of the building, the building is assigned to Seismic Design Category C, D, E or F, and the building's structural system includes unreinforced masonry walls, the alteration work shall include installation of wall anchors at the floor and roof ~~line~~ lines to resist seismic forces, unless an evaluation demonstrates compliance of existing wall anchorage. For purposes of this section, design seismic forces need not be taken greater than 75 percent of those that would be required for the design of new buildings of similar structure, purpose and location.

[BS] 907.4.5 Wall anchors for concrete and masonry buildings.

For any building assigned to Seismic Design Category D, E or F with a structural system consisting of concrete or reinforced masonry

walls with a flexible roof diaphragm and any building assigned to Seismic Design Category C, D, E or F with a structural system consisting of unreinforced masonry walls with any type of roof diaphragm, the alteration work shall include installation of wall anchors at the roof line of all subject buildings and at the floor lines of unreinforced masonry buildings to resist the reduced International Building Code-level seismic forces in accordance with Section 301.1.4.2, unless an evaluation demonstrates compliance of existing wall anchorage.

S8024

Date Submitted	12/12/2018	**Section**	403.6	**Proponent**	Harold Barrineau
Chapter	4	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

Section 907.4.5

Summary of Modification

Modify Section Number 403.6 Wall Anchorage. New Section 403.6.1 Wall anchorage for unreinforced masonry walls in major alterations. New Section 403.6.2 Wall anchorage for concrete and reinforced masonry walls.

Rationale

This proposal resolves an inconsistency between the Work Area method and the Prescriptive method. Currently, the Work Area method has a sensible provision that requires roof-to-wall anchors in Level 3 Alterations for concrete and reinforced masonry walls as well as URM walls (907.4.5) but the Prescriptive method addresses only URM walls (403.6). This proposal adds a matching proposal for concrete and RM walls to the Prescriptive method.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement.

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

Will increase the cost of construction.
For certain buildings, including vulnerable tilt-ups, undergoing major alterations. No change for other buildings or lesser alterations.

Impact to industry relative to the cost of compliance with code

Will increase the cost of construction.
For certain buildings, including vulnerable tilt-ups, undergoing major alterations. No change for other buildings or lesser alterations.

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

Will increase the cost of construction.
For certain buildings, including vulnerable tilt-ups, undergoing major alterations. No change for other buildings or lesser alterations.

Requirements

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

Concrete and masonry walls pose a hazard that needs to be addressed and this change will include the installation of wall anchors as part of required alterations. The health, safety, and welfare of the general public will be improved.

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

Strengthens or improves the code by providing provisions for anchorage for concrete and reinforced masonry walls.

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

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

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

2nd Comment Period

S8024-G1

Proponent Robert Couch **Submitted** 5/13/2019 **Attachments** No

Comment:

This modification is good for Florida

2nd Comment Period

S8024-G2

Proponent Robert Couch **Submitted** 5/13/2019 **Attachments** No

Comment:

This modification is good for Florida

2nd Comment Period

S8024-G3

Proponent	Michael Savage	**Submitted**	5/14/2019	**Attachments**	No

Comment:

I agree with the proposed modification.

2nd Comment Period

S8024-G4

Proponent	Jennifer Privateer	**Submitted**	5/20/2019	**Attachments**	No

Comment:

I believe this is a good proposed modification for the FBC

403.6 ~~Wall anchorage for unreinforced masonry walls in major alterations.~~ Wall Anchorage.

403.6.1 Wall anchorage for unreinforced masonry walls in major alterations.

Where the ~~portion of the building undergoing the intended alteration~~ work area exceeds exceeds 50 percent of the aggregate area of the building, the building is assigned to Seismic Design Category C, D, E or F, and the building's structural system includes unreinforced masonry walls, the alteration work shall include installation of wall anchors at the roof line to resist seismic forces, unless an evaluation demonstrates compliance of existing wall anchorage. For purposes of this section, design seismic forces need not be taken greater than 75 percent of those that would be required for the design of new buildings of similar structure, purpose and location.

403.6.2 Wall anchorage for concrete and reinforced masonry walls.

Where the work area exceeds 50 percent of the building area, the building is assigned to Seismic Design Category D, E or F, and the building's structural system includes concrete or reinforced masonry walls with a flexible roof diaphragm, the alteration work shall include installation of wall anchors at the roof line, unless an evaluation demonstrates compliance of existing wall anchorage. Use of reduced International Building Code-level seismic forces shall be permitted.

S8051

Date Submitted 12/13/2018
Chapter 4
Section 403.6
Affects HVHZ No
Proponent Harold Barrineau
Attachments No
TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes
Alternate Language No

Related Modifications

Section 403.6.3 (New)
Section 907.4.7 (New)

Summary of Modification

403.6.3 Wall anchorage of unreinforced masonry partitions in major alterations. 907.4.7 Wall anchorage of unreinforced masonry partitions.

Rationale

This proposal adds a proactive mitigation trigger to address a common nonstructural falling hazard.
Currently, both the Prescriptive and Work Area methods include mitigation requirements for URM parapets and bearing walls, triggered by major (Level 3) alterations. A related hazard involves the failure of interior unreinforced masonry partitions, especially around stairwells and egress corridors.
Mitigation of this well-understood and common hazard is justified by a Level 3 alteration. Still, to avoid disproportionate impacts not associated with the intended work, the proposal would require the mitigation only within the work area and along egress paths from the work area to building exits. In many cases, an alteration project that involves 50 percent of a building's area will already have some partition removal or replacement in its scope.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity relative to enforcement of code.

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

Will increase the cost of construction.
The cost increase is for URM partitions only, and only within the work area and egress paths. Where the intended work already involves partition alteration, there is no cost increase.

Impact to industry relative to the cost of compliance with code

Will increase the cost of construction.
The cost increase is for URM partitions only, and only within the work area and egress paths. Where the intended work already involves partition alteration, there is no cost increase.

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

Will increase the cost of construction.
The cost increase is for URM partitions only, and only within the work area and egress paths. Where the intended work already involves partition alteration, there is no cost increase.

Requirements

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

This proposal addresses a significant potential hazard from unreinforced masonry partitions when major alterations are being performed.

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

This proposal strengthens and improves the code.

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

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

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

2nd Comment Period

S8051-G1

Proponent Robert Couch **Submitted** 5/13/2019 **Attachments** No

Comment:

This modification deserves consideration

2nd Comment Period

S8051-G2

Proponent	Michael Savage	**Submitted**	5/14/2019	**Attachments**	No

Comment:

I agree with the proposed modification.

2nd Comment Period

S8051-G3

Proponent	Michael Savage	**Submitted**	5/14/2019	**Attachments**	No

Comment:

I agree with the proposed modification.

2nd Comment Period

S8051-G4

Proponent	Jennifer Privateer	**Submitted**	5/20/2019	**Attachments**	No

Comment:

I agree

Add new text as follows:

403.6.3 Wall anchorage of unreinforced masonry partitions in major alterations.

Where the work areaexceeds 50 percent of the building area, and where the building is assigned to Seismic Design Category C, D, E, or F, unreinforced masonry partitions and nonstructural walls within the work area and adjacent to egress paths from the work area shall be anchored, removed, or altered to resist out-of-plane seismic forces, unless an evaluation demonstrates compliance of such items. Use of reduced Florida Building Code-level seismic forces shall be permitted.

907.4.7 Wall anchorage of unreinforced masonry partitions.

Where the building is assigned to Seismic Design Category C, D, E, or F, unreinforced masonry partitions and nonstructural walls within the work area and adjacent to egress paths from the work area shall be anchored, removed, or altered to resist out-of-

plane seismic forces, unless an evaluation demonstrates compliance of such items. Use of reduced Florida Building Code-level seismic forces shall be permitted.

S8075

Date Submitted	12/13/2018	**Section**	407.4	**Proponent**	Harold Barrineau
Chapter	4	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes | **Alternate Language** No

Related Modifications

Section: [BS] 1007.3.1

Summary of Modification

[BS] 407.4 Seismic force-resisting system. [BS] 1007.3.1 Seismic force-resisting system.

Rationale

This code change reconciles provisions of the prescriptive method with those of the work area method. Approval is consistent with actions on prior proposals.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal does not impact local entity relative to enforcement.

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

Will not increase the cost of construction.
By adding more exceptions to each method, the proposal will actually reduce the cost of construction.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction.
By adding more exceptions to each method, the proposal will actually reduce the cost of construction.

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

Will not increase the cost of construction.
By adding more exceptions to each method, the proposal will actually reduce the cost of construction.

Requirements

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

This proposal improves the heath, safety, and welfare of the general public.

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

This proposal strengthens or improves the code.

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

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

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

2nd Comment Period

S8075-G1

Proponent Robert Couch **Submitted** 5/13/2019 **Attachments** No

Comment:

This modification will improve the code

2nd Comment Period

S8075-G2

Proponent Michael Savage **Submitted** 5/14/2019 **Attachments** No

Comment:

I agree with the proposed modification.

2nd Comment Period

S8075-G3

Proponent Jennifer Privateer **Submitted** 5/20/2019 **Attachments** No

Comment:

I am good with this proposed modification to FBC

[BS] 407.4 ~~Structural~~ Seismic force-resisting system.

When a change of occupancy results in a ~~structure~~ building being ~~reclassified~~ assigned to a higher risk category, the ~~structure~~ building shall ~~conform to the seismic requirements for a new structure of the higher risk category. For purposes of this section, compliance with ASCE 41, using a Tier 3 procedure and the two-level performance objective in Table 301.1.4.1 for the applicable risk category, shall be deemed to meet~~ satisfy the requirements of Section 1613 of the International Building Code for the new risk category using International Building Code-level seismic forces.

Exceptions:

1. ~~Specific seismic detailing requirements of Section 1613 of the International Building Code for a new structure shall not be required to be met where the seismic performance is shown to be equivalent to that of a new structure. A demonstration of equivalence shall consider the regularity, overstrength, redundancy and ductility of the structure.~~ Where the area of the new occupancy is less than 10 percent of the building area and the new occupancy is not assigned to Risk Category IV, compliance with this section is not required. The cumulative effect of occupancy changes over time shall be considered.

2. When a change of use results in a ~~structure~~ building being reclassified from Risk Category I or II to Risk Category III and the ~~structure is located where the~~ seismic coefficient, ~~SDS~~ S_{DS},is less than 0.33, compliance with ~~the seismic requirements of Section 1613 of the International Building Code~~ this section is not required.

3. Unreinforced masonry bearing wall buildings assigned to Risk Category III, when assigned to Seismic Design Category A or B, shall be permitted to use Appendix Chapter A1 of this code.

[BS] 1007.3.1 ~~Compliance with International Building Code-level seismic forces.~~

Seismic force-resisting system.

~~Where~~ When a ~~building or portion thereof is subject to a~~ change of occupancy ~~that~~ results in ~~the~~ a building being assigned to a higher risk category ~~based on Table 1604.5 of the International Building Code~~, the building shall ~~comply with~~ satisfy the requirements ~~for~~ of Section 1613 of the International Building Code~~-level seismic forces as specified in Section 301.1.4.1~~ for the new risk category using International Building Code-level seismic forces

Exceptions:

~~1.~~ ~~Where approved by the code official, specific detailing provisions required for a new structure are not required to be met where it can be shown that an equivalent level of performance and seismic safety is obtained for the applicable risk category based on the provision for reduced International Building Code-level seismic forces as specified in Section 301.1.4.2.~~ When a change of use results in a building being reclassified from Risk Category I or II to Risk Category III and the seismic coefficient, S_{DS}, is less than 0.33, compliance with this section is not required.

2. Where the area of the new occupancy ~~with a higher hazard category~~ is less than ~~or equal to~~ 10 percent of the ~~total~~ building ~~floor~~ area and the new occupancy is not ~~classified as assigned~~ to Risk Category IV~~. For the purposes of~~, compliance with this ~~exception, buildings occupied by two or more occupancies~~ section is not ~~included in the same risk category, shall be subject to the provisions of Section 1604.5.1 of the International Building Code~~ required. The cumulative effect of ~~the area of~~ occupancy changes over time shall be considered ~~for the purposes of this exception~~.

3. Unreinforced masonry bearing wall buildings ~~in~~ assigned to Risk Category III~~,~~ when assigned to Seismic Design Category A or B, shall be ~~allowed~~ permitted to ~~be strengthened to meet the requirements of~~ use Appendix Chapter A1 of this code ~~[Guidelines for the Seismic Retrofit of Existing Buildings (GSREB)]~~.

S8231

Date Submitted 12/14/2018
Chapter 4
Section 401.2
Affects HVHZ No
Proponent Ann Russo4
Attachments No
TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes
Alternate Language No

Related Modifications

401.2.1 401.2.2 401.2.3
403.1
404.1
602.1 602.2

Summary of Modification

Removes provisions from Sections 401.2,401.2.2,401.2.3,602.1 & 602.2 that wer already moved to Chapter 3 last cycle

Rationale

The modification removes provisions that were already moved to Chapter 3 in the last cycle. When they were moved, however, the remaining duplicate provisions addressed by this proposal could not be deleted because of Group assignments.
Sections 401.2.1, 401.2.2, 602.1, and 602.2 are now in Sections 302.3 and 302.4. Section 401.2.3 is now in Sections 301.1.4.1 and 301.1.4.2.
If 401.2.1 - 401.2.3 are deleted as proposed, the balance of 401.2 can be deleted as well.
Section 403.1 is revised accordingly to cite the existing sections that cover new and existing materials.
In Section 404.1, the two references to Section 401.2 are removed and not replaced because they are actually erroneous references that should have been removed in a previous cycle. Their
removal here is at most editorial, but could even be construed as errata. The reference to 401.2 used to match a provision in FBC Chapter 34 that referred to Section 3401.2 Maintenance, but that
section no longer exists in the FEBC in any of its compliance methods. The first instance could be revised to refer instead to 302.4, but it is frankly not needed, as 302.4 applies even without a direct reference. The second instance is clearly a mistaken reference to the old maintenance provision, not a reference to the current provisions about new and existing materials.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity as this is already a code requirement

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

No impact to building and property owners as this is already a code requirement

Impact to industry relative to the cost of compliance with code

No impact to building and property owners as this is already a code requirement

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

No impact to small businesses as this is already a code requirement

Requirements

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

Improves the health, safety, and welfare of the general public by cleaning up duplicate language

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

Improves the code by cleaning up duplicate language

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

Does not discriminate against material, products, methods, or systems of construction of demonstrated capabilities, this is a current code requirement that does not limit material, products, methods, or systems of construction

Does not degrade the effectiveness of the code

Increases the effectiveness of the code by cleaning up duplicate language

2nd Comment Period

S8231-G1

Proponent Borrone Jeanette **Submitted** 5/21/2019 **Attachments** No

Comment:

I agree with the proposed revision to clean up the code

2nd Comment Period

S8231-G2

Proponent	Harold Barrineau	**Submitted**	5/26/2019	**Attachments**	No

Comment:

I agree with this modification.

Delete without substitution:

~~**401.2 Building materials and systems.** Building materials and systems shall comply with the requirements of this section.~~

~~**401.2.1 Existing materials.** Materials already in use in a building in compliance with requirements or approvals in effect at the time of their erection or installation shall be permitted to remain in use unless determined by the building official to be unsafe per Section 115.~~

~~**401.2.2 New and replacement materials.** Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for repairs and alterations, provided no hazard to life, health or property is created. Hazardous materials shall not be used where the code for new construction would not permit their use in buildings of similar occupancy, purpose and location.~~

~~**401.2.3 Existing seismic force-resisting systems.** Where the existing seismic force-resisting system is a type that can be designated ordinary, values of R, 0 and Cdfor the existing seismic force-resisting system shall be those specified by the International Building Code for an ordinary system unless it is demonstrated that the existing system will provide performance equivalent to that of a detailed, intermediate or special system.~~

Revise as follows:

403.1 General. Except as provided by ~~Section 401.2~~Sections 302.3, 302.4, or this section, *alterations* to any building or structure shall comply with the requirements of the *Florida Building Code* for new construction. *Alterations* shall be such that the existing building or structure is no less conforming to the provisions of the *Florida Building Code* than the *existing building* or structure was prior to the *alteration*.

Exceptions:

1. An existing stairway shall not be required to comply with the requirements of Section 1011 of the *Florida Building Code* where the existing space and construction does not allow a reduction in pitch or slope.

2. Handrails otherwise required to comply with Section 1011.11 of the *Florida Building Code* shall not be required to comply with the requirements of Section 1014.6 of the *Florida Building Code* regarding full extension of the handrails where such extensions would be hazardous due to plan configuration.

404.1 General. Buildings and structures, and parts thereof, shall be repaired in compliance with ~~Sections 401.2 and 404~~this section. Work on nondamaged components that is necessary for the required *repair* of damaged components shall be considered part of the *repair* and shall not be subject to the requirements for alterations in this chapter. ~~Routine maintenance required by Section 401.2~~Maintenance, ordinary repairs exempt from permit in accordance with Section 105.2, and abatement of wear due to normal service conditions shall not be subject to the requirements for repairs in this section.

Delete without substitution:

~~**602.1 Existing building materials.** Materials already in use in a building in compliance with requirements or approvals in effect at the time of their erection or installation shall be permitted to remain in use unless determined by the code *official* to render the building or structure *unsafe* or dangerous as defined in Chapter 2. **602.2 New and replacement materials.** Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for *repairs* and *alterations*, provided no *dangerous* or *unsafe condition*, as defined in Chapter 2, is created. Hazardous materials, such as~~

~~asbestos and lead-based paint, shall not be used where the code for new construction would not permit their use in buildings of similar occupancy, purpose and location.~~

S8232

Date Submitted	12/14/2018	**Section**	401.2.1	**Proponent**	Ann Russo4
Chapter	4	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

401.2.2
302.1 602.2

Summary of Modification

Deletes the "Existing [Building] Materials" and "New and Replacement Materials" sections from Chapters 4 and 6 because they are already inserted in chapter 3.

Rationale

This Modification deletes the "Existing [Building] Materials" and "New and Replacement Materials" sections from Chapters 4 and 6 because they are already inserted in chapter 3. The content in
Chapter 3 applies to all methods in the FEBC so deleting these sections in the other method chapters reduces redundancy.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity as this is already a code requirement

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

No impact to building and property owners as this is already a code requirement

Impact to industry relative to the cost of compliance with code

No impact to industry as this is already a code requirement

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

No impact to small businesses as this is already a code requirement

Requirements

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

Improves the health, safety, and welfare of the general public by removing wording that already is in Chapter 3

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

Improves the code by removing wording that already is in Chapter 3

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

Improves the health, safety, and welfare of the general public by removing wording that already is in Chapter 3

Does not degrade the effectiveness of the code

Improves the effectiveness of the code by removing wording that already is in Chapter 3

2nd Comment Period

S8232-G1

Proponent Borrone Jeanette **Submitted** 5/21/2019 **Attachments** No

Comment:

I agree with the proposed revision.

2nd Comment Period

S8232-G2

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

2015 International Existing Building Code

Delete without substitution:

~~**401.2.1 Existing materials.** Materials already in use in a building in compliance with requirements or approvals in effect at the time of their erection or installation shall be permitted to remain in use unless determined by the building official to be unsafe per Section 115.~~

~~**401.2.2 New and replacement materials.** Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for *repairs* and *alterations*, provided no hazard to life, health or property is created. Hazardous materials shall not be used where the code for new construction would not permit their use in buildings of similar occupancy, purpose and location.~~

Date Submitted 12/14/2018
Chapter 4
Section 403.4
Affects HVHZ No
Proponent Ann Russo4
Attachments No
TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes **Alternate Language** No

Related Modifications

807.5

Summary of Modification

Makes editorial changes applying the preferred language from the two parallel sections: 403.4, the referencing 403.9, not 403.5.In 807.5 refer toSections 1609 and 1613.

Rationale

This modification makes corresponding sections of the Prescriptive and Work Area methods identical. It makes a number of editorial revisions (listed below) and one substantive change. The substantive change is this: Currently, for exactly the same situations, Section 807.5 allows the use of reduced seismic loads, while Section 403.4 does not. Reduced loads are appropriate in these cases, so the proposal revises 403.4 to match 807.5.
The editorial changes simply make the wording match, applying the preferred language from the two parallel sections:

- In 403.4, the reference to the section on voluntary retrofit should be to 403.9, not 403.5. This is errata.
- In 807.5, instead of referring to "wind and seismic provisions,"the text should refer more specifically to Sections 1609 and 1613.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity as this is an editorial changes simply make the wording match, applying the preferred language from the two parallel sections

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

No impact to building and property owners as this is an editorial changes simply make the wording match, applying the preferred language from the two parallel sections

Impact to industry relative to the cost of compliance with code

No impact to industry as this is an editorial changes simply make the wording match, applying the preferred language from the two parallel sections

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

No impact to small business owners as this is an editorial changes simply make the wording match, applying the preferred language from the two parallel sections

Requirements

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

Improves the health, safety, and welfare of the general public by cleaning up wording making wording match

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

Improves the code by cleaning up wording making wording match

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

Does not discriminate against material, products, methods, or systems of construction of demonstrated capabilities, this is a current code requirement that does not limit material, products, methods, or systems of construction

Does not degrade the effectiveness of the code

Improves the effectiveness of the code by cleaning up wording making wording match

2nd Comment Period

S8241-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

Revise as follows:

[BS] 403.4 Existing structural elements carrying lateral load. Except as permitted by Section ~~403.5~~ 403.9, where the *alteration* increases design lateral loads ~~in accordance with Section 1609 or 1613 (the High-Velocity Hurricane Zone shall comply with Section 1620) of the *Florida Building Code*~~, or where the *alteration* results in a prohibited structural irregularity as defined in ASCE 7, or where the *alteration* decreases the capacity of any existing lateral load-carrying structural element, the structure of the altered building or structure shall ~~be shown to~~ meet the requirements of Sections 1609 and 1613 of the *Florida Building Code*. ~~For purposes of this section, compliance with ASCE 41, using a Tier 3 procedure and the two-level performance objective in Table 301.1.4.1 for the applicable risk category~~, Reduced Florida Building Code-level seismic forces shall be ~~deemed to meet the requirements of Section 1613(the HVHZ shall comply with Section 1620) of the Florida Building Code~~ permitted.

Exception: Any existing lateral load-carrying structural element whose demand-capacity ratio with the *alteration* considered is ~~no~~ not more than 10 percent greater than its demand-capacity ratio with the *alteration* ignored shall be permitted to remain unaltered. For purposes of calculating demand-capacity ratios, the demand shall consider applicable load combinations with design lateral loads or forces in accordance with Sections 1609 and 1613 (the HVHZ shall comply with Section 1620) of the *Florida Building Code*. Reduced Florida Building Code-level seismic forces shall be permitted. For purposes of this exception, comparisons of demand-capacity ratios and calculation of design lateral loads, forces, and capacities shall account for the cumulative effects of *additions* and *alterations* since original construction.

[BS] 807.5 Existing structural elements resisting lateral loads. Except as permitted by Section 807.6, where the alteration increases design lateral loads, or where the alteration results in prohibited structural irregularity as defined in ASCE 7, or where the alteration decreases the capacity of any existing lateral load-carrying structural element, the structure of the altered building or structure shall ~~be shown to~~ meet the ~~wind~~ requirements of Sections 1609 and ~~seismic provisions~~ 1613 of the *Florida Building Code*. Reduced *Florida Building Code*-level seismic forces ~~in accordance with Section 301.1.4.2~~ shall be permitted.

Exception: Any existing lateral load-carrying structural element whose demand-capacity ratio with the alteration considered is not more than 10 percent greater than its demand-capacity ratio with the alteration ignored shall be permitted to remain unaltered. For purposes of calculating demand-capacity ratios, the demand shall consider applicable load combinations with design lateral loads or forces in accordance with ~~*Florida Building Code*~~ Sections 1609 and 1613 of the *Florida Building Code*. Reduced *Florida Building Code* level seismic forces ~~in accordance with Section 301.1.4.2~~ shall be permitted. For purposes of this exception, comparisons of demand-capacity ratios and calculation of design lateral loads, forces, and capacities shall account for the cumulative effects of additions and alterations since original construction.

S8245

Date Submitted 12/14/2018
Chapter 4
Section 403.4.1
Affects HVHZ No
Proponent Ann Russo4
Attachments No
TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments **Yes**

Alternate Language **No**

Related Modifications

403.6 403.7

Summary of Modification

Revises these provisions more consistent with the work area method which would only address alterations that have reconfigured space over 50% of the building. This proposal limits the area of alterations to the defined term; "work area"

Rationale

The modification revises the provisions more consistent with the work area method which would only address alterations that have reconfigured space over 50% of the building. This proposal limits the area of alterations to the defined term; "work area". This will prevent the inclusion of other areas, such as portions of the building where incidental work is being performed

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity as this is already a code requirement

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

No impact to building and property owners as this is already a code requirement

Impact to industry relative to the cost of compliance with code

No impact to industry as this is already a code requirement

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

No impact to small businesses as this is already a code requirement

Requirements

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

Improves the health, safety, and welfare of the general public by making the provision more consistent with the work are method

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

Improves by making the provision more consistent with the work are method

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

Does not discriminate against material, products, methods, or systems of construction of demonstrated capabilities, this is a current code requirement that does not limit material, products, methods, or systems of construction

Does not degrade the effectiveness of the code

Increases the effectiveness of the code by making the provision more consistent with the work are method

2nd Comment Period

S8245-G1

Proponent Borrone Jeanette **Submitted** 5/21/2019 **Attachments** No

Comment:

I agree with the proposed revision code clarification

Revise as follows:

[BS] 403.4.1 Seismic Design Category F. Where the work area portion of the building undergoing the intended alteration exceeds 50 percent of the aggregate area of the building, and where the building is assigned to Seismic Design Category F, the structure of the altered building shall be shown to meet the earthquake design provisions of the *Florida Building Code*. For purposes of this section, the earthquake loads need not be taken greater than 75 percent of those prescribed in Section 1613 of the *Florida Building Code* for new buildings of similar occupancy, purpose and location. New structural members and connections required by this section shall comply with the detailing provisions of this code for new buildings of similar structure, purpose and location.

[BS] 403.6 Wall anchorage for unreinforced masonry walls in major alterations. Where the work area portion of the building undergoing the intended alteration exceeds 50 percent of the aggregate area of the building, the building is assigned to Seismic Design Category C, D, E or F, and the building's structural system includes unreinforced masonry walls, the alteration work shall include installation of wall anchors at the roof line to resist seismic forces, unless an evaluation demonstrates compliance of existing wall anchorage. For purposes of this section, design seismic forces need not be taken greater than 75 percent of those that would be required for the design of new buildings of similar structure, purpose and location.

[BS] 403.7 Bracing for unreinforced masonry parapets in major alterations. Where the work area portion of the building undergoing the intended alteration exceeds 50 percent of the aggregate area of the building, and where the building is assigned to Seismic Design Category C, D, E or F, parapets constructed of unreinforced masonry shall have bracing installed as needed to resist out-of-plane seismic forces, unless an evaluation demonstrates compliance of such items. For purposes of this section, design seismic forces need not be taken greater than 75 percent of those that would be required for the design of similar nonstructural components in new buildings of similar purpose and location.

S8248

Date Submitted	12/14/2018	**Section**	403.4.1	**Proponent**	Ann Russo4
Chapter	4	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

403.6 403.7

Summary of Modification

This code change clarifies the work area method as it applies to alterations. The modification makes further simplifications and also substitutes the defined term, "building area".

Rationale

The modification revises these provisions more consistent with the work area method which would only address alterations that have reconfigured space over 50% of the building. This proposal limits the area of alterations to the defined term; "work area". This will prevent the inclusion of other areas, such as portions of the building where incidental work is being performed. The modification makes further simplifications and also substitutes the defined term, "building area".

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entity as this is already a code requirement

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

No impact to building and property owners as this is already a code requirement

Impact to industry relative to the cost of compliance with code

No impact to industry as this is already a code requirement

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

No impact to small businesses as this is already a code requirement

Requirements

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

Improves the health, safety, and welfare of the general public by making the provision more consistent with the work are method

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

Improves the code by making the provision more consistent with the work are method

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

Does not discriminate against material, products, methods, or systems of construction of demonstrated capabilities, this is a current code requirement that does not limit material, products, methods, or systems of construction

Does not degrade the effectiveness of the code

Improves the effectiveness of the code by making the provision more consistent with the work are method

2nd Comment Period

S8248-G1

Proponent Borrone Jeanette **Submitted** 5/21/2019 **Attachments** No

Comment:

I agree with the proposed revision code clarification.

2nd Comment Period

S8248-G2

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

Revise as follows:

[BS] 403.4.1 Seismic Design Category F. Where the work area ~~portion of the building undergoing the intended alteration~~ exceeds 50 percent of the ~~aggregate~~ building area ~~of the building~~, and where the building is assigned to Seismic Design Category F, the structure of the altered building shall be shown to meet the earthquake design provisions of the *Florida Building Code*. For purposes of this section, the earthquake loads need not be taken greater than 75 percent of those prescribed in Section 1613 of the *Florida Building Code* for new buildings of similar occupancy, purpose and location. New structural members and connections required by this section shall comply with the detailing provisions of this code for new buildings of similar structure, purpose andlocation.

