Contents

CHAPTER 1 APPLICATION AND ADMINISTRATION

SECTION 101 GENERAL

101.1 Purpose. The purpose of this standard is to establish the minimum requirements for the testing of magnesium oxide boards for use in construction.

101.2 Scope. This standard applies to the classification for magnesium oxide boards for use in interior and exterior construction in both commercial and residential buildings and all types as applicable. This standard also applies to mechanically attached, fiber-reinforced, magnesium oxide based boards that are intended to be installed for use as exterior wall sheathing, interior wall sheathing, roof sheathing, low slope roof sheathing, subfloor underlayment, subfloor sheathing, tile backer units of both ceramic tile, natural stone, or dimensional stone veneers on floors and walls of interior and exterior areas.

101.3 Alternative means and methods. Nothing in this standard is intended to prevent the use of designs, technologies or products as alternatives to any prescriptions in this standard, provided equivalence is demonstrated and approved.

SECTION 102 APPLICABILITY

102.1 Conflicts. Where there is a conflict between a general requirement and a specific requirement of this standard, the specific requirement shall be applicable. Where, in any specific case, different sections of the code specify different requirements, the most restrictive shall govern.

102.2 Other laws. The provisions of this standard shall not be deemed to nullify any provisions of local, state or federal law.

102.3 Referenced standards. The standards referenced in this standard shall be considered part of the requirements of this standard to the prescribed extent of each such reference and as further regulated in Sections 102.3.1 and 102.3.2.

102.3.1 Conflicts. Where conflicts occur between provisions of this standard and referenced standards, the provisions of this standard shall apply.

102.3.2 Provisions in Referenced Standards. Where the extent of the reference to a referenced standard includes subject matter that is within the scope of this standard, the provisions of this standard shall take precedence over the provisions in the referenced standard.

CHAPTER 2 DEFINITIONS

SECTION 201 GENERAL

201.1 General. For the purposes of this standard, the terms listed in Section 202 shall have the indicated meaning.

201.2 Undefined terms. The terms not specifically defined in this standard or in standards referenced herein shall have the ordinarily accepted meanings such as the context implies.

201.3 Interchangeability. Words used in the present tense include the future; words stated in the masculine gender include the feminine and neuter; the singular number includes the plural and the plural, the singular.

SECTION 202 DEFINITIONS

Areas, Dry. All areas not included in the definition of wet areas.

Aspect Ratio. The height divided by the length of a braced or shear wall panel.

Braced Wall Panel. A full-height section of wall constructed to resist in-plane shear loads through interaction of framing members, sheathing material and anchors. The panel's length meets the requirements of its particular bracing method, and contributes toward the total amount of bracing required along its braced wall line.

Coastal Region. Areas within 3,000 feet (915 m) of the shoreline of a body of saltwater.

Continuously Sheathed. Sheathing material to all sheathable areas of a wall, including areas above and below wall openings as addressed for continuously sheathed braced in accordance with IRC.

Drift. The horizontal in-plane displacement under racking shear load of the top horizontal member of the wall frame relative to the bottom horizontal member of the wall frame.

Drift At Reference Shear Load (for continuously sheathed braced wall panels). The drift corresponding to the racking shear load determined as the product of 280 plf unit shear strength, the reduction factor from Table 3, and the overall length of the wall tested.

Dry Condition. Specimens conditioned to represent dry conditions placed in a controlled condition at 73 ±4°F and 50 ±5% humidity for a minimum of six days, or until the difference between two consecutive weight measurements, at intervals not less than twenty-four hours, is less than 0.1% by mass.

Engineered Wood. For purposes of this standard, engineered wood includes products such as structural glued-laminated timber, wood structural panels, and structural composite lumber.

Exterior Wall. A wall, bearing or nonbearing, that is used as an enclosing wall for a building, other than a fire wall, and that has a slope of 60 degrees (1.05 rad) or greater with the horizontal plane.

Fastening system. A method to mechanically attach substrate sheets, sheathing or single floor grade sheets to framing. The system can include nails and screws.

Fiber-reinforced Inorganic Composite. A composite material composed primarily of inorganic matrix materials reinforced primarily with inorganic fibers. Inorganic aggregates may be combined within the inorganic matrix.

Fiber-reinforced Magnesium-oxide-based Sheets. Fiber-reinforced magnesium-oxide-based sheets are sheet products consisting of a proprietary composition of magnesium oxide, such as oxychloride cement, magnesium oxysulfate, or magnesium phosphate cement that is reinforced by a fibermat or fiber scrim made of organic or inorganic fibers. The sheets may contain proprietary additives and have factory-applied coatings. The sheets are manufactured in various lengths and widths, and in thicknesses from 1/4 to 1 inch (6.3 to 25.4 mm).

Head Area Ratio (HAR). A ratio of the difference between the area of the nail head and the area of the nail shank to the area of the nail head, (Ah-As)/Ah.

Intermittent Bracing. A construction method for installing a sheathing material in a non-continuous fashion at discrete and separate locations along a wall as addressed for intermittent bracing methods in IRC Section R602.10.4.

Labeling. An identification applied on a product by the manufacturer that contains the provisions of Chapter 8 (Identification).

Light-frame Wall Construction. Construction whose vertical and horizontal structural elements are primarily formed by a system of repetitive wood or cold-formed steel framing members.

Manufacturing Plant Specification. The manufacturing plant specification provides the reference values used as benchmarks for ongoing quality control testing and is unique to each product qualified under this performance standard.

Minimum Head Area Ratio. Head area ratio calculated using the minimum head dimensions and the maximum shank diameter specified by the manufacturer.

Nails, Bright. A term used to describe carbon steel nails which have no coating.

Nails, Commodity. Smooth shank, ring shank and screw shank nails, including hardened nails, that comply with the material specifications, dimensions and tolerances in ASTM F1667.

Nails, Galvanized. Galvanized nails are carbon steel nails with a zinc coating. The nails may be hot-dip galvanized, electrogalvanized or mechanically galvanized.

Nails, Proprietary. Nails that are characterized by one or more of these features:

- Shank geometry not considered in ASTM F1667.
  Minimum specified bending yield strengths exceed the values in Table 1 of Appendix A.

Nails, Proprietary-coated. Nails with a coating other than electrodeposited or hot-dipped galvanizing.

Nails, Stainless Steel. Stainless steel nails are formed from stainless steel wire, without a coating. See Section 3.2.2.2.1 for applicable types.

Net Deflection. Gross horizontal movement (drift) of the top horizontal member of a tested shear wall panel subjected to racking load reduced by subtracting the slippage of the bottom plate of the wall and contribution of assumed rigid body rotation caused by upward and downward movement of the stud at each end of the shear wall panel.

Peak Horizontal Racking Shear Load. The maximum shear load resisted by the test assembly.

Shear Wall Panel. A full-height section of a light-frame wall construction containing a sheathing, designed to resist in-plane shear loads through the interaction of the framing members, sheathing, and anchors.

Reference Unit Withdrawal Design Value. The reference withdrawal design value for a given unit of fastener penetration depth in the supporting member, used to distinguish from the total withdrawal design value that takes into account the total length of the fastener embedded in the supporting member.

Reference Value. The target value established for the manufacturing plant specification for a given mechanical or physical property.

Ring Growth. For ring shank nails, the increase in diameter at the threads, relative to the measured unthreaded shank diameter.

Sheathing Grade. Sheets used as sheathing that require a separate underlayment installed on top of the sheets.

Single Floor Grade. Sheets used as a combination subfloor and underlayment installed with edge treatment, blocking or covered with an approved material. Panel edges shall have approved tongue-and-groove joints or shall be supported with blocking unless ¼ inch minimum thickness underlayment or 1 ½ inches of approved cellular or lightweight concrete is placed over the subfloor, or finish floor is ¾ inch wood strip. Allowable uniform loads shall comply with Tables 702.3.1 and 702.3.2 of this standard.

Span. Distance between centers of sheathing supports.

Span Rating. The recommended maximum center-to-center spacing in inches (mm) of floor or roof framing used to support the sheets for the specified end use under normal use conditions.

Specimen. An individual test piece cut from a sample test panel.

Structural Cementitious Sheathing Panel. Structural cementitious sheathing panels are fiber-reinforced inorganic composite panels intended for end-use as floor sheathing (combination subfloor and underlayment) or roof sheathing, when fastened to cold-formed steel framing spaced in accordance with the panel's span rating.

Test Exposure Condition. The condition to which a panel is subjected prior to test. Generally, such conditions are referred to as dry or wet conditions.

Thread Pitch. Spacing of threads for ring-shank nails.

Unit Shear Capacity. Unit shear capacity is determined by dividing the peak applied horizontal racking shear load by the horizontal length of the racking shear tested wall assembly.

Unit Shear Resistance. Unit shear resistance is determined by dividing the applied peak racking shear load by the horizontal length of the racking shear tested wall assembly.

Wet Condition. Wet conditioning of full panels requires continuous wetting of panels held in a vertical condition for seven days, at an ambient temperature of 73 ±4°F, and tested while wet. Unless otherwise noted, wet conditioning of small-scale test specimens require immersion in water at a temperature of 73 ±7°F for a minimum of 48 hours.

Wet Areas. Locations where there will be direct or indirect exposure to water or in areas subject to continuous high humidity.

CHAPTER 3 REQUIREMENTS FOR ALL USE TYPES

SECTION 301 GENERAL

301.1 General. All products in conformance with this standard shall meet the requirements listed in Table 301.1 and this Chapter.

301.1.1 Manufacturer shall provide durability performance as required by application.

Table 301.1
Minimum Physical Property Requirements

Property	Test Method	Requirement
Flexural Strength	ASTM C1185	> 580 psi (4,000 kPa) both wet and dry
Freeze-Thaw	ASTM C666 Proc. B	No evidence of deterioration
Dimensions and Tolerance	ASTM C1185 Section 7; Acceptance per ASTM C1186 Section 7	+/- 1/8” (3 mm) width and length +/- 1/32” (0.75 mm) thickness
Moisture Movement	ASTM C1185 Section 8	Report percentage change from 30% - 90% RH
Water Absorption	ASTM C1185 Section 9	Report percentage change of weight following 48-hour submersion
Compression Indentation	ASTM D2394	Less than 0.05” (1.3 mm) true deformation at 1250 psi (8,620 kPa)
Nail-Head Pull-Through	ASTM D1037	> 90 lbf (400 N) saturated
Falling Ball Impact	ASTM D1037	No failure at 12” (305 mm) drop
Shear Bond Strength	ANSI 118.9 Section 4.1.3	> 50 psi (345 kPa) after 7-day cure both wet and dry
Humidified Deflection	ASTM C473	< 5/16” (7.9 mm) ceiling board use < 0.0639” (1.62 mm) as tile base
Surface Burning Characteristics	ASTM E84	Flame Spread Index (FSI) ≤ 10 Smoke Developed Index (SDI) ≤ 25
Fungus Resistance	ASTM G21	≤ 1
Corrosion Resistance	Section 302.18	≤ 20 mils/year for all Conditions

SECTION 302 PERFORMANCE REQUIREMENTS

302.1 Testing. Testing shall be done in accordance with Sections 302.2 through 302.19.

302.2 Flexural Strength. Testing shall be done in accordance with ASTM C1185, with conditions of acceptance of 580 psi (4000 kPa) minimum average flexural strength, both wet and dry. Testing shall be performed in both machine and cross directions.

302.3 Freeze – Thaw Cycling. When testing sheathing for non-roof applications in accordance with ASTM C666, Procedure B, the test samples shall be cut to 4 in. by 12 in. (102 mm x 305

mm) and show no deterioration following 25 cycles. A minimum of 5 specimens shall be tested. Deterioration is as defined in ANSI 118.9 Section 4.12.

302.4 Dimensions and Tolerance. Testing in accordance with Section 7 of ASTM C1185 with conditions of acceptance as noted in Section 7 of ASTM C1186.

302.5 Moisture Movement. When tested in accordance with Section 8 of ASTM C1185, linear variation with change in moisture content shall be stated as the percentage change in length based on a relative humidity change from 30 to 90 percent. Sampling for tests shall be in accordance with Section 4 of ASTM C1185.

302.6 Water Absorption. When testing sheathing in accordance with Section 9 of ASTM C1185, the water absorption shall be reported as the percentage increase in weight of dry specimens following submersion for a period of 48 hours. Sampling for tests shall be in accordance with Section 4 of ASTM C1185.

302.7 Compression Indentation. When tested in accordance with ASTM D2394, samples shall show no true deformation greater than 0.05 inch (1.3 mm) at 1250 psi (8.620 kPa). A minimum of 5 specimens shall be tested.

Exception: Tile backer for Wall, Ceiling, and Soffit use is exempt from this testing.

302.8 Nail-Head Pull Through. The substrate sheets shall have a minimum thickness of 1/4-inch-thick (6 mm) and shall have a minimum saturated nail-head pull-through resistance of 90 lbf (400 N) when tested in accordance with ASTM D1037 utilizing a roofing nail with a 0.375-inch-diameter (10 mm) head and a shank diameter of 0.121 inch (3 mm). A minimum of 5 specimens shall be tested.

302.9 Falling Ball Impact. When tested in accordance with ASTM D1037, samples shall show no damage to top or bottom surfaces at a 12-inch (305 mm) drop. A minimum of 5 specimens shall be tested.

Exception: Ceiling and Soffit uses are exempt from this testing.

302.10 Shear Bond Strength. The substrate sheets shall be tested in accordance with ANSI 118.9 Section 4.1.3, using test specimens consisting of the substrate sheet adhered to substrate sheet, and shall demonstrate a minimum shear bond strength at seven-day curing of 50 psi (345 kPa) both wet and dry. A minimum of 5 specimens shall be tested.

302.11 Humidified Deflection. Testing in accordance with ASTM C473. Conditions of acceptance are as described in Section 5.1.2 of ASTM C1396. For use as ceiling boards, the sheets shall have a maximum humidified deflection of 5/16 inch (7.9 mm), when used as ceiling finish (textured or painted), or 0.0639 inch (1.62 mm), when used as a base for tile.

302.12 Surface Burning Characteristics. The substrate sheets shall be tested in accordance with ASTM E84 or UL 723 and shall have a maximum Flame Spread Index (FSI) of 10 and

maximum Smoke Developed Index (SDI) of 25. If substrate sheet is tested to Section 302.13 then it may be used as demonstrating compliance with this section.

302.13 Extended Surface Burning Characteristics (Optional): The substrate sheets shall be tested in accordance with ASTM E2768 and shall have a maximum Flame Spread Index (FSI) of 10 and maximum Smoke Developed Index (SDI) of 25. A flame front shall not progress more than 10 feet 6 inches (3200 mm) beyond the centerline of the burners at any time during the test.

302.14 Use as an Alternative to Fire-Retardant Treated Wood Structural Panels (Optional): For use as an alternative to fire-retardant treated wood structural panels, the material shall be tested in accordance with Section 302.13; the material shall also demonstrate compliance with the associated end use(s) outlined in the following Chapters of the IBC, as applicable.