[BS] 403.6 Wall anchorage for unreinforced masonry walls in major alterations. Where the work area ~~portion of the building~~ ~~undergoing the intended alteration~~ exceeds 50 percent of the ~~aggregate~~ building area ~~of the building~~, the building is assigned to Seismic Design Category C, D, E or F, and the building's structural system includes unreinforced masonry walls, the alteration work shall include installation of wall anchors at the roof line to resist seismic forces, unless an evaluation demonstrates compliance of existing wall anchorage. For purposes of this section, design seismic forces need not be taken greater than 75 percent of those that would be required for the design of new buildings of similar structure, purpose and location.

[BS] 403.7 Bracing for unreinforced masonry parapets in major alterations. Where the work area ~~portion of the building~~ ~~undergoing the intended alteration~~ exceeds 50 percent of the ~~aggregate~~ building area ~~of the building~~, and where the building is assigned to Seismic Design Category C, D, E or F, parapets constructed of unreinforced masonry shall have bracing installed as needed to resist out-of-plane seismic forces, unless an evaluation demonstrates compliance of such items. For purposes of this section, design seismic forces need not be taken greater than 75 percent of those that would be required for the design of similar nonstructural components in new buildings of similar purpose and location.

S8250

Date Submitted	12/14/2018	**Section**	403.4.1	**Proponent**	Ann Russo4
Chapter	4	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

Summary of Modification

Reconciles a substantive difference between the Work Area and Prescriptive Method adding. It adds wind requirements. The Work Area method is preferred, and the Prescriptive method is revised to match.

Rationale

This proposal reconciles a substantive difference between the Work Area and Prescriptive methods.
Current section 403.4.1 already has a seismic evaluation/retrofit trigger that matches section 907.4.3, but 907.4.3 also has a wind requirement. This proposal adds a matching wind requirement to the Prescriptive provision.
Since the provision only applies in high seismic areas (SDC F), it is unlikely that a wind requirement will govern over the seismic requirement, but FEBC provisions traditionally treat wind and seismic together, so the Work Area method is preferred, and the Prescriptive method is revised to match.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will impact local entity only for SDC F buildings with high wind loads undergoing major alterations

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

Will impact building and property owners. Will increase the cost of construction
Cost-beneficial cost increase, only for SDC F buildings with high wind loads undergoing major alterations

Impact to industry relative to the cost of compliance with code

Will impact Industry. Will increase the cost of construction
Cost-beneficial cost increase, only for SDC F buildings with high wind loads undergoing major alterations

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

Will impact small business owners. Will increase the cost of construction
Cost-beneficial cost increase, only for SDC F buildings with high wind loads undergoing major alterations

Requirements

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

Improves the health, safety, and welfare of the general public by reconciling a substantive difference between the Work Area and Prescriptive methods

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

Improves the code by reconciling a substantive difference between the Work Area and Prescriptive methods

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

Does not discriminate against material, products, methods, or systems of construction of demonstrated capabilities, this is a current code requirement that does not limit material, products, methods, or systems of construction

Does not degrade the effectiveness of the code

Improves the effectiveness of the code by reconciling a substantive difference between the Work Area and Prescriptive methods

2nd Comment Period

S8250-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

Revise as follows:

[BS] 403.4.1 Seismic Design Category F. Where the portion of the building undergoing the intended alteration exceeds 50 percent of the aggregate area of the building, and where the building is assigned to Seismic Design Category F, the structure of the altered building shall ~~be shown to~~ meet the ~~earthquake design provisions~~ requirements of Sections 1609 and 1613 of the *Florida Building Code*. For purposes of this section, the earthquake loads need not be taken greater than 75 percent of those prescribed in Section 1613 of the *Florida Building Code* for new buildings of similar occupancy, purpose and location. New structural members and connections required by this section shall comply with the detailing provisions of this code for new buildings of similar structure, purpose and location.

S8380

Date Submitted	12/15/2018	**Section**	602	**Proponent**	Ann Russo8
Chapter	6	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

EB14-15 CH 6
EB14-15 CH 4

Summary of Modification

The proposal removes provisions that were already moved to Chapter 3 in the last cycle. Sections 602.1, and 602.2 are now in Sections 302.3 and 302.4.

Rationale

The proposal removes provisions that were already moved to Chapter 3 in the last cycle. Sections 602.1, and 602.2 are now in Sections 302.3 and 302.4.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

The proposal removes provisions that were already moved to Chapter 3 in the last cycle so there is no impact on enforcement of the code.

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

The proposal removes provisions that were already moved to Chapter 3 in the last cycle and does not increase the cost of construction.

Impact to industry relative to the cost of compliance with code

The proposal removes provisions that were already moved to Chapter 3 in the last cycle and does not increase the cost of construction.

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

The proposal removes provisions that were already moved to Chapter 3 in the last cycle and does not increase the cost of construction.

Requirements

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

The proposal removes provisions that were already moved to Chapter 3 in the last cycle so there is no impact on enforcement of the code.

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

The proposal removes provisions that were already moved to Chapter 3 in the last cycle so there is no impact on enforcement of the code.

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

The proposal removes provisions that were already moved to Chapter 3 in the last cycle and does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The proposal removes provisions that were already moved to Chapter 3 in the last cycle and does not degrade the effectiveness of the code.

2nd Comment Period

S8380-G1

Proponent Jennifer Privateer **Submitted** 5/23/2019 **Attachments** No

Comment:

I agree

2nd Comment Period

S8380-G2

Proponent Harold Barrineau **Submitted** 5/25/2019 **Attachments** No

Comment:

I agree with this modification

Sections: 602.1, 602.2

Delete without substitution:

~~**602.1 Existingbuildingmaterials.**Materialsalreadyinuseinabuildingincompliancewithrequirements or approvals in effect at the time of their erection or installation shall be permitted to remain in use unless determined by the *code official* to render the building or structure unsafe or *dangerous* as defined in Chapter2.~~

~~**602.2 New and replacement materials.** Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permittedfor*repairs*and*alterations*,providedno*dangerous*or*unsafe*condition,asdefinedinChapter2, is created. Hazardous materials, such as asbestos and lead-based paint, shall not be used where the code for new construction would not permit their use in buildings of similar occupancy, purpose and location.~~

S7525

Date Submitted 11/29/2018
Chapter 7
Section 706
Affects HVHZ Yes
Proponent Michael Silvers (FRSA)
Attachments Yes
TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments No
Alternate Language Yes

Related Modifications

Changes to Section 707 and 403.8 are also included and shouldn't be considered separately.

Summary of Modification

Expands 706.7 Mitigation by eliminating "single family residential" thereby covering all applicable site built structures. It removes the "roofing materials are removed" trigger and replaces it with prescriptive methods already in code.

Rationale

Engineers who can perform an evaluation can't agree when it applies, or what it requires. It states: "When roofing materials are removed from more than 50 percent of the roof diaphragm" which when you consider the 25% rule (Existing Building, 706.1.1) makes the 50% threshold actually 25%. It can be interpreted that during any roof replacement the structural evaluation and mitigation is required. The owner must commit to an open ended contract with a no idea of the potential cost, what the scope of work might be or how many trades may be involved. Some older deck types that proceed uplift testing are deemed unacceptable for use as a substrate. This could necessitate complete deck replacement as well as reworking or replacement of the roof to wall connections. If the building is occupied there is additional cost. The cost of this work could very well make continued use of the building nonviable. This would apply to a building that conformed to the building code when it was built. Expanding the current prescriptive methods in 706.7 Mitigation will provide a clear, consistent and familiar approach to improving the wind resistance of applicable structures. Changing the trigger from "Where roofing materials are removed from more than 50 percent of the roof diaphragm" to "Where more than 25 percent of the roof diaphragm is repaired or replaced" will properly place the requirement for a roof diaphragm and roof to wall connection evaluation and possible repair or replacement in the structural scope as opposed to part of the routine building maintenance of a roof covering replacement. The 25% threshold mirrors existing requirements to bring the balance of the work into compliance with the code. See 706.1.1. This approach will address recommendations outlined in the FBC funded University of Florida report titled Cost Impacts of 2017 FBC-EB 707.3.2 Roof Diaphragm Reroofing Requirements. (Portions attached)

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification provides cost savings by reducing enforcement of requirements of 707.3.2 on all applicable roof replacement projects and replacing them with prescriptive methods currently in the code.

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

This modification provides cost savings. See Support File.

Impact to industry relative to the cost of compliance with code

This modification provides cost savings. See Support File

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

This modification provides cost savings. See Support File.

Requirements

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

This modification eliminates the extremely burdensome requirements and associated cost of 707.3.2 on all applicable roof replacements. The change clarifies when the required engineering evaluation and related work needs to be done.

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

It will allow a simple roof covering replacement without the burdensome roof diaphragm engineering evaluation currently required. The current requirements are ambiguous which creates wide spread confusion for contractors, engineers and code enforcement officials.

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

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

Does not degrade the effectiveness of the code

This modification does not degrade the effectiveness of the code. Current requirements of 707.3.2 are ambiguous and are typically ignored. The modification replaces the confusing and unenforced requirements with prescriptive requirements currently in the code for applicable structures

2nd Comment Period

7525-A1

Proponent T Stafford **Submitted** 5/22/2019 **Attachments** Yes

Rationale

This public comment represents a compromise on a package of proposals regarding the roof diaphragm mitigation provisions of the FBCEB and the sealed roof deck proposals submitted for the FBCB and FBCR. This public comment combines some of the key elements of Modifications 7525 and 7960 with some additional clarification. Specifically, this public comment proposes the following: 1. Limits the applicability of the roof diaphragm mitigation provisions of Sections 707.3.2 and 403.8 of the FBCEB to situations where more than 30% of the roof deck is removed for repair. 2. Expands the mitigation provisions of Sections 706.7 and 706.8 to apply to all buildings with wood roofs. We have worked with the key stakeholders to craft this compromise that will benefit homeowners and building owners throughout the State of Florida. In exchange for support of the sealed roof deck proposals (Modifications 7696 and 7694), we believe a relaxing of the roof diaphragm mitigation provisions in the FBCEB is warranted. We request the TAC support this public comment with an action of Approved as Submitted.

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

Will reduce the cost associated with reroofing on certain commercial buildings.

Impact to industry relative to the cost of compliance with code

Will reduce the cost associated with reroofing on certain commercial buildings.

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

This modification provides cost savings. See Support File.

Requirements

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

This public comment expands the wind mitigation triggers of the existing code to all buildings with wood roofs.

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

This public comment will improve the code by making it easier to perform wind mitigation on certain types of commercial buildings and will strengthen the code through support of other proposals for the FBCB and FBCR addressing water intrusion through roofs.

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

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

Does not degrade the effectiveness of the code

This public comment does not degrade the effectiveness of the code.

1st Comment Period History

S7525-G1

Proponent Gaspar Rodriguez **Submitted** 1/16/2019 **Attachments** No

Comment:

The code section referring to site-built single-family residential structure is derived from statutorily-mandated language. 553.844(2) (b) FS, specifically indicates “single-family residential structures.” This proposed code mod will expand the statue, which I believe is beyond the scope of updating the code.

Also, the cost savings indicated on the support file only refers to the Cost Impact of Roof Diaphragm Reroofing Requirements. I would maintain that the cost impact of expanding FEBC 706.7 Mitigation Section, has an increase cost impact on enforcement cost.

1st Comment Period History

S7525-G2

Proponent Mo Madani **Submitted** 1/27/2019 **Attachments** No

Comment:

Mitigation techniques and requirements of the 2017 FBC are consistent with section 553.844 FS.

Replace the original modification completely with the revised text as follows:

706.7 Mitigation.

When a roof covering on an existing ~~site-built single-family residential~~ structure with a sawn lumber, wood plank, or wood structural panel roof deck is removed and replaced, the following procedures shall be permitted to be performed by the roofing contractor:

(a) Roof-decking attachment shall be as required by Section 706.7.1.

(b) A secondary water barrier shall be provided as required by Section 706.7.2.

Exception: ~~Single-family residential~~ structures permitted subject to the Florida Building Code are not required to comply with this section.

706.7.1 Roof decking attachment for existing ~~site-built single family residential~~ structures with wood roof decks.

~~For site-built single-family residential structures the f~~Fastening for sawn lumber, wood plank, or wood structural panel roof decks shall be in accordance with Section 706.7.1.1 or 706.7.1.2 as appropriate for the existing construction. 8d nails shall be a minimum of 0.113 inch (2.9 mm) in diameter and shall be a minimum of $2^1/_4$ inches (57 mm) long to qualify for the provisions of this section for existing nails regardless of head shape or head diameter.

Remaining text unchanged.

706.7.2 Roof secondary water barrier for existing ~~site-built singlefamily residential~~ structures with wood roof decks.

706.8

When a roof covering on an existing ~~site-built single family residential~~ structure with a sawn lumber, wood plank, or wood structural panel roof deck is removed and replaced on a building that is located in the wind-borne debris region as defined in the Florida Building Code, Building and that has an insured value of $300,000 or more or, if the building is uninsured or for which documentation of insured value is not presented, has a just valuation for the structure for purposes of ad valorem taxation of $300,000 or more:

(a) Roof to wall connections shall be improved as required by Section 706.8.1.

(b) Mandated retrofits of the roof-to-wall connection shall not be required beyond a 15 percent increase in the cost of reroofing.

Exception: ~~Single-family residential~~ structures permitted subject to the Florida Building Code are not required to comply with this section.

706.8.1 Roof-to-wall connections for ~~site-built singlefamily residential~~ structures with wood roof decks.

Remaining text unchanged.

SECTION 707
STRUCTURAL

707.3.2 Roof diaphragms resisting wind loads in high-wind regions. Where ~~roofing materials are~~ the structural roof deck is removed from more than ~~50~~ 30 percent of the ~~roof~~ structural diaphragm or section of a building located where the ultimate design wind speed, V_{ult}, is greater than 115 mph, as defined in Section 1609 (the HVHZ shall comply with Section 1620) of the *Florida Building Code, Building*, roof diaphragms, connections of the roof diaphragm to roof framing members, and roof-to-wall connections shall be evaluated for the wind loads specified in the *Florida Building Code, Building*, including wind uplift. If the diaphragms and connections in their current condition are not capable of resisting at least 75 percent of those wind loads, they shall be replaced or strengthened in accordance with the loads specified in the *Florida Building Code, Building*.

Exceptions:

~~1.~~ This section does not apply to buildings permitted subject to the Florida Building Code.

~~2.This section does not apply to buildings permitted subject to the 1991 *Standard Building Code*, or later edition, or designed to the wind loading requirements of the ASCE 7-88 or later editions, where an evaluation is performed by a registered design professional to confirm the roof diaphragm, connections of the roof diaphragm to roof framing members, and roof-to-wall connections are in compliance with the wind loading requirements of either of these standards or later editions.~~

~~3.Buildings with steel or concrete moment resisting frames shall only be required to have the roof diaphragm panels and diaphragm connections to framing members evaluated for wind uplift.~~

~~4. This section does not apply to site-built singlefamily dwellings. Site-built single-family dwellings shall comply with Sections 706.7 and 706.8.~~

~~5. This section does not apply to buildings permitted within the HVHZ after January 1, 1994 subject to the 1994 South Florida Building Code, or later editions, or where the building's wind design is based on the wind loading requirements of ASCE 7-88 or later editions.~~

SECTION 403
ALTERATIONS

403.8 Roof diaphragms resisting wind loads in highwind regions. Where ~~the intended alteration requires a permit for reroofing and involves removal of roofing materials~~ the structural roof deck is removed from more than ~~50~~ 30 percent of the ~~roof~~ structural diaphragm of a building or section of a building located where the ultimate design wind speed is greater than 115 mph (51 m/s) in accordance with Figure 1609.3(1) of the Florida Building Code, Building as defined in Section 1609 (the HVHZ shall comply with Section 1620) of the Florida Building Code, Building, roof diaphragms, connections of the roof diaphragm to roof framing members, and roof-to-wall connections shall be evaluated for the wind loads specified in Section 1609 of the Florida Building Code, Building, including wind uplift. If the diaphragms and connections in their current condition are not capable of resisting at least 75 percent of those wind loads, they shall be replaced or strengthened in accordance with the loads specified in Section 1609 of the Florida Building Code, Building.

Exceptions:

~~1.~~ This section does not apply to buildings permitted subject to the Florida Building Code.

~~2.This section does not apply to buildings permitted subject to the 1991 *Standard Building Code*, or later edition, or designed to the wind loading requirements of the ASCE 7-88 or later editions, where an evaluation is performed by a registered design professional to confirm the roof diaphragm, connections of the roof diaphragm to roof framing members, and roof-to-wall connections are in compliance with the wind loading requirements of either of these standards or later editions.~~

~~3.Buildings with steel or concrete moment resisting frames shall only be required to have the roof diaphragm panels and diaphragm connections to framing members evaluated for wind uplift.~~

~~4. This section does not apply to site-built singlefamily dwellings. Site-built single-family dwellings shall comply with Sections 706.7 and 706.8.~~

~~5. This section does not apply to buildings permitted within the HVHZ after January 1, 1994 subject to the 1994 South Florida Building Code, or later editions, or where the building's wind design is based on the wind loading requirements of ASCE 7-88 or later editions.~~

706.7 Mitigation.

When a roof covering on an existing site-built ~~single-family residential~~ structure is removed and replaced, the following procedures shall be permitted to be performed by the roofing contractor:

(a) Roof-decking attachment shall be as required by Section 706.7.1.

(b) A secondary water barrier shall be provided as required by Section 706.7.2.

Exception: ~~Single-family residential~~ structures permitted subject to the Florida Building Code are not required to comply with this section.

706.7.1 Roof decking attachment for site-built ~~singlefamily residential~~ structures.

For site-built ~~single-family residential~~ structures the fastening shall be in accordance with Section 706.7.1.1 or 706.7.1.2 as appropriate for the existing construction. 8d nails shall be a minimum of 0.113 inch (2.9 mm) in diameter and shall be a minimum of $2^1/_4$ inches (57 mm) long to qualify for the provisions of this section for existing nails regardless of head shape or head diameter.

Remaining text unchanged.

706.7.2 Roof secondary water barrier for site-built ~~singlefamily residential~~ structures.

706.8

When a roof covering on an existing site-built ~~single family residential~~ structure is removed and replaced on a building that is located in the wind-borne debris region as defined in the Florida Building Code, Building and that has an insured value of $300,000 or more or, if the building is uninsured or for which documentation of insured value is not presented, has a just valuation for the structure for purposes of ad valorem taxation of $300,000 or more:

(a) Roof to wall connections shall be improved as required by Section 706.8.1.

(b) Mandated retrofits of the roof-to-wall connection shall not be required beyond a 15 percent increase in the cost of reroofing.

Exception: ~~Single-family residential~~ structures permitted subject to the Florida Building Code are not required to comply with this section.

706.8.1 Roof-to-wall connections for site-built ~~singlefamily residential~~ structures.

Remaining text unchanged.

SECTION 707
STRUCTURAL

707.3.2 Roof diaphragms resisting wind loads in high-wind regions.
Where ~~roofing materials are removed from~~ more than ~~50~~ <u>25</u> percent of the roof diaphragm ~~or section~~ ~~of~~ <u>is repaired or replaced on</u> a building located where the ultimate design wind speed, V_{ult}, is greater than 115 mph, as defined in Section 1609 (the HVHZ shall comply with Section 1620) of the *Florida Building Code, Building*, roof diaphragms, connections of the roof diaphragm to roof framing members, and roof-to-wall connections shall be evaluated for the wind loads specified in the *Florida Building Code, Building*, including wind uplift. If the diaphragms and connections in their current condition are not capable of resisting at least 75 percent of those wind loads, they shall be replaced or strengthened in accordance with the loads specified in the *Florida Building Code, Building*.

~~**Exceptions:**~~

~~1.This section does not apply to buildings permitted subject to the Florida Building Code.~~

~~2.This section does not apply to buildings permitted subject to the 1991 *Standard Building Code*, or later edition, or designed to the wind loading requirements of the ASCE 7-88 or later editions, where an evaluation is performed by a registered design professional to confirm the roof diaphragm, connections of the roof diaphragm to roof framing members, and roof-to-wall connections are in compliance with the wind loading requirements of either of these standards or later editions.~~

~~3.Buildings with steel or concrete moment resisting frames shall only be required to have the roof diaphragm panels and diaphragm connections to framing members evaluated for wind uplift.~~

~~4. This section does not apply to site-built singlefamily dwellings. Site-built single-family dwellings shall comply with Sections 706.7 and 706.8.~~

~~5. This section does not apply to buildings permitted within the HVHZ after January 1, 1994 subject to the 1994 South Florida Building Code, or later editions, or where the building's wind design is based on the wind loading requirements of ASCE 7-88 or later editions.~~

SECTION 403

ALTERATIONS

403.8 Roof diaphragms resisting wind loads in highwind regions.

Where ~~the intended alteration requires a permit for reroofing and involves removal of roofing materials from~~ more than ~~50~~<u>25</u> percent of the roof diaphragm <u>is repaired or replaced on </u>~~of a building or section of~~ a building located where the ultimate design wind speed is greater than 115 mph (51 m/s) in accordance with Figure 1609.3(1) of the Florida Building Code, Building as defined in Section 1609 (the HVHZ shall comply with Section 1620) of the Florida Building Code, Building, roof diaphragms, connections of the roof diaphragm to roof framing members, and roof-to-wall connections shall be evaluated for the wind loads specified in Section 1609 of the Florida Building Code, Building, including wind uplift. If the diaphragms and connections in their current condition are not capable of resisting at least 75 percent of those wind loads, they shall be replaced or strengthened in accordance with the loads specified in Section 1609 of the Florida Building Code, Building.

Remaining text unchanged.

Cost Impact of 2017 FBC-EB § 707.3.2 Roof Diaphragm Reroofing Requirements

RINKER-CR-2018-105

Final Report

1 June 2018

Submitted to

Mo Madani

Department of Business and Professional Regulation
1940 North Monroe Street
Tallahassee, FL 32399

Authors

R. Raymond Issa, PhD Civil Eng., JD, PE*, F ASCE, API (University of Florida)
R.N. Sailappan, PE, Quest Engineering & Testing, Inc., Pompano Beach, FL

CACIM
Rinker School
University of Florida
Box 115703
Gainesville, FL 32611-5703
www.bcn.ufl.edu/cacim

Table 7. Bid Prices for A-F Roof type and A-C Repair Scenarios+*

Repair	LWC on Bar Joists	Wood Deck System	Metal on Steel Bar Joists	Gypsum on Spaced Joists	Tectum on Spaced Joists	LWEC Deck System
Base Bid (incl. in A-C Repair Scenarios)	**1:**$129,940 **2:**$109,688 **3:**$138,000	**1:** $128,540 **2:** $105,931 **3:** $139,000	**1:** $153,300 **2:** $128,773 **3:** $149,000	**1:**$129,940 **2:**$118,311 **3:**$143,000	**1:**$128,570 **2:**$118,311 **3:**$146,000	**1:**$128,540 **2:**$106,334 **3:**$141,000
Bid Line No.	1	1	1	1	1	1
A. Enhanced fastening of the roof deck	**1:**$134,440+ **2:**$157,556 **3:**$164,400	NA	**1:**$156,800+ **2:** $140,092 **3:** $163,425	NA	NA	**1:**$133,040+ **2:**$118,753 **3:**$155,900
Bid Line Nos.	1,2,3,4 & 8	---------	1,2,3,4 & 8	---------	---------	1,2,3,4,5 & 9
B. Roof-to-wall connections enhanced fastening	**1:**$146,940+* **2:**$128,208 **3:**$164,990	**1:** $131,040+ **2:** $123,631 **3:** $158,560	**1:** $169,300+* **2:** $147,293 **3:** $173,200	**1:**$145,940+ **2:**$134,231 **3:**$134,575	**1:**$144,570+ **2:**$134,231 **3:**$179,075	**1:**$145,540+* **2:**$125,954 **3:**$165,675
Bid Line Nos.	1,2, 4,5 & 8	1, 2, 3 & 7	1,2,4,5 & 8	1,2,3,4 & 7	1,2,3,4 & 7	1,2,3,5,6 & 9
C. Entire roof deck replacement	**1:**$284,440+ **2:**$265,188* **3:**$173,790	**1:** $158,540+ **2:** $148,431* **3:** $196,600	**1:** $231,800+ **2:** $219,273* **3:** $230,150	**1:**$293,440+ **2:**$226,211* **3:**$207,795	**1:**$282,070+ **2:**$226,211* **3:**$246,815	**1:**$283,040+ **2:**$252,934* **3:**$235,075
Bid Line Nos.	1,2,4,7 & 8	1, 2, 6 &7	1,2, 4,7 & 8	1,2,3,6 & 7	1,2,3,6 & 7	1,2,3,5,8 & 9

+ = No Bid Items; * = Condition/Exclusions

COST NOTES:

- For all 6 deck types the following cost items need to be also taken into consideration:
  1: Cost for relocation if needed of occupants, contents, etc. (Depends on use)
  2: Cost for loss of business (Depends on use)
  3: Cost for isolating dust from occupied area if contents are not relocated (Depends on use)
  4: Cost to repair or replacing ceilings (Depends on use)
  5: Cost to keep temporarily watertight or phasing of work to do the same (Factored in Bid)
  6: Cost of engineering for each protocol ($8,250).
- For deck types with rigid insulation for replacement (A, B, D, E & F) the Cost for the cover board that is required over the polyisocyanurate insulation is factored in bid and cost if replacement triggers energy code requirements would apply across the boards regardless of diaphragm frame.
- For light weight insulating concrete deck type (A) the cost for required tapered insulation for replacement of LWIC fill is factored in bid.
- For gypsum deck type (D) cost for relocation (mandatory) depends on building use type and the cost for removal and replacement of ceiling, ductwork, wiring etc. depends on building use type and cannot all be pinned on diaphragm roof type.

Table 8. Mean Bid Prices for A-F Roof type and A-B Repair Scenarios+*

Repair	LWC on Bar Joists	Wood Deck System	Metal on Steel Bar Joists	Gypsum on Spaced Joists	Tectum on Spaced Joists	LWEC Deck System
Base Bid (incl. in A-C Repair Scenarios)	**1:** $129,940	**1:** $128,540	**3:** $149,000	**1:** $129,940	**1:** $128,570	**1:** $128,540
A. Enhanced fastening of the roof deck	**2:** $157,556	NA	**3:** $163,425	NA	NA	**1:** $133,040+
% Cost Increase over Base Bid	21.3 %	----	9.7%	----	----	3.5%
B. Roof-to-wall connections enhanced fastening	**1:** $146,940+*	**1:** $131,040+	**3:** $173,200	**1:** $134,575	**1:** $144,570+	**1:** $145,540+*
% Cost Increase over Base Bid	13.1%	1.9%	16.2%	3.6%	12.4%	13.2%
C. Entire roof deck replacement	**2:** $265,188*	**1:** $158,540+	**3:** $230,150	**2:** $226,211*	**3:** $246,815	**2:** $252,934*
% Cost Increase over Base Bid	104.1%	23.3%	54.5%	74.1%	92.0%	96.8%

+ = No Bid Items; * = Condition/Exclusions

COST NOTES:

- For all 6 deck types the following cost items need to be also taken into consideration:
  - **7:** Cost for relocation if needed of occupants, contents, etc. (Depends on use)
  - **8:** Cost for loss of business (Depends on use)
  - **9:** Cost for isolating dust from occupied area if contents are not relocated (Depends on use)
  - **10:** Cost to repair or replacing ceilings (Depends on use)
  - **11:** Cost to keep temporarily watertight or phasing of work to do the same (Factored in Bid)
  - **12:** Cost of engineering for each protocol ($8,250).
- For deck types with rigid insulation for replacement (A, B, D, E & F) the Cost for the cover board that is required over the polyisocyanurate insulation is factored in bid and cost if replacement triggers energy code requirements would apply across the boards regardless of diaphragm frame.
- For light weight insulating concrete deck type (A) the cost for required tapered insulation for replacement of LWIC fill is factored in bid.
- For gypsum deck type (D) cost for relocation (mandatory) depends on building use type and the cost for removal and replacement of ceiling, ductwork, wiring etc. depends on building use type and cannot all be pinned on diaphragm roof type.

Conclusions

Roofing subcontractor bid data were collected for six roof types (A-F) covering the base bid and three repair scenarios (A-C). Unit costs were also collected for partial roof replacement options. The collected data was used to make cost comparisons between different replacement scenarios among three roofing subcontractors and determine mean base bid costs and repair/replacement costs for three scenarios: enhanced fastening of the roof deck; roof-to-wall connections enhanced fastening; and entire roof deck replacement. In general, based solely on the three bids received, the wood deck system was the least costly system to bring in compliance with 2017 FBC-EB § 707.3.2, while the LWC on bar joists was the most expensive

Future work should address the following:

a. Setting minimum deck attachment criteria (similar to wood decks) and standardizing this for all NOA/Product Approval tests. This will eliminate non-applicability of approved products for several field conditions and streamline the roofing permitting process.
b. On properties valued over a certain threshold (say $500,000), requiring scenario B (roof to wall connections and enhanced edge supports) up to a pre-set percentage (say 15%) of re-roofing cost.
c. Conducting a cost impact analysis for future code changes, before implementation, except in the case of life and/or fire safety requirements.

S8079

Date Submitted 12/13/2018
Chapter 7
Section 606.2.1
Affects HVHZ No
Proponent Harold Barrineau
Attachments No
TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

[BS] 606.2.1.1

Summary of Modification

[BS] 606.2.1 Repairs for less than substantial structural damage. 606.2.1.1 Snow damage.

Rationale

This proposal adds a limited and minor upgrade requirement for structural damage caused by snow.
Instead of allowing repair to the predamage condition, the proposal would require any repaired or replaced elements --but not any other similar elements that escaped damage --to be designed for the requirements for new construction.
This requirement is justified because snow loads, especially with the effects of climate change, are different from dead, live, earthquake, and wind loads that are otherwise addressed in Chapter 6. Existing framing carrying dead and live loads generally does not require upgrade even when it's non-conforming because it has a history of adequate service. Design level snow loads don't have that history. And unlike wind or earthquake loads, snow loads at damaging or design levels are likely to occur again within a few years. Thus, it is folly to allow deficient components to be repaired only to the state in which we can expect them to be damaged again next winter.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal does not impact local entity relative to enforcement.

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

Will increase the cost of construction.
There will be a slight increase in the cost of construction, but only the damaged elements.

Impact to industry relative to the cost of compliance with code

Will increase the cost of construction.
There will be a slight increase in the cost of construction, but only the damaged elements.

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

Will increase the cost of construction.
There will be a slight increase in the cost of construction, but only the damaged elements.

Requirements

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

This code change introduces a common sense approach to repairing structural components damaged by snow loading. This proposal improves the health, safety, and welfare of the general public.

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

This proposal strengthens or improves the code.

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

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

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

2nd Comment Period

S8079-G1

Proponent Robert Couch **Submitted** 5/13/2019 **Attachments** No

Comment:

This proposal will improve the code

2nd Comment Period

S8079-G2

Proponent Michael Savage **Submitted** 5/14/2019 **Attachments** No

Comment:

I agree with the proposed modification.

2nd Comment Period

S8079-G3

Proponent Jennifer Privateer **Submitted** 5/20/2019 **Attachments** No

Comment:

I agree

[BS] 606.2.1 Repairs for less than substantial structural damage.

~~For~~ Unless otherwise required by this section, for damage less thansubstantial structural damage,the damaged elements shall be permitted to be restored to their predamage condition.

606.2.1.1 Snow damage.

Structural components whose damage was cause by or related to snow load effects shall be repaired, replaced, or altered to satisfy the requirements of Section 1608 of the International Building Code.

S8088

Date Submitted	12/13/2018	**Section**	1007.1	**Proponent**	Harold Barrineau
Chapter	10	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	No Affirmative Recommendation				
Commission Action	Pending Review				

Comments

General Comments Yes **Alternate Language** No

Related Modifications

Section: 202 (New), [BS] 1007.2, [BS] 1007.3.2

Summary of Modification

Add new definition as follows: RISK CATEGORY [BS] 1007.1 Live loads. [BS] 1007.2 Snow and wind loads. [BS] 1007.3.2 Access to Risk Category IV.

Rationale

This proposal makes editorial changes for consistency, clarity, and simplification. The revisions use the preferred wording and logic approved for other sections in recent code cycles, so as to make the structural provisions more uniformly understandable and enforceable throughout the IEBC.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

These changes, which are primarily editorial, make the IEBC provisions more understandable and enforceable.

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

Will not increase the cost of construction

This is an editorial change, so there will be no change to construction requirements.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction

This is an editorial change, so there will be no change to construction requirements.

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

Will not increase the cost of construction

This is an editorial change, so there will be no change to construction requirements.

Requirements

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

This proposal improves the health, safety, and welfare of the general public.

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

This proposal strengthens or improves the code.

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

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

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

2nd Comment Period

S8088-G1

Proponent Robert Couch **Submitted** 5/13/2019 **Attachments** No

Comment:

I believe this is good for our state.

2nd Comment Period

S8088-G2

Proponent Michael Savage **Submitted** 5/14/2019 **Attachments** No

Comment:

Barrineau

2nd Comment Period

S8088-G3

Proponent Michael Savage **Submitted** 5/14/2019 **Attachments** No

Comment:

I agree with the proposed modification.

2nd Comment Period

S8088-G4

Proponent Jennifer Privateer **Submitted** 5/20/2019 **Attachments** No

Comment:

Agreed.

Add new definition as follows:

RISK CATEGORY. A categorization of buildings and other structures for determination of flood, wind, snow, ice and earthquake loads based on the risk associated with unacceptable performance, as provided in Section 1604.5 of the International Building Code.

Revise as follows:

[BS] 1007.1 ~~Gravity~~ Live loads. ~~Buildings or portions thereof subject to~~ structural elements carrying tributary live loads from an area with a change of occupancy ~~where such change in~~ shall satisfy the ~~nature~~ requirements of ~~occupancy results in higher uniform or concentrated loads based on the Florida Building Code, Building, Table 1607.1 shall comply with the gravity load provisions~~ Section 1607 of the Florida Building Code, Building. Design live loads for areas of new occupancy shall be based on Section 1607 of the Florida Building Code, Building. Design live loads for other areas shall be permitted to use previously approved design live loads.

> **Exception:** ~~Structural elements whose stress is not increased by more than 5 percent.~~Structural elements whose demand-capacity ratio considering the change of occupancy is not more than 5 percent greater than the demand-capacity ratio based on previously approved live loads need not comply with this section.

[BS] 1007.2 Snow and wind loads. ~~Buildings and structures subject to~~ When a ~~change of occupancy where such~~ change ~~in the nature~~ of occupancy results in a structure being assigned to a higher ~~wind or snow~~ risk ~~categories based on the Florida Building Code, Building Table 1604.5.~~ category, the structure shall satisfy the requirements of Sections 1608 and 1609 of the Florida Building Code, Building ~~shall be analyzed and shall comply with~~ for the ~~applicable wind or snow load provisions of the Florida Building Code, Building~~ new risk category. (High-Velocity Hurricane Zones shall comply with Section 1620) shall be analyzed and shall comply with the applicable wind or snow load provisions of the Florida Building Code, Building.

Exception: ~~Where the new occupancy with a higher risk category is less than or equal to 10 percent of the total building floor area. The cumulative effect of the area of occupancy changes shall be considered for the purposes of this exception.~~ Where the area of the new occupancy is less than 10 percent of the building area, compliance with this section is not required. The cumulative effect of occupancy changes over time shall be considered.

[BS] 1007.3.2 Access to Risk Category IV. ~~Where a change of occupancy is such~~ Any structure that ~~compliance with Section 1007.3.1 is required and the building is~~ provides operational access to an adjacent structure assigned to Risk Category IV, as the ~~operational access to the building result of a change of occupancy~~ shall ~~not be through an adjacent structure, unless that structure conforms to~~ itself satisfy the requirements of Section 1613 of the Florida Building Code, Building for Risk Category IV structures using Florida Building Code-level seismic forces. Where operational access to the Risk Category IV structure is less than 10 feet (3048 mm) from either an interior lot line or from another structure, access protection from potential falling debris shall be provided ~~by the owner of the Risk Category IV structure~~.

S8090

Date Submitted	12/13/2018	**Section**	1007.2	**Proponent**	Harold Barrineau
Chapter	10	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

None

Summary of Modification

[BS] 1007.2 Snow and wind loads.

Rationale

Table 1604.5 of the FBC is not about wind or snow categories; it is entitled "Risk Category". To say that a change in the nature of the occupancy results in a higher wind or snow category is inaccurate, so this proposal deletes that language.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal does not impact local entity relative to enforcement.

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

Will not increase the cost of construction.
The proposed modification does not change the requirement, so cost is not impacted.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction.
The proposed modification does not change the requirement, so cost is not impacted.

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

Will not increase the cost of construction.
The proposed modification does not change the requirement, so cost is not impacted.

Requirements

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

This proposal improves the health, safety, and welfare of the general public.

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

This proposal strengthens or improves the code.

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

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

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

2nd Comment Period

S8090-G1

Proponent Robert Couch **Submitted** 5/13/2019 **Attachments** No

Comment:

This is a good modification

2nd Comment Period

S8090-G2

Proponent Michael Savage **Submitted** 5/14/2019 **Attachments** No

Comment:

I agree with the proposed modification.

2nd Comment Period

S8090-G3

Proponent	Jennifer Privateer	**Submitted**	5/20/2019	**Attachments**	No

Comment:

agreed

Revise as follows:

[BS] 1007.2 Snow and wind loads. Buildings and structures subject to achange of occupancywhere such change in the nature of occupancy results in higher~~wind or snow~~ risk categories based on of theFlorida Building Code, BuildingTable 1604.5~~.~~ shall be analyzed and shall comply with the applicable wind or snow load provisions of theFlorida Building Code, Building. (High-Velocity Hurricane Zones shall comply with Section 1620) shall be analyzed and shall comply with the applicable wind or snow load provisions of the Florida Building Code, Building.

Exception: Where the new occupancy with a higher risk category is less than or equal to 10 percent of the total building floor area. The cumulative effect of the area of occupancy changes shall be considered for the purposes of this exception.

S8356

Date Submitted	12/15/2018	**Section**	1007.2	**Proponent**	Kimberly Gilliam
Chapter	10	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes **Alternate Language** No

Related Modifications

Summary of Modification

Corrects a mistake in the current reference to risk categories referencing wind or snow categories.

Rationale

Corrects a mistake in the current reference to risk categories referencing wind or snow categories. Table 1604.5 of the FBC, Building is entitled "Risk Categories of Buildings and Other Structures" and does not reference wind or snow.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None. The proposed modification does not change the requirement. It is simply a correction of erroneous language.

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

None. The proposed modification does not change the requirement. It is simply a correction of erroneous language.

Impact to industry relative to the cost of compliance with code

None. The proposed modification does not change the requirement. It is simply a correction of erroneous language.

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

None. The proposed modification does not change the requirement. It is simply a correction of erroneous language.

Requirements

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

No, the proposed modification does not change the requirement. It is simply a correction of erroneous language.

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

Yes, the proposed modification improves the clarification and coordination of code language.

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

No, it does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

No, it improves the effectiveness of the code by providing clarification and better coordination of code language.

2nd Comment Period

S8356-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

[BS] 1007.2 Snow and wind loads.

Buildings and structures subject to a *change of occupancy* where such change in the nature of occupancy results in higher ~~wind or snow~~ risk categories based on the Florida Building Code, Building Table 1604.5, (High-Velocity Hurricane Zones shall comply with Section 1620) shall be analyzed and shall comply with the applicable wind or snow load provisions of the Florida Building Code, Building.

Exception: Where the new occupancy with a higher risk category is less than or equal to 10 percent of the total building floor area. The cumulative effect of the area of occupancy changes shall be considered for the purposes of this exception.

BACK

Code Change No: EB51-16

Original Proposal

Section: [BS] 1007.2

Proponent: Kathleen Petrie, representing City of Seattle, Department of Planning and Development (kathleen.petrie@seattle.gov)

THIS CODE CHANGE WILL BE HEARD BY THE IBC-STRUCTURAL CODE COMMITTEE. SEE THE TENTATIVE HEARING ORDER FOR THIS COMMITTEE.

Revise as follows:

[BS] 1007.2 Snow and wind loads. Buildings and structures subject to a *change of occupancy* where such change in the nature of occupancy results in higher ~~wind or snow~~ risk categories based on Table 1604.5 of the *International Building Code* shall be analyzed and shall comply with the applicable wind or snow load provisions of the *International Building Code*.

> **Exception:** Where the new occupancy with a higher risk category is less than or equal to 10 percent of the total building floor area. The cumulative effect of the area of occupancy changes shall be considered for the purposes of this exception.

Reason: Table 1604.5 of the IBC is not about wind or snow categories; it is entitled "Risk Category of Buildings and Other Structures". To say that a change in the nature of the occupancy results in a higher wind or snow category is inaccurate, so this proposal deletes that language.

Cost Impact: Will not increase the cost of construction
The proposed modification does not change the requirement, so cost is not impacted

Report of Committee Action Hearings

Committee Action: **Approved as Submitted**

Committee Reason: The proposal corrects a mistake in the current reference to risk categories.

Assembly Action: **None**

Final Action Results

EB51-16	**AS**

201

Date Submitted	12/15/2018	**Section**	301.2	**Proponent**	Harold Barrineau
Chapter	2901	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

None

Summary of Modification

[BS] A301.2 Scope.

Rationale

The purpose of this code change is to coordinate the exceptions to Section A303 with the Group R occupancies and uses in the IBC. The original scope of this appendix in the UBC was limited to single-family homes, duplexes, and other small congregate residences. Proposal EB78-04/05 modified the scope and exception to replace the reference to UBC Group R, Division 1 with the what was intended to be the appropriate Group R categories in the IBC. The modification was not quite correct.

Detached small group homes/congregate residences are equivalent to single family homes, Thus, the exception needs to be modified to remove the limitation on Group R-4 buildings. These facilities should be able to use this appendix.

In addition, the language regarding number of dwelling units typically does not apply to Group R-1, but more typically to Group R-2 and R-3. It is noted the UBC originally excluded all multifamily occupancies and other Group R, Division 1 occupancies and uses from the appendix. Thus the limiting language is split between transient lodging (Group R-1) and facilities with dwelling units (all Group R).

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal does not impact local entity relative to enforcement.

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

Will not increase the cost of construction.

The original intent was for the provisions of Appendix A3 to apply to single family homes, including small group homes, for reasons of public health and safety. This proposal restores that intent.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction.

The original intent was for the provisions of Appendix A3 to apply to single family homes, including small group homes, for reasons of public health and safety. This proposal restores that intent.

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

Will not increase the cost of construction.

The original intent was for the provisions of Appendix A3 to apply to single family homes, including small group homes, for reasons of public health and safety. This proposal restores that intent.

Requirements

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

This proposal improves the health, safety, and welfare of the general public.

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

This proposal strengthens or improves the code.

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

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

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

2nd Comment Period

S8296-G1

Proponent Harold Barrineau **Submitted** 5/8/2019 **Attachments** No

Comment:

I believe this is a good proposed modification to the Florida Building Code that would benefit certain areas of the state.

2nd Comment Period

S8296-G2

Proponent	Robert Couch	**Submitted**	5/13/2019	**Attachments**	No

Comment:

I think this is good for the State of Florida

2nd Comment Period

S8296-G3

Proponent	Michael Savage	**Submitted**	5/14/2019	**Attachments**	No

Comment:

Barrineau

2nd Comment Period

S8296-G4

Proponent	Michael Savage	**Submitted**	5/14/2019	**Attachments**	No

Comment:

I agree with the proposed modification.

2nd Comment Period

S8296-G5

Proponent	Jennifer Privateer	**Submitted**	5/20/2019	**Attachments**	No

Comment:

I agree

Revise as follows:

[BS] A301.2 Scope. The provisions of this chapter apply to residential buildings of light-frame wood construction containing one or more of the structural weaknesses specified in Section A303.

Exception:

The provisions of this chapter do not apply to the buildings, or elements thereof, listed below. These buildings or elements require analysis by a registered design professional in

accordance with Section A301.3 to determine appropriate strengthening:

1. Group R-1.
2. Group ~~R-1, R-2 or R-4 occupancies~~ R with more than four dwelling units.
3. Buildings with a lateral force-resisting system using poles or columns embedded in the ground.
4. Cripple walls that exceed 4 feet (1219 mm) in height.
5. Buildings exceeding three stories in height and any three-story building with cripple wall studs exceeding 14 inches (356 mm) in height.
6. Buildings where the code official determines that conditions exist that are beyond the scope of the prescriptive requirements of this chapter.
7. Buildings or portions thereof constructed on concrete slabs on grade.

S7214

84

Date Submitted 11/21/2018
Chapter 2
Section 202
Affects HVHZ No
Proponent Joseph Crum
Attachments No
TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes
Alternate Language No

Related Modifications

G9-16 Part II

Summary of Modification

This proposal revises the definitions of fenestration and vertical fenestration in the FBC and FBCR, for consistency with the FBCECC, and each other

Rationale

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

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

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

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

Will not increase the cost of construction

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

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction

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

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

Will not increase the cost of construction

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

Requirements

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

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

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

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

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

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

Does not degrade the effectiveness of the code

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

2nd Comment Period

S7214-G1

Proponent Dick Wilhelm **Submitted** 5/1/2019 **Attachments** No

Comment:

Same as S 7381-A1 and7382-G1.

2nd Comment Period

S7214-G2

Proponent	Jennifer Privateer	Submitted	5/23/2019	Attachments	No

Comment:

I agree

2nd Comment Period

S7214-G3

Proponent	Harold Barrineau	Submitted	5/25/2019	Attachments	No

Comment:

I agree with this modification

FBCR SECTION R202

~~[RE]FENESTRATION. Skylights, roof windows, vertical windows (whether fixed or moveable); opaque doors; glazed doors; glass block; and combination opaque and glazed doors.~~

~~See Section R202 of the Florida Building Code, Energy Conservation.~~

FENESTRATION. Products classified as either vertical fenestration or skylights.

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

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

S7382

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

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes **Alternate Language** No

Related Modifications

Summary of Modification

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

Rationale

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

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

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

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

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

Impact to industry relative to the cost of compliance with code

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

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

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

Requirements

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

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

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

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

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

The code change proposal is simply a clarification for consistency between the FBCB, FBCR and FBCEC. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The code change proposal is simply a clarification for consistency between the FBCB, FBCR and FBCEC. Does not degrade the effectiveness of the code.

2nd Comment Period

S7382-G2

Proponent Jennifer Privateer **Submitted** 5/23/2019 **Attachments** No

Comment:

agreed

2nd Comment Period

S7382-G3

Proponent Harold Barrineau **Submitted** 5/25/2019 **Attachments** No

Comment:

I agree with this modification

2nd Comment Period

S7382-G4

Proponent Harold Barrineau **Submitted** 5/25/2019 **Attachments** No

Comment:

I agree with this modification

1st Comment Period History

S7382-G1

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

Comment:

This mod (and the companion S7381) proposes language that directly contradicts other definitions for skylights in the same chapter. I strongly urge the TAC to disapprove, since the proponent did not address the conflict or provide any reason for the contradiction to exist.

FBCR SECTION 202

Delete existing and replace with the new definition.

- [RE]~~**FENESTRATION.** Skylights, roof windows, vertical windows (whether fixed or moveable); opaque doors; glazed doors; glass block; and combination opaque and glazed doors.~~

FENESTRATION. Products classified as either vertical fenestration or skylights.

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

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

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

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

Summary of Modification

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

Rationale

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

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

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

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

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

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

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

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

Impact to industry relative to the cost of compliance with code

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

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

None foreseen

Requirements

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

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

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

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

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

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

Does not degrade the effectiveness of the code

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

2nd Comment Period

S7504-G1

Proponent Dick Wilhelm **Submitted** 5/1/2019 **Attachments** No

Comment:

AAMA supports the definition proposed by the proponent.

2nd Comment Period

S7504-G2

Proponent Borrone Jeanette **Submitted** 5/21/2019 **Attachments** No

Comment:

I agree with the proposed revision.

2nd Comment Period

S7504-G3

Proponent Jennifer Privateer **Submitted** 5/24/2019 **Attachments** No

Comment:

agreed

2nd Comment Period

S7504-G4

Proponent Harold Barrineau **Submitted** 5/25/2019 **Attachments** No

Comment:

I agree with this modification

Delete:

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

Replace with:

FENESTRATION. Products classified as either vertical fenestration or skylights and sloped glazing, installed in such a manner as to preserve the weather resistant barrier of the wall or roof in which they are installed. Fenestration includes products with glass or other transparent or translucent materials.

Add new definition as follows:

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

S7709

Date Submitted	12/6/2018	**Section**	202	**Proponent**	Borrone Jeanette
Chapter	2	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes **Alternate Language** No

Related Modifications

FBC R401.4 & R801.3
new definitions: COLLAPSIBLE SOILS, COMPRESSIBLE SOILS, EXPANSIVE SOILS

Summary of Modification

add new definitions: COLLAPSIBLE SOILS, COMPRESSIBLE SOILS, EXPANSIVE SOILS Revise R401.4 Soil tests & R801.3 Roof drainage

Rationale

There is currently no definition for collapsible soils to provide guidance to design professionals and building officials on identification and design procedures to address these soils. These terms are used in IRC Section R401.4 and R801.3.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will not impact local entity

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

Will not increase the cost of construction The change is for clarification so there is not change to construction requirements

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction The change is for clarification so there is not change to construction requirements

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

Will not increase the cost of construction The change is for clarification so there is not change to construction requirements

Requirements

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

Improves the health, safety, and welfare of the general public by adding needed definitions for these soils and provides clarification to the code text

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

Improves the code by adding needed definitions for these soils and provides clarification to the code text

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

Does not discriminate against materials, products, methods, or systems of construction adding needed definitions for these soils and provides clarification to the code text

Does not degrade the effectiveness of the code

Increases the effectiveness of the code by adding needed definitions for these soils and provides clarification to the code text

2nd Comment Period

S7709-G1

Proponent Borrone Jeanette **Submitted** 5/3/2019 **Attachments** No

Comment:

I agree with this proposed modification

2nd Comment Period

S7709-G2

Proponent Michael Savage **Submitted** 5/14/2019 **Attachments** No

Comment:

I agree with the proposed revision.

2nd Comment Period

S7709-G3

Proponent	Harold Barrineau	**Submitted**	5/20/2019	**Attachments**	No

Comment:

This is a good proposed modification for the Florida Building Code.

2nd Comment Period

S7709-G4

Proponent	Jennifer Privateer	**Submitted**	5/20/2019	**Attachments**	No

Comment:

I agree that this is a good proposed modification to FBC

Add new definitions:

COLLAPSIBLE SOILS.

Soils that exhibit volumetric reduction in response to partial or full wetting under load.

COMPRESSIBLE SOILS

Soils that exhibit volumetric reduction in response to the application of load even in the absence of wetting or drying.

EXPANSIVE SOILS.

Soils that exhibit volumetric increase or decrease (swelling or shrinking) in response to partial or full wetting or drying under load.

Revise as follows:

R401.4 Soil tests.

Where quantifiable data created by accepted soil science methodologies indicate *expansive* soils, *compressible soils*, shifting or other questionable soil characteristics are likely to be present, the *building official* shall determine whether to require a soil test to determine the soil's characteristics at a particular location. This test shall be done by an *approved agency* using an *approved* method.

R801.3 Roof drainage.

In areas where *expansive* soils *or collapsible soils* are known to exist, all *dwellings* shall have a controlled method of water disposal from roofs that will collect and discharge roof drainage to the ground surface not less than 5 feet (1524 mm) from foundation walls or to an *approved* drainage system.

S7434

Date Submitted 11/26/2018
Chapter 4
Section 401.2
Affects HVHZ No
Proponent Hill Kevin
Attachments No
TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments **Yes**

Alternate Language **No**

Related Modifications

Summary of Modification

Clarify for all foundation soils, not just fill soils, should be designed, installed, compacted and tested.

Rationale

Clarification that all foundation soils (not just fill soils) should be designed, installed, compacted and tested.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

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

None

Impact to industry relative to the cost of compliance with code

None

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

None

Requirements

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

Improves safety by requiring that all foundation soils be properly designed, compacted and tested.

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

Improves the code by requiring that all foundation soils (not just fill soils) be properly designed, compacted and tested.

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

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the code.

2nd Comment Period

S7434-G1

Proponent Hill Kevin **Submitted** 5/14/2019 **Attachments** No

Comment:

Soil compaction below foundations should not be limited to fill soils. In-situ soils should also be compacted.

R401.2Requirements.

Foundations shall be capable of resisting all loads from roof uplift and building overturn. Foundation uplift for light-frame wood or steel buildings shall be calculated or determined from Table R401.1. Masonry buildings within the dimensional scope of Table R401.1 shall be assumed to be of adequate weight so as not to require uplift resistance greater than that provided by the structure and any normal foundation. Foundation construction shall also be capable of accommodating all gravity loads in accordance with Section R301 and of transmitting the resulting loads to the supporting soil. ~~Fill s~~Soils that support footings and foundations shall be designed, installed/compacted and tested in accordance with accepted engineering practice. Gravel fill used as footings for wood and precast concrete foundations shall comply with Section R403.

S7435

Date Submitted 11/26/2018
Chapter 4
Section 401.4
Affects HVHZ No
Proponent Hill Kevin
Attachments Yes
TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

7398, 7396, 7404

Summary of Modification

Adding highly organic soils to expansive soils to require testing, reducing presumptive load-bearing values for sandy soils from 2000 to 1500psf (same as proposed change in Building Ch.18, Mod 7398) and defining what complete organic removal is (same as mod 7404 for Building).

Rationale

Highly organic soil should have the same consideration as expansive soil for foundation design. Florida sands should not have a 2000psf presumptive bearing pressure as there are footing widths and water table depth combinations that have nearly zero safety factor in such cases. 1500psf is more commonly used for design on Florida sands.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Very little impact. Building official may now more easily require soil testing if highly organic soils are present.

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

Should not impact. Likely none.

Impact to industry relative to the cost of compliance with code

Likely none.

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

Likely none.

Requirements

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

Improves safety by increasing safety factor against bearing failure, which was too low for certain conditions under current code. Also improves safety by requiring testing if highly organic soils are present.

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

Improves the code by increasing safety factor against bearing failure, which was too low for certain conditions under current code. Also improves the code by requiring testing if highly organic soils are present and defining what highly organic soils are and what complete removal is.

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

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code.

2nd Comment Period

S7435-G1

Proponent Hill Kevin **Submitted** 5/14/2019 **Attachments** No

Comment:

This mod is important to include the same inclusions of organic soils and presumptive bearing values for Residential Code as the mod submissions for Building Code.

R401.4Soil tests.

Where quantifiable data created by accepted soil science methodologies indicate expansive, highly organic, compressible, shifting or other questionable soil characteristics are likely to be present, the *building official* shall determine whether to require a soil test to determine the soil's characteristics at a particular location. This test shall be done by an *approved agency* using an *approved* method. Soils shall be considered highly organic if the Organic Content by weight, determined in accordance with ASTM D2974, is greater than 8 percent and the total thickness of organic layer(s) is greater than 12 inches.

R401.4.1Geotechnical evaluation.

In lieu of a complete geotechnical evaluation, the load-bearing values in Table R401.4.1shall be assumed.

TABLE R401.4.1

PRESUMPTIVE LOAD-BEARING VALUES OF FOUNDATION MATERIALS[a]

CLASS OF MATERIAL	LOAD-BEARINGPRESSURE(pounds per square foot)
Crystalline bedrock	12,000
Sedimentary and foliated rock	4,000
Sandy gravel and/or gravel (GW and GP)	3,000
~~Sand, silty sand, clayey sand, s~~Silty gravel and clayey gravel (~~SW, SP, SM, SC,~~ GM and GC)	2,000
Sand, silty sand, clayey sand, ~~C~~Clay, sandy, silty clay, clayey silt, silt and sandy siltclay (SW, SP, SM, SC, CL, ML, MH and CH)	1,500[b]

For SI: 1 pound per square foot = 0.0479 kPa.

1. a.Where soil tests are required by Section R401.4, the allowable bearing capacities of the soil shall be part of the recommendations.
2. b.Where the building official determines that in-place soils with an allowable bearing capacity of less than 1,500 psf are likely to be present at the site, the allowable bearing capacity shall be determined by a soils investigation.

R401.4.2Compressible, highly organic or shifting soil.

Instead of a complete geotechnical evaluation, where top or subsoils are compressible, highly organic or shifting, they shall be removed to a depth and width sufficient to ensure stable moisture content in each active zone and shall not be used as fill or stabilized within each active zone by chemical, dewatering or presaturation. Removal of highly organic soil shall be considered complete when the total thickness of all organic layers remaining in the soil is less than 12 inches thick and organic content of the remaining soil is less than 8 percent by weight. If highly organic soil is to be treated rather than removed, an approved geotechnical report shall be required that includes design of such treatment and recommendations for construction.

Designation: D2974 – 14

Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils[1]

This standard is issued under the fixed designation D2974; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 These test methods cover the measurement of moisture content, ash content, and organic matter in peats and other organic soils, such as organic clays, silts, and mucks. Test Method D2216 provides an alternative method for determining moisture content in mineral soils and rock.

1.1.1 *Test Method A*—Moisture is determined by drying peat or organic sample at 110 ± 5°C.

1.1.2 *Test Method B*—Alternative moisture method which removes the total moisture in two steps: (*1*) evaporation of moisture at room temperature, (*2*) subsequent oven drying of air dried sample at 110 ± 5°C. This method is used when the peat is to be used as fuel.

1.1.3 *Test Method C*—Ash content of a peat or organic soil sample, for general purposes, is determined by igniting oven dried sample from moisture content determination in a furnace at 440 ± 40°C.

1.1.4 *Test Method D*—Ash content of a peat or organic soil sample, for materials used for fuel, is determined by igniting oven dried sample from moisture content determination in a furnace at 750 ± 38°C.

1.2 Test Method A should be used for general classification, except for use of the peat as a fuel. Test Method B should be used when peats are being evaluated for use as a fuel

1.3 The values stated in SI units are to be regarded as the standard. No other units of measurement are included in this standard.