Note: If products are shown to comply with Section 302.17, compliance with this section is not needed.

302.14.1 Allowable materials in Type I and II construction as described in IBC Section 603.1.

302.14.2 Wall sheathing for exterior walls for Type III construction with a two-hour rating or less (IBC Section 602.3 and Tables 601 and 602).

302.15 Fire-resistance-rated Construction (Optional): For use in fire-resistance-rated construction, tests shall be conducted in accordance with ASTM E119.

302.16 NFPA 285 (Optional): For use in exterior walls taller than forty feet in height or containing foam plastic insulation and panel is found to not comply with 302.16, then it must be part of an approved NFPA 285 assembly by either testing or an Engineering Judgement for use in Types I, II, III, or IV building construction.

302.17 Noncombustible Construction (Optional): For use as a noncombustible material in Types I, II, III and IV construction, the material must be shown to be noncombustible in accordance with ASTM E136 or by testing to ASTM E2652 using the acceptance criteria prescribed by ASTM E136.

302.18 Mold Resistance. Sheathing panels shall be tested for mold resistance per ASTM G21. Panel specimens shall have a mold resistance value of 1 or less when tested per ASTM G21.

302.19 Corrosion Effects. The sheets shall be evaluated for corrosion effects in accordance with the following criteria in order to address compatibility with common construction metals, including fasteners used for attachment of the sheets, and metals in contact with the surfaces of the sheets. The appropriate end use exposure test conditions shall be selected with consideration of the end use applications evaluated in accordance with Table 302.19 of this criteria (i.e., if the panels are evaluated for use as roof sheathing in accordance with Chapter 8

of this standard, corrosion effects must be evaluated per the requirements of End Use Severity Rating 1 and End Use Severity Rating 2 and/or 3 as outlined in Table 302.19, as applicable).

TABLE 302.19—EXPOSURE TEST CONDITIONS BASED ON END USE

END USE SEVERITY RATING	END USE	DESCRIPTION	APPLICABLE EXPOSURE TESTING REQUIREMENTS[a]
1	Interior Walls	Walls that do not fall under the definition of *Exterior Wall* that are fully contained within the conditioned interior space, outside of *wet areas*.	Section 302.19.5.1
	Interior Floors	Floors fully contained within the conditioned interior space, outside of *wet areas*.	
2	Exterior Walls in Non-Coastal Regions	*Exterior Walls*, including fire-resistance rated walls located more than 3,000 feet from the shoreline of a body of saltwater. Sheets shall be covered by water-resistive material.	Section 302.19.5.2
	Roof Sheathing in Non-Coastal Regions	Roof sheathing in structures located more than 3,000 feet from the shoreline of a body of saltwater. Sheets shall be covered by an approved roof covering.	
	Interior Wet Areas	Areas as defined in Section 202 and are fully contained within the conditioned interior space.	
3	Exterior Walls in Coastal Regions	Exterior Walls including fire-resistance rated walls, in structures located less than 3,000 feet from the shoreline of a body of saltwater. Sheets shall be protected by water-resistive material.	Section 302.19.5.3
	Roof Sheathing in Coastal Regions	Roof sheathing in structures located less than 3,000 feet from the shoreline of a body of saltwater. The MgO sheets shall be covered by an approved roof covering.	

a. All sheets are required to test Exposure Condition 1; however, testing to Exposure Condition 3 may be utilized to qualify for Exposure Condition 2.

302.19.1 Test Assembly: The combination of MgO sheets and metal coupons of the type being evaluated.

302.19.1.1 Uncoated MgO Sheets: For MgO sheets that do not have a coating or surface treatment on either side, one set of samples for each combination of exposure condition described in Section 302.19.4.4, MgO sheet, and coupon shall be tested.

302.19.1.2 Coated MgO Sheets: For the purposes of this section, coated MgO sheets are those which have a coating or surface treatment, other than those intended for weather resistance.

302.19.1.2.1 Sheets Coated on One Side: For sheets that are coated on one side, two sets of samples for each combination of exposure condition described in Section 302.19.4.4, MgO sheet, and coupon shall be tested.

Both the coated and uncoated side shall be tested in contact with the metal coupons unless it can be established that one side (coated or uncoated) is a worst-case scenario. If it can be established that one side is a worst-case scenario, then this side can be used for validation of both sides.

302.19.1.2.2 Sheets Coated on Both Sides: For sheets that are coated on both sides, one set of samples for each combination of exposure condition described in Section 302.19.4.4, MgO sheet, and coupon shall be tested.

302.19.2 Test Material Requirements: A minimum of five samples shall be prepared following AWPA E12 for each type of coupon to be evaluated. The sheets shall be sized to accommodate coupons to be tested. The sheets used in testing shall be the maximum thickness to be evaluated for each formulation and end use as applicable. Exposure tests shall include MgO sandwich assemblies.

302.19.2.1 Material Types: Any type of metal may be evaluated if a standard coupon can be obtained which is representative of the metal composition and surface treatment, as applicable. Suggested metals to be tested are galvanized steel, stainless steel, aluminum (2024-T3 or 5154-0 alloys), copper (ASTM B370) and any other metals that are representative of fasteners, coatings and metals to encounter a sheet. For evaluation of corrosion effects on galvanized cold-formed steel, guidance is given in Table 302.19.1. The actual coating weights of materials tested shall be verified to be within +/- 10% of the minimum coating weight specified in the applicable standard. Testing with the minimum coating weight designated in Table 302.19.1 will also qualify use of heavier coating weights. Coupon dimensions shall be in accordance with section 2.1 of AWPA E12.

TABLE 302.19.2.1—MINIMUM COATING WEIGHTS FOR COMMON GALVANIZED STEEL MATERIALS

Coating Type:	Applicable Standard	Minimum Coating Weight Designation for Testing, Imperial (SI)	Coating Weight Designations Qualified by Extension, Imperial (SI)
Zinc	ASTM A653	G40 (Z120)	G60 (Z180), G90 (Z275)
Zinc Iron	ASTM A653	A60 (ZF180)	
55% Al-Zinc	ASTM A792	AZ50 (AZM150)	
Zinc-5%	ASTM A875	GF30 (ZGF90)	GF45 (ZGF135)

302.19.3 Testing Scope: Testing shall be performed using, at a minimum, Exposure Condition 1. If the criteria for passing Exposure Condition 1 is met as defined in Section 302.19.7, additional testing may be conducted using Exposure Condition 2 or Exposure Condition 3. Tests for a defined application are applicable to the same metal / MgO

Sheet combination at lower application levels of conditions 2 and 3. Table 302.19 shall be used to establish the exposure test requirements for each use application level.

302.19.4 Test Method: Testing shall include exposure of metal coupons to MgO sheets in accordance with the general size and assembly methods of AWPA E12. The initial moisture condition of the material shall be in accordance with the following:

302.19.4.1 Conditioning: Prior to testing, MgO sheets should be conditioned to equilibrium per ASTM C1185 5.2.3.1. Equilibrium moisture content should be verified by recording less than 0.2% wt. change in a 24-hour period.

302.19.4.2 Number of Coupons: A minimum of ten (10) coupons per metal type given in Section A5.0, or requested by manufacturer, shall be exposed to the proprietary MgO sheet.

302.19.4.3 Coupon Measurements: Each coupon shall be weighed to a precision of 0.5 percent, and the thickness measured at a precision of 1 percent.

302.19.4.4 Coupon Assembly: The test units shall be assembled by placing a metal coupon between two MgO sheets and securing each with two 6 mm nylon bolts (20 thread per inch). A 6 mm flat nylon washer is placed under the bolt head and nut, which is then tightened. The bolts should be tightened alternately to ensure that uniform clamping pressure is applied to the MgO pieces and metal. Alternate tightening should be continued until 7 +/-1 pounds of torque is reached, or the nut slips on the threads of the bolt.

302.19.5 Exposure Testing Conditions: Each condition to be tested shall be tested to the following exposure environment and time intervals.

302.19.5.1 Exposure Condition 1: The test specimens shall be exposed to a steady state environment of not less than 90°F (32°C) and 90-percent relative humidity. The test duration shall be a minimum of 366 +/- 6 hours. No visible moisture should be observed during the period.

302.19.5.2 Exposure Condition 2: Water-spray testing shall be performed in accordance with ASTM B117 for a period of 366 +/- 6 hours, except distilled water (Type IV) shall be used in place of salt water.

302.19.5.3 Exposure Condition 3: Water-spray testing shall be performed in accordance with ASTM B117 for a period of 366 +/- 6 hours, utilizing salt water.

302.19.6 Coupon Removal and Cleaning: When the tests are terminated, the metal coupons shall be removed by opening the MgO sheet test specimen, followed by careful separation of the metal coupon from the MgO sheet test member. If coating is lost by adhesion to the test members, the loss shall be noted in the report. Coupons shall be cleaned in accordance with AWPA E12 Section 8.

302.19.7 Evaluating Results: Both contact surfaces of the metal coupons shall be evaluated according to AWPA E12-20, section 9.0. Criteria for passing shall be 20 mil/year or less.

302.19.7.1 Reporting shall include the Exposure Condition(s) that were tested and each metal type(s) tested for each thickness and formulation of each Exposure Condition, should they differ.

CHAPTER 4 WALL SHEATHING

SECTION 401 GENERAL

401.1 GENERAL. Wall sheathing shall comply with this section.

SECTION 402 PERFORMANCE

402.1 Performance. Wall sheathing testing and conditions of acceptance shall be in accordance with Sections 402.2 through 402.5 and Section 301, as applicable.

402.2 Use in Noncombustible Construction. Sheets intended for use in building elements required to be of noncombustible materials shall be tested in accordance with either Section 402.2.1 or 402.2.2 as applicable.

402.2.1 Qualification for use as a noncombustible material. Magnesium oxide board sheathing, without facings shall be tested in accordance with, and pass, ASTM E136 or tested in accordance with, and pass, ASTM E2652 using the criteria of acceptance of ASTM E136.

402.2.2 Exterior Wall Assemblies. Sheets not complying with Section 402.2.1 shall be permitted for use in exterior wall assemblies required to be of noncombustible construction based on testing in accordance with either Section 402.2.2.1 or 402.2.2.2 as applicable.

402.2.2.1 Exterior Wall Assemblies 40-ft or less in height Above Grade Plane. Use of sheets in exterior wall assemblies of 40-ft in height or less shall be permitted based on testing in accordance with Section 3.X.

> **Exception:** Use of sheets in exterior wall assemblies of any height above grade plane that contain foam plastic insulation shall require large-scale testing prescribed in Section 402.2.2.2.

402.2.2.2 Exterior Wall Assemblies Greater than 40-ft in height Above Grade Plane. Use of sheets in exterior wall assemblies greater than 40-ft in height above grade plane shall be permitted based on large-scale testing conducted in accordance with and meeting the acceptance criteria of NFPA 285. Tests shall be performed on test specimens of the exterior wall assembly intended for use.

402.3 Racking shear resistance in cold-formed steel and wood light-frame wall construction. For recognition of resistance to racking shear forces for use with **cold-formed steel and** wood light-frame wall construction, tests shall be conducted in accordance with this section. Where intended for exterior use, tests shall be conducted after wetting in accordance with Section 15 of ASTM E72, and the allowable loads shall be determined as prescribed by this section, except what they shall be determined from the results of the wet tests.

402.3.1 General. Qualification for shear wall design and construction shall be limited to the sizes and types of materials and framing used in the tested assemblies. Representative specimens shall

be taken from the sheathing used in the racking shear test assemblies for baseline fingerprinting testing of the sheathing. The specific test parameter and test procedure selected for the fingerprinting testing needs to be the same property and test procedure used in the quality control procedures for the continued manufacturing of the sheathing to provide assurance of equivalent racking shear performance. Sufficient specimens shall be tested to establish the quality control conditions of acceptance to be specified in the quality documentation (See Section 5.0).

402.3.2 Racking Shear Evaluation. The shear wall racking shear design values shall be established by testing in accordance with Section 402.3.4. The description of the tested shear wall assemblies in the test report shall include the following:

1. The height and length of the tested shear wall assemblies.

2. A description of the magnesium oxide board sheathing, including the thickness, width, length, installation orientation of the sheathing the framing and location of the required vertical sheathing joint. In addition, the test report shall include the results of the fingerprinting tests of the sheathing used in the racking shear test assemblies. See Section 3 1 for additional Information regarding the required sheathing fingerprinting.

3. The framing of the tested shear wall assemblies shall be representative of shear wall framing intended for the end-use and shall be described in the test report.

    a. For wood framing members, the description of the framing members of the tested shear wall assembly shall include dimensions, species, grade, specific gravity, and moisture content wood framing members shall be sawn lumber with minimum nominally 2-inch (508 mm) thickness and with grading standards and specifications described in the applicable code. Top and bottom plates shall be continuous over the length of the tested assembly.
    b. For cold-formed steel framing members, the description of framing members of the tested shear wall assembly shall include the framing designator and material specification. Top and bottom tracks shall be continuous over the length of the tested assembly.

4. Sheathing-to-framing, stud-to-plate, and test assembly to the test apparatus connection details shall be described in the test report. Fasteners shall be described, including fastener type, diameter, length and location. Fasteners used in sheathing-to-framing and stud-to-plate connections of the tested assemblies shall comply as code-specified fasteners, or data described in an applicable acceptance criteria or specification for proprietary fasteners shall be provided. The test report shall Include the fastener spacing and edge distance. Sheathing-to-framing fastener spacing shall not exceed 12 inches (304.8 mm) along intermediate framing members and 6 inches (1524 mm) along sheathing edges. Fasteners used to attach the sheathing to the framing shall be placed at the minimum edge distance to be specified in the

manufacturer's installation instructions. Fasteners shall not be placed less than 3/8 inch (9.5 mm) from the edge of framing members.

5. Holes and notches need not to be installed in framing members of the test assemblies. Holes and notches in framing members in the end-use conditions will be as permitted by the code or code-referenced documents.

6. Sheathing Penetrations and Joints as follows:

    a. A description of any holes in the sheathing of the tested assemblies is to be included in the test report. Penetrations in the sheathing will be permitted only at predetermined locations based on the tested assemblies, including the appropriate size and location of any holes in the sheathing as intended for end use. The manufacturer's installation instructions shall state the limitations for holes (sizes and locations) ascertained by testing.

    b. The location and width of all sheathing joints of the tested assemblies shall be included in the test report. The joints in the sheathing shall occur over framing members or shall be blocked, with the sheathing attached to the framing members and blocking, Assemblies tested with unblocked horizontal sheathing joints will be the basis for this method of installation being reported in the manufacturer's installation instructions.

402.3.3 Shear Wall Panel Aspect Ratios. The maximum height-to-width aspect ratio of shear wall panels shall be 1:1.

Exception: For magnesium oxide board sheathing qualified in accordance with Section 402.6 to be equivalent to wood structural panel, the tested wall assemblies shall have aspect ratios (wall height-to-length ratios) and dimensions consistent with the intended end use, and such aspect ratios shall be the maximum permitted for specification in the manufacturer's installation instruction. Test wall assemblies constructed in accordance with Section 402.3.4.1 shall have an aspect ratio of 1:1 to determine full nominal strength for applications with aspect ratios equal to or less than 2:1, provided the test wall assemblies are constructed with two 8-foot-high-by-4-foot-wide panels. The maximum wall aspect ratio shall be no greater than 2:1.

402.3.4 Test Methods and Analysis Requirements. The test method and analysis shall be in accordance with Sections 402.3.4.1 and 402.3.4.2.

402.3.4.1 Test Specimen Construction. The test specimens shall be 8 feet high by 8 feet long (2438 by 2438 mm) and shall be constructed with two 8-foot-high-by4-foot-wide (1219 by 2438 mm) panels and in accordance with Section 403.2.2 The framing members, receiving sheathing fasteners, shall comply with Item 3 of Section 403.2.2. Where framing members are wood, the

framing shall be Douglas fir, Southern yellow pine or other lumber species, conforming to NIST Voluntary Product Standard PS 20. Framing members receiving sheathing fasteners shall have a measured average specific gravity (oven-dry basis) not exceeding the nationally specified value plus 0.03 for the species of framing members in accordance with NDS-2018 and NDS-2015 Table 12.3.3A (NOS-12 Table 11.3.2A) and a measured average moisture content of 15 percent or less. The test assemblies shall be constructed with magnesium oxide board sheathing installed on one side of the wall framing and without gypsum wallboard or any other sheathing installed on the opposite face of the wall framing. The magnesium oxide board sheathing shall be installed with a vertical sheathing joint.

402.3.4.1.1 Test Methods. The racking shear load testing shall be in accordance with the principles of Section 14 of ASTM E72. The load beam and base fixture shall not be in contact with the magnesium oxide board sheathing and shall not interfere with movement of the sheathing during the entire test procedure Loading procedures from ASTM E72 shall be followed (except that the test specimen shall be allowed to recover for five minutes after the load is removed following the first and second loading stages). An additional sensor shall be installed at the right lower corner of the specimen (Figure 7 of ASTM E72) to measure bottom plate compressive deformation and the displacement of the wall end stud relative to the base of the test fixture. The ASTM E72 specified hold-down rods shall be used. Where framing members are wood, the specific gravity (oven-dry basis) of the framing members receiving sheathing fasteners shall be determined in accordance with ASTM D2395. Specific gravity measurements taken at moisture contents other than oven-dry condition shall be adjusted to the oven-dry moisture content in accordance with Appendix X1 of ASTM D2395.

402.3.4.1.2 Test Repetitions. Six identical 8-foot-by-8-foot shear wall assemblies shall be constructed in accordance with Section 402.3.4.1 for each shear wall configuration (i.e., variations in the assemblies that might result in a different racking shear capacity, such as, but not limited to, sheathing thickness, fastener type, fastener schedule and framing spacing) for which evaluation is sought. Three assemblies shall be tested in accordance with ASTM E72 Section 14 (dry tests) and the other three shall be conditioned in accordance with ASTM E72 Section 15 (wet tests) and then tested in accordance with ASTM E72 Section 14.4.

> **Exception:** For magnesium oxide board sheathing not subject to wetting during construction or while in service (such as that for interior use), the testing of three assemblies conditioned in accordance with ASTM E72 Section 15 (wet tests) is not required.

402.3.4.1.3 Net Deflection. Net deflection, used to establish the allowable racking shear load and stiffness, shall be calculated by subtracting the end stud uplift displacement, end stud compressive deformation, and bottom plate slip from the total wall horizontal deflection measured at the top plate of the tested assemblies.

402.3.4.2 Data Analysis.

402.3.4.2.1 General. For each tested configuration, the average ultimate load from the wet test assemblies shall not be less than 77 percent of the average ultimate load from the three dry test

assemblies. From the load-deflection curves representing the average of the three dry and three wet test assemblies, the wet test assembly deflection at 23 percent of the dry test average ultimate bad shall not exceed the deflection of the dry test assemblies at the same load level by more than 40 percent, and the wet test assembly deflection at 46 percent of the dry average ultimate load shall not exceed the deflection of the dry test assemblies at the same load level by more than 33 percent. Magnesium oxide board that fails to meet this standard shall not qualify for racking shear resistance in cold-formed steel and wood light-frame wall construction (Section 402.3 of this standard).

Exception: For magnesium oxide board sheathing not subjected to wetting during construction or while in service (such as that for interior use), loss of strength and stiffness from wet testing need not be considered.

402.3.4.2.2 Determination of Nominal Racking Shear Load Values. Test results from the dry testing shall be used to determine nominal racking shear load values. The nominal racking shear load value shall be taken as the lowest ultimate racking shear of the three dry test assemblies reduced for lumber specific gravity using a multiplication adjustment factor (Specific Gravity Adjustment Factor) for spruce-pine-fir derived from Equation 4-1, with the Specific Gravity Adjustment Factor not greater than 1.0:

Equation 4-1 Specific Gravity Adjustment Factor = 1 - (SG - 0.42)

where:

SG = Nationally recognized specific gravity of the lumber species used in the testing.

402.3.4.2.3 Determination of Allowable Design Racking Shear Load Values. The allowable design racking shear load value (pounds per foot or N/m) for each tested configuration shall be the lesser of the loads determined based on the ultimate load limit and a drift limit, determined in accordance with Sections 402.3.4.2.3.1 and 402.3.4.2.3.2.

402.3.4.2.3.1 Ultimate Load. The allowable design racking shear load (pounds per foot or N/m) is the nominal racking shear load value divided by the length of the tested shear wall divided by a safety factor determined in accordance with applicable engineering practice for the framing type and intended use. The safety factor shall be reported in the analysis.

402.3.4.2.3.2 Drift Limit. The allowable design racking shear load (pounds per foot or N/m) based on drift the average applied load In pounds (or N) that causes a net deflection of 0.2 inch (5.1 mm), divided by the length of the tested shear wall.

402.3.5 Statements and Limitations. The manufacturer's installation instructions shall include the following statements and limitations regarding use of the magnesium oxide board sheathing in shear walls.

402.3.5.1 Installation. Installation shall be in accordance with Sections 402.3.5.1.1 through 402.3.5.1.4.

402.3.5.1.1 Holes and Notches in Framing Members. A statement that holes and notches in the framing of shear walls in the end use conditions will be as permitted by the code or code-referenced documents.

402.3.5.1.2 Penetrations. A statement that holes in the magnesium oxide sheathing shall be limited to the sizes and locations ascertained by testing.

402.3.5.1.3 Aspect Ratios. The shear wall height-to-width aspect ratio of 1:1, or the aspect ratio determined in accordance with Exception to Section 402.3.3 , shall be reported in the installation instructions.

402.3.5.1 Manufacturer's Instructions. The tested shear wall configurations shall be detailed in the manufacturer's installation instructions.

402.3.5.2 Conditions of use. The following Conditions of use for the magnesium oxide board sheathing used as shear walls shall be included in the manufacturer's installation instructions, as applicable.

402.3.5.2.1 Special Inspections. Special inspections shall be provided in accordance with the applicable building code when magnesium oxide board sheathing is incorporated into the Wind-Resistance Components or Seismic Resistance of the structure.

402.3.5.2.2 Seismic Design Categories A, B and C. The magnesium oxide board sheathing used as shear walls is evaluated for use in Seismic Design Categories A, B and C, with earthquake load resistance determined using the maximum values of R = 2.O, Ω_0 = 2.5, and C_d = 2.0 shall be noted in accordance with Section 402.3.5.2.2.1 or Section 402.3.4.2.2.2.

402.3.5.2.3 Either as noted in the following Sections 402.3.5.2.3.1 or 402.3.5.2.3.2, as applicable:

402.3.5.2.3.1 Water Resistive Barrier. The magnesium oxide board sheathing shall be covered by an approved water-resistive barrier and an approved exterior cladding.

402.3.5.2.3.2 Not Subject to Wetting. The magnesium oxide board sheathing is evaluated for use in applications where the sheathing is not subject to wetting during construction or in-service use.

402.3.5.4 Engineered Design. A statement that allows for use under the IRC when engineered design is submitted.

402.4 Exterior Wall Sheathing Resistance to Transverse Loads. Tests to determine resistance of magnesium oxide board exterior wall sheathing to transverse loads shall be conducted in accordance with this section.

402.4.1 General: Structural tests are required to determine allowable positive (inward) and negative (outward) pressures that may be imposed on the sheets and their fastening system. The test specimens shall represent the critical conditions of installation. This includes maximum size and support spacing and minimum sheet thickness, support material thickness, density, connections, and any other conditions that affect the structural performance of the sheets.

402.4.2 Testing. Testing shall be done according to ASTM E72 At least three positive and three negative load tests shall be conducted with sheets fastened to the framing system in accordance with the published installation instructions. Tests shall be conducted on systems assembled without the use of adhesives.

402.4.3 Testing Assemblies. Test assemblies shall be a minimum of 4 feet by 8 feet (1219 mm by 2438 mm). [Four-foot-by-4-foot (1219 mm by 1219 mm) specimens can be used if the sheet spans between framing members without bearing on the top and bottom headers.] Load deflection readings at the midpoint of sheet spans shall be reported.

402.4.4 Conditions of Acceptance. Allowable loading shall be based on a factor of safety of 3 applied to the average ultimate load, if all of the following are satisfied:

1. Allowable load does not exceed established values for mechanical connectors such as nails and screws.

2. No single test result varies by more than 15 percent from the average of three tests. Variations exceeding this limit will result in larger safety factors.

402.4.5 Humidified Deflection. Tests shall be in accordance with ASTM C473, Section 14, except that the humidified detection measurement shall be reported to the nearest 0.01 inch. A minimum of three specimens shall be used.

402.4.6 Fastener Lateral Load. Testing shall be in accordance with ASTM D1037, Sections 13 through 16. A minimum of five specimens for each environmental exposure condition shall be used.

402.5 Ceiling Applications (Optional). Ceiling applications shall be in accordance with Sections 402.5.1 through 402.5.2

402.5.1 Humidified Deflection. Humidified Deflection. A of tests on the reinforced cementitious sheets shall be submitted in accordance with Section 402.4.5 of this standard. The humidified deflections shall be less than or equal to values shown in Table 402.5.1.

Table 402.5.1 - HUMIDIFIED DEFLECTION CRITERIA

INTENDED USE	DEFLECTION (inch), maximum
Ceiling Finish (textured or painted)	5/16
Base for tile	0.0639[1]

For **SI**: 1 inch = 25.4 mm; 1 lbf = 4.48 N

1- Based on 1/360 of 23-inch test span

402.5.2 Fastener Holding. A report shall be submitted of fastener lateral load tests in accordance with Section 402.4.6. The specifications of the fastener and connected material shall be representative of the end-use. The lateral load strength of the tested configurations shall be greater than or equal to values provided in Table 402.5.2.

Table 402.5.2 - FASTENER LATERAL LOAD CRITERIA

PANEL THICKNESS	PEAK LOAD (lbf), minimum
Less than ½ inch	60
½ inch or greater	90

For **SI**: 1 inch = 25.4 mm; 1 lbf = 4.48 N

402.6 Braced Wall Panels under the International Residential Code. Braced wall panels intended to be used under the IRC shall comply with Sections 402.6.1 through 402.6.

402.6.1 General. Magnesium oxide board sheathing intended for use as braced wall panels under the International Residential Code® (IRC®), equivalency to a code-specified wall bracing material shall be determined in accordance with this section. Such equivalence shall be limited to the sizes and types of materials used in racking shear qualification testing. Representative specimens shall be taken from the sheathing of the racking shear test assemblies for fingerprint testing of the sheathing. The specific test property and test procedure selected for the fingerprint testing need to be the same property and test procedure used in the quality control procedures for the continued manufacturing of the sheathing, to provide assurance of the equivalent racking shear performance A sufficient number of specimens shall be tested to establish the quality control conditions of acceptance to be specified in the quality documentation (see Section 5.0).

402.6.2 Wall Bracing Panel Evaluation. The magnesium oxide board sheathing shall be tested and analyzed in accordance with Section 402.6.3. The description of the test assemblies in the test report shall include the following:

1. The height and length of the assemblies.

2. A description of the magnesium oxide board sheathing, including the thickness, width, length, and installation orientation of the sheathing on the framing and location of the vertical sheathing joint. In addition, the test report shall include the results of the fingerprinting tests of the sheathing used in the racking shear test assemblies. See Section 3 1 for additional Information regarding the required sheathing fingerprinting.

3. The description of the framing members of the tested assembly shall include stud spacings, dimensions, thickness, and if wood framing, the species, grade, specific gravity, and moisture content. Where framing members are wood the framing members shall be sawn lumber, having a nominal 2-inch (50.8 mm) thickness, with grading standards and specifications described in the applicable code. Top and bottom plates shall be continuous over the length of the tested assembly. See Section 402.6.3.1.1 for

the required lumber species for the intermittent braced wall panels, and Sections 402.6.3.2.1 and 402.6.3.2.3 for the continuously sheathed braced wall panels.

4. Fasteners shall be described in the test report, including fastener type, diameter, length, spacing, and location. Fasteners used in the sheathing-to-framing connections shall be code-specified fasteners, or else data described in applicable acceptance criteria or specification for proprietary fasteners shall be submitted. Fasteners used in the stud-to-plate connections of the tested assemblies shall be code-specified fasteners. Sheathing-to-framing and stud-to-plate connection details shall be described in the test report. Connections and anchorages for the attachment of the wall assembly to the test frame shall be detailed or adequately described in the test report.

5. The framing of the assemblies tested under Sections 402.6.3.1 and 402.6.3.2 do not need to include holes or notches in the framing members. Holes and notches in framing members in the end-use conditions will be as permitted in the IRC.

6. Sheathing Penetrations and Joints shall be in accordance with the following:

    6.1 Penetrations in the magnesium oxide board sheathing will be permitted only at predetermined locations. The test assemblies shall include the size and location of hole(s) in the sheathing as intended for end-use. The manufacturers installation instructions shall state the limitations for hole sizes and locations ascertained by testing.

    6.2 The joints in the magnesium oxide board sheathing shall occur over framing members or shall be blocked, with the sheathing attached to the framing members and blocking. Sheathing tested with unblocked horizontal joints may be evaluated for this method of installation.

402.6.3 Test Methods and Analysis Requirements. Test methods and analysis for intermittent braced wall panel construction shall be in accordance with Section 402.6.3.1 and for continuously sheathed braced wall panels shall be in accordance with Section 402.6.3.2.