1.4 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026.

1.4.1 The procedures used to specify how data are collected/recorded or calculated in this standard are regarded as the industry standard. In addition, they are representative of the significant digits that generally should be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user's objectives; and it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations. It is beyone the scope of this standard to consider significant digits used in analysis methods for engineering design.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

D2944 Practice of Sampling Processed Peat Materials

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing

D6026 Practice for Using Significant Digits in Geotechnical Data

E145 Specification for Gravity-Convection and Forced-Ventilation Ovens

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of common technical terms in this standard, refer to Terminology D653.

4. Summary of Test Methods

4.1 *Test Method A*—Moisture is determined by drying a peat or organic soil sample at 110 ± 5°C. The moisture content is expressed as a percent of the oven dry mass.

[1] These test methods are under the jurisdiction of ASTM Committee D18 on Soil and Rock and are the direct responsibility of Subcommittee D18.22 on Soil as a Medium for Plant Growth.

Current edition approved Nov. 1, 2014. Published November 2014. Originally approved in 1971. Last previous edition approved in 2013 as D2974 – 13. DOI: 10.1520/D2974-14.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard**

4.2 *Test Method B*—This is an alternative moisture method which removes the total moisture in two steps: (*1*) evaporation of moisture in air at room temperature (air-drying), and (*2*) the subsequent oven drying of the air-dried sample at 110 ± 5°C. This method is used when the peat is to be used as fuel. The moisture content is expressed as both a percent of the oven dry mass and of the as received mass.

4.3 *Test Methods C and D*—Ash content of a peat or organic soil sample is determined by igniting the oven-dried sample from the moisture content determination in a furnace at 440 ± 40°C (Test Method C) or 750 ± 38°C (Test Method D). The substance remaining after ignition is the ash. The ash content is expressed as a percentage of the mass of the oven-dried sample.

4.4 Organic matter is determined by subtracting percent ash content from one hundred.

5. Significance and Use

5.1 This test method can be used to determine the moisture content, ash content, and percent organic matter in soil.

5.2 The percent organic matter is important in the following: (*1*) classifying peat or other organic soil, (*2*) geotechnical and general classification purposes, and (*3*) when peats are being evaluated as a fuel.

NOTE 1—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Oven,* meeting the requirements of E145 and capable of being regulated to a constant temperature of 110 ± 5°C.

6.2 The temperature of 110 ± 5°C is quite critical for organic soils. The oven should be checked for "hot spots" to avoid possible ignition of the specimen.

6.3 *Furnace,* capable of producing constant temperatures of 440 ± 40°C and 750 ± 38°C.

6.4 *Balance or Scale,* a balance or scale for determining the mass of the soil having a minimum capacity of 500 g and meeting the requirements of Guide D4753 for a balance or scale of 0.01 g readability.

6.5 *Rubber Sheet, Oil Cloth,* or other non-absorbent material.

6.6 *Evaporating Dishes,* of high silica or porcelain of not less than 100-mL capacity.

6.7 *Aluminum Foil,* heavy-duty.

6.8 *Porcelain Pan, Spoons,* and equipment of the like.

6.9 *Desiccator.*

7. Sampling and Test Specimens

7.1 Place a representative field sample on a rubber sheet, oil cloth, or equivalent material and mix thoroughly.

7.2 Reduce the sample to the quantity required for a test specimen by quartering.

7.3 Place the test specimen and the remaining sample in separate waterproof containers.

7.4 Work rapidly to prevent moisture loss or perform the operation in a room with a high humidity.

8. Procedure

8.1 *Moisture Content Determination:*

8.1.1 *Test Method A:*

8.1.1.1 Record to the nearest 0.01 g the mass of a high silica or porcelain evaporating dish fitted with a heavy-duty aluminum foil cover. The dish shall have a capacity of not less than 100 mL.

8.1.1.2 Following the instruction in Section 7 above, place a test specimen of at least 50 g in the container described in 8.1.1.1. Crush soft lumps with a spoon or spatula. The thickness of peat in the container should not exceed 3 cm.

8.1.1.3 Record the mass to the nearest 0.01 g.

8.1.1.4 Dry uncovered for at least 16 h at 110 ± 5°C or until there is less than 0.1 % change in mass of the sample per hour. Remove from the oven, cover tightly, cool in a desiccator, and record the mass to the nearest 0.01 g keeping exposure to the room atmosphere to a minimum.

8.1.2 *Calculations for Test Method A:*

8.1.2.1 Calculate the moisture content as follows:

$$\text{Moisture Content, } \% = \left[(A - B) \times 100 \right] / B \tag{1}$$

where:

A = mass of the as-received test specimen, g, and
B = mass of the oven-dried specimen, g.

(*1*) This calculation is used for general purposes (except when the peat is to be used as a fuel) and the result should be referred to as the moisture content as a percentage of oven-dried mass.

8.1.3 *Test Method B:*

8.1.3.1 This test method should be used if the peat is to be used as a fuel.

8.1.3.2 Following the instructions in Section 7, select a 100 to 300 g representative test specimen. Determine the mass of this test specimen to the nearest 0.01 g and spread it evenly on a large flat pan. Crush soft lumps with a spoon or spatula and let the sample come to moisture equilibrium with room air. This will require at least 24 h. Stir occasionally during the normal workday to maintain maximum air exposure of the entire sample. Continue drying until there is less than 0.1% change in mass per hour, then calculate the moisture removed during air drying as a percentage of the as-received mass.

8.1.3.3 After thoroughly mixing the air-dried sample, obtain 50 g of material and record to the nearest 0.01 g.

8.1.3.4 Place the sample in a container as described in 8.1.1 and proceed as in Test Method A.

8.1.4 *Calculations for Test Method B:*

8.1.4.1 Calculate the moisture content as follows:

$$\text{Moisture Content for Air-Dried Sample, } \% = \left((A_D - B) \times 100 \right) / B \tag{2}$$

where:

A_D = mass of the air-dried sample, g, and
B = mass of the oven-dried sample, g.

(1) This calculation gives moisture content of the air dried sample as a percentage of oven-dried mass.

8.2 *Ash Content Determination:*

8.2.1 *Test Method C:*

8.2.1.1 Determine the mass of a covered high-silica or porcelain dish to the nearest 0.01 g.

8.2.1.2 Place a part or all of the oven-dried test specimen from a moisture determination in the dish and determine the mass of the dish and specimen to the nearest 0.01 g.

8.2.1.3 Remove the cover and place the dish in a furnace. Gradually bring the temperature in the furnace to 440 ± 40°C and hold until the specimen is completely ashed (no change of mass occurs after at least 1 hr period of heating).

8.2.1.4 Cool in a desiccator, and determine the mass to the nearest 0.01 g keeping the exposure to the room atmosphere to a minimum.

8.2.1.5 This test method should be used for general classification purposes, except the use of peat for fuel.

8.2.2 *Test Method D:*

8.2.2.1 Determine the mass of a covered high-silica or porcelain dish to the nearest 0.01 g.

8.2.2.2 Place a part of the oven-dried test specimen from a moisture determination in the dish and determine the mass of the dish and specimen to the nearest 0.01 g.

8.2.2.3 Remove the cover and place the dish in a furnace. Gradually bring the temperature in the furnace to 750 ± 38°C and hold until the specimen is completely ashed (no change in mass of the sample after further drying periods in excess of 1 h).

8.2.2.4 Cool in a desiccator, and determine the mass to the nearest 0.01 g keeping the exposure to the room atmosphere to a minimum.

8.2.2.5 This test method should be used when peats are being evaluated for use as a fuel.

8.2.3 *Calculation for Test Methods C and D:*

8.2.3.1 Calculate the ash content as follows:

$$\text{Ash Content, \%} = (C \times 100)/B \tag{3}$$

where:

C = mass of ash, g, and
B = oven-dried test specimen, g.

8.3 *Organic Matter Determination:*

8.3.1 *Calculation:*

8.3.1.1 Determine the amount of organic matter to the nearest 0.1 % by difference, as follows:

$$\text{Organic matter, \%} = 100.0 - D \tag{4}$$

where:

D = ash content, % (nearest 0.1 %).

9. Report: Test Data Sheet(s)/Form(s)

9.1 The methodology used to specify how data are recorded on the test data sheet(s)/form(s), as follows, is covered in 1.4.

9.2 Record as a minimum the following general information (data):

9.2.1 Sample/specimen identifying information, such as Project No., Boring No., Sample No., Depth, and alike.

9.2.2 Any special selection and preparation process, such as removal of gravel or other materials.

9.2.3 Technician name or initials, method used and date.

9.3 Record as a minimum the following test specimen data:

9.3.1 Results for organic matter and ash content, to the nearest 0.1 %.

9.3.2 Furnace temperature used for ash content determinations.

9.3.3 Express results for moisture content as a percentage of oven-dried mass as follows:

9.3.3.1 Below 100 % to the nearest 1 %.

9.3.3.2 Between 100 % and 500 % to the nearest 5 %.

9.3.3.3 Between 500 % and 1000 % to the nearest 10 %.

9.3.3.4 Above 1000 % to the nearest 20 %.

10. Precision and Bias

10.1 *Precision*—Test data on precision is not presented due to the nature of the soil materials tested by this test method. It is either not feasible or too costly at this time to have ten or more laboratories participate in a round-robin testing program.

10.1.1 The Subcommittee D18.22 is seeking any data from the users of this test method that might be used to make a limited statement on precision.

10.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

11. Keywords

11.1 ash content; moisture content; organic soil; peat; percent organic matter

SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (D2974 – 13) that may impact the use of this standard. (Approved November 1, 2014)

(1) Changes made throughout to clarify the uses of the different test methods contained in this standard.

(2) Reference to D2944 was added for sampling methodology.

S7514

Date Submitted 11/28/2018
Chapter 4
Section 403.1
Affects HVHZ No
Proponent Hill Kevin
Attachments No
TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

Summary of Modification

Adding "highly organic" to expansive soil requirements and replacing "undisturbed soil" with compacted soil requirements for foundations.

Rationale

Highly organic soils should require the same special attention as expansive soils with regard to footings or other foundations. Also, "undisturbed" soil has no importance in Florida soils as undisturbed soil is generally loose to very loose. Of greater importance is ensuring at least 12 inches of embedment below final grade.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Should be none, but Building Official can more easily require a geotechnical report if highly organic soils are present.

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

Typically no impact.

Impact to industry relative to the cost of compliance with code

Typically no impact.

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

Typically no impact.

Requirements

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

Improves public safety and general welfare by requiring testing if highly organic soils are present.

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

Improves the code by better defining foundation embedment, removing undisturbed soil that isn't relevant in Florida, and helping to ensure highly organic soils be tested prior to building.

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

Does not discriminate

Does not degrade the effectiveness of the code

Does not degrade the code

2nd Comment Period

S7514-G1

Proponent Hill Kevin **Submitted** 5/14/2019 **Attachments** No

Comment:

It is important that "undisturbed" soil be removed from the code as in-situ soils are typically too loose for foundation support without compaction. Also, organic soils should have the same treatment as expansive soils in Residential, similar to mod submissions for Building.

SECTION R403 FOOTINGS

R403.1 General.

All exterior walls shall be supported on continuous solid or fully grouted masonry or concrete footings, crushed stone footings, wood foundations, or other *approved* structural systems which shall be of sufficient design to accommodate all loads according to Section R301 and to transmit the resulting loads to the soil within the limitations as determined from the character of the soil. Footings shall be supported on ~~undisturbed~~compacted natural soils or engineered fill. Footings shall not be installed above highly organic soils without an approved geotechnical report to provide foundation design. Concrete footing shall be designed and constructed in accordance with the provisions of Section R403 or in accordance with ACI 332.

R403.1.4 Minimum depth.

Exterior footings shall be placed not less than 12 inches (305 mm) below ~~the undisturbed ground surface~~final grade. Where applicable, the depth of footings shall also conform to Sections R403.1.4.1 through R403.1.4.2.

R403.1.8 Foundations on expansive or highly organic soils.

Foundation and floor slabs for buildings located on expansive or highly organic soils shall be designed in accordance with Section 1808.6 of the Florida Building Code, Building.

> **Exception:** Slab-on-ground and other foundation systems which have performed adequately in expansive soil conditions similar to those encountered at the building site are permitted subject to the approval of the *building official*.

Date Submitted 12/2/2018 **Section** 403.3 **Proponent** Ann Russo8
Chapter 4 **Affects HVHZ** No **Attachments** No
TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes **Alternate Language** No

Related Modifications

RB179-16

Summary of Modification

This proposal updates the IRC to be consistent with the latest published design values for insulation materials used on frost-protected shallow foundations (FPSF), per ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations.

Rationale

This proposal updates the IRC to be consistent with the latest published design values for insulation materials used on frost-protected shallow foundations (FPSF), per ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations;

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal updates the FBCR to be consistent with the latest published design values for insulation materials used on frost-protected shallow foundations (FPSF), per ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations only. No impact to code enforcement.

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

This proposal updates the FBCR to be consistent with the latest published design values for insulation materials used on frost-protected shallow foundations (FPSF), per ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations only. No cost impact.

Impact to industry relative to the cost of compliance with code

This proposal updates the FBCR to be consistent with the latest published design values for insulation materials used on frost-protected shallow foundations (FPSF), per ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations only. No cost impact.

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

This proposal updates the FBCR to be consistent with the latest published design values for insulation materials used on frost-protected shallow foundations (FPSF), per ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations only. No cost impact.

Requirements

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

This proposal updates the FBCR to be consistent with the latest published design values for insulation materials used on frost-protected shallow foundations (FPSF), per ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations only. No impact to code enforcement.

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

This proposal updates the FBCR to be consistent with the latest published design values for insulation materials used on frost-protected shallow foundations (FPSF), per ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations only. No effect on the code.

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

Updates the FBCR with the latest published design values for insulation materials used on frost-protected shallow foundations (FPSF), per ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations only. Does not discriminate against materials, products, methods etc.

Does not degrade the effectiveness of the code

Updates the FBCR to be consistent with the latest published design values for insulation materials used on frost-protected shallow foundations (FPSF), per ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations only. Does not degrade the effectiveness of the code.

2nd Comment Period

S7632-G1

Proponent Jennifer Privateer **Submitted** 5/23/2019 **Attachments** No

Comment:

I agree

2nd Comment Period

S7632-G2

Proponent Harold Barrineau **Submitted** 5/25/2019 **Attachments** No

Comment:

I agree with this modification

Revise as follows:

TABLE R403.3 (1)
MINIMUM FOOTING DEPTH AND INSULATION REQUIREMENTS FOR FROST-PROTECTED FOOTINGS IN HEATED BUILDINGS.[a]

AIR FREEZING INDEX (°F-days)[b]	MINIMUM FOOTING DEPTH, D (inches)	VERTICAL INSULATION R-VALUE[c, d]	HORIZONTAL INSULATION R-VALUE[c, e]		HORIZONTAL INSULATION DIMENSIONS PER FIGURE R403.3(1) (inches)		
			Along walls	At corners	A	B	C
1,500 or less	12	4.5	Not required	Not required	Not required	Not required	Not required
2,000	14	5.6	Not required	Not required	Not required	Not required	Not required
2,500	16	6.7	1.7	4.9	12	24	40
3,000	16	7.8	6.5	8.6	12	24	40
3,500	16	9.0	8.0	11.2	24	30	60
4,000	16	10.1	10.5	13.1	24	36	60

For SI: 1 inch = 25.4 mm, °C = [(°F) - 32]/1.8.

a. Insulation requirements are for protection against frost damage in heated buildings. Greater values may be required to meet energy conservationstandards.

b. See Figure R403.3(2) or Table R403.3(2) for Air Freezing Indexvalues.

c. Insulation materials shall provide the stated minimum R-values under long-term exposure to moist, below-ground conditions in freezing climates. The following R-values shall be used to determine insulation thicknesses required for this application: Type II expanded polystyrene~~-2.4R~~ (EPS)-3.2R per inch; ~~Type IV extruded polystyrene 4.5R~~ for vertical insulation and 2.6R per inch; ~~Type VI extruded polystyrene 4.5R per inch;~~ for horizontal insulation; Type IX expanded polystyrene~~-3.2R~~ (EPS)-3.4R per inch for vertical insulation and 2.8R per inch for horizontal insulation; Type IV, V, VI, VII, and X extruded polystyrene (XPS)-4.5R per inch for vertical insulation and 4.0R per inch for horizontalinsulation.

d. Vertical insulation shall be expanded polystyrene insulation or extruded polystyreneinsulation.

e. Horizontal insulation shall be expanded polystyrene insulation or extruded polystyreneinsulation.

S7699

Date Submitted	12/5/2018	**Section**	403.1.6	**Proponent**	Borrone Jeanette
Chapter	4	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

Revise foundation anchorage R403.1.6

Summary of Modification

The change clarifies the anchorage of cold-formed steel framing with wood sill plates.

Rationale

This proposed revision is an editorial change intended to clarify the anchorage requirements for cold-formed steel wall assemblies. The referenced sections (R505.3.1 and R603.3.1) cover the anchorage requirements for cold-formed steel directly to the foundation or to the wood sill plate. The connection of the wood sill plate (that supports the CFS) to the foundation is intended to conform to this section.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will not impact local entity

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

Will not increase the cost of construction This is simply a proposed editorial change that does not effect the intended prescribed construction requirements

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction This is simply a proposed editorial change that does not effect the intended prescribed construction requirements

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

Will not increase the cost of construction This is simply a proposed editorial change that does not effect the intended prescribed construction requirements

Requirements

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

Improves the health, safety, and welfare of the general public by clarifying the anchorage requirements for cold-formed steel wall assemblies

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

Improves the code by clarifying the anchorage requirements for cold-formed steel wall assemblies

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

Does not discriminate against materials, products, methods, or systems of construction clarifying the anchorage requirements for cold-formed steel wall assemblies

Does not degrade the effectiveness of the code

Increases the effectiveness of the code by clarifying the anchorage requirements for cold-formed steel wall assemblies

2nd Comment Period

S7699-G1

Proponent Harold Barrineau **Submitted** 5/9/2019 **Attachments** No

Comment:

I agree and believe this is a good proposed modification.

2nd Comment Period

S7699-G2

Proponent Jennifer Privateer **Submitted** 5/20/2019 **Attachments** No

Comment:

agreed as modified

R403.1.6 Foundation anchorage.

Wood sill plates and wood walls supported directly on continuous foundations shall be anchored to the foundation in accordance with this section.

Cold-formed steel framing shall be anchored directly to the foundation or fastened to wood sill plates ~~anchored to the foundation~~in accordance with Section R505.3.1 or R603.3.1, as applicable. ~~Anchorage of cold-formed steel framing and~~ Wood sill plates supporting cold-formed steel framing shall be anchored to the foundation in accordance with this section ~~and Section R505.3.1 or R603.3.1~~.

Wood sole plates at all exterior walls on monolithic slabs, wood sole plates of braced wall panels at building interiors on monolithic slabs and all wood sill plates shall be anchored to the foundation with minimum 1/2-inch-diameter (12.7 mm) anchor bolts spaced a maximum of 6 feet (1829 mm) on center or approved anchors or anchor straps spaced as required to provide equivalent anchorage to 1/2-inch-iameter (12.7 mm) anchor bolts. Bolts shall extend a minimum of 7 inches (178 mm) into concrete or grouted cells of concrete masonry units. The bolts shall be located in the middle third of the width of the plate. A nut and washer shall be tightened on each anchor bolt. There shall be a minimum of two bolts per plate section with one bolt located not more than 12 inches (305 mm) or less than seven bolt diameters from each end of the plate section. Interior bearing wall sole plates on monolithic slab foundation that are not part of a braced wall panel shall be positively anchored with approved fasteners. Sill plates and sole plates shall be protected against decay and termites where required by Sections R317 and R318.

Exceptions:

1. Walls 24 inches (610 mm) total length or shorter connecting offset braced wall panels shall be anchored to the foundation with a minimum of one anchor bolt located in the center third of the plate section and shall be attached to adjacent braced wall panels at corners as shown in Item 9 of Table R602.3(1).
2. Connection of walls 12 inches (305 mm) total length or shorter connecting offset braced wall panels to the foundation without anchor bolts shall be permitted. The wall shall be attached to adjacent braced wall panels at corners as shown in Item 9 of Table R602.3(1).

S8385

Date Submitted 12/15/2018
Chapter 4
Section 408.3
Affects HVHZ No
Proponent Craig Conner
Attachments No
TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes | **Alternate Language** No

Related Modifications

none

Summary of Modification

Additional option for unvented crawlspace dehumidification

Rationale

Unvented crawl spaces are required by Section R408.3 to provide to provide a method for moisture control. Typical conditioning measures involve supplying conditioned air from the occupied (conditioned) space of the building or exhausting air from the crawl space with make up air provided from the occupied (conditioned) space of the building. This code change allows another means of conditioning and controlling moisture, specifically dehumidification.

The existing language is based on a work done in the 1990's under the U.S. Department of Energy Building America Program. The work also examined dehumidification approaches.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

none

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

potentially lower cost because it is an additional option

Impact to industry relative to the cost of compliance with code

potentially lower cost because it is an additional option

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

Adds an option for crawlspace dehumidification.

Requirements

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

yes proven to mitigate moisture in crawlspace cavities

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

Provides a potentially less expensive option and reduces moisture condensation and problems in crawlspace cavities.

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

Allows another option

Does not degrade the effectiveness of the code

Providing usable options improves the code.

2nd Comment Period

S8385-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

R408.3 Unvented crawl space. Ventilation openings in under-floor spaces specified in Sections R408.1and R408.2 shall not be required where the following items are provided:

1. Exposed earth is covered with a continuous Class I vapor retarder. Joints of the vapor retarder shall overlap by 6 inches (152 mm) and shall be sealed or taped. The edges of the vapor retarder shall extend not less than 6 inches (152 mm) up the stem wall and shall be attached and sealed to the stem wall or insulation.

2. One of the following is provided for the under-floor space:

2.1.Continuously operated mechanical exhaust ventilation at a rate equal to 1 cubic foot per minute (0.47 L/s) for each 50 square feet (4.7 m^2) of crawl space floor area, including an air pathway to the common area (such as a duct or transfer grille), and perimeter walls insulated in accordance with Section N1102.2.11 of this code.

2.2. Conditioned air supply sized to deliver at a rate equal to 1 cubic foot per minute (0.47 L/s) for each 50 square feet (4.7 m^2) of under-floor area, including a return air pathway to the common area (such as a duct or transfer grille), and perimeter walls insulated in accordance with Section N1102.2.11 of this code.

2.3. Plenum in existing structures complying with Section M1601.5, if under-floor space is used as a plenum.

<u>2.4. Dehumidification sized to provide 70 pints (33 liters) of moisture removal per day for every 1,000 ft2 (93 m^2) of crawl space floor area.</u>

S7657

Date Submitted	12/3/2018	**Section**	502.6	**Proponent**	Ann Russo8
Chapter	5	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

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

Related Modifications

RB192-16

Summary of Modification

This change provides better organization of this section for current construction techniques and improves the organization and the terminology.

Rationale

This change provides better organization of this section for current construction techniques and improves the organization and the terminology.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Editorial clarification and reorganization of the section only.

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

Editorial clarification and reorganization of the section only. Will not increase construction cost.

Impact to industry relative to the cost of compliance with code

Editorial clarification and reorganization of the section only. Will not increase construction cost.

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

Editorial clarification and reorganization of the section only. Will not increase construction cost.

Requirements

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

Editorial clarification and reorganization of the section only. Will make code interpretation and enforcement easier without increase in cost of construction.

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

Editorial clarification and reorganization of the section only. Should make code interpretation and enforcement easier.

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

Editorial clarification and reorganization of the section only. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not degrade the effectiveness of the code

Editorial clarification and reorganization of the section only. Does not degrade the effectiveness of the code

2nd Comment Period

S7657-G1

Proponent Borrone Jeanette **Submitted** 5/21/2019 **Attachments** No

Comment:

I agree with the proposed revision.

2nd Comment Period

S7657-G2

Proponent Jennifer Privateer **Submitted** 5/23/2019 **Attachments** No

Comment:

agree

2nd Comment Period

S7657-G3

Proponent Harold Barrineau **Submitted** 5/25/2019 **Attachments** No

Comment:

I agree with this modification

Revise as follows:

R502.6 Bearing. The ends of each joist, beam or girder shall have not less than 1 1/2 inches (38 mm) of bearing on wood or metal and not less than 3 inches (76 mm) on masonry or concrete or be supported by approved joist hangers. Alternatively, the ends of joists shall be supported on a 1-inch by 4-inch (25 mm by 102 mm) ribbon strip and shall be nailed to the adjacent stud ~~or fastened by means of approved joist hangers. Alternatively, the ends of beams and girders shall be supported on approved connectors.~~ The bearing on masonry or concrete shall be direct, or a sill plate of 2-inch-minimum (51 mm) nominal thickness shall be provided under the joist, beam or girder. The sill plate shall provide a minimum nominal bearing area of 48 square inches (30 865 square mm).

S7661

Date Submitted	12/3/2018	**Section**	507.4	**Proponent**	Ann Russo8
Chapter	5	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes **Alternate Language** Yes

Related Modifications

RB209-16 and RB198-16

Summary of Modification

This code change modifies the decking text approved by the commission in October under change RB198 to permit custom decking materials and custom fasteners.

Rationale

This code change modifies the decking text approved by the commission in October under change RB198 to permit custom decking materials and custom fasteners.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Editorial change to allow additional options for decking only. No impact on code enforcement.

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

Editorial change to allow additional options for decking only. No added cost to comply with the code.

Impact to industry relative to the cost of compliance with code

Editorial change to allow additional options for decking only. Does not increase the cost of construction.

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

Editorial change to allow additional options for decking only. Does not increase the cost of construction.

Requirements

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

Editorial change to allow additional options for decking only.

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

Editorial change to allow additional options for decking only. No effect on the code.

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

Editorial change to allow additional options for decking only. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

Editorial change to allow additional options for decking only. Does not degrade the effectiveness of the code.

Alternate Language

2nd Comment Period

7661-A1

Proponent Paul Coats **Submitted** 5/26/2019 **Attachments** Yes

Rationale

This alternative language reflects what is contained in the 2018 IRC. The phrase "shall be permitted" in the original modification is overly broad in this instance because there are no specific performance requirements for the alternative decking or fastener system. The proposed revisions add "approved" to clarify that the alternative decking or fastener system is subject to approval by the building official as are all alternative systems. Revisions also clarify that installation shall be per manufacturer's installation instructions.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

The modification with the alternative language will allow the code official to permit alternative decking systems appropriately.

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

May reduced cost since it introduces the possibility of alternative decking systems.

Impact to industry relative to the cost of compliance with code

No impact or possibly reduced cost depending on the alternative chosen.

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

Editorial change to allow additional options for decking only. Does not increase the cost of construction.

Requirements

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

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

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade effectiveness.

2nd Comment Period

S7661-G1

Proponent Borrone Jeanette **Submitted** 5/21/2019 **Attachments** No

Comment:

I agree with the proposed revision.

2nd Comment Period

S7661-G2

Proponent Jennifer Privateer **Submitted** 5/23/2019 **Attachments** No

Comment:

I agree with this proposed modification

2nd Comment Period

S7661-G3

Proponent Harold Barrineau **Submitted** 5/25/2019 **Attachments** No

Comment:

I agree with this modification

Replace the proposed modification with the following:

~~**R507.4**~~ **Decking.** Maximum allowable spacing for joists supporting decking shall be in accordance with Table ~~R507.4~~. Wood decking shall be attached to each supporting member with not less than (2) 8d threaded nails or (2) No. 8 wood screws. <u>Other approved decking or fastener systems shall be installed in accordance with the manufacturer's installation</u>

Revise as follows:

SECTION R507
EXTERIOR DECKS

- **~~R507.4~~ R507.7 Decking. Maximum allowable spacing for joists supporting decking shall be in accordance with Table ~~R507.4~~R507.7. Wood decking shall be attached to each supporting member with not less than (2) 8d threaded nails or (2) No. 8 wood screws. Other types of decking or fastener systems shall be permitted in accordance with manufacturer's installation requirements.**

RB209-16

IRC: R507, R507.4.

Proposed Change as Submitted

Proponent : Charles Bajnai, representing Deck Code Coalition and Chesterfield County, VA; and North American Deck and Railing Association (NADRA) (bajnaic@chesterfield.gov)

2015 International Residential Code

SECTION R507 EXTERIOR DECKS

~~R507.4~~ R507.7 Decking. Maximum allowable spacing for joists supporting decking shall be in accordance with Table ~~R507.4~~ R507.7. Wood decking shall be attached to each supporting member with not less than (2) 8d threaded nails or (2) No. 8 wood screws. Other types of decking or fastener systems shall be permitted in accordance with manufacturer's installation requirements.

TABLE ~~R507.4~~ R507.7
MAXIMUM JOIST SPACING FOR DECKING

DECKING MATERIAL TYPE AND NOMINAL SIZE	MAXIMUM ON-CENTER JOIST SPACING	
	Decking perpendicular to joist	Decking diagonal to joist[a]
$1\frac{1}{4}$-inch-thick wood	16 inches	12 inches
2-inch-thick wood	24 inches	16 inches
Plastic composite	In accordance with Section R507.3	In accordance with Section R507.3

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.01745 rad.

a. Maximum angle of 45 degrees from perpendicular for wood deck boards

---

Reason:

WHAT: This code change modifies the decking text to permit custom decking materials and custom fasteners.

WHY: The Deck Code Coalition (DCC) thought it was imperative to permit all of the new decking materials being developed over the past few years. Also the market has seen many new fasteners and fastening systems being developed.

The Deck Code Coalition (DCC) is a diverse group of stakeholders, including building officials, industry associations, product manufacturers, design professionals, and academia who have worked since the 2012 IRC code development cycle in an effort to consolidate and improve deck construction methods from across the country.

Our goals are threefold:

1. Consolidate existing code scattered throughout the IRC under the newly expanded Section R507. Being able to easily locate all deck related code provisions in one section equally serves the builder, code official and design professional to a safer, code-conforming deck.
2. Create realistic, fact-based, prescriptive solutions to fill critical gaps in the current deck code. Many parts of existing deck code rely on subjective interpretations by the reader leading to an inconsistent approach to meeting minimum code.
3. Maintain and promote a safer deck structure without unduly burdening the builder. In all cases the DCC want to offer safe minimum requirements without stifling the creativity of the design professional or builder.

Cost Impact: Will not increase the cost of construction
There is no cost impact. It may even save a bit by allowing proprietary fastening systems.

RB209-16 :
R507.4-
BAJNAI11690

Public Hearing Results

Committee Action: **Approved as Submitted**

Committee Reason: The committee felt this is a good update to this section as it allows alternative decking material and fastener systems.

Assembly Action: **None**

Individual Consideration Agenda

Public Comment 1:

Proponent : Paul Coats, PE CBO (pcoats@awc.org) requests Approve as Modified by this Public Comment.

Modify as Follows:

2015 International Residential Code

R507.7 Decking. Maximum allowable spacing for joists supporting decking shall be in accordance with Table R507.7. Wood decking shall be attached to each supporting member with not less than (2) 8d threaded nails or (2) No. 8 wood screws. Other ~~types of~~ *approved* decking or fastener systems shall be ~~permitted~~ installed in accordance with manufacturer's installation requirements.

Commenter's Reason: The phrase "shall be permitted" is overly broad in this instance because there are no specific performance requirements for the alternative decking or fastener system. The proposed revisions add "approved" to clarify that the alternative decking or fastener system is subject to approval by the building official as are all alternative systems. Revisions also clarify that installation shall be per manufacturer's installation instructions.

RB209-16

Final action: Approved as Modified by Public Comment 1

S7727

Date Submitted 12/6/2018
Chapter 6
Section 609
Affects HVHZ No
Proponent Borrone Jeanette
Attachments No
TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments **Yes**

Alternate Language **No**

Related Modifications

Add new definition: Impact Protective System

Summary of Modification

Add new definition: Impact Protective System and Revise Wind-borne debris protection and Fenestration testing and labeling

Rationale

This proposal is one of several that are addressing labeling of critical components of the building envelope. The primary purpose of this code change is to require that impact protective systems (hurricane shutters) have a permanent label that provides a way for building owners, homeowners, and others to be able to determine their performance characteristics after the building has been occupied. The 2015 IRC does not require any type of label for impact protective systems. For products that don't have permanent labels, it becomes nearly impossible for the owner to determine the structural wind load resistance and impact resistance of the products after they've occupied the building. This proposal would simply require some type of permanent marking on the impact protective system indicating the manufacturer and model/series number, and performance characteristics so that the specific performance characteristics could be retrieved at a later date. The permanent label would only need to provide traceability to the product. However, it could provide all the required information. If the relevant information is not provided on a permanent label, a temporary removable label is required to be applied so that local code officials can verify that the appropriate impact protective system was provided.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will not impact local entity

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

Will result in an increase in cost. a. Water Resistant Self-adhering Permanent Labels approximately $0.15 per label. b. Embossed or ink jet labels used on metal and plastic panels would cost approximately $0.05 per label

Impact to industry relative to the cost of compliance with code

Will result in an increase in cost. a. Water Resistant Self-adhering Permanent Labels approximately $0.15 per label. b. Embossed or ink jet labels used on metal and plastic panels would cost approximately $0.05 per label

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

Will result in an increase in cost. a. Water Resistant Self-adhering Permanent Labels approximately $0.15 per label. b. Embossed or ink jet labels used on metal and plastic panels would cost approximately $0.05 per label

Requirements

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

Improves the health, safety, and welfare of the general public by requiring that impact protective systems have a permanent label that provides a way for building owners, homeowners, and others to be able to determine their performance characteristics after the building has been occupied.

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

Improves the code by requiring that impact protective systems have a permanent label that provides a way for building owners, homeowners, and others to be able to determine their performance characteristics after the building has been occupied.

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

Does not discriminate against materials, products, methods, or systems of construction it helps future building owners, inspectors, and contractors.

Does not degrade the effectiveness of the code

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

2nd Comment Period

S7727-G1

Proponent Borrone Jeanette **Submitted** 5/3/2019 **Attachments** No

Comment:

I agree with this proposed modification

2nd Comment Period

S7727-G2

Proponent	Michael Savage	Submitted	5/14/2019	Attachments	No

Comment:

I agree with the proposed revision.

2nd Comment Period

S7727-G3

Proponent	Harold Barrineau	Submitted	5/20/2019	Attachments	No

Comment:

I agree. This proposed modification would be good for the Florida Building Code.

2nd Comment Period

S7727-G4

Proponent	Jennifer Privateer	Submitted	5/20/2019	Attachments	No

Comment:

So true; I agree with this proposed modification

Add new definition to Section 202 as follows:

Impact Protective System Construction:

Impact Protective System Construction that has been shown by testing to withstand the impact of test missiles and that is applied, attached, or locked over exterior glazing.

Revise as follows:

R609.6 Wind-borne debris protection. Protection of exterior ~~glazed openings~~ windows and, glass doors, and doors with glass in buildings located in wind-borne debris regions shall be in accordance with Section R301.2.1.2.

R609.6.1 Fenestration testing and labeling. Fenestration shall be tested by an approved independent laboratory, listed by an approved entity, and bear a label identifying manufacturer, performance characteristics, and approved inspection agency to indicate compliance with the requirements of the following specification(s):

ASTM E 1886 and ASTM E 1996; or

1. AAMA 506.

Add new text as follows:

R609.6.2 Impact protective systems testing and labeling Impact protective systems shall be tested for impact resistance by an approved independent laboratory for compliance with ASTM E 1886 and ASTM E 1996. Impact protective systems shall also be tested for design wind pressure by an approved independent laboratory for compliance with ASTM E 330. Required design wind pressures shall be determined in accordance with Table R301.2(2) adjusted for height and exposure in accordance with Table R301.2(3) or determined in accordance with ASCE 7. For the purposes of this section, design wind pressures determined in accordance with ASCE 7 are permitted to be multiplied by 0.6.

Impact protective systems bear a label identifying the manufacturer, performance characteristics, and approved inspection agency. Impact protective systems shall have a permanent label providing traceability to the manufacturer, product designation, and performance characteristics. The permanent label shall be acid etched, sand blasted, ceramic fired, laser etched, embossed or of a type that, once applied, cannot be removed without being destroyed.

S7731

Date Submitted	12/6/2018	**Section**	609	**Proponent**	Borrone Jeanette
Chapter	6	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes **Alternate Language** No

Related Modifications

R609.2 Performance. R609.3 and R609.5

Summary of Modification

Exterior windows and doors shall be capable of resisting the design wind loads specified in Table R301.2(2) adjusted for height and exposure in accordance with Table R301.2(3) or determined in accordance with ASCE 7

Rationale

This proposal is intended to clarify that the use of the 0.6 conversion multiplier is allowed with respect to the determination of design wind pressures in accordance with ASCE 7 and testing of the respective assemblies in accordance with Section R609.3 or R609.5 accordingly. While that is what the existing provision allows, as currently written, that is not entirely clear and has led to confusion regarding wind load requirements. This proposed amendment expressly states that the use of 0.6 multiplier is allowed and will alleviate the confusion that currently exists benefiting all – code officials, manufacturers and builders.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will not impact local entity

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

Will not increase the cost of construction This is a clarification. No substantive change.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction This is a clarification. No substantive change.

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

Will not increase the cost of construction This is a clarification. No substantive change.

Requirements

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

Improves the health, safety, and welfare of the general public by clarifying that the use of the 0.6 conversion multiplier is allowed

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

Improves the code by clarifying that the use of the 0.6 conversion multiplier is allowed

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

Does not discriminate against materials, products, methods, or systems of construction clarifying that the use of the 0.6 conversion multiplier is allowed

Does not degrade the effectiveness of the code

Increases the effectiveness of the code by clarifying that the use of the 0.6 conversion multiplier is allowed

2nd Comment Period

S7731-G1

Proponent Borrone Jeanette **Submitted** 5/3/2019 **Attachments** No

Comment:

I agree with this proposed modification

2nd Comment Period

S7731-G2

Proponent Michael Savage **Submitted** 5/14/2019 **Attachments** No

Comment:

I agree with the proposed revision.

2nd Comment Period

S7731-G3

Proponent Harold Barrineau **Submitted** 5/20/2019 **Attachments** No

Comment:

This proposed modification would provide the clarity needed. I agree.

2nd Comment Period

S7731-G4

Proponent Jennifer Privateer **Submitted** 5/20/2019 **Attachments** No

Comment:

agree as proposed

R609.2 Performance. Exterior windows and doors shall be ~~designed to resist~~capable of resisting the design wind loads specified in Table R301.2(2) adjusted for height and exposure in accordance with Table R301.2(3) or determined in accordance with ASCE 7 ~~using the allowable stress~~. For exterior windows and doors tested in accordance with Sections R609.3 and R609.5, required design ~~loadcombinationsof~~ wind pressures determined from ASCE 7 are permitted to be multiplied by 0.6. Design wind loads for exterior glazing not part of a labeled assembly shall be permitted to be determined in accordance with Chapter 24 of the *Florida Building Code, Building*.

S8081

Date Submitted	12/13/2018	**Section**	602.3	**Proponent**	Paul Coats
Chapter	6	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	No Affirmative Recommendation				
Commission Action	Pending Review				

Comments

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

Related Modifications

8084, 8092, 8096

Summary of Modification

Adjustment to roof sheathing nail spacing in accordance with the criteria of ASCE 7-10

Rationale

This modification was approved by the ICC committee and membership and appears in the 2018 edition of the International Residential Code. Nailing requirements provided in the IRC Table 602.3(1) were reviewed using loads from ASCE 7-10 Minimum Design Loads for Buildings and Other Structures. Nailing requirements for common species of roof framing with specific gravities of 0.42 or greater (e.g. SPF, Hem-Fir) were analyzed and it was found that the nail spacing requirements in footnote "f" needed to be slightly modified to clarify that nail spacing for all sheathing to framing attached to intermediate supports within 48" of roof end zones, eaves, and ridges must be reduced, not just at the gable end roof framing. For ultimate wind speeds of 130 mph and greater, the threshold for reducing the nail spacing from 6" to 4" in the 48" end zone areas w as slightly modified while clarifying that ultimate wind speeds of 140 mph or greater are is outside the scope of the IRC structural provisions. The language in footnote "f" was revised to clarify the intent of this footnote. A sentence was also added to R803.2.3 to clarify the appropriate limit on the distance unsupported sheathing can cantilever past the gable end roof framing. Tabulated calculation results based on ASCE 7-10 are provided in the uploaded support file reason statement. Please note that although the 2018 IRC references the 2016 edition of ASCE 7, component and cladding wind pressures and criteria in Chapter 3 remained as in the previous edition of the IRC (in accordance with ASCE 7-10) and this change was also adopted in the 2018 IRC. For complete consistency with ASCE 7-16, see proposed modifications 8084, 8092, and 8096 as an alternative to this one.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Enforcement will remain the same with slightly modified nail spacings.

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

May have a slight cost increase.

Impact to industry relative to the cost of compliance with code

May have a very slight cost increase.

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

No cost-related impact.

Requirements

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

Nail spacings slightly modified in accordance with design standards.

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

Strengthens the code.

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

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

2nd Comment Period

S8081-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

2nd Comment Period

S8081-G2

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

Revise footnote "f" of Table R602.3(1) as follows:

~~f.Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.~~

<ins>For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48" of roof end zones, eaves, and ridges, nails shall be spaced at 6 inches on center where the ultimate design wind speed is less than 130 mph and shall be spaced 4 inches on center where the ultimate design wind speed is 130 mph or greater but less than 140 mph.</ins>

RB221-16

IRC: R602.3, R803.2.3.

Proponent : James Smith (jsmith@awc.org)

2015 International Residential Code

TABLE R602.3 (1)
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Roof			
1	Blocking between ceiling joists or rafters to top plate	4-8d box (2 1/2 ″ × 0.113″) or 3-8d common (2 1/2 ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
2	Ceiling joists to top plate	4-8d box (2 1/2 ″ × 0.113″); or 3-8d common (2 1/2 ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Sections R802.3.1, R802.3.2 and Table R802.5.1(9)]	4-10d box (3″ × 0.128″); or 3-16d common (3 1/2 ″ × 0.162″); or 4-3″ × 0.131″ nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Sections R802.3.1 and R802.3.2 and Table R802.5.1(9)]	Table R802.5.1(9)	Face nail
5	Collar tie to rafter, face nail or 1 1/4 ″ × 20 ga. ridge strap to rafter	4-10d box (3″ × 0.128″); or 3-10d common (3″ × 0.148″); or 4-3″ × 0.131″ nails	Face nail each rafter

6	Rafter or roof truss to plate	3-16d box nails ($3\frac{1}{2}$″ × 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 ($3\frac{1}{2}$″ × 0.135″); or 3-10d common ($3\frac{1}{2}$″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box $3\frac{1}{2}$″ × 0.135″); or 2-16d common ($3\frac{1}{2}$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
Wall			
8	Stud to stud (not at braced wall panels)	16d common ($3\frac{1}{2}$″ × 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 ($3\frac{1}{2}$″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
		16d common ($3\frac{1}{2}$″ × 0.162″)	16″ o.c. face nail
10	Built-up header (2″ to 2″ header with $\frac{1}{2}$″ spacer)	16d common ($3\frac{1}{2}$″ × 0.162″)	16″ o.c. each edge face nail
		16d box ($3\frac{1}{2}$″ × 0.135″)	12″ o.c. each edge face nail
11	Continuous header to stud	5-8d box ($2\frac{1}{2}$″ × 0.113″); or 4-8d common ($2\frac{1}{2}$″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toe nail
		16d common ($3\frac{1}{2}$″ × 0.162″)	16″ o.c. face nail

12	Top plate to top plate	10d box (3″ × 0.128″); or 3″ × 0.131″ nails	12″ o.c. face nail
13	Double top plate splice for SDCs A-D2 with seismic braced wall line spacing	8-16d common ($3^1/_2$ ″ × 0.162″); or 12-16d box ($3^1/_2$ ″ × 0.135″); or 12-10d box (3″ × 0.128″); or 12-3″ × 0.131″ nails	Face nail on each side of end joint (minimum 24″ lap splice length each side of end joint)
	Double top plate splice SDCs D_0 , D_1 , or D_2 ; and braced wall line spacing ≥ 25′	12-16d ($3^1/_2$ ″ × 0.135″)	

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
14	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common ($3^1/_2$ ″ × 0.162″)	16″ o.c. face nail
		16d box ($3^1/_2$ ″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
15	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box ($3^1/_2$ ″ × 0.135″); or 2-16d common ($3^1/_2$ ″ × 0.162″); or 4-3″ × 0.131″ nails	3 each 16″ o.c. face nail 2 each 16″ o.c. face nail 4 each 16″ o.c. face nail
16	Top or bottom plate to stud	4-8d box ($2^1/_2$ ″ × 0.113″); or 3-16d box ($3^1/_2$ ″ × 0.135″); or 4-8d common ($2^1/_2$ ″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box ($3^1/_2$ ″ × 0.135″); or 2-16d common ($3^1/_2$ ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail

17	Top plates, laps at corners and intersections	3-10d box (3″ × 0.128″); or 2-16d common ($3^1/_2$ ″ × 0.162″); or 3-3″ × 0.131″ nails	Face nail
18	1″ brace to each stud and plate	3-8d box ($2^1/_2$ ″ × 0.113″); or 2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples $1^3/_4$ ″	Face nail
19	1″ × 6″ sheathing to each bearing	3-8d box ($2^1/_2$ ″ × 0.113″); or 2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	Face nail
20	1″ × 8″ and wider sheathing to each bearing	3-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	Face nail
		Wider than 1″ × 8″ 4-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 4 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	
Floor			
21	Joist to sill, top plate or girder	4-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
		8d box ($2^1/_2$ ″ × 0.113″)	4″ o.c. toe nail

22	Rim joist, band joist or blocking to sill or top plate (roof applications also)	8d common ($2^1/_2$ ″ × 0.131″); or 10d box (3″ × 0.128″); or 3″ × 0.131″ nails	6″ o.c. toe nail
23	1″ × 6″ subfloor or less to each joist	3-8d box ($2^1/_2$ ″ × 0.113″); or 2-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	Face nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Floor			
24	2″subfloor to joist or girder	3-16d box ($3^1/_2$ ″× 0.135″); or 2-16d common ($3^1/_2$ ″× 0.162″)	Blind and face nail
25	2″planks (plank & beam—floor & roof)	3-16d box ($3^1/_2$ ″× 0.135″); or 2-16d common ($3^1/_2$ ″× 0.162″)	At each bearing, face nail
26	Band or rim joist to joist	3-16d common ($3^1/_2$ ″× 0.162″) 4-10 box (3″× 0.128″), or 4-3″× 0.131″nails; or	End nail

		4-3″× 14 ga. staples, 7/16 ″crown		
27	Built-up girders and beams, 2-inch lumber layers	20d common (4″× 0.192″); or	Nail each layer as follows: 32″o.c. at top and bottom and staggered.	
		10d box (3″× 0.128″); or 3″× 0.131″nails	24″o.c. face nail at top and bottom staggered on opposite sides	
		And: 2-20d common (4″× 0.192″); or 3-10d box (3″× 0.128″); or 3-3″× 0.131″nails	Face nail at ends and at each splice	
28	Ledger strip supporting joists or rafters	4-16d box (3 1/2 ″× 0.135″); or 3-16d common (3 1/2 ″× 0.162″); or 4-10d box (3″× 0.128″); or 4-3″× 0.131″nails	At each joist or rafter, face nail	
29	Bridging to joist	2-10d (3″× 0.128″)	Each end, toe nail	
ITEM	**DESCRIPTION OF BUILDING ELEMENTS**	**NUMBER AND TYPE OF FASTENER[a, b, c]**	**SPACING OF FASTENERS**	
			<u>Panel</u> Edges (inches)[h]	**Intermediate supports[c, e] (inches)**
Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing [see Table R602.3(3) for wood structural panel *exterior* wall sheathing to wall framing]				

30	3/8"– 1/2"	6d common (2"× 0.113") nail (subfloor, wall)[i] 8d common (2 1/2"× 0.131") nail (roof)	6	12[f]	31	19/32"– 1"	8d common nail (2 1/2"× 0.131")	6	12[f]
32	1 1/8"–1 1/4"	10d common (3"× 0.148") nail; or 8d (2 1/2"× 0.131") deformed nail	6	12					
Other wall sheathing[g]									
33	1/2"structural cellulosic fiberboard sheathing	1 1/2"galvanized roofing nail, 7/16" head diameter, or 1"crown staple 16 ga., 1 1/4" long	3	6					
34	25/32"structural cellulosic fiberboard sheathing	1 3/4"galvanized roofing nail, 7/16"head diameter, or 1"crown staple 16 ga., 1 1/4" long	3	6					
		1 1/2							

35	1 /2 "gypsum sheathing[d]	"galvanized roofing nail; staple galvanized, 1 1/2 "long; 1 1/4 " screws, Type W or S	7	7
36	5 /8 "gypsum sheathing[d]	1 3/4 "galvanized roofing nail; staple galvanized, 1 5/8 " long; 1 5/8 " screws, Type W or S	7	7
Wood structural panels, combination subfloor underlayment to framing				
37	3 /4 " and less	6d deformed (2"× 0.120") nail; or 8d common (2 1/2 "× 0.131") nail	6	12
38	7 /8 "– 1"	8d common (2 1/2 "× 0.131") nail; or 8d deformed (2 1/2 "× 0.120") nail	6	12
39	1 1/8 "– 1 1/4 "	10d common (3"× 0.148") nail; or 8d deformed (2 1	6	12

		/2 "× 0.120") nail		

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.

a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.

b. Staples are 16 gage wire and have a minimum $^{7}/_{16}$ -inch on diameter crown width.

c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.

d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.

e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).

~~f. Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.~~

f. For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48" of roof end zones, eaves, and ridges, nails shall be spaced at 6 inches on center where the ultimate design wind speed is less than 130 mph and shall be spaced 4 inches on center where the ultimate design wind speed is 130 mph or greater but less than 140 mph.

g. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.

h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.

i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

R803.2.3 Installation. Wood structural panel used as roof sheathing shall be installed with joints staggered or not staggered in accordance with Table R602.3(1), APA E30 for wood roof framing or with Table R804.3 for cold-formed steel roof framing. Wood structural panel roof sheathing shall not cantlever more than 9 inches beyond the gable end wall unless supported by gable overhang framing.

Reason: Nailing requirements provided in the IRC Table 602.3(1) were reviewed using loads from ASCE 7-10 *Minimum Design Loads for Buildings and Other Structures.* Nailing requirements for common species of roof framing with specific gravities of 0.42 or greater (e.g. SPF, Hem-Fir) were analyzed and it was found that the nail spacing requirements in footnote "f" needed to be slightly modified to clarify that nail spacing for all sheathing to framing attached to intermediate supports within 48" of roof end zones, eaves, and ridges must be reduced, not just at the gable end roof framing. For ultimate wind speeds of 130 mph and greater, the threshold for reducing the nail spacing from 6" to 4" in the 48" end zone areas was slightly modified while clarifying that ultimate wind speeds of 140 mph or greater are is outside the scope of the IRC structural provisions. The language in footnote "f" was revised to clarify the intent of this footnote. A sentence was also added to R803.2.3 to clarify the appropriate limit on the distance unsupported sheathing can cantilever past the gable end roof framing. Tabulated calculation results based on ASCE 7-10 are provided below: (insert attachment here)

WFCM Table 3.10 (Exposure C) - Based on ASCE 7-10
Roof Sheathing Attachment Requirements for Wind Loads

700-yr. Wind Speed 3-second gust (mph)			110		115		120		130		140	
			Wood Structural Panel Sheathing									
			E	F	E	F	E	F	E	F	E	F
Sheathing Location[1]	Rafter/Truss Framing Specific Gravity, G	Rafter/Truss Spacing (in.)	Maximum Nail Spacing for 8d Common Nails or 10d Box Nails (inches, o.c.)[2]									
Interior Zone	0.42	12	6	12	6	12	6	12	6	12	6	12
		16	6	12	6	12	6	12	6	12	6	12
		19.2	6	12	6	12	6	12	6	12	6	12
		24	6	12	6	12	6	12	6	12	6	12
Perimeter Edge Zone	0.42	12	6	12	6	12	6	12	6	12	6	6
		16	6	12	6	6	6	6	6	6	6	6
		19.2	6	6	6	6	6	6	6	6	6	6
		24	6	6	6	6	6	6	6	4	6	4
Gable Endwall Rake or Rake Truss with up to 9" Rake Overhang	0.42	-	6		6		6		4		4	

E - Nail spacing at panel edges (in.)
F - Nail spacing at intermediate supports in the panel field (in.)

1 For roof sheathing within 4 feet of the perimeter edge of the roof, including 4 feet on each side of the roof peak, the 4 foot perimeter edge zone attachment requirements shall be used.
2 For wind speeds greater than 130 mph, blocking is required which transfers shear load to two additional joi

Cost Impact: Will not increase the cost of construction
The change to footnote "f" is a clarification of the current footnote "f" intent. The 9" limit on gable overhang is not really an increase in requirement, but a limitation to allow more efficient nailing patterns.

RB221-16 : TABLE R602.3-SMITH11542

Final Action: AM (Approved as Modified by the Committee)

RB221-16

Committee Action: **Approved as Modified**

Modification:

TABLE R602.3 (1)
FASTENING SCHEDULE

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.
a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.
b. Staples are 16 gage wire and have a minimum $^{7}/_{16}$-inch on diameter crown width.
c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.
d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.
e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).
f. For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48" of roof ~~end zones, eaves,~~ edges and ridges, nails shall be spaced at 6 inches on center where the ultimate design wind speed is less than 130 mph and shall be spaced 4 inches on center where the ultimate design wind speed is 130 mph or greater but less than 140 mph.
g. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.

h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.
i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

R803.2.3 Installation. Wood structural panel used as roof sheathing shall be installed with joints staggered or not staggered in accordance with Table R602.3(1), APA E30 for wood roof framing or with Table R804.3 for cold-formed steel roof framing. Wood structural panel roof sheathing in accordance with Table R503.2.1.1(1) shall not cantlever more than 9 inches beyond the gable end wall unless supported by gable overhang framing.

Committee Reason:

The committee approved this change based on the proponents published reason statement. The proposal aligns the roof sheathing nail spacing with the ASCE 7-10 loading and provides an allowable cantilever for the sheathing past the gable end. The modifications deleted the terms end zones and eaves to avoid confusion with edges and added a reference to the sheathing installation table.

Assembly Action: **None**

S8084

Date Submitted 12/13/2018
Chapter 6
Section 602.3
Affects HVHZ No
Proponent Paul Coats
Attachments Yes
TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes | **Alternate Language** No

Related Modifications

8073

Summary of Modification

Adjustment to roof sheathing nail spacing in accordance with the criteria of ASCE 7-16

Rationale

The nailing requirements provided in IRC Table R602.3(1) were reviewed using loads from the New ASCE 7-16 Minimum Design Loads for Buildings and Other Structures. As show n in the table below , calculated wind loads on elements and fasteners with small tributary areas like roof sheathing nails have increased dramatically, almost doubling in the interior portions of the roof (Roof Zone 1). To determine the impact of the new ASCE 7-16 loading provisions, nailing requirements for common species of roof framing with specific gravities of 0.42 or greater (e.g. SPF, Hem-Fir) w ere analyzed using ASCE 7-16 and it was found that the nail spacing requirements in Table R602.3(1) needed to be significantly modified, especially in the interior portion of the roof. As shown in the tabulated results below , nailing at intermediate supports in the interior portions of the roof (Roof Zone 1) need to be reduced from 12" o.c. to 6" o.c. How ever, changes to loads in the end zone portions of the roof were less significant and required far less adjustment. In fact, the 6" o.c. spacing is appropriate for all connection in the end zone portions, except w here ultimate wind speeds equal or exceed 120 mph. The language in footnote "f" needed to be slightly modified to clarify that nail spacing for all sheathing to framing attached to gable end roof framing and intermediate supports within 48" of roof end zones, eaves and ridges must be reduced from 6" to 4" where ultimate wind speeds exceed 120 mph. Language w as also added to clarify that ultimate wind speeds of 140 mph or greater is outside the scope of the IRC structural provisions. A sentence was also added to R803.2.3 to clarify the appropriate limit on the distance unsupported sheathing can cantilever past the gable end roof framing. See the additional tables in the Reason statement of the attached support file.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Enforcement will remain the same with slightly modified nail spacings.

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

May have a slight cost increase.

Impact to industry relative to the cost of compliance with code

May have a very slight cost increase.

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

No cost-related impact.

Requirements

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

Nail spacings slightly modified in accordance with design standards.

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

Strengthens the code.

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

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

2nd Comment Period

S8084-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

2nd Comment Period

S8084-G2

Proponent	Harold Barrineau	Submitted	5/26/2019	Attachments	No

Comment:

I agree with this modification.

Revise rows 30 and 31, and footnote "f" of Table R602.3(1) as follows:

30	3/8" – 1/2"	6d common (2" × 0.113") nail (subfloor, wall)i8d common (21/2" × 0.131") nail (roof)
31	19/32" – 1"	8d common nail (21/2" × 0.131")

~~f.Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.~~

For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48" of roof end zones, eaves, and ridges, nails shall be spaced at 4" on center where the ultimate design wind speed is 120 mph or greater but less than 140 mph.

RB222-16

IRC: R602.3, R803.2.3.