402.6.3.1 Intermittent Braced Wall Panel Construction. The racking shear load testing of the magnesium oxide board sheathing for use as intermittent braced wall panels shall be in accordance with Section 14 of ASTM E72. The test specimen shall be allowed to recover for five minutes after the load is removed following the first and second loading stages. Where framing members are wood, the specific gravity (oven-dry basis) of the framing members receiving sheathing fasteners shall be determined in accordance with ASTM D2395. Specific gravity measurements taken at moisture contents other than oven-dry condition shall be adjusted to the oven-dry moisture content in accordance with Appendix X1 of ASTM D2395. The moisture content of wood framing members shall be determined in accordance with ASTM D4442, ASTM D4444, or ASTM D7438.

402.6.3.1.1 Test Assembly Construction. The test assemblies shall be 8 feet high by 8 feet long (2438 by 2438 mm) and constructed in accordance with Section 402.6.2. The framing shall be in accordance with Figure 6 of ASTM E72, except that the stud spacing shall be the maximum intended for use, but is not to exceed 24 inches (610 mm) on center. Where framing members are wood, the framing members, receiving sheathing fasteners, shall comply with Section 402.6.2(3) and be spruce-pine-fir, Douglas fir-larch, Southern pine or other lumber species conforming to NIST Voluntary Product Standard PS 20. Framing members receiving sheathing fasteners, shall have a measured average specific gravity (oven-dry basis) not exceeding the nationally specified value plus 0.03 for the species of framing members in accordance with Table 12.3.3A of the 2018 and 2015 NOS [Table 11.3.3A of the 2012 NOS for the 2012 IRC] and a measured average moisture content of 15 percent or less. The magnesium oxide board sheathing shall be attached to the framing using fasteners specified in Section 402.6.2(4). Sheathing-to-framing fastener spacing shall be consistent with the manufacturer's installation instructions, but shall not exceed 12 inches (304.8 mm) along intermediate framing members and 6 inches (152.4 mm) along sheathing edges. Fasteners used to attach the sheathing to the framing shall be placed at the minimum edge distance to be specified in the manufacturer's installation instructions along all sheathing edges. The test assemblies shall be constructed without gypsum wallboard or any other sheathing installed on the opposite face of the wall framing. The proprietary sheathing shall be installed with a vertical sheathing joint.

402.6.3.1.1.1 Test Repetitions and Conditioning. A minimum of six identical assemblies shall be tested. Three assemblies shall be tested in a dry (as received) condition as described in ASTM E72 Section 14. The remaining three assemblies shall be subjected to wet conditioning in accordance with ASTM E72 Section 15.

> **Exception:** For sheathing evaluated for installation only Interior walls or partitions, not subjected to wetting during construction or in-service, the testing of three assemblies conditioned in accordance with ASTM E72 Section 1 5 (wet test) s not required.

402.6.3.1.2 Data Analysis. Data analysis shall be in accordance with this section.

402.6.3.1.2.1 Nominal Unit Shear Capacity Value. The tested nominal unit shear capacity value shall be taken as the lowest peak unit shear capacity of the three dry test assemblies. Where framing members are wood and the lumber species is other than spruce-pine-fir, the tested nominal unit shear capacity value shall be reduced to normalize the data to spruce-pine-fir. For code-specified nails, a multiplication adjustment factor (Specific Gravity Adjustment Factor) derived from Equation 4-2 shall be used. For code-specified staples, the adjustment factors given in footnote (a) to IBC Table 2306.3(1) shall be used For proprietary fasteners, a specific gravity adjustment factor equation shall be derived based on the test results of proprietary fasteners tested with multiple lumber species.

Equation 4-2 Where Specific Gravity Adjustment Factor is not greater than 1.0:

$$\text{Specific Gravity Adjustment Factor} = 1 - (SG - O.42)$$

where:

SG = Nationally recognized specific gravity of the lumber species used in the testing.

402.6.3.1.2.2 Conditions of Acceptance. The criteria for acceptance specified in Sections 402.6.3.1.2.2.1, 402.6.3.1.2.2.2, and 402.6.3.1.2.2.3 shall be satisfied.

402.6.3.1.2.2.1 Stiffness Criteria. Based on the average net deflection of each set of three tested wall assemblies, the net average deflection shall not exceed the deflection limits for the two load levels noted in Table 402.6.3.1.2.2.1. The Table 402.6.3.1.2.2.1 detection limits are for two load levels stated as a percentage of the tested nominal unit shear capacity determined for the dry racking test series. All applicable deflection limits of Table 402.6.3.1.2.2.1 must be satisfied.

Exception: Wet racking deflection criteria of Table 402.6.3.1.2.2.1 are not applicable to proprietary sheathing addressed by the exception in Section 402.6.3.1.2.

402.6.3.1.2.2.2 Deflection at Peak Load Criteria. The average net deflection at the peak load for each set of three wall assemblies tested dry shall not be less than 0.75 inch (19.1 mm).

402.6.3.1.2.2.3 Strength Criteria. The tested nominal dry unit shear capacity value for cold-formed steel framed wall assemblies, and wood light-framed wall assemblies adjusted for wood species from Section 402.6.3.1.2.2.1, shall be equal to, or exceed the appropriate value indicated in Table 402.6.3.1.2.2.3 and the average peak racking shear value of the wet shear tests must be at least 77 percent of the average peak dry racking shear test.

Exception: Wet racking strength criteria are not applicable to proprietary sheathing addressed by the exception in Section 402.6.3.1.1.1.

Table 402.6.3.1.2.2.1 - DEFLECTION (STIFFNESS) CRITERIA

APPLIED RACKING SHEAR LOAD (PERCENTAGE OF NOMINAL UINT SHEAR CAPACITY VALUE)[1]		MAXIMUM AVERAGE NET DEFLECTION[2] (inch)	
		Dry Racking Tests (ASTM E72 Section 14 Conditioning)	Wet Racking Tests (ASTM E72 Section 15 Conditioning)
23%		0.2	0.28
46%		0.6	0.80

For **SI**: 1 inch = 25.4 mm

[1]The nominal; unit shear capacity value should be permitted to be reduced to achieve compliance with the listed deflection limits. Consequently, the reduced nominal unit shear value shall be used to determine equivalency in accordance with Section 402.6.3.1.2.2 and Table 402.6.3.1.2.2.3 .

[2]The measured average net deflection at the dry peak load shall also meet the requirements of Section 402.6.3.1.2.2.2.

Table 402.6.3.1.2.2.3 – NOMINAL UNIT SHEAR CAPACITY VALUES FOR EQUIVALENCY TO THE IRC INTERMITTENT BRACED WALL PANEL METHODS[1]

METHOD[2]	MATERIAL	NOMINAL UNIT SHEAR (plf)
GB	Gypsum wallboard (single sided)	200
DBS, WSP, SFB, PBS, PCP, or HPS	Diagonal Wood Boards, Wood Structural Panels, Structural Fiberboard Sheathing, Particleboard Sheathing, Portland Cement Plaster, or Hardboard Panel Siding	500 560[3]

For **SI**: 1 lbf = 14.6 n/M

[1]Design properties are based on use of spruce-pine-fir framing lumber and are rounded to the values indicated for the grouped bracing methods.

[2]See IRC Table R602.10.4 for full description.

[3]For magnesium oxide board sheathing where qualification is sought for use as continuously sheathed braced wall panels using the CS-WSP method, the nominal unit shear value tested with spruce-pine-fir or Douglas fir-larch lumber shall be 560 lbf and the net deflections shall not exceed 0.2 inch and 0.6 inch at 200 lbf and 400 lbf target unit shear values, respectively. The tested nominal unit shear values and target unit shear values shall not be adjusted for spruce-pine-fir framing.

402.6.3.1.2.3 End-Use Bracing Requirements. For the code-specified bracing method(s) for which equivalency is demonstrated under Section 402.6.3.1.2.2, the sheathing used in wall bracing panels shall follow the prescribed lengths which are specified in IRC Table R602.10 3(1), modified by the applicable adjustment factors of IRC Table R602 The minimum braced wall panel length shall be 48 inches (1219 mm) for wall height up to 10 feet (3048 mm), 53 inches (1346 mm) for walls not exceeding 11 feet (3352 mm) in height, and 58 inches (1473 mm) for walls not exceeding 12 feet (3658 mm) in height, in accordance with IRC Table R602 IOS The proprietary sheathings shall be installed on wall framing in a manner consistent with the installation used in the construction of test assemblies under Section 402.6.3.1.1.

402.6.3.2 Continuously Sheathed Braced Wall Panels. Continuously sheathed braced wall panels shall be in accordance with this section.

402.6.3.2.1 General. Magnesium oxide board sheathing evaluated successfully for compliance with the requirements of Section 402.6.3.1 as an alternative to the WSP intermittent bracing method shall be permitted to be additionally evaluated as an alternative to the continuously sheathed wood structural panel bracing method (CS-WSP) of IRC Section R602.10.4 under this standard section, provided the racking shear tests described Section 402.6.3.1 are conducted on test assemblies constructed with the sheathing attached to spruce-pine-fir or Douglas fir-larch framing and the tested nominal unit shear value determined in accordance with Section 402.6.3.1.2.1 is equal to or greater than 560 plf. In addition to the conditions of acceptance in Section 402.6.3.1.2.2, the testing shall also show that, at target unit shear values of 200 plf and 400 plf, the net detections do not exceed 0.2 inch and 0.6 inch, respectively. The tested nominal unit shear value and the target unit shear value shall not be adjusted for the spruce-pine-fir framing.

402.6.3.2.2 Test Method. Racking shear testing shall be conducted in accordance with ASTM E564 and incorporating the use of a load beam. The load beam and base fixture shall not be in contact with the sheathing and shall not interfere with movement of the sheathing during the test procedure. A displacement-controlled ramp function shall be permitted in lieu of the loading

procedure of ASTM E564 when an electronic data acquisition system is used. The maximum load shall be achieved in not less than five minutes and not more than twenty minutes or, alternatively, a displacement rate of 0.3 inch/minute shall be used.

Where framing members are wood, the specific gravity (oven-dry basis) of the wood framing members receiving sheathing fasteners of shall be determined in accordance With ASTM D2395. Specific gravity measurements taken at moisture contents other than oven-dry condition shall be adjusted to the oven-dry moisture content in accordance with Appendix X1 of ASTM D2395.

The moisture content of wood framing members shall be determined in accordance with ASTM D4442, ASTM D4444, or ASTM D7438.

402.6.3.2.3 Test Assembly Construction. Where framing members are wood, the wood framing members shall be spruce-pine-fir, or Douglas fir-larch, having a measured average specific gravity (oven-dry basis) of the framing members receiving sheathing fasteners that does not exceed the nationally specified value plus 0.03 for the species of framing members in accordance with Table 12.3.3A of the 2018 and 2015 NOS [Table 11.3.3A of the 2012 NOS for 2012 IRC] and a measured average moisture content of 15 percent or less. Stud spacing shall be the maximum intended for use, but must not to exceed 24 inches (610 mm) on center The sheathing shall be attached to framing using the fasteners specified in Section 402.6.2(4). Sheathing-to-framing fastener spacing shall be consistent with the manufacturer's installation instructions, but must not exceed 12 inches (3048 mm) along Intermediate framing members and 6 Inches (152.4 mm) along sheathing edges. Fasteners used to attach the sheathing to the framing shall be placed at the minimum edge distance to be specified in the manufacturer's installation instructions along all sheathing edges The test assemblies shall be constructed, without gypsum wallboard or any other sheathing installed on the opposite face of the wall framing, in accordance with the wall types of Table 402.6.3.2.3 and the following:

402.6.3.2.3.1 Specimen Configuration. Wall Type 1 shall be an 8-foot-by-8-foot (2 4 m by 2 4 m) specimen with the sheathing installed with a vertical sheathing joint. Wall Type 2 shall be an 8-foot-high-by-12-foot-long (24 m by 3.6 m) specimen with a 2-foot-long (0.6 m) comer return at each end of the wall panels. Wall Types 3 through 7 shall be a minimum of 8 feet (24 m) high and 12 feet (360 m) long, and shall have a minimum of one opening. Each opening shall be a minimum of 4 feet (12 m) wide. Wall panels shall have the minimum length permitted by IRC Table R602 10.5, based on the adjacent openings. Each opening height included in IRC Table R602 10.5 (i.e., 100 percent, 85 percent, and 65 percent of wall height) shall be incorporated in at least one wall type.

402.6.3.2.3.2 Overturning Restraints. Hold-down connectors or a corner return overturning restraint shall be provided at the wall ends as indicated in Table 402.6.3.2.3. Where specified in Table 402.6.3.2.3, hold-downs shall be rated at an ASD allowable tensile capacity of not greater than 2,500 pounds for the species of wood framing used in the test wall assemblies to prevent an overturning failure mode.

402.6.3.2.3.3 Number of Assemblies. One wall assembly of each wall type of Table 402.6.3.2.3 shall be tested with the sheathing and fasteners from the same sampling group, except that two wall assemblies of Wall Type 1 shall be tested.

402.6.3.2.3.3.1 Wall Type 1 noncompliance. If the results from either of the two tests of Wall Type 1 do not comply with Section 402.6.3.2.4.1, a minimum of one additional test of wall Type 1, with the sheathing and fasteners from the same sampling group used in the first test, shall be required.

402.6.3.2.3.3.2 Wall Type 1 through 7 noncompliance. If the results of any one of the tests of Wall Type 2 to Wall Type 7 do not comply With Section 402.6.3.2.4.2, a minimum of one additional test of each and every one of the specimens of Wall Type 2 to Wall Type 7, with the sheathing and fasteners from the same sampling group used in the first test, is required

402.6.3.2.3.4 Boundary Conditions for Testing Purposes. Anchor bolts and hold-down devices shall be tightened to no more than finger tight plus 1/8 turn. The loading beam shall have a bending stiffness capacity, *EI*, of no more than 35,000 kip-in^2 (100 kN-m^2) and shall not interfere with displacement of the sheathing. Additional gravity load shall not be applied to the specimens or testing fixtures. Bottom plate shall be anchored to the test apparatus using 5/8-inch-diameter (15.9 mm) anchor bolts spaced at 24 inches (610 mm) on center with 3-inch-by-3-inch-by-1/4-inch-thick (76 mm by 76 mm by 6.35 mm thick) square plate washers installed between the plate and the nut. Anchor bolt spacings exceeding 24 inches (610 mm) on center may be considered, provided a suitable engineering evaluation is performed. Anchor bolts shall be located not more than 13 inches (330 mm) nor less than 11 inches (279 mm) from each end of the wall. For Wall Type 2 of Table 402.6.3.2.3, one anchor bolt shall be centrally located in the bottom plate of the comer return not more than 15 inches (381 mm) nor less than 13 inches (330 mm) from the contact surface between the common comer stud and the wall sheathing. A 2-foot-by-2-foot-leg (610 by 610 mm) triangular gusset plate of 7/16-inch-thick (11.1 mm) OSB shall be placed on top of the wall plates at the corner. Each 2-foot (610 mm) leg of the gusset plate shall be face-nailed to the top plates of the wall and corner return at 6 inches on center using 8d common nails. For Wall Type 2, the magnesium oxide board sheathing on the corner return and wall shall be fastened to the common comer stud using the required edge fastening requirement for the magnesium oxide board sheathing.

402.6.3.2.4 Conditions of Acceptance. Each wall shall be tested with prefabricated hold-downs, except for walls of Type 2, which shall be tested with corner returns lieu of hold-downs, to establish its peak unit racking shear strength and its drift at reference shear load (for Wall Type 1, the net deflections at specified unit shear loads).

402.6.3.2.4.1 Wall Type 1. For wall Type 1, if only two walls are tested, the peak unit racking shear strength of each shall be equal to or greater than 560 plf, and at unit shear values of 200 plf and 400 plf, the net deflections (see Section 202 of each wall shall not exceed 0.2 in and 0.6 in, respectively. If more than two walls are tested, the average peak unit racking shear strength of all walls tested shall be equal to or greater than 560 plf and at unit shear values of 200 plf and 400 plf, the average net deflections of all walls tested shall not exceed 0.2 and 0.6 inches, respectively.

402.6.3.2.4.2 Wall Types 2 through 7. If only one test is performed for each wall of Types 2 through 7, the measured peak racking shear loads of each of the tested assemblies of Wall Types 2 through 7 shall be equal to or greater than the predicted peak racking shear capacity; and, the drift at reference shear load for each of the tested assemblies of Wall Types 2 through 7 shall not exceed 0.6 inch. If more than one test is performed for each wall of Types 2 through 7, the average peak racking shear load for all walls of a given type shall be equal to or greater than the predicted peak racking shear capacity value for that wall type; and, the average drift at reference shear load for all walls of a given type shall not exceed 0.6 inch. The predicted peak racking shear capacity values shall be determined as the product of the reduction factor from Table 402.6.3.2.3, the measured average peak unit racking shear strength from Wall Type 1 test assembly, and the overall length of the wall type to be evaluated. The drift at reference shear load shall be at racking shear loads determined as the product of 280 plf unit shear strength, the reduction factor from Table 402.6.3.2.3,, and the overall length of the wall type to be evaluated. In all cases, the drift at reference shear load shall be determined as defined in Section 202.

402.6.3.2.5 End-use Bracing Amounts. For continuously sheathed braced wall panels, the bracing amounts for end-use installations shall be the bracing amount (length) as specified in IRC Table R602 as adjusted by IRC Table R602.10 3(1) for continuous sheathing (CS-WSP Method). The magnesium oxide board sheathings shall be installed on wall framing consistent with the manner of installation used in the construction of test assemblies under Section 402.6.3.2.3 .

402.6.4 Statements and Limitations. The statements and limitations shall comply with this section.

402.6.4.1 Installation. The following is information that shall be included in the manufacturer's installation for the magnesium oxide board sheathing used as braced wall panels:

402.6.4.1.1 Proprietary Fasteners. Proprietary fasteners, if used in the test wall assemblies, shall be described in the manufacturer's installation instructions.

402.6.4.1.2 Holes and Notches in Framing Members. Holes and notches may be installed in the framing as limited by size and location specified in the IRC Section R602.6.

402.6.4.1.3 Penetrations in Bracing Materials. Penetrations in the proprietary sheathing evaluated under Section 402.6.3.1 will be permitted only at the predetermined locations as justified by the testing under this standard for both intermittent and continuous sheathing.

402.6.4.1.4 Minimum Length of Braced Wall Panels and Minimum Total Length of Braced Wall Panels along a Braced Wall Line. The minimum length of braced wall panels and the minimum total length of braced wall panels with the magnesium oxide board sheathing along a braced wall line shall be as specified in Sections 402.6.3.1.2.3 and 402.6.3.2.5, as applicable

402.6.4.1.5 Detailing Requirements. The wall assembly conditions specific to the proper installation of the magnesium oxide board sheathing and construction of the wall panel framing as evaluated under this standard shall be detailed in the manufacturer's installation instructions.

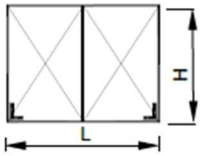
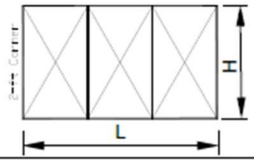
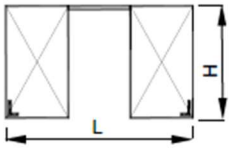
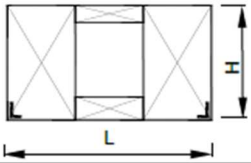
Details that rely on prescriptive requirements in the IRC shall be noted as such in the installation instructions and differentiated from details specific to the magnesium oxide board sheathing.

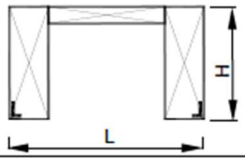
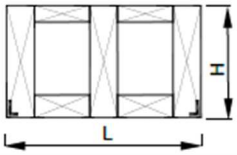
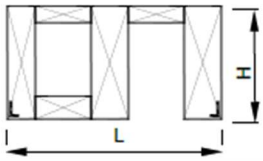
402.6.4.1.6 Maximum Stud Spacing. The maximum stud spacing permitted shall be the on-center stud spacing used in the tested assemblies under Section 402.6.3.1.1 or Section 402.6.3.2.3 .

402.6.4.2 Gypsum wallboard. The manufacturer's installation instructions shall include a statement that gypsum wallboard is to be installed on the side of the wall opposite to the bracing material/magnesium oxide board sheathing in accordance With IRC Section R602.10.4.3.

402.6.4.3 The manufacturer's installation instructions shall indicate that the magnesium oxide board sheathing has been evaluated for use in braced wall panels in Seismic Design Categories A, B, and C (excluding townhouses in SOC C) and areas where wind design is not required per IRC Section R301.2.1.1. The installation instructions shall also include a statement that the use of sheathing in other conditions is outside the scope of the permitted uses and installations.

Table 402.6.3.2.3 – TEST MATRIX AND CRITERIA FOR CONTINUOUS SHEATHED BRACED WALL PANELS

WALL TYPE ID	WALL TYPE CONFIGURATION[1]	SIZE H x L	CLEAR OPENING HEIGHT (% of H)	REDUCTION FACTOR[2,3]	TYPES OF OPENINGS	SEGMENT ASPECT RATIO[4]	PURPOSE OF TEST
1		8x8	0%	1.0	None	1:1	Baseline
2		8x12	0%	0.79	None	1:1.5	Evaluate corner restraint for IRC equivalency
3		8x12	100%	0.43	Full height	2:1	IRC CS-WSP equivalency
4		8x12	65%	0.65	Window	2:1	IRC CS-WSP equivalency

5		8x13.3	85%	0.29	Door	3:1	IRC CS-WSP equivalency
6		8x14	65%	0.41	Two windows	4:1	IRC CS-WSP equivalency
7		8x15.3	65%, 85%	0.38	Window and door	4:1, 3:1	IRC CS-WSP equivalency

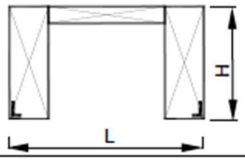
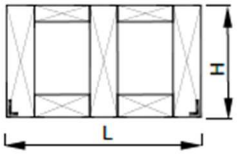
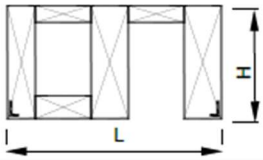
For **SI:** 1 foot = 0.3 m.

[1]Configurations 1 and 3 through 7 shall be tested with the same metal hold-down devices anchoring end studs of the wall as shown. Configuration 2 shall be tested with 2-foot-long corner returns (legs) at each end of the wall detailed in accordance with IRC Figure R602.10.4.4(1).

[2]The predicted peak racking shear capacity for use with Section 4.2.4 shall be determined as the product of the reduction factor, the measured unit racking shear strength from Wall Type 1 test assembly, and the overall wall length of the wall type to be evaluated.

[3]The drift at reference shear load for use with Section 4.2.4 shall be for shear loads determined as the product of 280 plf unit shear strength, the reduction factor, and the overall wall length of the wall type to be evaluated.

[4]Segment aspect ratio is the aspect ratio for an individual full height panel, using an 8-foot-high segment and the width of the panel. Aspect ratio is defined in Section R202 of the IRC.

5		8x13.3	85%	0.29	Door	3:1	IRC CS-WSP equivalency
6		8x14	65%	0.41	Two windows	4:1	IRC CS-WSP equivalency
7		8x15.3	65%, 85%	0.38	Window and door	4:1, 3:1	IRC CS-WSP equivalency

For **SI:** 1 foot = 0.3 m.

[1]Configurations 1 and 3 through 7 shall be tested with the same metal hold-down devices anchoring end studs of the wall as shown. Configuration 2 shall be tested with 2-foot-long corner returns (legs) at each end of the wall detailed in accordance with IRC Figure R602.10.4.4(1).

[2]The predicted peak racking shear capacity for use with Section 4.2.4 shall be determined as the product of the reduction factor, the measured unit racking shear strength from Wall Type 1 test assembly, and the overall wall length of the wall type to be evaluated.

[3]The drift at reference shear load for use with Section 4.2.4 shall be for shear loads determined as the product of 280 plf unit shear strength, the reduction factor, and the overall wall length of the wall type to be evaluated.

[4]Segment aspect ratio is the aspect ratio for an individual full height panel, using an 8-foot-high segment and the width of the panel. Aspect ratio is defined in Section R202 of the IRC.

CHAPTER 5 TILE BACKER

SECTION 501 GENERAL

501.1 General. Tile Backer shall comply with this section for all non-structural applications with tile overlayed and attached to a structural subfloor, wall, ceiling or external structural element.

SECTION 502 Performance

502.1 Performance. Testing and conditions of acceptance shall be in accordance with Sections 301 and 302 for all thicknesses and applications. Additional testing as listed below by application and thickness.

Exception: Tile backer for Wall, Ceiling, and Soffit use is exempt from 302.8

SECTION 503 Nonstructural Tile Backer

503.1 Nonstructural use in walls and ceilings. Tile backer for walls and ceilings shall comply with Section 301.

503.1.1 Freeze thaw for exterior installations. Tile backer for use in exterior installations shall comply with Section 302.3 with 50 cycles.

503.2 Nonstructural use in flooring underlayment. Tile backer for use as floor underlayment shall comply with Section 301.

503.2.1 Testing. Tile backer for use as floor underlayment shall be tested using Robinson Floor testing (ASTM C-627) which gives a use rating.

CHAPTER 6 RESERVED

CHAPTER 7 STRUCTURAL FLOOR SHEATHING ATTACHED TO COLD-FORMED STEEL OR WOOD FRAMING

SECTION 701 GENERAL

701.1 General. The testing and acceptance of Magnesium Oxide Board intended to be used as structural floor sheathing attached to cold-formed steel or wood framing shall be in accordance with this chapter.

SECTION 702 PERFORMANCE

702.1 Performance Requirements. Magnesium Oxide Board intended to be used as floor sheathing, structural cementitious panels shall be tested and analyzed in accordance with the requirements of Sections 5.1 through 5.10. The span ratings determined in accordance with Section 5.2 shall result in a minimum allowable uniform floor load of 60 pounds per square foot (2.87 kN/m2) at a deflection of 1/360 of the span.

702.2 Test Exposure Condition. The condition to which a panel is subjected prior to test. Generally, such conditions are referred to as dry or wet conditions.

702.2.1 Dry Condition. Specimens conditioned to represent dry conditions shall be placed in a controlled condition at 73 ±4°F and 50 ±5% humidity for a minimum of six days, or until the difference between two consecutive weight measurements, at intervals not less than twenty-four hours, is less than 0.1% by mass.

702.2.2 Wet Condition. Wet conditioning of full panels requires continuous wetting of panels held in a vertical condition for seven days, at an ambient temperature of 73 ±4°F, and tested while wet. Unless otherwise noted, wet conditioning of small-scale test specimens requires immersion in water at a temperature of 73 ±7°F for a minimum of 48 hours.

702.3 Structural Performance. Testing shall be performed under both dry and wet conditions.

702.3.1 Concentrated Loads. Panels shall be tested according to the procedures of ASTM E661 for concentrated static loads before and after impact loading. Impact testing shall be conducted in accordance with Section 8.5 of ASTM E661, using a 75 ft-lb impact for span ratings up to 24 inches on center, a 90 ft-lb impact for a span rating of 32 inches on center and a 180 ft-lb impact for a span rating of 48 inches on center (10.3, 12.4 and 24.7 m-kg for span ratings of 610, 815 and 1220 mm, respectively). A minimum of three tests shall be conducted for each test exposure condition. Panels shall comply with Table 702.3.1 for the intended span rating, under both wet and dry conditions.

TABLE 702.3.1—CONCENTRATED STATIC AND IMPACT TEST PERFORMANCE CRITERIA

FOR PANELS TESTED ACCORDING TO ASTM E661

SPAN RATING	PERFORMANCE REQUIREMENTS	
	Minimum Static Concentrated Load (lbf)	Maximum Deflection (inch)

	Before Impact	After Impact	Under 200-pound Load[1]
FLOOR SHEATHING			
Single Floor- 16	550	400	0.078
Single Floor- 20	550	400	0.094
Single Floor- 24	550	400	0.108

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N.

[1]Criteria shall apply to static concentrated load before and after impact.

702.3.2 Uniform Loads. Panels shall be tested according to the procedures of ASTM E330 for uniform loads. Specimens shall be tested in a two-span condition. A minimum of three replicate assemblies shall be tested. Panels shall comply with Table 702.3.2 for the intended span rating.

TABLE 702.3.2—UNIFORM LOAD PERFORMANCE CRITERIA FOR SHEATHING GRADE AND SINGLE FLOOR GRADE SHEETS

SPAN RATING (in.)	CONDITIONS AT TESTS[1]	MINIMUM PERFORMANCE REQUIREMENTS[4]	
		Average Deflection Under Load ($^1/_{360}$ of the span)[2,3]	Minimum Peak Load (psf)
16	Dry Wet/redry	0.044 in. at 60 psf	200
20	Dry Wet/redry	0.053 in. at 60 psf	200
24	Dry Wet/redry	0.067 in. at 60 psf	200

For **SI:** 1 inch = 25.4 mm, 1 lbf = 0.0045 kN, 1 psf = 0.0479 kN/m^2.

[1]Wet/redry shall be exposure to three days of continuous wetting, followed by testing dry. Dry shall be conditioned in accordance with ASTM E661.
[2]Maximum deflection of sheathing shall be measured relative to framing. The average value of all specimens shall be or below the tabulated requirements.
[3]Specimens shall be tested in two-span conditions.
[4]Loads may be increased such that the allowable total uniform gravity load for floor sheathing shall be the lesser of the peak uniform load determined from testing, divided by a safety factor of 3.0; and the uniform test load which produces a deflection of 1/360 of the span.