Proponent : James Smith (jsmith@awc.org)

2015 International Residential Code

TABLE R602.3 (1)
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Roof			
1	Blocking between ceiling joists or rafters to top plate	4-8d box ($2^1/_2$ " × 0.113") or 3-8d common ($2^1/_2$ " × 0.131"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails	Toe nail
2	Ceiling joists to top plate	4-8d box ($2^1/_2$ " × 0.113"); or 3-8d common ($2^1/_2$ " × 0.131"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Sections R802.3.1, R802.3.2 and Table R802.5.1(9)]	4-10d box (3" × 0.128"); or 3-16d common ($3^1/_2$ " × 0.162"); or 4-3" × 0.131" nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Sections R802.3.1 and R802.3.2 and Table R802.5.1(9)]	Table R802.5.1(9)	Face nail
5	Collar tie to rafter, face nail or $1^1/_4$ " × 20 ga. ridge strap to rafter	4-10d box (3" × 0.128"); or 3-10d common (3" × 0.148"); or 4-3" × 0.131" nails	Face nail each rafter

6	Rafter or roof truss to plate	3-16d box nails (3 1/2 ″ × 0.135″); or 3-10d common nails (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss[i]
7	Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2″ ridge beam	4-16d (3 1/2 ″ × 0.135″); or 3-10d common (3 1/2 ″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box 3 1/2 ″ × 0.135″); or 2-16d common (3 1/2 ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
Wall			
8	Stud to stud (not at braced wall panels)	16d common (3 1/2 ″ × 0.162″)	24″ o.c. face nail
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	16″ o.c. face nail
9	Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d box (3 1/2 ″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
		16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail
10	Built-up header (2″ to 2″ header with 1/2 ″ spacer)	16d common (3 1/2 ″ × 0.162″)	16″ o.c. each edge face nail
		16d box (3 1/2 ″ × 0.135″)	12″ o.c. each edge face nail
11	Continuous header to stud	5-8d box (2 1/2 ″ × 0.113″); or 4-8d common (2 1/2 ″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toe nail
		16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail

12	Top plate to top plate	10d box (3″ × 0.128″); or 3″ × 0.131″ nails	12″ o.c. face nail
13	Double top plate splice for SDCs A-D2 with seismic braced wall line spacing	8-16d common ($3\frac{1}{2}$″ × 0.162″); or 12-16d box ($3\frac{1}{2}$″ × 0.135″); or 12-10d box (3″ × 0.128″); or 12-3″ × 0.131″ nails	Face nail on each side of end joint (minimum 24″ lap splice length each side of end joint)
	Double top plate splice SDCs D_0 , D_1 , or D_2 ; and braced wall line spacing ≥ 25′	12-16d ($3\frac{1}{2}$″ × 0.135″)	

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
14	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common ($3\frac{1}{2}$″ × 0.162″)	16″ o.c. face nail
		16d box ($3\frac{1}{2}$″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
15	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box ($3\frac{1}{2}$″ × 0.135″); or 2-16d common ($3\frac{1}{2}$″ × 0.162″); or 4-3″ × 0.131″ nails	3 each 16″ o.c. face nail 2 each 16″ o.c. face nail 4 each 16″ o.c. face nail
16	Top or bottom plate to stud	4-8d box ($2\frac{1}{2}$″ × 0.113″); or 3-16d box ($3\frac{1}{2}$″ × 0.135″); or 4-8d common ($2\frac{1}{2}$″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box ($3\frac{1}{2}$″ × 0.135″); or 2-16d common ($3\frac{1}{2}$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail

17	Top plates, laps at corners and intersections	3-10d box (3″ × 0.128″); or 2-16d common ($3^1/_2$ ″ × 0.162″); or 3-3″ × 0.131″ nails	Face nail
18	1″ brace to each stud and plate	3-8d box ($2^1/_2$ ″ × 0.113″); or 2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples $1^3/_4$ ″	Face nail
19	1″ × 6″ sheathing to each bearing	3-8d box ($2^1/_2$ ″ × 0.113″); or 2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	Face nail
20	1″ × 8″ and wider sheathing to each bearing	3-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	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**	
			<u>Panel</u> 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]				

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30	3/8"– 1/2"	6d common (2"× 0.113") nail (subfloor, wall)[i] 8d common (2 1/2 "× 0.131") nail (roof)	6	~~12~~6[f]
31	19/32 "– 1"	8d common nail (2 1/2 "× 0.131")	6	~~12~~6[f]
32	1 1/8 "–1 1/4 "	10d common (3"× 0.148") nail; or 8d (2 1/2 "× 0.131") deformed nail	6	12
Other wall sheathing[g]				
33	1/2 "structural cellulosic fiberboard sheathing	1 1/2 "galvanized roofing nail, 7/16 " head diameter, or 1"crown staple 16 ga., 1 1/4 " long	3	6
34	25/32 "structural cellulosic fiberboard sheathing	1 3/4 "galvanized roofing nail, 7/16 "head diameter, or 1"crown staple 16 ga., 1 1/4 " long	3	6
		1 1/2		

35	1/2 "gypsum sheathing[d]	"galvanized roofing nail; staple galvanized, 1 1/2 "long; 1 1/4 " screws, Type W or S	7	7
36	5/8 "gypsum sheathing[d]	1 3/4 "galvanized roofing nail; staple galvanized, 1 5/8 " long; 1 5/8 " screws, Type W or S	7	7
Wood structural panels, combination subfloor underlayment to framing				
37	3/4 " and less	6d deformed (2"× 0.120") nail; or 8d common (2 1/2 "× 0.131") nail	6	12
38	7/8 "– 1"	8d common (2 1/2 "× 0.131") nail; or 8d deformed (2 1/2 "× 0.120") nail	6	12
39	1 1/8 "– 1 1/4 "	10d common (3"× 0.148") nail; or 8d deformed (2 1	6	12

		/2 "× 0.120") nail			

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.

a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.

b. Staples are 16 gage wire and have a minimum $^{7}/_{16}$ -inch on diameter crown width.

c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.

d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.

e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).

~~f. Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.~~

f. For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48" of roof end zones, eaves, and ridges, nails shall be spaced at 4" on center where the ultimate design wind speed is 120 mph or greater but less than 140 mph.

g. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.

h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.

i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

Revise as follows:

R803.2.3 Installation. Wood structural panel used as roof sheathing shall be installed with joints staggered or not staggered in accordance with Table R602.3(1), APA E30 for wood roof framing or with Table R804.3 for cold-formed steel roof framing. Wood structural panel roof sheathing shall not cantilever more than 9 inches beyond the gable end wall unless supported by gable overhang framing.

Reason: The nailing requirements provided in IRC Table R602.3(1) were reviewed using loads from the New ASCE 7-16 *Minimum Design Loads for Buildings and Other Structures*. As shown in the table below, calculated wind loads on elements and fasteners with small tributary areas like roof sheathing nails have increased dramatically, almost doubling in the interior portions of the roof (Roof Zone 1).

Roof	ASCE 7-10			ASCE 7-16			Increase
Zone	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 show n in the tabulated results below , nailing at intermediate supports in the interior portions of the roof (Roof Zone 1) need to be reduced from 12" o.c. to 6" o.c. How ever, changes to loads in the end zone portions of the roof w ere less significant and required far less adjustment. In fact, the 6" o.c. spacing is appropriate for all connection in the end zone portions, except w here ultimate w ind 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 w ithin 48" of roof end zones, eaves and ridges must be reduced from 6" to 4" w here ultimate w ind speeds exceed 120 mph. Language w as also added to clarify that ultimate w ind speeds of 140 mph or greater is outside the scope of the IRC structural provisions. A sentence w as 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 row s 30 and 31 of the table w ill increase the number of nails and the time to install, w hich w ill increase cost. This increase in cost is the direct result of compliance w ith the increased w ind uplift loads in ASCE 7-16.

RB222-16 : TABLE R602.3-SMITH11567

Final Action: D (Disapproved)

RB222-16

Committee Action: **Disapproved**

Committee Reason: Based on the proponets request for disapproval and the committees previous action on RB20-16.

Assembly Action: **None**

RB222-16

IRC: R602.3, R803.2.3.

Proponent : James Smith (jsmith@awc.org)

2015 International Residential Code

TABLE R602.3 (1)
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Roof			
1	Blocking between ceiling joists or rafters to top plate	4-8d box ($2^1/_2$ " × 0.113″) or 3-8d common ($2^1/_2$ " × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
2	Ceiling joists to top plate	4-8d box ($2^1/_2$ " × 0.113″); or 3-8d common ($2^1/_2$ " × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Sections R802.3.1, R802.3.2 and Table R802.5.1(9)]	4-10d box (3″ × 0.128″); or 3-16d common ($3^1/_2$ " × 0.162″); or 4-3″ × 0.131″ nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Sections R802.3.1 and R802.3.2 and Table R802.5.1(9)]	Table R802.5.1(9)	Face nail
5	Collar tie to rafter, face nail or $1^1/_4$ " × 20 ga. ridge strap to rafter	4-10d box (3″ × 0.128″); or 3-10d common (3″ × 0.148″); or 4-3″ × 0.131″ nails	Face nail each rafter

6	Rafter or roof truss to plate	3-16d box nails ($3^1/_2$ ″ × 0.135″); or 3-10d common nails (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss[i]
7	Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2″ ridge beam	4-16d ($3^1/_2$ ″ × 0.135″); or 3-10d common ($3^1/_2$ ″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box $3^1/_2$ ″ × 0.135″); or 2-16d common ($3^1/_2$ ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
Wall			
8	Stud to stud (not at braced wall panels)	16d common ($3^1/_2$ ″ × 0.162″)	24″ o.c. face nail
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	16″ o.c. face nail
9	Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d box ($3^1/_2$ ″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
		16d common ($3^1/_2$ ″ × 0.162″)	16″ o.c. face nail
10	Built-up header (2″ to 2″ header with $^1/_2$ ″ spacer)	16d common ($3^1/_2$ ″ × 0.162″)	16″ o.c. each edge face nail
		16d box ($3^1/_2$ ″ × 0.135″)	12″ o.c. each edge face nail
11	Continuous header to stud	5-8d box ($2^1/_2$ ″ × 0.113″); or 4-8d common ($2^1/_2$ ″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toe nail
		16d common ($3^1/_2$ ″ × 0.162″)	16″ o.c. face nail

12	Top plate to top plate	10d box (3″ × 0.128″); or 3″ × 0.131″ nails	12″ o.c. face nail
13	Double top plate splice for SDCs A-D2 with seismic braced wall line spacing	8-16d common ($3\frac{1}{2}$″ × 0.162″); or 12-16d box ($3\frac{1}{2}$″ × 0.135″); or 12-10d box (3″ × 0.128″); or 12-3″ × 0.131″ nails	Face nail on each side of end joint (minimum 24″ lap splice length each side of end joint)
	Double top plate splice SDCs D_0 , D_1 , or D_2 ; and braced wall line spacing ≥ 25′	12-16d ($3\frac{1}{2}$″ × 0.135″)	

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
14	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common ($3\frac{1}{2}$″ × 0.162″)	16″ o.c. face nail
		16d box ($3\frac{1}{2}$″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
15	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box ($3\frac{1}{2}$″ × 0.135″); or 2-16d common ($3\frac{1}{2}$″ × 0.162″); or 4-3″ × 0.131″ nails	3 each 16″ o.c. face nail 2 each 16″ o.c. face nail 4 each 16″ o.c. face nail
16	Top or bottom plate to stud	4-8d box ($2\frac{1}{2}$″ × 0.113″); or 3-16d box ($3\frac{1}{2}$″ × 0.135″); or 4-8d common ($2\frac{1}{2}$″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box ($3\frac{1}{2}$″ × 0.135″); or 2-16d common ($3\frac{1}{2}$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail

17	Top plates, laps at corners and intersections	3-10d box (3″ × 0.128″); or 2-16d common ($3^1/_2$″ × 0.162″); or 3-3″ × 0.131″ nails	Face nail
18	1″ brace to each stud and plate	3-8d box ($2^1/_2$″ × 0.113″); or 2-8d common ($2^1/_2$″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples $1^3/_4$″	Face nail
19	1″ × 6″ sheathing to each bearing	3-8d box ($2^1/_2$″ × 0.113″); or 2-8d common ($2^1/_2$″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1^3/_4$″ long	Face nail
20	1″ × 8″ and wider sheathing to each bearing	3-8d box ($2^1/_2$″ × 0.113″); or 3-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3 staples, 1″ crown, 16 ga., $1^3/_4$″ long	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]				

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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**

S7716

Date Submitted	12/6/2018	**Section**	702.2.2	**Proponent**	Borrone Jeanette
Chapter	7	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	No Affirmative Recommendation				
Commission Action	Pending Review				

Comments

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

Related Modifications

R702.2.2 Cement plaster

Summary of Modification

corrects a standard pointer to the installation portion and eliminates erroneous statements about the veneer thickness at the end of the section

Rationale

There is an misplacement error in the reference standards as listed in the current section. ASTM C 926, Standard Specification for Application of Portland Cement - Based Plaster, is an application standard and belongs after "...in compliance with" prior to "ASTM C 1063."

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will not impact local entity

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

Will not increase the cost of construction. There is no cost of construction significance in this item

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction. There is no cost of construction significance in this item

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction. There is no cost of construction significance in this item

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by corrects a standard pointer to the installation portion and eliminates erroneous statements about the veneer thickness at the end of the section

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by corrects a standard pointer to the installation portion and eliminates erroneous statements about the veneer thickness at the end of the section

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials, products, methods, or systems of construction corrects a standard pointer to the installation portion and eliminates erroneous statements about the veneer thickness at the end of the section

Does not degrade the effectiveness of the code

Increases the effectiveness of the code by corrects a standard pointer to the installation portion and eliminates erroneous statements about the veneer thickness at the end of the section

2nd Comment Period

S7716-G1

Proponent Borrone Jeanette **Submitted** 5/3/2019 **Attachments** No

Comment:

I agree with this proposed modification

2nd Comment Period

S7716-G2

Proponent Harold Barrineau **Submitted** 5/9/2019 **Attachments** No

Comment:

I agree and believe this is a good proposed modification.

2nd Comment Period

S7716-G3

Proponent	Michael Savage	**Submitted**	5/14/2019	**Attachments**	No

Comment:

I agree with the proposed revision.

2nd Comment Period

S7716-G4

Proponent	Jennifer Privateer	**Submitted**	5/20/2019	**Attachments**	No

Comment:

agree

R702.2.2 Cement plaster.

Cement plaster materials shall conform to ASTM C 91 (Type M, S or N), C 150 (Type I, II and III), C 595 Type IP, I (PM), IS and I (SM), C 847, C 897, ~~C 926~~, C 933, C 1032, C 1047 and C 1328, and shall be installed or applied in compliance with ASTM C 926andC 1063. Gypsum lath shall conform to ASTM C 1396. Plaster shall be not less than three coats where applied over metal lath and not less than two coats where applied over other bases permitted by this section, ~~except that veneer plaster shall be applied in one coat not to exceed 3/16 inch (4.76 mm) thickness, provided the total thickness is in accordance with Table R702.1(1).~~

S7719

Date Submitted 12/6/2018
Chapter 7
Section 702.2.1
Affects HVHZ No
Proponent Borrone Jeanette
Attachments No
TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes
Alternate Language No

Related Modifications

R702.2.1 Gypsum plaster - This reference standard is new to the ICC Code Books

Summary of Modification

Add new standard to Gypsum plaster

Rationale

As currently written, the Code eliminates the use of full-depth plaster in favor of veneer plaster. However, the values in Table R702.1(1) Thickness of Plaster, reflect the values of ASTM C 842, Standard Specification for Application of Interior Gypsum Plaster. Thickness values for C 843, Standard Specification for Application of Gypsum Veneer Plaster, are much thinner. In addition, application of gypsum base is covered in the current reference standard, ASTM C 844.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will not impact local entity

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction. There is no cost of construction significance in this item

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction. There is no cost of construction significance in this item

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction. There is no cost of construction significance in this item

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the health, safety, and welfare of the general public by adding a new standard Specification for Installation of Interior Lathing and Furring and for Application of Interior Gypsum Plaster

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by adding a new standard Specification for Installation of Interior Lathing and Furring and for Application of Interior Gypsum Plaster

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials, products, methods, or systems of construction adding a new standard Specification for Installation of Interior Lathing and Furring and for Application of Interior Gypsum Plaster

Does not degrade the effectiveness of the code

Increases the effectiveness of the code by adding a new standard Specification for Installation of Interior Lathing and Furring and for Application of Interior Gypsum Plaster

2nd Comment Period

S7719-G1

Proponent Borrone Jeanette **Submitted** 5/3/2019 **Attachments** No

Comment:

I agree with this proposed modification

2nd Comment Period

S7719-G2

Proponent Harold Barrineau **Submitted** 5/9/2019 **Attachments** No

Comment:

I agree that this is a good proposed modification.

2nd Comment Period

S7719-G3

Proponent Michael Savage **Submitted** 5/14/2019 **Attachments** No

Comment:

I agree with the proposed revision.

2nd Comment Period

S7719-G4

Proponent Jennifer Privateer **Submitted** 5/20/2019 **Attachments** No

Comment:

I agree

R702.2.1 Gypsum plaster.

Gypsum plaster materials shall conform to ASTM C 5, C 22, C 28, C 35, C 59, C 61, C 587, C 631, C 847, C 933, C 1032 and C 1047, and shall be installed or applied in compliance with ASTM C841, C ~~843~~ 842 and C ~~844~~ 843. Gypsum lath or gypsum base for veneer plaster shall conform to ASTM C 1396 and shall be installed in compliance with ASTM C 844. Plaster shall be not less than three coats where applied over metal lath and not less than two coats where applied over other bases permitted by this section, except that veneer plaster shall be applied in one coat not to exceed 3/16 inch (4.76 mm) thickness, provided the total thickness is in accordance with Table R702.1(1).

Reference standards type:

This reference standard is new to the ICC Code Books

Add new standard(s) as follows:

ASTM C 841-03 (Reapproved 2013) Standard Specification for Installation of Interior Lathing and Furring;

ASTM C 842-05 (Reapproved 2015) Standard Specification for Application of Interior Gypsum Plaster;

S7833

Date Submitted	12/10/2018	**Section**	702	**Proponent**	Ann Russo1
Chapter	7	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments **Yes** **Alternate Language** **No**

Related Modifications

Summary of Modification

Modification correlates the requirements for exterior lath and plaster (stucco) with the requirements of ASTM C926 and C1063 and ACI 524R-08 Guide to Portland Cement-Based Plaster

Rationale

The purpose of this code change is to correlate the requirements for exterior lath and plaster (stucco) with the requirements of ASTM C926 and C1063 and ACI 524R-08 Guide to Portland Cement-Based Plaster The code requirements in the FBC Residential are not in alignment with the reference standards and industry recommended practice. This change clarifies that lath is not required for stucco to be applied to masonry, concrete or stone surfaces and updates the acceptable types of cement to current ASTM designations.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

The change corrects the designations for acceptable, currently available cement types and clarifies that lath is not required where stucco is permitted to be placed directly on concrete or masonry surfaces. No negative impact to local entity relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal simply corrects the designations for acceptable, currently available cement types clarifies that lath is not required where stucco is permitted to be placed directly on concrete or masonry surfaces.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal will improve the application of the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal will not discriminate against materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This proposal will not degrade the effectiveness of the code.

2nd Comment Period

S7833-G1

Proponent ashley ong **Submitted** 5/13/2019 **Attachments** No

Comment:

This proposal will provide clarity to the application of the code for all users. First part of the code modification is simply to fix the typos. The added exception will clarify the exclusion of lath when stucco is applied directly to masonry. This will eliminate confusions between inspectors and contractors. As stated in the rationale, the modification simply correlates the requirements for stucco and lath that are referenced in ASTM and ACI. Contractors will mostly benefit on this modification. Please support this change.

2nd Comment Period

S7833-G2

Proponent Borrone Jeanette **Submitted** 5/21/2019 **Attachments** No

Comment:

I agree with the proposed revision.

2nd Comment Period

S7833-G3

Proponent	Jennifer Privateer	**Submitted**	5/23/2019	**Attachments**	No

Comment:

I agree

2nd Comment Period

S7833-G4

Proponent	Harold Barrineau	**Submitted**	5/25/2019	**Attachments**	No

Comment:

I agree with this modification

Revise as follows:

TABLE R702.1(3)
CEMENT PLASTER PROPORTIONS, PARTS BY VOLUME

COAT	CEMENT PLASTER TYPE	CEMENTITIOUS MATERIALS				VOLUME OF AGGREGATE PER SUM OF SEPARATE VOLUMES OF CEMENTITIOUS MATERIALS[b]
		Portland Cement Type I, II or III or Blended Hydraulic Cement Type IP, I(S<70), IL, or IT(S<70); or Hydraulic Cement Type GU, HE, MS, HS, or MH~~(PM), IS or I (SM)~~	Plastic Cement	Masonry Cement Type M, S or N	Lime	
First	Portland or blended	1			$^3/_4$ - $1^1/_2$[a]	$2^1/_2$- 4
	Masonry			1	~~1~~	$2^1/_2$- 4
	Plastic		1			$2^1/_2$- 4
Second	Portland or blended	1			$^3/_4$ - $1^1/_2$	3 -5
	Masonry			1		3 -5
	Plastic		1			3- 5
Finish	Portland or blended	1			~~$^3/_4$ - 2~~ 1 ½ - 2	$1^1/_2$ -3
	Masonry			1		$1^1/_2$- 3
	Plastic		1			$1^1/_2$- 3

(no change to the notes below)

Revise as follows:

R703.7 Exterior plaster (stucco).

(no change to the text)

R703.7.1 Lath.

Lath and lath attachments shall be of corrosion-resistant materials. Expanded metal or woven wire lath shall be attached with ~~11/2~~1 1/2-inch-long (38 mm), 11 gage nails having a 7/16-inch (11.1 mm) head, or 7/8-~~inchlong~~inch-long (22.2 mm), 16 gage staples, spaced not more than 6 inches (152mm) or as otherwise approved.

Exception: Lath is not required over masonry, cast-in-place concrete, precast concrete or stone substrates prepared in accordance with ASTM C1063.

R703.7.2 Plaster.

Plastering with ~~portland~~ cement plaster shall be ~~not less than three coats where applied over metal lath or wire lath and shall be not less than two coats where applied over masonry, concrete, pressure-preservativetreated wood or decay-resistant wood as specified on Section R317.1 or gypsum backing. If the plaster surface is completely covered by veneer or other facing materials or is completely concealed, plaster application need be only two coats, provided the total thickness is as set forth in Table R702.1(1).~~in accordance with ASTM C926. Cement materials shall be in accordance with one of the following:

1. Masonry cement conforming to ASTM C91 Type M, S or N.

2. Portland cement conforming to ASTM C150 Type I, II or III.

3. Bleanded hydraulic cement conforming to ASTM C595 Type IP, IS(S<70), IL or IT(S<70).

4. Hydraulic cement conforming to ASTM C1157 Type GU, HE, MS, HS or MH.

5. Plaster (stucco) cement conforming to ASTM C1328.

Plaster shall be not less than three coats where applied over metal lath or wire lath and shall be not less than two coats where applied over masonry, concrete, pressure-preservative-treated wood or decay- resistant wood as specified in Section R317.1 or gypsum backing. If the plaster surface is completely covered by veneer or other facing material or is completely concealed, plaster application need be only two coats, provided the total thickness is as set forth in Table R702.1(1).

On wood-frame construction with an on-grade floor slab system, exterior plaster shall be applied to cover, but not extend below, lath, paper and screed.

The proportion of aggregate to cementitious materials shall be as set forth in Table R702.1(3).

S7943

Date Submitted	12/11/2018	**Section**	703.2	**Proponent**	Ann Russo8
Chapter	7	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation	No Affirmative Recommendation
Commission Action	Pending Review

Comments

General Comments	**Yes**	**Alternate Language**	**No**

Related Modifications

RB283-16 & RB284-16

Summary of Modification

This proposal is to remove the exception for accessory buildings and requires them to have the water-resistive barrier.

Rationale

The wall sheathing and framing will experience the same damaging affect of moisture as a SFD will experience.

- Virtually all exterior wall covering manufacturers require a water resistive barrier under their products.
- Vinyl siding installer typically seek to use this except to allow installation of vinyl siding over sheathing on exterior walls of detached garages and storage sheds; however the siding manufacturers installation instructions specifically state their product should not be considered a water resistive barrier.
- Eliminating this exception will provide clarity to the code in that the water-resitive barrier is required by the manufacturers, insuring the products are installed correctly.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Eliminating this exception will provide clarity to the code in that the water-resitive barrier is required by the manufacturers, insuring the products are installed correctly.

Impact to building and property owners relative to cost of compliance with code

Eliminating this exception will provide clarity to the code in that the water-resitive barrier is required by the manufacturers, insuring the products are installed correctly and should not increase the cost of construction.

Impact to industry relative to the cost of compliance with code

Eliminating this exception will provide clarity to the code in that the water-resitive barrier is required by the manufacturers, insuring the products are installed correctly and should not increase the cost of construction.

Impact to small business relative to the cost of compliance with code

Eliminating this exception will provide clarity to the code in that the water-resitive barrier is required by the manufacturers, insuring the products are installed correctly and should not increase the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Eliminating this exception will provide clarity to the code in that the water-resitive barrier is required by the manufacturers, insuring the products are installed correctly and will provide better protection of property.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Eliminating this exception will provide clarity to the code in that the water-resitive barrier is required by the manufacturers, insuring the products are installed correctly and will provide better protection of property.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This is a clarification only and does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code but actually enhances the effectiveness of the code.

2nd Comment Period

S7943-G1

Proponent	Borrone Jeanette	**Submitted**	5/21/2019	**Attachments**	No

Comment:

I agree with the proposed revision.

2nd Comment Period

S7943-G2

Proponent	Jennifer Privateer	**Submitted**	5/23/2019	**Attachments**	No

Comment:

I agree with this modification as proposed

2nd Comment Period

S7943-G3

Proponent	Harold Barrineau	**Submitted**	5/25/2019	**Attachments**	No

Comment:

I agree with this modification

Section: R703.2

Revise as follows:

R703.2 Water-resistive barrier. One layer of No. 15 asphalt felt, free from holes and breaks, complying with ASTM D 226 for Type 1 felt or other approved water-resistive barrier shall be applied over studs or sheathing of all exterior walls. ~~Such~~ No.15 asphalt felt ~~or material~~ shall be applied horizontally, with the upper layer lapped over the lower layer not less than 2 inches (51 mm). Where joints occur, felt shall be lapped not less than 6 inches (152 mm). Other approved materials shall be installed in accordance with the *water-resistive barrier* manufacturer's installation instructions. The No. 15 asphalt felt or other approved *water-resistive barrier* material shall be continuous to the top of walls and terminated at penetrations and building appendages in a manner to meet the requirements of the exterior wall envelope as described in Section R703.1. ~~The water-resistive barrier is not required for detached accessory buildings.~~

Date Submitted	12/15/2018	**Section**	703.15.1	**Proponent**	John Woestman
Chapter	7	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments **Yes** **Alternate Language** **No**

Related Modifications

Summary of Modification

This proposal updates the existing tables by applying a consistent rounding down to the nearest 0.05” for foam sheathing thickness to better and more efficiently accommodate various foam sheathing products that have actual thickness that vary from nominal thickness currently in the table.

Rationale

This proposal updates the existing tables by applying a consistent rounding down to the nearest 0.05” for foam sheathing thickness to better and more efficiently accommodate various foam sheathing products that have actual thickness that vary from nominal thickness currently in the table. The same rounding is applied to the addition of an 18 psf cladding weight category at the request of the brick industry. All of the values were determined using the same analysis and research basis of the original tables, including capping foam thicknesses at 2” for 0.113-in diameter nail in wood framing and 3” for 0.120-in diameter nail in wood framing was done for the existing tables based on availability of fastener lengths and practicality considerations.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Revisions to the entries in the table should not have an impact on code enforcement.

Impact to building and property owners relative to cost of compliance with code

This proposal should not increase cost of code compliance. This proposal may actually decrease cost as a result of more efficient design for foam thickness and fastener sizing.

Impact to industry relative to the cost of compliance with code

This proposal should not increase cost of code compliance. This proposal may actually decrease cost as a result of more efficient design for foam thickness and fastener sizing.

Impact to small business relative to the cost of compliance with code

This proposal should not increase cost of code compliance. This proposal may actually decrease cost as a result of more efficient design for foam thickness and fastener sizing.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Appropriate requirements for maximum thickness of foam sheathing and fastening of cladding over this foam help assure long-term performance of the cladding.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code with refinements in requirements.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials - provides choices and options.

Does not degrade the effectiveness of the code

Improves the effectiveness of the code.

2nd Comment Period

S8346-G1

Proponent John Woestman **Submitted** 5/22/2019 **Attachments** No

Comment:

We ask the TAC to reconsider this proposal.

The Florida Residential Code currently includes these two tables (Table R703.15.1 and Table R703.15.2) which provide guidance for attaching cladding over foam plastic sheathing based on the foam thickness, cladding weight, wood framing spacing (16” or 24” o.c.), and the use of furring or no furring.

The proposal includes revisions to these two tables:

1. Add the 18 psf cladding weight columns at the request of the brick industry.
2. Clarification of the foam sheathing thickness by consistent rounding down to the nearest 0.05”.

These revisions are based on the same analysis and research as the original tables, and have been incorporated in the 2018 IBC.

We recognize exterior foam sheathing is not utilized in Florida as commonly as in cooler climates, but recommend the most current requirements be available in the Florida Residential Code for use when and where applicable.

2nd Comment Period

S8346-G2

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

Revise the body of Table R703.15.1 by inserting the 18 psf column, and modifying most cells. Revisions are shown as replacing existing entries in the cells.