702.3.3 Fastener Holding. Panels shall be tested for fastener lateral load, withdrawal load, and pull-through load in accordance, respectively, with PS2, Section 7.4; ASTM D1037, Section 14; and ASTM D1037, Section 15. At the option of the panel manufacturer, fastener holding tests may be conducted using screws, nails, or both fastener types. Screws shall be Type S, No. 8 screws with a nominal diameter of 0.164 inch (4.17 mm) and a head diameter of 1/4 inch (6.4 mm). The screws shall be of sufficient length for at least three full threads to penetrate through the sheathing panel. Nails shall be 8d common smooth shank nails. Lateral loads shall be determined in both the machine and cross-machine directions. A minimum of twenty tests shall

be conducted for each test exposure condition under each load case. Panels shall comply with Table 702.3.3 of this criteria for the applicable panel thickness.

TABLE 702.3.3 — SCREW AND NAIL PERFORMANCE CRITERIA UNDER LATERAL LOADS, WITHDRAWAL LOADS, AND PULL-THROUGH LOADS

PANEL THICKNESS (inch)	CONDITION AT TEST	MINIMUM ULTIMATE LOAD (lbf)		
		Lateral	Withdrawal	Pull-Through
Greater than $^1/_2$	Dry	210	20	200
	Wet	160	15	150

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N.

702.4 Allowable Uniform Load for Floor Sheathing. The allowable uniform gravity load for floor sheathing shall be the lesser of the ultimate uniform load determined from testing, divided by a safety factor of 3.0; and the uniform test load which produces a deflection of 1/360 of the span. Determination of allowable uniform load for spans shorter than what is tested shall consider both flexural strength and shear strength of the sheathing panels.

702.5 Diaphragms for Cold-Formed Steel Framing (Optional): Cold-formed steel framing used in the test assemblies shall comply with the appropriate standard for the quality of steel specified. Compliance shall be determined by test reports submitted by the mill or an accredited testing laboratory. Where the number of steel coupon specimens is not noted in the specific standard, a minimum of two steel coupon specimens shall be tested to determine compliance with the appropriate standard and to determine the minimum uncoated steel thickness and strength. Steel tension tests and elongation calculations shall be performed in accordance with ASTM A370.

702.5.1 Diaphragm Testing. At a minimum, diaphragm testing shall be performed in accordance with AISI S907 to determine the nominal shear strength and nominal shear stiffness of the assemblies. Instead of testing assemblies with at least five panels, as required by AISI S907, test assemblies shall consist of the following: five or more support spans; end and edge sheathing joints; fastening consistent with the panel manufacturer's installation instructions; and installation conditions (including block/unblocked joints) which are to be addressed in the evaluation report. In addition, at the manufacturer's option, Simple Beam Diaphragm testing shall be performed in accordance with ASTM E455, to determine the nominal shear strength and nominal shear stiffness of a diaphragm loaded parallel to the repetitive cold-formed steel framing members. The expected maximum diaphragm assembly test load shall be estimated for the purpose of determining the appropriate test load increments and test load rate for full-scale diaphragm tests. Full-scale diaphragm assembly tests shall be conducted using the minimum specified number of load increments and the minimum load rate specified in AISI S907 or ASTM E455, as applicable.

702.5.2 Analysis. Analysis of diaphragm assembly test results, sealed by a registered design professional, shall be provided to determine/verify the following:

1. The equation used to determine diaphragm deflection.

2. The nominal shear strengths, in pounds per linear foot, for the diaphragm assemblies to be addressed in the evaluation report. The nominal diaphragm shear strengths shall be based on testing in accordance with Section 702.5.1, but shall not exceed the nominal shear strength reported in the evaluation report on the screw, multiplied by the number of screws per foot at the perimeter of the diaphragm

3. Available strengths for the diaphragms using a safety factor, Ω, of 2.8 and a resistance factor, ϕ, of 0.6, as applicable, in accordance with Section B5.4.2.5 of AISI S240.

4. The minimum edge and end distances of the fasteners installed in the sheathing and in the steel framing.

SECTION 703 DIAPHRAM TESTING FOR WOOD FRAMING (OPTIONAL)

703.1 Diaphragm testing for Wood Framing (Optional): Diaphragms on wood floor framing assemblies shall comply with this section.

703.1.1 General. The shear strength and shear stiffness of fiber-reinforced cement sheathing used as the web of a horizontal wood-framed floor diaphragm shall be based on tests conducted in accordance with Section 4.4 of this criteria. The test shall include sufficient details for each diaphragm assembly; such as: descriptions of each diaphragm assembly; specifications of diaphragm components; diaphragm sizes; installation pattern of the floor sheathing; fastener location and spacing; test setup; descriptions of the test procedure; the means of determining the expected maximum diaphragm test load and all details pertinent to the test.

703.1.1.1 Maximum Test Load. The expected maximum diaphragm assembly test load shall be estimated for the purpose of determining the appropriate test load increments and test load rate for full-scale diaphragm tests. The results of the connection tests noted in Section 3.6.4 of this criteria, or other alternative methods, are permitted to be used to estimate the expected maximum diaphragm assembly test load. Regardless of estimation method used, full-scale diaphragm assembly tests shall be conducted using the minimum specified load rate specified in Section 9.0 of ASTM E455.

703.1.1.2 Specimens. Diaphragm tests shall be conducted on a minimum of three similar specimens. For unblocked diaphragms, there shall be at least three additional assemblies for each configuration so the test may be conducted with the load applied in two orthogonal directions.

703.1.2 Density of Fiber-Reinforced Sheets. Density tests shall be performed in accordance with ASTM C1185 Section 6 on fiber-reinforced sheets used in the connection and diaphragm tests. The density test results shall be reported.

703.1.3 Wood Framing. Specific gravity and moisture content shall be measured and reported of wood framing members used in connection and diaphragm tests. The specific gravity and moisture content tests may be performed in accordance with ASTM D2395 and ASTM D4442, respectively. The wood framing shall be representative of the end use condition with a minimum nominal width of 2 inches (50.8 mm).

703.1.4 Fasteners. Data in accordance with this section shall be submitted.

703.1.4.1 Bending Yield Strength. For nails intended for use in structural applications, bending yield strength, F_{yb}, shall be evaluated according to ASTM F1575. Testing for unhardened, smooth shank nails shall be done on either the finished nail or specimens of drawn wire stock. Tests for hardened nails and for deformed shank nails shall be done on the fully manufactured nail products. Test specimens shall be randomly selected to represent the parent population of nails in accordance with the objectives of the test program. At least 15 replicates shall be tested for each nail type. Test reports shall include the following:

1. Calculation of F_{yb} for each nail according to the Annex of ASTM F1575.

2. Average calculated bending yield strength.

3. Other requirements as described in Section 11 of ASTM F1575.

At a minimum, the average bending yield strength for each nail type shall comply with Table 701.2(1). When the applicant specifies minimum bending yield strengths which exceed the applicable values in Table 703.1.4.1, the tested bending yield strength shall comply with the applicant's specifications.

TABLE 703.1.4.1 —MINIMUM BENDING YIELD STRENGTHS FOR STRUCTURAL NAILS

NOMINAL NAIL DIAMETER (inch)	MINIMUM BENDING YIELD STRENGTH (psi)
Unhardened1	
0.099 ≤ D ≤ 0.142	100,000
0.142 < D ≤ 0.177	90,000
0.177 < D ≤ 0.254	80,000
0.254 < D ≤ 0.273	70,000
Hardened2	
0.120 ≤ D ≤ 0.142	130,000
0.142 < D ≤ 0.192	115,000
0.192 < D ≤ 0.207	100,000

For SI: 1 inch = 25.4 mm, 1 psi = 6.89 kPa
1Reference IBC Section 2303.6 and Table S1.1 of ASTM F1667.
2Reference Table S1.2 of ASTM F1667

703.1.4.2 Dowell Bearing Strength. When needed for rational analysis in accordance with Section 3.3.1.1, dowel bearing strength shall be determined. Dowel bearing strengths for nails

with a diameter of 0.099 inch (2.5 mm) or greater shall be determined in accordance with Table 12.3.3 of the NDS. For all other nails, dowel bearing strength of the nails in wood-based materials shall be determined in accordance with ASTM D5764, on a minimum of 15 specimens per wire diameter. Dowel bearing strength shall be determined for each species of lumber that will be addressed in the evaluation report; as an alternative, species may be grouped, with tests conducted on the species with the least specific gravity in each group.

703.1.4.3 Lateral Resistance Test. Lateral resistance testing of connections shall be conducted in accordance with Sections 701.4.2.4.3.1 through 701.4.2.4.3.4.

703.1.4.3.1 Test Method. Lateral resistance tests shall be conducted in accordance with ASTM D1761 procedures. The lateral resistance tests shall be conducted on specimens of each species and material for which evaluation is desired, or, as an alternative, species may be grouped, with tests conducted on the species with the least specific gravity in each group. Nails shall be driven into wood conditioned in accordance with Section 9.1 of ASTM D1761 or with the planned end use. The average F_{yb} of the nails as determined in accordance with Section 3.2.6 shall be within 10 percent of the specified F_{yb}. The ultimate load and 75 percent of the proportional limit load shall be determined for each tested connection.

703.1.4.3.2 Sample Size. When the reference lateral design value will be determined by calculation, and confirmed by testing, as described in Section 3.3.1.1, a minimum of 15 specimens shall be tested. When the reference lateral design value will be determined empirically through testing, as described in Section 3.3.1.3, the number of samples needed to achieve a precision of 5 percent at a 75 percent confidence interval (determined in accordance with ASTM D2915, Equation 1) shall be tested. The sample size shall be a minimum of 15 specimens and need not exceed 40 specimens.

703.1.4.3.3 Specific Gravity and Moisture Content. The specific gravity of each wood member used in the connection tests shall be determined in accordance with ASTM D2395, on an oven-dry weight and volume basis. One sample specific gravity calculation shall be provided within the submitted test reports. Reference design values derived from connection tests may be assigned to connections with wood species having a higher specific gravity than tested. However, reference design values for connections with wood species exceeding a specific gravity of 0.50 shall be evaluated if predrilled holes meeting the requirements of NDS Section 12.1.6.2 are not used. Wood samples shall be conditioned to reach equilibrium with a moisture content of 10 to 14 percent when testing for dry in-service conditions. The moisture content of the wood samples shall be determined in accordance with ASTM D4442 or D4444 (handheld moisture meters). One sample moisture content calculation shall be provided within the submitted test reports.

703.1.4.3.4 Steel Plate Characteristics. The base-metal thickness and tensile strength, Fu, of the steel side plate shall be determined using coupons from the same steel sheet or plate used to make the side member or by mill certification. Base-metal thickness shall be determined by measuring the base-metal thickness of representative steel side plates. Tensile testing shall comply with ASTM A370. Tests performed in accordance with applicable sections of AC116 are to determine the expected allowable lateral strength of the combinations of sheathing density and thickness(es), wood species and thickness, and fastener and connected material shall be

reported and shall be representative of the report applicant's end use recommendations. The load applied during the lap shear connection tests, as well as the slip, shall be measured. Allowable lateral loads shall be calculated in accordance with Section 4.3.2.4.4, and expected diaphragm assembly allowable loads shall be derived. The derivation of the fastener slip equation shall be based on ASTM D1761 connection test results.

703.1.4.4 Connection Strength Determination. The connection strength determination shall be determined in accordance with this section.

703.1.4.4.1 Reference Lateral Design Values. Reference lateral design values for connections with commodity steel nails shall be determined in accordance with the NDS. Reference lateral design values for connections with the following nails shall be determined in accordance with Section 703.1.4.4.1.1 or Section 703.1.4.4.1.2:

1. Nails with penetration into the main member of less than 6D.
2. Nails with a diameter of less than 0.099 inch (2.5 mm).
3. Proprietary Nails.

703.1.4.4.1.1 Rationale Analysis with Confirmatory Testing. When evaluation of applicability of the yield mode equations in the NDS is sought, dowel bearing strength shall be determined in accordance with Section 3.3.1.2 and the reference lateral design value shall be calculated in accordance with the NDS. Confirmatory connection testing shall be conducted in accordance with Section 4.1. The calculated value shall not exceed 75 percent of the proportional limit load, or the average ultimate load, multiplied by the adjustment factor, Rs, defined in Section 3.3.1.4 (if applicable) and divided by a factor of 3.2. The factor of 3.2 assumes a duration of load of 1.6 and a maximum coefficient of variation (COV) of 15 percent. Where the COV is greater than 15 percent, the calculated reference lateral design value shall not exceed:

Equation 7-1

where:

F_{all} = Bound of calculated reference lateral load, lbf (N).

COV = s/F = Coefficient of variation in a test series.

S = Standard deviation in a test series, lbf (N).

F = Average ultimate load in test series, multiplied by the adjustment factor, Rs, of Section 3.3.1.4, as applicable, lbf (N).

Where tests are done on species groups, reference design values for each group shall be determined based on applicable data for the tested species. When lateral design values from testing are less than the calculated values, reference lateral design values shall be determined in accordance with Section 701.4.2.4.3.4.1.2.

703.1.4.4.1.2 Testing Only. The ASD reference lateral design value shall be the average ultimate load determined in accordance with Section 4.1, multiplied by the adjustment factor, Rs, defined in Section 4.3.2.4.4.1.3 (if applicable) and divided by 5.

703.1.4.4.1.3 Adjustment of Test Values Based on Steel Side Plate Properties. Test values for connections where the side member is a steel plate shall be adjusted to account for the measured or mill certified tensile strength and base-metal thickness of the steel. The adjustment factor, Rs, shall be determined in accordance with Equation 7-2.

Equation 7-2

where:

($F_{u\text{-}spec}$) = Minimum specified tensile strength of the side plate steel, ksi.

($F_{u\text{-}test}$) = Measured or mill certified tensile strength of the side plate steel used in the test, ksi.

(t_{spec}) = Specified minimum side plate base-metal thickness, inch.

(t_{test}) = Measured base-metal thickness of tested side plate, inch

Each ratio of specified characteristic to tested characteristic must be ≤ 1.0.

703.1.4.5 Analysis. Analysis of diaphragm assembly test results, sealed by a registered design professional, shall be provided to determine/verify the items in Sections 703.1.4.5.1 through 703.1.4.5.5

703.1.4.5.1 Diaphragm Deflection. Analysis for diaphragm deflection shall account for the bending deflection, diaphragm web shear deflection, as well as any other factors, such as fastener slip, which will contribute to deflection of the diaphragm.

703.1.4.5.2 Allowable Shear Values. The allowable shear values, in pounds per linear foot, for the diaphragm assembly/assemblies (blocked and unblocked) to be recognized. Each combination of fastener type and spacing, sheathing density and thickness, and wood species and thickness shall be addressed. The allowable shear for fiber-reinforced cement sheet diaphragm with wood framing for wind and seismic loading, shall be derived from the lowest value of ASTM E455 tests divided by a factor of safety of 2.8 for Allowable Stress Design (ASD), or multiplied by 0.57 for Lateral Resistance Factor Design (LRFD) load. The diaphragm allowable strength will be based on analysis utilizing the fasteners capacity provided the diaphragm test results are equal to or greater than the calculated capacity for the tested diaphragm configurations.

703.1.4.5.3 Wind Resistance Factor of Safety. For wind resistance only, the factor of safety in Section 3.6.5.2 may be reduced for ASD or increased for LRFD by a factor no greater than 1.4, provided the test data is analyzed for strength and stiffness and compares favorably with the values in Table 4.2a of ANSI/AF&PA SDPWS[-2008 or -2005].

703.1.4.5.4 Allowable Lateral Strength. The allowable lateral strength of the fastener shall be determined in accordance with Section 701.3.2.4.

703.1.4.5.5 Edge and End Distance. The minimum edge and end distances of the fasteners installed in the sheathing and the wood framing as tested in the lap shear connection tests in Section 4.3.2.4, the fastener holding tests in Section 4.3.1 and diaphragm tests in Section 4.3.2.5.5.1. When the diaphragm test requires staggered fasteners, the staggered pattern shall be specified. The fastener end and edge distances shall be representative of the end use conditions.

703.1.4.5.5.1 Diaphragm Test Method. Diaphragm testing shall be performed in accordance with ASTM E455. The diaphragm assembly shall consist at least five panels or five support spacings (i.e., sheathing spans), including sheathing end and side joints, with the cantilever beam diaphragm assembly size not less than 8 feet (2.44 m) in either length or width, and the size of the simple beam diaphragm tested assembly 8 feet (2.4 m) wide by 24 feet (7.31 m) long. The installation and support conditions of the sheathing shall reflect field installation and support conditions for which recognition is sought. The loading method and rate chosen shall be consistent for each diaphragm assembly.

CHAPTER 8 STRUCTURAL ROOF SHEATHING ATTACHED TO COLD-FORMED STEEL OR WOOD FRAMING

SECTION 801 GENERAL

801.1 General. The testing and acceptance of Magnesium Oxide Board intended to be used as structural roof sheathing attached to cold-formed steel or wood framing shall be in accordance with this chapter.

SECTION 802 PERFORMANCE REQUIREMENTS

802.1 Performance Requirements. Magnesium Oxide Board intended for use as roof sheathing, structural cementitious panels shall be tested and analyzed in accordance with the requirements of Sections 6.1 through 6.11 of Appendix A of this criteria. The span ratings determined in accordance with Section 6.2 shall result in a minimum allowable uniform roof load of 35 pounds per square foot (1.68 MPa) at a deflection of 1/240 of the span.

802.1.1 Test Exposure Condition. The condition to which a panel is subjected prior to test. Generally, such conditions are referred to as dry or wet conditions.

802.1.1.1 Dry Condition. Specimens conditioned to represent dry conditions shall be placed in a controlled condition at 73 ±4°F and 50 ±5% humidity for a minimum of six days, or until the difference between two consecutive weight measurements, at intervals not less than twenty-four hours, is less than 0.1% by mass.

802.1.1.2 Wet Condition. Wet conditioning of full panels requires continuous wetting of panels held in a vertical condition for seven days, at an ambient temperature of 73 ±4°F, and tested while wet. Unless otherwise noted, wet conditioning of small-scale test specimens require immersion in water at a temperature of 73 ±7°F for a minimum of 48 hours.

802.1.2 Structural Performance. Testing shall be performed under both dry and wet conditions.

802.1.2.1 Concentrated Loads. Panels shall be tested according to the procedures of ASTM E661 for concentrated static loads before and after impact loading. Impact testing shall be conducted in accordance with Section 8.5 of ASTM E661, using a 75 ft-lb impact for span ratings up to 24 inches on center, a 90 ft-lb impact for a span rating of 32 inches on center and a 180 ft-lb impact for a span rating of 48 inches on center (10.3, 12.4 and 24.7 m-kg for span ratings of 610, 815 and 1220 mm, respectively). A minimum of three tests shall be conducted for each test exposure condition. Panels shall comply with Table 802.1.2.1 for the intended span rating, under both wet and dry conditions.

TABLE 802.1.2.1 — CONCENTRATED STATIC AND IMPACT TEST PERFORMANCE CRITERIA

FOR PANELS TESTED ACCORDING TO ASTM E661

SPAN RATING	PERFORMANCE REQUIREMENTS	
	Minimum Static Concentrated Load (lbf)	Maximum Deflection (inch)

	Before Impact	After Impact	Under 200-pound Load[1]
ROOF SHEATHING			
16	400	300	0.438
20	400	300	0.469
24 and higher	400	300	0.500

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N.

[1]Criteria shall apply to static concentrated load before and after impact.

802.1.2.2 Uniform Loads. Panels shall be tested according to the procedures of ASTM E330 for uniform loads. Specimens shall be tested in a two-span condition. A minimum of three replicate assemblies shall be tested. Panels shall comply with Table 802.1.2.2 for the intended span rating.

TABLE 802.1.2.2 — UNIFORM LOAD PERFORMANCE CRITERIA FOR PANELS TESTED PER ASTM E330

SPAN RATING	PERFORMANCE REQUIREMENTS	
	Average Deflection Under Load[1]	Minimum Ultimate Uniform Load (psf)
ROOF SHEATHING		
16	0.067″ at 35 psf	150
20	0.080″ at 35 psf	150
24	0.100″ at 35 psf	150
32	0.133″ at 35 psf	150
48	0.200” at 35 psf	150

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N.

[1]Maximum deflection of sheathing shall be measured relative to framing. The average value of all specimens shall be at or below the tabulated requirement.

802.1.2.3 Fastener Holding. Panels shall be tested for fastener lateral load, withdrawal load, and pull-through load in accordance, respectively, with PS2, Section 7.4; ASTM D1037, Section 14; and ASTM D1037, Section 15. At the option of the panel manufacturer, fastener holding tests may be conducted using screws, nails, or both fastener types. Screws shall be Type S, No. 8 screws with a nominal diameter of 0.164 inch (4.17 mm) and a head diameter of 1/4 inch (6.4 mm). The screws shall be of sufficient length for at least three full threads to penetrate through the sheathing panel. Nails shall be 8d common smooth shank nails. Lateral loads shall be determined in both the machine and cross-machine directions. A minimum of twenty tests

shall be conducted for each test exposure condition under each load case. Panels shall comply with Table 802.1.2.3 for the applicable panel thickness.

TABLE 802.1.2.3 — SCREW AND NAIL PERFORMANCE CRITERIA UNDER LATERAL LOADS, WITHDRAWAL LOADS, AND PULL-THROUGH LOADS

PANEL THICKNESS (inch)	CONDITION AT TEST	MINIMUM ULTIMATE LOAD (lbf)		
		Lateral	Withdrawal	Pull-Through
Greater than 1/2	Dry	210	20	200
	Wet	160	15	150

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N.

802.1.2.4 Flexural Strength – Benchmark. A minimum of ten specimens shall be tested for flexural strength in accordance with Section 5.2.4 of ASTM C1185 in both wet and dry conditions. Five of these specimens shall be cut parallel to the length of the panel (machine direction) and five shall be cut perpendicular to the panel (cross-machine direction). Specimens shall be sized in accordance with Section 5.2.1 of ASTM C1185. Wet specimens shall retain a minimum of 70 percent of the dry flexural strength and stiffness. For each test condition, the bending strength shall be determined in accordance with Equation 8-1.

Equation 8-1 $M = \frac{3PL}{b}$

Where:

M = Bending strength of the specimen, lbf-in/ft of width

P = Test load, lbf

L = Test span, inches

b = Width of the test specimen, inches

For the dry test condition, the Apparent Modulus of Elasticity, E, shall be determined in accordance with Section 5.4 of ASTM C1185.

802.1.2.5 Thickness Swell. Panels shall be tested in accordance with ASTM D1037, Section 23, Method B, starting with panels that are in a dry condition as defined in Section A4.9.1. A minimum of three specimens shall be tested. Thickness swell of the sheathing panel shall be 3 percent, maximum.

802.1.2.7 Panel Freeze/Thaw Resistance. Sheathing panels shall be tested in accordance with ASTM C1185, Section 12, except only one set of specimens shall be used. This set shall

be subjected to freeze/thaw cycling in accordance with Section 12.3 of ASTM C1185; wet conditioned in accordance with Section 6.1.2 and tested for flexural strength in accordance with Section 5.4 of ASTM C1185. The sheathing panel shall retain a minimum of 75 percent of the dry benchmark flexural strength values after 50 cycles, in both the machine and cross machine direction.

802.1.2.8 Long-term Durability (Warm Water). Sheathing panels shall be tested per ASTM C1185, Section 13, except that only one set of ten specimens shall be used. This set shall be saturated and conditioned in accordance with Section 13.3.2 of ASTM C1185; examined in accordance with Section 13.3.3 of ASTM C1185; wet conditioned in accordance with Section 6.1.2 and tested for flexural strength in accordance with Section 5.4 of ASTM C1185. A minimum retention of 75 percent of the dry benchmark strength and stiffness values shall be achieved for the warm water conditioned specimens. Testing shall be conducted in both the machine and the cross-machine directions.

802.1.2.9 Density. A minimum of five specimens shall be tested in a dry condition. Each specimen shall be cut from a separate sampled panel to dimensions of 6 inches by 12 inches. Specimen length, width and thickness shall be measured in accordance with Section 7 of ASTM C1185, and the specimen shall be weighed. The calculated density for each specimen, as well as the average density shall be reported.

802.1.2.10 Heat/Rain – Roof Sheathing. Sheathing panels to be used for roof applications shall be tested in accordance with ASTM C1185, Section 15. Panels shall be tested for 25 cycles. Following completion of the radiant heat portion of the final cycle of testing, the sheathing panel shall retain a minimum of 75 percent of the dry benchmark strength and stiffness values. Cycled specimens shall be tested in the as-is condition, immediately following removal from the test frame. Cycled specimens shall be cut and prepared for flexural testing in accordance with Section 5.2.4.1 of ASTM C1185.

802.1.2.11 Allowable Uniform Load. The allowable uniform gravity and uplift loads for roof sheathing shall be the lesser of the ultimate uniform load determined from testing, divided by a safety factor of 3.0; and the uniform test load which produces a deflection of 1/240 of the span. Determination of allowable uniform load for spans shorter than what is tested shall consider both flexural strength and shear strength of the sheathing panels.

802.1.2.12 Diaphragms for Cold Formed Steel Framing (Optional): Cold-formed steel framing used in the test assemblies shall comply with the appropriate standard for the quality of steel specified. Compliance shall be determined by test reports submitted by the mill or an accredited testing laboratory. Where the number of steel coupon specimens is not noted in the specific standard, a minimum of two steel coupon specimens shall be tested to determine compliance with the appropriate standard and to determine the minimum uncoated steel thickness and strength. Steel tension tests and elongation calculations shall be performed in accordance with ASTM A370. Where the actual steel material strength exceeds the specified strength, test results shall be adjusted, when failure is attributed to the steel framing, by the ratio Fu(specified) /Fu(actual).

802.1.2.12.1 Diaphragm Testing. At a minimum, diaphragm testing shall be performed in accordance with AISI S907 to determine the nominal shear strength and nominal shear stiffness

of the assemblies. Instead of testing assemblies with at least five panels, as required by AISI S907, test assemblies shall consist of the following: five or more support spans; end and edge sheathing joints; fastening consistent with the panel manufacturer's installation instructions; and installation conditions (including block/unblocked joints) which are to be addressed in the evaluation report. In addition, at the manufacturer's option, Simple Beam Diaphragm testing shall be performed in accordance with ASTM E455, to determine the nominal shear strength and nominal shear stiffness of a diaphragm loaded parallel to the repetitive cold-formed steel framing members. The expected maximum diaphragm assembly test load shall be estimated for the purpose of determining the appropriate test load increments and test load rate for full-scale diaphragm tests. Full-scale diaphragm assembly tests shall be conducted using the minimum specified number of load increments and the minimum load rate specified in AISI S907 or ASTM E455, as applicable

802.1.2.12.2 Analysis. Analysis of diaphragm assembly test results, sealed by a registered design professional, shall be provided to determine/verify the following:

1. The equation used to determine diaphragm deflection.

2. The nominal shear strengths, in pounds per linear foot, for the diaphragm assemblies to be addressed in the evaluation report. The nominal diaphragm shear strengths shall be based on testing in accordance with Section 6.2.12.1 but shall not exceed the nominal shear strength reported in the evaluation report on the screw, multiplied by the number of screws per foot at the perimeter of the diaphragm.

3. Available strengths for the diaphragms using a safety factor, Ω, of 2.8 and a resistance factor, ϕ, of 0.6, as applicable, in accordance with Section B5.4.2.5 of AISI S240.

The minimum edge and end distances of the fasteners installed in the sheathing and in the steel framing.

SECTION 803 DIAPHRAM FOR WOOD FRAME (OPTIONAL)

803.1 Diaphragm for Wood Frame (Optional): Diaphragms on wood roof framing assemblies shall comply with this section.

803.1.1 General. The shear strength and shear stiffness of fiber-reinforced cement sheathing used as the web of a horizontal wood-framed floor diaphragm shall be based on tests conducted in accordance with Section 4.4 of this criteria. The plan shall include sufficient test details for each diaphragm assembly; such as: descriptions of each diaphragm assembly; specifications of diaphragm components; diaphragm sizes; installation pattern of the floor sheathing; fastener location and spacing; test setup; descriptions of the test procedure; the means of determining the expected maximum diaphragm test load and all details pertinent to the test. If the test plan contains several diaphragm configurations and not all diaphragm

configurations will be tested, the bases for selecting different diaphragm configurations shall be provided for ICC-ES consideration. The test plan shall include the text matrix showing the minimum and maximum fastener spacing intended for recognition for each combination of sheathing density and thickness, wood framing species and thickness and fastener type and size.

803.1.1.1 Maximum Test Load. The expected maximum diaphragm assembly test load shall be estimated for the purpose of determining the appropriate test load increments and test load rate for full-scale diaphragm tests. The results of the connection tests noted in Section 3.6.4 of this criteria, or other alternative methods, are permitted to be used to estimate the expected maximum diaphragm assembly test load. Regardless of estimation method used, full-scale diaphragm assembly tests shall be conducted using the minimum specified load rate specified in Section 9.0 of ASTM E455.

803.1.1.2 Specimens. Diaphragm tests shall be conducted on a minimum of three specimens of each assembly that is to be recognized in the evaluation report. For unblocked diaphragms, there shall be at least three additional assemblies for each configuration so the test may be conducted with the load applied in two orthogonal directions.

803.1.2 Density of Fiber-Reinforced Sheets. Density tests shall be performed in accordance with ASTM C1185 on fiber-reinforced sheets used in the connection (Section 3.6.4) and diaphragm tests. The density test results shall be reported.

803.1.3 Wood Framing. Specific gravity and moisture content shall be measured and reported of wood framing members used in connection (Section 3.6.4) and diaphragm tests. The specific gravity and moisture content tests may be performed in accordance with ASTM D2395 and ASTM D4442, respectively. The wood framing shall be representative of the end use condition with a minimum nominal width of 2 inches (50.8 mm).