TABLE R703.15.1 CLADDING MINIMUM FASTENING REQUIREMENTS

FOR DIRECT ATTACHMENT OVER FOAM PLASTIC SHEATHING

TO SUPPORT CLADDING WEIGHT[a]

Cladding Fastener Through Foam Sheathing into:	Cladding Fastener -Type and Minimum Size[b]	Cladding Fastener Vertical Spacing (inches)	Maximum Thickness of Foam Sheathing[c] (inches)							
			16" o.c. Fastener Horizontal Spacing				24" o.c. Fastener Horizontal Spacing			
			Cladding Weight:				Cladding Weight:			
			3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Wood Framing (minimum 1-1/4 inch penetration)	0.113" diameter nail	6	2.00	1.45	0.75	DR	2.00	0.85	DR	DR
		8	2.00	1.00	DR	DR	2.00	0.55	DR	DR
		12	2.00	0.55	DR	DR	1.85	DR	DR	DR
	0.120" diameter nail	6	3.00	1.70	0.90	0.55	3.00	1.05	0.50	DR
		8	3.00	1.20	0.60	DR	3.00	0.70	DR	DR
		12	3.00	0.70	DR	DR	2.15	DR	DR	DR
	0.131" diameter nail	6	4.00	2.15	1.20	0.75	4.00	1.35	0.70	DR
		8	4.00	1.55	0.80	DR	4.00	0.90	DR	DR
		12	4.00	0.90	DR	DR	2.70	0.50	DR	DR
	0.162" diameter nail	6	4.00	3.55	2.05	1.40	4.00	2.25	1.25	0.80
		8	4.00	2.55	1.45	0.95	4.00	1.60	0.85	0.50
		12	4.00	1.60	0.85	0.50	4.00	0.95	DR	DR

(Table Notes unchanged)

Revise the body of Table R703.15.2 by inserting the 18 psf column, and modifying most cells. Revisions are shown as replacing existing entries in the cells.

TABLE R703.15.2 FURRING MINIMUM FASTENING REQUIREMENTS FOR APPLICATION

OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[a,b]

Furring Material	Framing Member	Fastener Type and Minimum Size	Minimum Penetration into Wall Framing (inches)	Fastener Spacing in Furring (inches)	Maximum Thickness of Foam Sheathing[d] (inches)							
					16"oc Furring[e]				24"oc Furring[e]			
					Siding Weight:				Siding Weight:			
					3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Minimum 1x Wood Furring[c]	Minimum 2x Wood Stud	0.131" diameter nail	1-1/4	8	4.00	2.45	1.45	0.95	4.00	1.60	0.85	DR
				12	4.00	1.60	0.85	DR	4.00	0.95	DR	DR
				16	4.00	1.10	DR	DR	3.05	0.60	DR	DR
		0.162" diameter nail	1-1/4	8	4.00	4.00	2.45	1.60	4.00	2.75	1.45	0.85
				12	4.00	2.75	1.45	0.85	4.00	1.65	0.75	DR
				16	4.00	1.90	0.95	DR	4.00	1.05	DR	DR
		No. 10 wood screw	1	12	4.00	2.30	1.20	0.70	4.00	1.40	0.60	DR
				16	4.00	1.65	0.75	DR	4.00	0.90	DR	DR
				24	4.00	0.90	DR	DR	2.85	DR	DR	DR
		¼" lag screw	1-1/2	12	4.00	2.65	1.50	0.90	4.00	1.65	0.80	DR
				16	4.00	1.95	0.95	0.50	4.00	1.10	DR	DR
				24	4.00	1.10	DR	DR	3.25	0.50	DR	DR

(Table notes unchanged)

Date Submitted	12/15/2018	**Section**	703.16.1	**Proponent**	John Woestman
Chapter	7	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments **Yes** **Alternate Language** **No**

Related Modifications

8346

Summary of Modification

This proposal updates the existing tables by applying a consistent rounding down to the nearest 0.05" for foam sheathing thickness to better and more efficiently accommodate various foam sheathing products that have actual thickness that vary from nominal thickness currently in the table.

Rationale

This proposal updates the existing tables by applying a consistent rounding down to the nearest 0.05" for foam sheathing thickness to better and more efficiently accommodate various foam sheathing products that have actual thickness that vary from nominal thickness currently in the table. The same rounding is applied to the addition of an 18 psf cladding weight category at the request of the brick industry. All of the values were determined using the same analysis and research basis of the original tables, including capping foam thicknesses at and 3" for #8 screw in steel framing was done for the existing tables based on availability of fastener lengths and practicality considerations.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Revisions to the entries in the table should not have an impact on code enforcement.

Impact to building and property owners relative to cost of compliance with code

This proposal should not increase cost of code compliance. This proposal may actually decrease cost as a result of more efficient design for foam thickness and fastener sizing.

Impact to industry relative to the cost of compliance with code

This proposal should not increase cost of code compliance. This proposal may actually decrease cost as a result of more efficient design for foam thickness and fastener sizing.

Impact to small business relative to the cost of compliance with code

This proposal should not increase cost of code compliance. This proposal may actually decrease cost as a result of more efficient design for foam thickness and fastener sizing.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Appropriate requirements for maximum thickness of foam sheathing and fastening of cladding over this foam help assure long-term performance of the cladding.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code with refinements in requirements.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials - provides choices and options.

Does not degrade the effectiveness of the code

Improves the effectiveness of the code.

2nd Comment Period

S8348-G1

Proponent John Woestman **Submitted** 5/22/2019 **Attachments** No

Comment:

We ask the TAC to reconsider this proposal.

The Florida Residential Code currently includes these two tables (Table R703.16.1 and Table R703.16.2) which provide guidance for attaching cladding over foam plastic sheathing based on the foam thickness, cladding weight, steel framing spacing (16" or 24" o.c.), and the use of furring or no furring.

The proposal includes revisions to these two tables:

1. Add the 18 psf cladding weight columns at the request of the brick industry.
2. Clarification of the foam sheathing thickness by consistent rounding down to the nearest 0.05".

These revisions are based on the same analysis and research as the original tables, and have been incorporated in the 2018 IBC.

We recognize exterior foam sheathing is not utilized in Florida as commonly as in cooler climates, but recommend the most current requirements be available in the Florida Residential Code for use when and where applicable.

2nd Comment Period

S8348-G2

Proponent	Harold Barrineau	**Submitted**	5/26/2019	**Attachments**	No

Comment:

I agree with this modification.

Revise the body of Table R703.16.1 by inserting the 18 psf column, and modifying most cells. Revisions are shown as replacing existing entries in the cells.

TABLE R703.16.1 CLADDING MINIMUM FASTENING REQUIREMENTS FOR DIRECT ATTACHMENT OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[1]

Cladding Fastener Through Foam Sheathing into:	Cladding Fastener -Type and Minimum Size[2]	Cladding Fastener Vertical Spacing (inches)	Maximum Thickness of Foam Sheathing[3] (inches)							
			16"oc Fastener Horizontal Spacing				24"oc Fastener Horizontal Spacing			
			Cladding Weight:				Cladding Weight:			
			3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Steel Framing (minimum penetration of steel thickness + 3 threads)	#8 screw into 33 mil steel or thicker	6	3.00	2.95	2.20	1.45	3.00	2.35	1.25	DR
		8	3.00	2.55	1.60	0.60	3.00	1.80	DR	DR
		12	3.00	1.80	DR	DR	3.00	0.65	DR	DR
	#10 screw into 33 mil steel	6	4.00	3.50	2.70	1.95	4.00	2.90	1.70	0.55
		8	4.00	3.10	2.05	1.00	4.00	2.25	0.70	DR
		12	4.00	2.25	0.70	DR	3.70	1.05	DR	DR
	#10 screw into 43 mil steel or thicker	6	4.00	4.00	4.00	3.60	4.00	4.00	3.45	2.70
		8	4.00	4.00	3.70	3.00	4.00	3.85	2.80	1.80
		12	4.00	3.85	2.80	1.80	4.00	3.05	1.50	DR

(Table notes unchanged)

Revise the body of Table R703.16.2 by inserting the 18 psf column, and modifying most cells. Revisions are shown as replacing existing entries in the cells.

TABLE R703.16.2 FURRING MINIMUM FASTENING REQUIREMENTS FOR APPLICATION OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[1]

Furring Material	Framing Member	Fastener Type and Minimum Size[2]	Minimum Penetration into Wall Framing (inches)	Fastener Spacing in Furring (inches)	Maximum Thickness of Foam Sheathing[4] (inches)							
					16"oc FURRING[5]				24"oc FURRING[5]			
					Cladding Weight:				Cladding Weight:			
					3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Minimum 33mil Steel Furring or Minimum 1x Wood Furring[3]	33 mil Steel Stud	#8 screw	Steel thickness + 3 threads	12	3.00	1.80	DR	DR	3.00	0.65	DR	DR
				16	3.00	1.00	DR	DR	2.85	DR	DR	DR
				24	2.85	DR	DR	DR	2.20	DR	DR	DR
		#10 screw	Steel thickness + 3 threads	12	4.00	2.25	0.70	DR	3.70	1.05	DR	DR
				16	3.85	1.45	DR	DR	3.40	DR	DR	DR
				24	3.40	DR	DR	DR	2.70	DR	DR	DR
	43 mil or thicker Steel Stud	#8 Screw	Steel thickness + 3 threads	12	3.00	1.80	DR	DR	3.00	0.65	DR	DR
				16	3.00	1.00	DR	DR	2.85	DR	DR	DR
				24	2.85	DR	DR	DR	2.20	DR	DR	DR
		#10 screw	Steel thickness + 3 threads	12	4.00	3.85	2.80	1.80	4.00	3.05	1.50	DR
				16	4.00	3.30	1.95	0.60	4.00	2.25	DR	DR
				24	4.00	2.25	DR	DR	4.00	0.65	DR	DR

(Table notes unchanged)

S8396

Date Submitted 12/15/2018
Chapter 7
Section 703.4
Affects HVHZ No
Proponent Joseph Belcher for FHBA
Attachments No
TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments **No**
Alternate Language **Yes**

Related Modifications

Summary of Modification

Modify flashing requirements

Rationale

The lead sentence indicates only corrosion-resistant flashing materials may be used and then immediately refers to self-adhering, flexible, and liquid flashings. Any or all of these materials may be used in accordance with their manufacturer's instruction. The current language has caused serious confusion in the field.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact.

Impact to building and property owners relative to cost of compliance with code

No impact.

Impact to industry relative to the cost of compliance with code

No impact.

Impact to small business relative to the cost of compliance with code

No impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Will reduce confusion as to what types of flashing may be used.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by clearing up what materials may be used for flashing.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

2nd Comment Period

8396-A1

Proponent Joseph Belcher **Submitted** 5/24/2019 **Attachments** Yes

Rationale

As the proponent I requested the NAR to allow me time to work with AAMA to address some of their concerns. The original reason for the change was to clarify that metal flashing was not required but an option. Some jurisdictions require metal flashing in all cases because of the beginning of the first sentence of the current language "Apoproved corrosion-resistant flashing shall be..." .

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No cost impact. Will clarify flashing requirements.

Impact to building and property owners relative to cost of compliance with code

No cost impact. Will clarify flashing requirements.

Impact to industry relative to the cost of compliance with code

No cost impact. Will clarify flashing requirements.

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

Substantially affects the general public by clarifying various types of flashing may be used.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by clearly allowing various types of flashing to be used.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials and may remove discrimination.

Does not degrade the effectiveness of the code

Improves the effectiveness of the code.

1st Comment Period History

S8396-G1

Proponent Dick Wilhelm **Submitted** 2/8/2019 **Attachments** No

Comment:

No change needed, current language in FBC Residential covers the flashing material specifications.

R703.4 Flashing. Approved ~~corrosion-resistant~~ metal flashing, vinyl flashing, self-adhered membranes and mechanically attached flexible flashing shall be applied shingle-fashion ~~in a manner to prevent entry of water into the wall cavity or penetration of water the building structural framing components.~~ or in accordance with the manufacturer's instructions. Metal flashing shall be corrosion resistant. Fluid-applied membranes used as flashing shall be applied in accordance with the manufacturer's instructions. All flashing shall be applied in a manner to prevent the entry of water into the wall cavity or penetration of water to the building structural framing components. Self-adhered membranes used as flashing shall comply with AAMA 711. All exterior fenestration products shall be sealed at the juncture with the building wall with a sealant complying with AAMA 800 or ASTM C920 Class 25 Grade NS or greater for proper joint expansion and contraction, ASTM C1281, AAMA 812, or other approved standard as appropriate for the type of sealant. Fluid-applied membranes used as flashing in exterior walls shall comply with AAMA 714. The flashing shall extend to the surface of the exterior wall finish.
Approved ~~corrosion resistant~~ flashing shall be installed at the following locations:

Remainder unchanged,

R703.4 Flashing. Approved corrosion-resistant flashing, self-adhered membranes, mechanically attached flexible flashings, or fluid-applied membranes used as flashing shall be applied shingle-fashion or in accordance with the manufacturer's instructions in a manner to prevent entry of water into the wall cavity or penetration of water to the building structural framing components. Self-adhered membranes used as flashing shall comply with AAMA 711. All exterior fenestration products shall be sealed at the juncture with the building wall with a sealant complying with AAMA 800 or ASTM C920 Class 25 Grade NS or greater for proper joint expansion and contraction, ASTM C1281, AAMA 812, or other approved standard as appropriate for the type of sealant. Fluid-applied membranes used as flashing in exterior walls shall comply with AAMA 714. The flashing shall extend to the surface of the exterior wall finish. Approved corrosion resistant flashings self-adhered membranes, mechanically attached flexible flashings, or fluid-applied membranes used as flashing shall be installed at the following locations:

REMAINDER OF SECTION UNCHANGED.

S7726

Date Submitted	12/6/2018	**Section**	806.5	**Proponent**	Ann Russo1
Chapter	8	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	No Affirmative Recommendation				
Commission Action	Pending Review				

Comments

General Comments **Yes** **Alternate Language** **No**

Related Modifications

Summary of Modification

Editorial improvement.

Rationale

This is an editorial improvement, which makes the code clearer. There is no change in the requirements.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No negative impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal is simply an editorial improvement which makes the code clearer.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal will make to code clearer which will improve the application of the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal will not discriminate against materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This proposal will not degrade the effectiveness of the code.

2nd Comment Period

S7726-G1

Proponent ashley ong **Submitted** 5/13/2019 **Attachments** No

Comment:

As stated in the summary, this modification is only editorial. It does allow air permeable insulation as an option. This modification will NOT discriminate other materials allowed in the code. Please support this editorial change.

2nd Comment Period

S7726-G2

Proponent Jennifer Privateer **Submitted** 5/23/2019 **Attachments** No

Comment:

agreed

2nd Comment Period

S7726-G3

Proponent Harold Barrineau **Submitted** 5/25/2019 **Attachments** No

Comment:

I agree with this modification

Revise as follows to make the code clearer:

R806.5 Unvented attic and unvented enclosed rafter assemblies.

(no change to the text in between)

5.1.2 Where air-permeable insulation is ~~provided inside the building thermal envelope, it shall be installed in accordance withSection 5.1.1. In addition to the air-permeable insulation~~ installed directly below the structural sheathing, rigid board or sheet insulation shall be installed directly above the structural roof sheathing in accordance with the R-values in Table R806.5 for condensation control.

(no change to the text below)

S8092

Date Submitted	12/13/2018	**Section**	803.2.3	**Proponent**	Paul Coats
Chapter	8	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	No Affirmative Recommendation				
Commission Action	Pending Review				

Comments

General Comments **Yes** | **Alternate Language** **No**

Related Modifications

8081, 8084

Summary of Modification

Limits wood structural panel roof sheathing cantilever to no more than 9 inches unless supported by gable overhand framing.

Rationale

This modification was approved by the ICC committee and membership and appears in the 2018 edition of the International Residential Code. A sentence is added to R803.2.3 to clarify the appropriate limit on the distance unsupported sheathing can cantilever past the gable end roof framing, for the design of roof sheathing and attachment that is consistent with other provisions for roof sheathing in the code. See the attached support files for additional information and how this is related to other modifications for roof sheathing attachment.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Unsupported roof sheathing cantilever span limits, there are no problematic issues with enforcement.

Impact to building and property owners relative to cost of compliance with code

No cost-related impact.

Impact to industry relative to the cost of compliance with code

No cost-related impact.

Impact to small business relative to the cost of compliance with code

No cost-related impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The limit will enhance wind resistant roof design.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

2nd Comment Period

S8092-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

2nd Comment Period

S8092-G2

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

R803.2.3Installation.

Wood structural panel used as roof sheathing shall be installed with joints staggered in accordance with Section R803.2.3.1 for wood roof framing or with Table R804.3 for cold-formed steel roof framing. Wood structural panel roof sheathing shall not cantilever more than 9 inches beyond the gable end wall unless supported by gable overhand framing.

RB221-16

IRC: R602.3, R803.2.3.

Proponent : James Smith (jsmith@awc.org)

2015 International Residential Code

TABLE R602.3 (1)
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
		Roof	
1	Blocking between ceiling joists or rafters to top plate	4-8d box ($2^1/_2$ ″ × 0.113″) or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
2	Ceiling joists to top plate	4-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Sections R802.3.1, R802.3.2 and Table R802.5.1(9)]	4-10d box (3″ × 0.128″); or 3-16d common ($3^1/_2$ ″ × 0.162″); or 4-3″ × 0.131″ nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Sections R802.3.1 and R802.3.2 and Table R802.5.1(9)]	Table R802.5.1(9)	Face nail
5	Collar tie to rafter, face nail or $1^1/_4$ ″ × 20 ga. ridge strap to rafter	4-10d box (3″ × 0.128″); or 3-10d common (3″ × 0.148″); or 4-3″ × 0.131″ nails	Face nail each rafter

6	Rafter or roof truss to plate	3-16d box nails (3$\frac{1}{2}$″ × 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$\frac{1}{2}$″ × 0.135″); or 3-10d common (3$\frac{1}{2}$″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box 3$\frac{1}{2}$″ × 0.135″); or 2-16d common (3$\frac{1}{2}$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
Wall			
8	Stud to stud (not at braced wall panels)	16d common (3$\frac{1}{2}$″ × 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$\frac{1}{2}$″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
		16d common (3$\frac{1}{2}$″ × 0.162″)	16″ o.c. face nail
10	Built-up header (2″ to 2″ header with $\frac{1}{2}$″ spacer)	16d common (3$\frac{1}{2}$″ × 0.162″)	16″ o.c. each edge face nail
		16d box (3$\frac{1}{2}$″ × 0.135″)	12″ o.c. each edge face nail
11	Continuous header to stud	5-8d box (2$\frac{1}{2}$″ × 0.113″); or 4-8d common (2$\frac{1}{2}$″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toe nail
		16d common (3$\frac{1}{2}$″ × 0.162″)	16″ o.c. face nail

12	Top plate to top plate	10d box (3″ × 0.128″); or 3″ × 0.131″ nails	12″ o.c. face nail
13	Double top plate splice for SDCs A-D2 with seismic braced wall line spacing	8-16d common ($3^1/_2$ ″ × 0.162″); or 12-16d box ($3^1/_2$ ″ × 0.135″); or 12-10d box (3″ × 0.128″); or 12-3″ × 0.131″ nails	Face nail on each side of end joint (minimum 24″ lap splice length each side of end joint)
	Double top plate splice SDCs D_0 , D_1 , or D_2 ; and braced wall line spacing ≥ 25′	12-16d ($3^1/_2$ ″ × 0.135″)	

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
14	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common ($3^1/_2$ ″ × 0.162″)	16″ o.c. face nail
		16d box ($3^1/_2$ ″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
15	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box ($3^1/_2$ ″ × 0.135″); or 2-16d common ($3^1/_2$ ″ × 0.162″); or 4-3″ × 0.131″ nails	3 each 16″ o.c. face nail 2 each 16″ o.c. face nail 4 each 16″ o.c. face nail
16	Top or bottom plate to stud	4-8d box ($2^1/_2$ ″ × 0.113″); or 3-16d box ($3^1/_2$ ″ × 0.135″); or 4-8d common ($2^1/_2$ ″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box ($3^1/_2$ ″ × 0.135″); or 2-16d common ($3^1/_2$ ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail

17	Top plates, laps at corners and intersections	3-10d box (3″ × 0.128″); or 2-16d common ($3^1/_2$ ″ × 0.162″); or 3-3″ × 0.131″ nails	Face nail
18	1″ brace to each stud and plate	3-8d box ($2^1/_2$ ″ × 0.113″); or 2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples $1^3/_4$ ″	Face nail
19	1″ × 6″ sheathing to each bearing	3-8d box ($2^1/_2$ ″ × 0.113″); or 2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	Face nail
20	1″ × 8″ and wider sheathing to each bearing	3-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	Face nail
		Wider than 1″ × 8″ 4-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 4 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	
Floor			
21	Joist to sill, top plate or girder	4-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
		8d box ($2^1/_2$ ″ × 0.113″)	4″ o.c. toe nail

22	Rim joist, band joist or blocking to sill or top plate (roof applications also)	8d common ($2^1/_2$ " × 0.131"); or 10d box (3" × 0.128"); or 3" × 0.131" nails	6" o.c. toe nail
23	1" × 6" subfloor or less to each joist	3-8d box ($2^1/_2$ " × 0.113"); or 2-8d common ($2^1/_2$ " × 0.131"); or 3-10d box (3" × 0.128"); or 2 staples, 1" crown, 16 ga., $1^3/_4$ " long	Face nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
		Floor	
24	2"subfloor to joist or girder	3-16d box ($3^1/_2$ "× 0.135"); or 2-16d common ($3^1/_2$ "× 0.162")	Blind and face nail
25	2"planks (plank & beam—floor & roof)	3-16d box ($3^1/_2$ "× 0.135"); or 2-16d common ($3^1/_2$ "× 0.162")	At each bearing, face nail
26	Band or rim joist to joist	3-16d common ($3^1/_2$ "× 0.162") 4-10 box (3"× 0.128"), or 4-3"× 0.131"nails; or	End nail

		4-3″× 14 ga. staples, 7 /16 ″crown					
27	Built-up girders and beams, 2-inch lumber layers	20d common (4″× 0.192″); or	Nail each layer as follows: 32″o.c. at top and bottom and staggered.				
		10d box (3″× 0.128″); or 3″× 0.131″nails	24″o.c. face nail at top and bottom staggered on opposite sides				
		And: 2-20d common (4″× 0.192″); or 3-10d box (3″× 0.128″); or 3-3″× 0.131″nails	Face nail at ends and at each splice				
28	Ledger strip supporting joists or rafters	4-16d box (3 1/2 ″× 0.135″); or 3-16d common (3 1/2 ″× 0.162″); or 4-10d box (3″× 0.128″); or 4-3″× 0.131″nails	At each joist or rafter, face nail	29	Bridging to joist	2-10d (3″× 0.128″)	Each end, toe nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING OF FASTENERS	
			Panel Edges (inches)[h]	Intermediate supports[c, e] (inches)
Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing [see Table R602.3(3) for wood structural panel *exterior* wall sheathing to wall framing]				

ICC COMMITTEE ACTION HEARINGS ::: April, 2016 RB518

30	3 /8 "– 1 /2 "	6d common (2"× 0.113") nail (subfloor, wall)[i] 8d common (2 1 /2 "× 0.131") nail (roof)	6	12[f]	31	19 /32 "– 1"	8d common nail (2 1 /2 "× 0.131")	6	12[f]
32	11 /8 "–11 /4 "	10d common (3"× 0.148") nail; or 8d (21 /2 "× 0.131") deformed nail	6	12					
Other wall sheathing[g]									
33	1 /2 "structural cellulosic fiberboard sheathing	1 1 /2 "galvanized roofing nail, 7 /16 " head diameter, or 1"crown staple 16 ga., 1 1 /4 " long	3	6					
34	25 /32 "structural cellulosic fiberboard sheathing	1 3 /4 "galvanized roofing nail, 7 /16 "head diameter, or 1"crown staple 16 ga., 1 1 /4 " long	3	6					
		1 1 /2							

35	1 /2 "gypsum sheathing[d]	"galvanized roofing nail; staple galvanized, 1 1 /2 "long; 1 1 /4 " screws, Type W or S	7	7
36	5 /8 "gypsum sheathing[d]	1 3 /4 "galvanized roofing nail; staple galvanized, 1 5 /8 " long; 1 5 /8 " screws, Type W or S	7	7
Wood structural panels, combination subfloor underlayment to framing				
37	3 /4 " and less	6d deformed (2"× 0.120") nail; or 8d common (2 1 /2 "× 0.131") nail	6	12
38	7 /8 "– 1"	8d common (2 1 /2 "× 0.131") nail; or 8d deformed (2 1 /2 "× 0.120") nail	6	12
39	1 1 /8 "– 1 1 /4 "	10d common (3"× 0.148") nail; or 8d deformed (2 1	6	12

		/2 "× 0.120") nail		

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.

a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.

b. Staples are 16 gage wire and have a minimum $^{7}/_{16}$ -inch on diameter crown width.

c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.

d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.

e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).

~~f. Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.~~

f. For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48" of roof end zones, eaves, and ridges, nails shall be spaced at 6 inches on center where the ultimate design wind speed is less than 130 mph and shall be spaced 4 inches on center where the ultimate design wind speed is 130 mph or greater but less than 140 mph.

g. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.

h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.

i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

R803.2.3 Installation. Wood structural panel used as roof sheathing shall be installed with joints staggered or not staggered in accordance with Table R602.3(1), APA E30 for wood roof framing or with Table R804.3 for cold-formed steel roof framing. Wood structural panel roof sheathing shall not cantlever more than 9 inches beyond the gable end wall unless supported by gable overhang framing.

Reason: Nailing requirements provided in the IRC Table 602.3(1) were reviewed using loads from ASCE 7-10 *Minimum Design Loads for Buildings and Other Structures*. Nailing requirements for common species of roof framing with specific gravities of 0.42 or greater (e.g. SPF, Hem-Fir) were analyzed and it was found that the nail spacing requirements in footnote "f" needed to be slightly modified to clarify that nail spacing for all sheathing to framing attached to intermediate supports within 48" of roof end zones, eaves, and ridges must be reduced, not just at the gable end roof framing. For ultimate wind speeds of 130 mph and greater, the threshold for reducing the nail spacing from 6" to 4" in the 48" end zone areas was slightly modified while clarifying that ultimate wind speeds of 140 mph or greater are is outside the scope of the IRC structural provisions. The language in footnote "f" was revised to clarify the intent of this footnote. A sentence was also added to R803.2.3 to clarify the appropriate limit on the distance unsupported sheathing can cantilever past the gable end roof framing. Tabulated calculation results based on ASCE 7-10 are provided below: (insert attachment here)

WFCM Table 3.10 (Exposure C) - Based on ASCE 7-10
Roof Sheathing Attachment Requirements for Wind Loads

700-yr. Wind Speed 3-second gust (mph)			110		115		120		130		140	
			Wood Structural Panel Sheathing									
			E	F	E	F	E	F	E	F	E	F
Sheathing Location[1]	Rafter/Truss Framing Specific Gravity, G	Rafter/Truss Spacing (in.)	Maximum Nail Spacing for 8d Common Nails or 10d Box Nails (inches, o.c.)[2]									
Interior Zone	0.42	12	6	12	6	12	6	12	6	12	6	12
		16	6	12	6	12	6	12	6	12	6	12
		19.2	6	12	6	12	6	12	6	12	6	12
		24	6	12	6	12	6	12	6	12	6	12
Perimeter Edge Zone	0.42	12	6	12	6	12	6	12	6	12	6	6
		16	6	12	6	6	6	6	6	6	6	6
		19.2	6	6	6	6	6	6	6	6	6	6
		24	6	6	6	6	6	6	6	4	6	4
Gable Endwall Rake or Rake Truss with up to 9" Rake Overhang	0.42	-	6		6		6		4		4	

E - Nail spacing at panel edges (in.)
F - Nail spacing at intermediate supports in the panel field (in.)

1 For roof sheathing within 4 feet of the perimeter edge of the roof, including 4 feet on each side of the roof peak, the 4 foot perimeter edge zone attachment requirements shall be used.
2 For wind speeds greater than 130 mph, blocking is required which transfers shear load to two additional joi

Cost Impact: Will not increase the cost of construction
The change to footnote "f" is a clarification of the current footnote "f" intent. The 9" limit on gable overhang is not really an increase in requirement, but a limitation to allow more efficient nailing patterns.

RB221-16 : TABLE R602.3-SMITH11542

Final Action: AM (Approved as Modified by the Committee)

RB221-16

Committee Action: **Approved as Modified**

Modification:

TABLE R602.3 (1)
FASTENING SCHEDULE

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.
a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.
b. Staples are 16 gage wire and have a minimum $^{7}/_{16}$ -inch on diameter crown width.
c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.
d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.
e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).
f. For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48" of roof ~~end zones, eaves,~~ edges and ridges, nails shall be spaced at 6 inches on center where the ultimate design wind speed is less than 130 mph and shall be spaced 4 inches on center where the ultimate design wind speed is 130 mph or greater but less than 140 mph.
g. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.

h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.
i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

R803.2.3 Installation. Wood structural panel used as roof sheathing shall be installed with joints staggered or not staggered in accordance with Table R602.3(1), APA E30 for wood roof framing or with Table R804.3 for cold-formed steel roof framing. Wood structural panel roof sheathing in accordance with Table R503.2.1.1(1) shall not cantilever more than 9 inches beyond the gable end wall unless supported by gable overhang framing.