803.1.4 Fasteners. Data in accordance with this section shall be submitted.

803.1.4.1 Bending Yield Strength. For nails intended for use in structural applications, bending yield strength, F_{yb}, shall be evaluated according to ASTM F1575. Testing for unhardened, smooth shank nails shall be done on either the finished nail or specimens of drawn wire stock. Tests for hardened nails and for deformed shank nails shall be done on the fully manufactured nail products. Test specimens shall be randomly selected to represent the parent population of nails in accordance with the objectives of the test program. At least 15 replicates shall be tested for each nail type. Test reports shall include the following:

4. Calculation of F_{yb} for each nail according to the Annex of ASTM F1575.

5. Average calculated bending yield strength.

6. Other requirements as described in Section 11 of ASTM F1575.

At a minimum, the average bending yield strength for each nail type shall comply with Table 801.2(1). When the applicant specifies minimum bending yield strengths which exceed the applicable values in Table 1, the tested bending yield strength shall comply with the applicant's specifications.

803.1.4.2 Dowell Bearing Strength. When needed for rational analysis in accordance with Section 3.3.1.1, dowel bearing strength shall be determined. Dowel bearing strengths for nails with a diameter of 0.099 inch (2.5 mm) or greater shall be determined in accordance with Table 12.3.3 of the NDS. For all other nails, dowel bearing strength of the nails in wood-based materials shall be determined in accordance with ASTM D5764, on a minimum of 15 specimens per wire diameter. Dowel bearing strength shall be determined for each species of lumber that will be addressed in the evaluation report; as an alternative, species may be grouped, with tests conducted on the species with the least specific gravity in each group.

803.1.4.3 Lateral Resistance Test. Lateral resistance testing of connections shall be conducted in accordance with Sections 803.1.4.3.1 through 803.1.4.3.4.

803.1.4.3.1 Test Method. Lateral resistance tests shall be conducted in accordance with ASTM D1761 procedures. The lateral resistance tests shall be conducted on specimens of each species and material for which evaluation is desired, or, as an alternative, species may be grouped, with tests conducted on the species with the least specific gravity in each group. Nails shall be driven into wood conditioned in accordance with Section 9.1 of ASTM D1761 or with the planned end use. The average F_{yb} of the nails as determined in accordance with Section 3.2.6 shall be within 10 percent of the specified F_{yb}. The ultimate load and 75 percent of the proportional limit load shall be determined for each tested connection.

803.1.4.3.2 Sample Size. When the reference lateral design value will be determined by calculation, and confirmed by testing, as described in Section 3.3.1.1, a minimum of 15 specimens shall be tested. When the reference lateral design value will be determined empirically through testing, as described in Section 3.3.1.3, the number of samples needed to achieve a precision of 5 percent at a 75 percent confidence interval (determined in accordance with ASTM D2915, Equation 1) shall be tested, The sample size shall be a minimum of 15 specimens and need not exceed 40 specimens.

803.1.4.3.3 Specific Gravity and Moisture Content. The specific gravity of each wood member used in the connection tests shall be determined in accordance with ASTM D2395, on an oven-dry weight and volume basis. One sample specific gravity calculation shall be provided within the submitted test reports. Reference design values derived from connection tests may be assigned to connections with wood species having a higher specific gravity than tested. However, reference design values for connections with wood species exceeding a specific gravity of 0.50 shall be evaluated if predrilled holes meeting the requirements of NDS Section 12.1.6.2 are not used. Wood samples shall be conditioned to reach equilibrium with a moisture content of 10 to 14 percent when testing for dry in-service conditions. The moisture content of the wood samples shall be determined in accordance with ASTM D4442 or D4444 (handheld moisture meters). One sample moisture content calculation shall be provided within the submitted test reports.

803.1.4.3.4 Steel Plate Characteristics. The base-metal thickness and tensile strength, Fu, of the steel side plate shall be determined using coupons from the same steel sheet or plate used to make the side member or by mill certification. Base-metal thickness shall be determined by measuring the base-metal thickness of representative steel side plates. Tensile testing shall

comply with ASTM A370. Tests performed in accordance with applicable sections of AC116 are to determine the expected allowable lateral strength of the combinations of sheathing density and thickness(es), wood species and thickness, and fastener and connected material shall be reported and shall be representative of the report applicant's end use recommendations. The load applied during the lap shear connection tests, as well as the slip, shall be measured. Allowable lateral loads shall be calculated in accordance with Section 4.3.2.4.4, and expected diaphragm assembly allowable loads shall be derived. The derivation of the fastener slip equation shall be based on ASTM D1761 connection test results.

803.1.4.4 Connection Strength Determination. The connection strength determination shall be determined in accordance with this section.

803.1.4.4.1 Reference Lateral Design Values. Reference lateral design values for connections with commodity steel nails shall be determined in accordance with the NDS. Reference lateral design values for connections with the following nails shall be determined in accordance with Section 803.1.4.4.1.1 or Section 803.1.4.4.1.2:

4. Nails with penetration into the main member of less than 6D.
5. Nails with a diameter of less than 0.099 inch (2.5 mm).
6. Proprietary Nails.

803.1.4.4.1.1 Rationale Analysis with Confirmatory Testing. When evaluation of applicability of the yield mode equations in the NDS is sought, dowel bearing strength shall be determined in accordance with Section 3.3.1.2 and the reference lateral design value shall be calculated in accordance with the NDS. Confirmatory connection testing shall be conducted in accordance with Section 4.1. The calculated value shall not exceed 75 percent of the proportional limit load, or the average ultimate load, multiplied by the adjustment factor, Rs, defined in Section 3.3.1.4 (if applicable) and divided by a factor of 3.2. The factor of 3.2 assumes a duration of load of 1.6 and a maximum coefficient of variation (COV) of 15 percent. Where the COV is greater than 15 percent, the calculated reference lateral design value shall not exceed:

Equation 8-1

where:

F_{all} = Bound of calculated reference lateral load, lbf (N).

COV = s/F = Coefficient of variation in a test series.

S = Standard deviation in a test series, lbf (N).

F = Average ultimate load in test series, multiplied by the adjustment factor, Rs, of Section 3.3.1.4, as applicable, lbf (N).

Where tests are done on species groups, reference design values for each group shall be determined based on applicable data for the tested species. When lateral design values from

testing are less than the calculated values, reference lateral design values shall be determined in accordance with Section 801.4.2.4.3.4.1.2.

803.1.4.4.1.2 Testing Only. The ASD reference lateral design value shall be the average ultimate load determined in accordance with Section 4.1, multiplied by the adjustment factor, Rs, defined in Section 4.3.2.4.4.1.3 (if applicable) and divided by 5.

803.1.4.4.1.3 Adjustment of Test Values Based on Steel Side Plate Properties. Test values for connections where the side member is a steel plate shall be adjusted to account for the measured or mill certified tensile strength and base-metal thickness of the steel. The adjustment factor, Rs, shall be determined in accordance with Equation 8-2.

Equation 8-2

where:

($F_{u\text{-}spec}$) = Minimum specified tensile strength of the side plate steel, ksi.

($F_{u\text{-}test}$) = Measured or mill certified tensile strength of the side plate steel used in the test, ksi.

(t_{spec}) = Specified minimum side plate base-metal thickness, inch.

(t_{test}) = Measured base-metal thickness of tested side plate, inch

Each ratio of specified characteristic to tested characteristic must be ≤ 1.0.

803.1.5 Analysis. Analysis of diaphragm assembly test results, sealed by a registered design professional, shall be provided to determine/verify the items in Sections 803.1.5.1 through 803.1.5.5

803.1.5.1 Diaphragm Deflection. Analysis for diaphragm deflection shall account for the bending deflection, diaphragm web shear deflection, as well as any other factors, such as fastener slip, which will contribute to deflection of the diaphragm.

803.1.5.2 Allowable Shear Values. The allowable shear values, in pounds per linear foot, for the diaphragm assembly/assemblies (blocked and unblocked) to be recognized. Each combination of fastener type and spacing, sheathing density and thickness, and wood species and thickness shall be addressed. The allowable shear for fiber-reinforced cement sheet diaphragm with wood framing for wind and seismic loading, shall be derived from the lowest value of ASTM E455 tests divided by a factor of safety of 2.8 for Allowable Stress Design (ASD), or multiplied by 0.57 for Lateral Resistance Factor Design (LRFD) load. The diaphragm allowable strength will be based on analysis utilizing the fasteners capacity provided the diaphragm test results are equal to or greater than the calculated capacity for the tested diaphragm configurations.

803.1.5.3 Wind Resistance Factor of Safety. For wind resistance only, the factor of safety in Section 3.6.5.2 may be reduced for ASD or increased for LRFD by a factor no greater than 1.4, provided the test data is analyzed for strength and stiffness and compares favorably with the values in Table 4.2a of ANSI/AF&PA SDPWS[-2008 or -2005].

803.1.5.4 Allowable Lateral Strength. The allowable lateral strength of the fastener shall be determined in accordance with Section 801.3.2.4.

803.1.5.5 Edge and End Distance. The minimum edge and end distances of the fasteners installed in the sheathing and the wood framing as tested in the lap shear connection tests in Section 4.3.2.4, the fastener holding tests in Section 4.3.1 and diaphragm tests in Section 4.3.2.5.5.1. When the diaphragm test requires staggered fasteners, the staggered pattern shall be specified. The fastener end and edge distances shall be representative of the end use conditions.

803.1.5.5.1 Diaphragm Test Method. Diaphragm testing shall be performed in accordance with ASTM E455. The diaphragm assembly shall consist at least five panels or five support spacings (i.e., sheathing spans), including sheathing end and side joints, with the cantilever beam diaphragm assembly size not less than 8 feet (2.44 m) in either length or width, and the size of the simple beam diaphragm tested assembly 8 feet (2.4 m) wide by 24 feet (7.31 m) long. The installation and support conditions of the sheathing shall reflect field installation and support conditions for which recognition is sought. The loading method and rate chosen shall be consistent for each diaphragm assembly.

CHAPTER 9 IDENTIFICATION

SECTION 901 GENERAL

901.1 General. Magnesium oxide boards shall comply with this section.

901.2 Identification. Magnesium oxide boards shall be labeled for purposes of identification. Each magnesium oxide board or package of boards shall have legibly marked thereon the following information:

1. Product name
2. Manufacturer name and address
3. Information allowing traceability of finished product back production quality control records at the manufacturing facility (e.g., Lot Number, Batch Number, etc.)
4. Nominal thickness
5. “ICC 1125 – See Manufacturer for specific compliance information.”

AISI

American Iron and Steel Institute
25 Massachusetts Avenue, NW Suite 800
Washington, DC 20001

AISI S907-2017	Test Standard for Determining the Strength and Stiffness of Cold-Formed Steel Diaphragms by the Cantilever Test Method 702.5.1, 802.1.2.12.1

ANSI	*American National Standards Institute* *25 West 43rd Street, Fourth Floor* *New York, NY 10036*
ANSI 118.9-2023	American National Standard Specification for Test Methods and Specifications for Cementitious Backer Units

ASTM *ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428*

ASTM A123/A123M-2024: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A370-2024a: Standard Test Methods and Definitions for Mechanical Testing of Steel Products

ASTM A653/A653M-2023: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process

ASTM A792/A792M-2023: Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process

ASTM A875/A875M-2023: Standard Specification for Steel Sheet, Zinc-5% Aluminum Alloy-Coated by the Hot-Dip Process

ASTM B117-2019: Standard Practice for Operating Salt Spray (Fog) Apparatus

ASTM B370-2022: Standard Specification for Copper Sheet and Strip for Building Construction

ASTM C627-18 (2024): Standard Test Method for Evaluating Ceramic Floor Tile Installation Systems Using the Robinson-Type Floor Tester

ASTM C473-2019: Standard Test Methods for Physical Testing of Gypsum Panel Products

ASTM C666/C666M-2015: Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing (Withdrawn 2024)

ASTM C1185-2023: Standard Test Methods for Sampling and Testing Fiber-Cement Flat Sheet, Roofing and Siding Shingles, and Clapboards

ASTM D610-08(2019): Standard Test method for Evaluating Degree of Rusting on painted Steel Surfaces

ASTM D1037-12 (2020): Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials

ASTM D1761-2020: Standard Test Methods for Mechanical Fasteners in Wood and Wood-Based Materials

ASTM D2394-17 (2022): Standard Test Methods for Simulated Service Testing of Wood and Wood-Based Finish Flooring

ASTM D2395-17 (2022): Standard Test Methods for Density and Specific Gravity (Relative Density) of Wood and Wood-Based Materials

ASTM D2915-17 (2022): Standard Practice for Sampling and Data-Analysis for Structural Wood and Wood-Based Products

ASTM D4442-2020: Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials

ASTM D4444-13 (2018): Standard Test Method for Laboratory Standardization and Calibration of Hand-Held Moisture Meters

ASTM D5764-2024: Standard Test Method for Evaluating Dowel-Bearing Strength of Wood and Wood-Based Products

ASTM D7438-2020: Standard Practice for Field Calibration and Application of Hand-Held Moisture Meters

ASTM E72-2022: Standard Test Methods of Conducting Strength Tests of Panels for Building Construction

ASTM E84-21a: Standard Test Methods for Surface Burning Characteristics of Building Materials

ASTM E136-2022: Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C
ASTM E330/E330M-14 (2021): Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

ASTM E455-2019: Standard Test Method for Static Load Testing of Framed Floor or Roof Diaphragm Constructions for Buildings

ASTM E661-2022: Standard Test Method for Performance of Wood and Wood-Based Floor and Roof Sheathing Under Concentrated Static and Impact Loads

ASTM E2652-18: Standard Test Method for Assessing Combustibility of Materials Using a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C

ASTM E2768 -11 (2018): Standard Test Method for Extended Duration Surface Burning Characteristics of Building Materials (30 min Tunnel Test)
ASTM F1575/F1575M-2024: Standard Test Method for Determining Bending Yield Moment of Nails, Spikes, and Dowel-type Threaded Fasteners

ASTM G21-15 (2021)e1: Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

AWC *American Wood Council, 222 Catoctin Circle SE, Suite 201, Leesburg, VA 20175*

ANSI/AWC NDS—2024: National Design Specification (NDS) for Wood Construction—with 2018 NDS Supplement

AWPA *American Wood Protection Association, P.O. Box 361784, Birmingham, AL 35236-1784*

AWPA E12-2020: Standard Method of Determining Corrosion of Metal in Contact with Treated Wood

DOC *U.S. Department of Commerce, National Institute of Standards and Technology 100 Bureau Drive, Gaithersburg, MD 20899*

PS1-22: Structural Plywood

NFPA *National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471*

285-23: Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components

UL *UL LLC, 333 Pfingsten Road, Northbrook, IL 60062*

UL 723-2018: Standard for Test for Surface Burning Characteristics of Building Materials