Committee Reason:

The committee approved this change based on the proponents published reason statement. The proposal aligns the roof sheathing nail spacing with the ASCE 7-10 loading and provides an allowable cantilever for the sheathing past the gable end. The modifications deleted the terms end zones and eaves to avoid confusion with edges and added a reference to the sheathing installation table.

Assembly Action: **None**

RB222-16

IRC: R602.3, R803.2.3.

Proponent : James Smith (jsmith@awc.org)

2015 International Residential Code

TABLE R602.3 (1)
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
Roof			
1	Blocking between ceiling joists or rafters to top plate	4-8d box ($2^1/_2$″ × 0.113″) or 3-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
2	Ceiling joists to top plate	4-8d box ($2^1/_2$″ × 0.113″); or 3-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Sections R802.3.1, R802.3.2 and Table R802.5.1(9)]	4-10d box (3″ × 0.128″); or 3-16d common ($3^1/_2$″ × 0.162″); or 4-3″ × 0.131″ nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Sections R802.3.1 and R802.3.2 and Table R802.5.1(9)]	Table R802.5.1(9)	Face nail
5	Collar tie to rafter, face nail or $1^1/_4$″ × 20 ga. ridge strap to rafter	4-10d box (3″ × 0.128″); or 3-10d common (3″ × 0.148″); or 4-3″ × 0.131″ nails	Face nail each rafter

6	Rafter or roof truss to plate	3-16d box nails (3 1/2 ″ × 0.135″); or 3-10d common nails (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss[i]
7	Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2″ ridge beam	4-16d (3 1/2 ″ × 0.135″); or 3-10d common (3 1/2 ″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box 3 1/2 ″ × 0.135″); or 2-16d common (3 1/2 ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
Wall			
8	Stud to stud (not at braced wall panels)	16d common (3 1/2 ″ × 0.162″)	24″ o.c. face nail
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	16″ o.c. face nail
9	Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d box (3 1/2 ″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
		16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail
10	Built-up header (2″ to 2″ header with 1/2 ″ spacer)	16d common (3 1/2 ″ × 0.162″)	16″ o.c. each edge face nail
		16d box (3 1/2 ″ × 0.135″)	12″ o.c. each edge face nail
11	Continuous header to stud	5-8d box (2 1/2 ″ × 0.113″); or 4-8d common (2 1/2 ″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toe nail
		16d common (3 1/2 ″ × 0.162″)	16″ o.c. face nail

12	Top plate to top plate	10d box (3″ × 0.128″); or 3″ × 0.131″ nails	12″ o.c. face nail
13	Double top plate splice for SDCs A-D2 with seismic braced wall line spacing	8-16d common ($3^1/2$ ″ × 0.162″); or 12-16d box ($3^1/2$ ″ × 0.135″); or 12-10d box (3″ × 0.128″); or 12-3″ × 0.131″ nails	Face nail on each side of end joint (minimum 24″ lap splice length each side of end joint)
	Double top plate splice SDCs D_0 , D_1 , or D_2 ; and braced wall line spacing ≥ 25′	12-16d ($3^1/2$ ″ × 0.135″)	

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
14	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common ($3^1/2$ ″ × 0.162″)	16″ o.c. face nail
		16d box ($3^1/2$ ″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
15	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box ($3^1/2$ ″ × 0.135″); or 2-16d common ($3^1/2$ ″ × 0.162″); or 4-3″ × 0.131″ nails	3 each 16″ o.c. face nail 2 each 16″ o.c. face nail 4 each 16″ o.c. face nail
16	Top or bottom plate to stud	4-8d box ($2^1/2$ ″ × 0.113″); or 3-16d box ($3^1/2$ ″ × 0.135″); or 4-8d common ($2^1/2$ ″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box ($3^1/2$ ″ × 0.135″); or 2-16d common ($3^1/2$ ″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail

17	Top plates, laps at corners and intersections	3-10d box (3″ × 0.128″); or 2-16d common ($3^1/_2$ ″ × 0.162″); or 3-3″ × 0.131″ nails	Face nail
18	1″ brace to each stud and plate	3-8d box ($2^1/_2$ ″ × 0.113″); or 2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples $1^3/_4$ ″	Face nail
19	1″ × 6″ sheathing to each bearing	3-8d box ($2^1/_2$ ″ × 0.113″); or 2-8d common ($2^1/_2$ ″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	Face nail
20	1″ × 8″ and wider sheathing to each bearing	3-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	Face nail
		Wider than 1″ × 8″ 4-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 4 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	
Floor			
21	Joist to sill, top plate or girder	4-8d box ($2^1/_2$ ″ × 0.113″); or 3-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
		8d box ($2^1/_2$ ″ × 0.113″)	4″ o.c. toe nail

22	Rim joist, band joist or blocking to sill or top plate (roof applications also)	8d common ($2^1/_2$ ″ × 0.131″); or 10d box (3″ × 0.128″); or 3″ × 0.131″ nails	6″ o.c. toe nail
23	1″ × 6″ subfloor or less to each joist	3-8d box ($2^1/_2$ ″ × 0.113″); or 2-8d common ($2^1/_2$ ″ × 0.131″); or 3-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1^3/_4$ ″ long	Face nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
		Floor	
24	2″subfloor to joist or girder	3-16d box ($3^1/_2$ ″× 0.135″); or 2-16d common ($3^1/_2$ ″× 0.162″)	Blind and face nail
25	2″planks (plank & beam—floor & roof)	3-16d box ($3^1/_2$ ″× 0.135″); or 2-16d common ($3^1/_2$ ″× 0.162″)	At each bearing, face nail
26	Band or rim joist to joist	3-16d common ($3^1/_2$ ″× 0.162″) 4-10 box (3″× 0.128″), or 4-3″× 0.131″nails; or	End nail

		4-3″× 14 ga. staples, $^{7}/_{16}$ ″crown					
27	Built-up girders and beams, 2-inch lumber layers	20d common (4″× 0.192″); or	Nail each layer as follows: 32″o.c. at top and bottom and staggered.				
		10d box (3″× 0.128″); or 3″× 0.131″nails	24″o.c. face nail at top and bottom staggered on opposite sides				
		And: 2-20d common (4″× 0.192″); or 3-10d box (3″× 0.128″); or 3-3″× 0.131″nails	Face nail at ends and at each splice				
28	Ledger strip supporting joists or rafters	4-16d box ($3^{1}/_{2}$ ″× 0.135″); or 3-16d common ($3^{1}/_{2}$ ″× 0.162″); or 4-10d box (3″× 0.128″); or 4-3″× 0.131″nails	At each joist or rafter, face nail	29	Bridging to joist	2-10d (3″× 0.128″)	Each end, toe nail
ITEM	**DESCRIPTION OF BUILDING ELEMENTS**	**NUMBER AND TYPE OF FASTENER**[a, b, c]	**SPACING OF FASTENERS**				
			Panel Edges (inches)[h]	**Intermediate supports**[c, e] **(inches)**			
Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing [see Table R602.3(3) for wood structural panel *exterior* wall sheathing to wall framing]							

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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 show n in the tabulated results below , nailing at intermediate supports in the interior portions of the roof (Roof Zone 1) need to be reduced from 12" o.c. to 6" o.c. How ever, changes to loads in the end zone portions of the roof w ere less significant and required far less adjustment. In fact, the 6" o.c. spacing is appropriate for all connection in the end zone portions, except w here ultimate w ind 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 w ithin 48" of roof end zones, eaves and ridges must be reduced from 6" to 4" w here ultimate w ind speeds exceed 120 mph. Language w as also added to clarify that ultimate w ind speeds of 140 mph or greater is outside the scope of the IRC structural provisions. A sentence w as 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 row s 30 and 31 of the table w ill increase the number of nails and the time to install, w hich w ill increase cost. This increase in cost is the direct result of compliance w ith the increased w ind 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**

S8255

Date Submitted 12/14/2018
Chapter 8
Section 802.5.1
Affects HVHZ No
Proponent Paul Coats
Attachments Yes
TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes
Alternate Language No

Related Modifications

Summary of Modification

Removes a redundant footnote from Table R802.5.1(9) Rafter/Ceiling Joist Heel Joint Connections

Rationale

This modification was approved by the ICC committee and membership and appears in the 2018 edition of the International Residential Code. Footnote "f"; is redundant to footnote "h"; in purpose. Footnote "f" should have been removed at the time footnote "h" was added to better account for the effect of rafter ties located above the bottom of the attic space. The approach in footnote "h" allow s application for use on lower slope rafter systems, less penalty for smaller raised distances, and a more simple method to determine heel joint connection requirements. There is no change to footnote h.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Cleans up a connection table by removing a superfluous footnote.

Impact to building and property owners relative to cost of compliance with code

No cost-related impact.

Impact to industry relative to the cost of compliance with code

No cost-related impact.

Impact to small business relative to the cost of compliance with code

No cost-related impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Cleans up important connection table.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

2nd Comment Period

S8255-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

TABLE R802.5.1(9)

RAFTER/CEILING JOIST HEEL JOINT CONNECTIONS[a, b, c, d, e, ~~f~~, h]

(no change to body of table, only delete footnote f in its entirety and renumber remaining footnotes)

1. ~~f.Where rafter ties are substituted for ceiling joists, the heel joint connection requirement shall be taken as the tabulated heel joint connection requirement for two-thirds of the actual rafter slope.~~

   ~~g.~~f. Applies to roof live load of 20 psf or less.

   ~~h.~~g. *(footnote h remains unchanged)*
2.

RB319-16

IRC: R802.5.1.

Proponent : Paul Coats, PE CBO, representing American Wood Council (pcoats@awc.org)

2015 International Residential Code

Revise as follows:

TABLE R802.5.1 (9)
RAFTER/CEILING JOIST HEEL JOINT CONNECTIONS[a, b, c, d, e, ~~f,~~ h]

RAFTER SLOPE	RAFTER SPACING (inches)	GROUND SNOW LOAD (psf)															
		20[g]				30				50				70			
		Roof span (feet)															
		12	20	28	36	12	20	28	36	12	20	28	36	12	20	28	36
		Required number of 16d common nails[a, b] per heel joint splices[c, d, e~~, f~~]															
3:12	12	4	6	8	10	4	6	8	11	5	8	12	15	6	11	15	20
	16	5	8	10	13	5	8	11	14	6	11	15	20	8	14	20	26
	24	7	11	15	19	7	11	16	21	9	16	23	30	12	21	30	39
4:12	12	3	5	6	8	3	5	6	8	4	6	9	11	5	8	12	15
	16	4	6	8	10	4	6	8	11	5	8	12	15	6	11	15	20
	24	5	8	12	15	5	9	12	16	7	12	17	22	9	16	23	29
5:12	12	3	4	5	6	3	4	5	7	3	5	7	9	4	7	9	12
	16	3	5	6	8	3	5	7	9	4	7	9	12	5	9	12	16
	24	4	7	9	12	4	7	10	13	6	10	14	18	7	13	18	23
7:12	12	3	4	4	5	3	3	4	5	3	4	5	7	3	5	7	9
	16	3	4	5	6	3	4	5	6	3	5	7	9	4	6	9	11

	24	3	5	7	9	3	5	7	9	4	7	10	13	5	9	13	17
9:12	12	3	3	4	4	3	3	3	4	3	3	4	5	3	4	5	7
	16	3	4	4	5	3	3	4	5	3	4	5	7	3	5	7	9
	24	3	4	6	7	3	4	6	7	3	6	8	10	4	7	10	13
12:12	12	3	3	3	3	3	3	3	3	3	3	3	4	3	3	4	5
	16	3	3	4	4	3	3	3	4	3	3	4	5	3	4	5	7
	24	3	4	4	5	3	3	4	6	3	4	6	8	3	6	8	10

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. 40d box nails shall be permitted to be substituted for 16d common nails.

b. Nailing requirements shall be permitted to be reduced 25 percent if nails are clinched.

c. Heel joint connections are not required where the ridge is supported by a load-bearing wall, header or ridge beam.

d. Where intermediate support of the rafter is provided by vertical struts or purlins to a load-bearing wall, the tabulated heel joint connection requirements shall be permitted to be reduced proportionally to the reduction in span.

e. Equivalent nailing patterns are required for ceiling joist to ceiling joist lap splices.

~~f. Where rafter ties are substituted for ceiling joists, the heel joint connection requirement shall be taken as the tabulated heel joint connection requirement for two-thirds of the actual rafter slope.~~

g. Applies to roof live load of 20 psf or less.

h. Tabulated heel joint connection requirements assume that ceiling joists or rafter ties are located at the bottom of the attic space. Where ceiling joists or rafter ties are located higher in the attic, heel joint connection requirements shall be increased by the following factors:

H_C/H_R	**Heel Joint Connection Adjustment Factor**
1/3	1.5
1/4	1.33
1/5	1.25
1/6	1.2
1/10 or less	1.11

where:

H_C = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.

H_R = Height of roof ridge measured vertically above the top of the rafter support walls.

Reason: Footnote "f" is redundant to footnote "h" in purpose. Footnote "f" should have been removed at the time footnote "h" was added to better account for the effect of rafter ties located above the bottom of the attic space. The approach in footnote "h" allows application for use on lower slope rafter systems, less penalty for smaller raised distances, and a more simple method to determine heel joint connection requirements. There is no change to footnote h.

Cost Impact: Will not increase the cost of construction
This is an editorial change that removes an unneeded provision which is captured by another footnote, and

therefore represents no increase in cost of construction.

Final Action: AS (Approved as Submitted

S8378

Date Submitted	12/15/2018	**Section**	806.5	**Proponent**	Craig Conner
Chapter	8	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes | **Alternate Language** No

Related Modifications

Chapter 2 definition

Summary of Modification

This adds expands unvented attic option and adds new materials.

Rationale

The proposed code change allows the use of lower cost alternatives. Specifically, the proposed code change allows the use of blown cellulose, fiberglass batts, and blown fiberglass to construct unvented attic assemblies. The approach is limited to Climate Zones 1, 2 and 3 based on research and historic experience over the past decade.

This same change was approved for the IRC last code cycle. This also allows insulation to be above the ceiling or on the attic floor. With air permeable insulation the insulation can be installed directly to the underside of the roof deck or at the floor or ceiling level of an attic assembly as moisture laden air is more buoyant than dry air and therefore the moisture will accumulate at the ridge and exit via the vapor diffusion.

The research work supporting this code change is an outgrowth of the original research work supporting unvented attic assemblies started in 1995 under the Department of Energy's Building America Program. The same technical team and the same technical rigor that supported the original code changes for unvented attics in the early 2000's are behind this proposed code change.
The technical rationale and research behind this code change can be found at Venting Vapor (http://buildingscience.com/documents/insights/bsi-088-venting-vapor?topic=doctypes/insights).
For a history of conditioned attics, see Cool Hand Luke Meets Attics (http://buildingscience.com/documents/insights/bsi-077-cool-hand-luke-meets-attics).
Here is the technical data (https://buildingscience.com/documents/building-america-reports/ba-1511-fieldtesting-unvented-roof-fibrous-insulation-tiles-and) and more technical data (http://buildingscience.com/documents/building-america-reports/ba-1409-field-testing-unvented-roofsasphalt-shingles-cold-and)
Links to two full research reports are at the bottom of the pages on the web site.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

none

Impact to building and property owners relative to cost of compliance with code

potentially lower cost because of additional options with less expensive materials

Impact to industry relative to the cost of compliance with code

potentially lower cost because of additional options with less expensive materials

Impact to small business relative to the cost of compliance with code

potentially lower cost because of additional options with less expensive materials

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

yes proven to mitigate moisture build up and rot in attic cavities

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Provides a potentially less expensive option and reduces moisture condensation and problems. Improves code because it uses a better method of controlling moisture buildup.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Allows construction with additional materials, instead of restricting practical application to one material.

Does not degrade the effectiveness of the code

Providing usable options improves the code.

2nd Comment Period

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

S8378-G1

Comment:

I agree with this modification.

Section 806.5
(806.5.1 no edit.)

~~5.2.Where preformed insulation board is used as the air-impermeable insulation layer, it shall be sealed at the perimeter of each individual sheet interior surface to form a continuous layer.~~

5.2. In climate zones 1, 2, and 3 air-permeable insulation installed in unvented attics shall meet the following requirements:
5.2.1. A vapor diffusion port shall be installed not more than 12 inches (305mm) from the highest point of the roof, measured vertically from the highest point of the roof to the lower edge of the port.
5.2.2. The port area shall be = 1:600 of the ceiling area. Where there are multiple ports in the attic, the sum of the port areas shall be greater than or equal to the area requirement.
5.2.3. The vapor permeable membrane in the vapor diffusion port shall have a vapor permeance rating of =20 perms when tested in accordance with Procedure A of ASTM E96.
5.2.4. The vapor diffusion port shall serve as an air barrier between the attic and the exterior of the building.
5.2.5. The vapor diffusion port shall protect the attic against the entrance of rain and snow.
5.2.6. Framing members and blocking shall not block the free flow of water vapor to the port. Not less than a 2-inch (50 mm) space shall be provided between any blocking and them roof sheathing. Air-permeable insulation shall be permitted within that space.
5.2.7. The roof slope shall be =3:12 (vertical/horizontal).
5.2.8. Where only air-permeable insulation is used, it shall be installed directly below the structural roof sheathing, on top the attic floor, or on top of the ceiling.
5.2.9. The air shall be supplied at a flow rate =50 CFM (23.6 L/s) per 1000 ft2of ceiling.
5.3. The air shall be supplied from ductwork providing supply air to the occupiable space when the conditioning system is operating. Alternatively, the air shall be supplied by a supply fan when the conditioning system is operating. Where preformed insulation board is used as the air-impermeable insulation layer, it shall be sealed at the perimeter of each individual sheet interior surface to form a continuous layer.

S7996

Date Submitted	12/12/2018	**Section**	46	**Proponent**	Bonnie Manley
Chapter	46	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments Yes **Alternate Language** No

Related Modifications

Summary of Modification

This proposal updates the AISI S230 reference to the 2018 edition.

Rationale

The 2018 editions of the IBC and IRC reference the 2015 edition of AISI S230. The 2015 edition of AISI S230 is based upon ASCE 7-10. With the Florida code cycle happening in 2019, there is an opportunity to adopt the 2018 edition of AISI S230, which is based upon ASCE 7-16. If ASCE 7-16 is chosen as a basis for both the Florida Building Code and Florida Residential Code, it would be appropriate to adopt this latest edition of AISI S230 for coordination.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No change in cost is anticipated.

Impact to building and property owners relative to cost of compliance with code

No change in cost is anticipated.

Impact to industry relative to the cost of compliance with code

No change in cost is anticipated.

Impact to small business relative to the cost of compliance with code

No change in cost is anticipated.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, it does.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, it does.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

No, it does not.

Does not degrade the effectiveness of the code

No, it does not.

2nd Comment Period

S7996-G1

Proponent Harold Barrineau **Submitted** 5/26/2019 **Attachments** No

Comment:

I agree with this modification.

AISI S230--18~~—07/S3-12 (2012)~~ *Standard for Cold-formed Steel Framing—Prescriptive Method for One- and Two-family Dwellings*, 2018~~2007 with Supplement 3, dated 2012 (Reaffirmed 2012)~~

S8395

Date Submitted	12/15/2018	**Section**	46	**Proponent**	Joseph Belcher for AAF
Chapter	46	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation No Affirmative Recommendation
Commission Action Pending Review

Comments

General Comments **No** | **Alternate Language** **Yes**

Related Modifications

N/A

Summary of Modification

Updates the AAF Guide to Aluminum Construction in High Wind Areas.

Rationale

The AAF is working with Dr. Timothy Reinhold, P.E. to get the AAF Guide updated to comply with ASCE 7-16. The design pressure for screen enclosures of Table 2002.4 are not affected because they are based on wind tunnel testing and the analysis of the wind tunnel data. There will be increases on solid roofs and we are working on completing those updates. Unfortunately, Hurricane Michael took some time and delayed the work. I am going to forward a copy of the AAF to the Structural TAC members and the staff and will provide the updated information during the Public Comment period.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact on cost of enforcement of code as the AAF Guide has been adopted for a number of years.

Impact to building and property owners relative to cost of compliance with code

No impact on cost of code compliance for property owners as the AAF Guide has been adopted for a number of years.

Impact to industry relative to the cost of compliance with code

No impact on cost of code compliance to industry as the AAF Guide has been adopted for a number of years. There will be an increase in uplift loads in the 15% range on solid roofs but that is due to changes in ASCE 7-16; not the AAF Guide.

Impact to small business relative to the cost of compliance with code

No cost impact relative to compliance with the code. No impact on cost of code compliance to small business as the AAF Guide has been adopted for a number of years. There will be an increase in uplift loads in the 15% range on solid roofs but that is due to changes in ASCE 7-16; not the AAF Guide.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The proposal is connected with the welfare and safety of the public because it updates a construction document to meet the latest design pressures due to the effects of wind.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The proposal improves the code because it is updating a prescriptive document to meet the latest design pressures due to the effects of wind.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The change does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The proposed change does not degrade the effectiveness of the code.

Alternate Language

2nd Comment Period

8395-A3

Proponent Joseph Belcher **Submitted** 5/26/2019 **Attachments** Yes

Rationale

All the tables were reviewed by Timothy Reinhold, P.E., PHd and tables affected by the changes to ASCE 7-16 were updated and are in compliance with ASCE 7-16. The design pressure for screen enclosures of Table 2002.4 are not affected because they are based on wind tunnel testing and the analysis of the wind tunnel data. The size of the documents will require delivery by a large file transfer service.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact on the cost of enforcement of code as the AAF Guide has been adopted for a number of years.

Impact to building and property owners relative to cost of compliance with code

No impact on the cost of code compliance for property owners for screen enclosures with screen roofs. Structures with solid roofs will see an estimated 15% increase in uplift loads and there will be an increase in cost for compliance. The increase in uplift loads is because of changes to ASCE 7-16.

Impact to industry relative to the cost of compliance with code

No impact on the cost of code compliance to the industry for screen enclosures with screen roofs. Changes to ASCE 7-16 increase the uplift loads for solid roofs by 15%. The increased uplift loads on solid roofs will result in an increase in cost.

Impact to Small Business relative to the cost of compliance with code

No cost impact relative to compliance with the code. No impact on cost of code compliance to small business as the AAF Guide has been adopted for a number of years. There will be an increase in uplift loads in the 15% range on solid roofs but that is due to changes in ASCE 7-16; not the AAF Guide.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The proposal relates to the welfare and safety of the public because it updates a construction document to meet the latest design pressures due to the effects of wind.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The proposal improves the code because it is updating a prescriptive document to meet the latest design pressures due to the effects of wind.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The change does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The proposed change does not degrade the effectiveness of the code.

Alternate Language

1st Comment Period History

8395-A2

Proponent Joseph Belcher for AAF **Submitted** 2/17/2019 **Attachments** Yes

Rationale

The updated version of the Guide to Aluminum Construction in High Wind Areas was provided to staff and the Structural TAC members. Approval of the updated standard will make the code compliant with ASCE 7-16 if adopted with no changes to the roofing provisions.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact.

Impact to building and property owners relative to cost of compliance with code

There will be an increase in projects with solid roof surfaces.

Impact to industry relative to the cost of compliance with code

There will be an increase in projects with solid roof surfaces.

Impact to Small Business relative to the cost of compliance with code

No cost impact relative to compliance with the code. No impact on cost of code compliance to small business as the AAF Guide has been adopted for a number of years. There will be an increase in uplift loads in the 15% range on solid roofs but that is due to changes in ASCE 7-16; not the AAF Guide.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Brings the referenced prescriptive document into compliance with ASCE 7-16.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Brings the referenced prescriptive document into compliance with ASCE 7-16.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the code.

Alternate Language

1st Comment Period History

8395-A1

Proponent Joseph Belcher for AAF **Submitted** 2/17/2019 **Attachments** Yes

Rationale

The modifications update the Guide to Aluminum Construction in High Wind Areas to bring it into compliance with ASCE 7-16.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact.

Impact to building and property owners relative to cost of compliance with code

There will be an increase to projects with solid roof surfaces but the changes are necessary to meet the updated national wind design standards.

Impact to industry relative to the cost of compliance with code

There will be an increase to projects with solid roof surfaces but the changes are necessary to meet the updated national wind design standards.

Impact to Small Business relative to the cost of compliance with code

No cost impact relative to compliance with the code. No impact on cost of code compliance to small business as the AAF Guide has been adopted for a number of years. There will be an increase in uplift loads in the 15% range on solid roofs but that is due to changes in ASCE 7-16; not the AAF Guide.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Brings the adopted prescriptive document into compliance with the adopted wind design standard.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Brings the adopted prescriptive document into compliance with the adopted wind design standard.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the code.

1st Comment Period History

S8395-G1

Proponent Joseph Belcher for AA **Submitted** 2/17/2019 **Attachments** Yes

Comment:

During our initial assessment, we did not believe Tables 202.4 and 2002.4A would need to be modified because the values were based on testing. However, we have engaged Dr. Timothy Reinhold and now recognized the need to modify the portion of the tables related to solid surfaces to comply with ASCE 7-16. If ASCE 7-16 is modified with no changes to the roofing provisions, the unmodified Tables 202.4 and 2002.4A contained in the FBC would not be in compliance with ASCE 7-16. Adoption of the attached tables will be an enhancement of the code by bringing it into compliance with the updated wind design standard.

Chapter 46 AAF

AAF	Aluminum Association of Florida 3203 Lawton Road #110 Orlando, FL 32803	
Standard Reference Number	Title	Referenced in code section number
AAF- ~~14~~ 20	Guide to Aluminum Construction in High Wind Areas (~~2014~~) (2020).	R301.2.1.1.1

A modified version of the Guide to Aluminum Construction in High Wind Areas was submitted to the Structural TAC and to staff. The modified version updates the year of the Guide, updates the edition of ASCE 7, and updates tables related to solid roof surfaces.

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Table 2002.4

DESIGN WIND PRESSURES SCREENED ENCLOSURES [a, b, f, g, h]
(STRENGTH DESIGN OR LRFD ONLY)

Surface	ULTIMATE DESIGN WIND SPEED V_{ult} (mph)																				
	110			120			130			140			150			160			170		
	Design Pressures by Exposure Category (psf)																				
	B	C	D	B	C	D	B	C	D	B	C	D	B	C	D	B	C	D	B	C	D
Horizontal Pressures on Windward Surfaces [d]	17	24	28	20	28	33	23	32	38	27	38	44	31	43	51	36	49	58	40	56	66
Horizontal Pressures on Leeward Surfaces [d]	13	18	21	15	22	26	20	26	31	21	29	34	22	34	40	25	39	46	29	44	52
Vertical Pressures on Screen Surfaces [c]	4	7	8	6	8	9	6	9	11	8	11	12	9	12	14	10	14	16	11	15	18
Vertical Pressures on Solid Surfaces [e]	~~14~~ 17	~~19~~ 24	~~23~~ 29	~~17~~ 21	~~23~~ 29	~~27~~ 34	~~20~~ 24	~~27~~ 34	~~32~~ 40	~~23~~ 28	~~32~~ 39	~~37~~ 46	~~25~~ 32	~~36~~ 45	~~42~~ 53	~~29~~ 36	~~41~~ 51	~~48~~ 60	~~33~~ 41	~~46~~ 58	~~54~~ 68

For SI: 1 pound per square foot = 9.479 kN/m2.

NOTES:

a. Pressures apply to enclosures with a mean enclosure roof height of 30 feet (10 m). For other heights, multiply the pressures in this table by the factors in Table 2002.4A.

b. Apply horizontal pressures to the area of the enclosure projected on a vertical plane normal to the assumed wind direction, simultaneously inward on the windward side and outward on the leeward side.

c. Apply vertical pressures upward and downward to the area of the enclosure projected on a horizontal plane.

d. Apply horizontal pressures simultaneously with vertical pressures.

e. Table pressures are MWFRS Loads. The design of solid roof panels and their attachments shall be based on component and cladding loads for enclosed, ~~or~~ partially enclosed structures, or attached canopies as appropriate.

f. Table pressures apply to 20 x 20 x 0.013" mesh screen. For 18 x14 x 0.013" mesh screen, pressures on screen surfaces may be multiplied by 0.88. For screen densities greater than 20 x 20 x 0.013", use pressures for enclosed buildings.

g. Table pressures may be interpolated using ASCE 7 methodology.

h. For allowable stress design (ASD) pressures shall be permitted to be multiplied by 0.6.

TABLE 2002.4A
HEIGHT ADJUSTMENT FACTORS

MEAN ROOF HEIGHT	EXPOSURE		
	B	C	D
0-15	~~1~~ 0.81	0.86	0.89
20	~~1~~ 0.89	0.92	0.93
25	~~1~~ ~~0.94~~	0.96	0.97
30	1	1	1
35	1.05	1.03	1.03
40	1.09	1.06	1.05
45	1.12	1.09	1.07
50	1.16	1.11	1.09
55	1.19	1.14	1.11
60	1.22	1.16	1.13