



**INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS**

**UNIFORM EVALUATION SERVICES**

**EVALUATION CRITERIA FOR**

**MINERAL COMPOSITE FIBER REINFORCED (MCFR) BUILDING SYSTEM**

**EC 030-2018**

**(Proposed November 2018)**

**1.0 INTRODUCTION**

- 1.1 Purpose:** The purpose of this evaluation criteria is to establish requirements for the evaluation and recognition of Mineral Composite Fiber Reinforced (MCFR) Building Systems under the 2018, 2015, 2012 and 2009 International Building Code® (IBC); and the 2018, 2015 and 2012 International Residential Code® (IRC). Bases of recognition are IBC Section 104.11 and IRC Section R104.11. The reason for the development of this criteria is to provide a guideline for the evaluation and use of MCFR Building Systems to build above grade, load-bearing and non-load-bearing, walls and shearwalls.
- 1.2 Scope:** This evaluation criteria is limited to molded components formed of mineral composite fiber reinforced material, used as part of a system to build interior and exterior, load-bearing and non-load-bearing wall assemblies for use in Construction Types V-A and V-B. The MCFR Building Systems are limited to use in Seismic Design Category A or B locations.
- 1.3 Definitions:** Terms not defined in this section shall be as defined in applicable codes and referenced standards or have the ordinary accepted definition in accordance with the context for which they are intended.
- 1.3.1 MCFR building units** - Wall components of various proprietary shapes, sizes, and lengths manufactured using a compression molding or pultrusion process. The building units shape allows the main components to be stacked vertically and interlock. Typical building components include starter units, line units, caps, plugs, fenestration opening channels, and plates.
- 1.3.2 MCFR wall assembly** - An assembly consisting of MCFR building units that are stacked, typically in a running bond pattern, adhered and/or mechanically interconnected to form entire walls.
- 1.3.3 MCFR adhesive** - The structural adhesive used to assemble the MCFR building units.

**2.0 REFERENCED STANDARDS**

Referenced standards shall be applied consistently with the specific edition of the code(s) for which the Evaluation Report is prepared unless otherwise approved.

**2.1 International Code Council (ICC)**

- 2018, 2015 and 2012 International Building Code® (IBC)
- 2018, 2015 and 2012 International Residential Code® (IRC)

## **2.2 American Society for Testing and Materials (ASTM)**

- ASTM D638, Standard Test Method for Tensile Properties of Plastics
- ASTM D695 Standard Test Method for Compressive Properties of Rigid Plastics
- ASTM D790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
- ASTM D1929 Standard Test Method for Ignition Properties of Plastics
- ASTM D2843 Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics
- ASTM E72 Standard Test Methods of Conducting Strength Tests of Panels for Building Construction
- ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
- ASTM E119 Standard Test Methods for Fire Tests of Building Construction and Materials
- ASTM E136 Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C
- ASTM E488 Strength of Anchors in Concrete Elements
- ASTM E564 Standard Practice for Static Load Test for Shear Resistance of Framed Walls for Buildings
- ASTM E330 / E330M Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

## **2.3 ISO/IEC**

- 17011:2004 Conformity Assessment--General Requirements for Accreditation Bodies
- 17065:2012 Conformity Assessment - Requirements for Bodies Certifying Products, Processes and Services
- 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories
- 17020:2012 Conformity assessment -- Requirements for the operation of various types of bodies performing inspection

## **2.4 National Fire Protection Association (NFPA)**

- NFPA 286 Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth

## **2.5 Underwriters Laboratories (UL)**

- UL 263 Fire Tests of Building Construction and Materials
- UL 723 Test for Surface Burning Characteristics of Building Materials

## **3.0 BASIC INFORMATION**

The following information and data shall be submitted for review and evaluation for recognition of MCFR Building Systems in an evaluation report:

- 3.1 Product Description:** Complete information pertaining to MCFR Building Systems and components, including assembly descriptions and drawings, component descriptions and drawings, material specifications, material safety data, weights, specifications for accessories such as fasteners and adhesive.
- 3.2 Manufacturing Process:** A description of the manufacturing process and storage requirements.
- 3.3 Packaging and Identification:** A description of the methods of packaging and field identification of the MCFR components shall be included. Identification provisions shall include the component name or part number, the manufacturer's name, contact information, and the evaluation report number.

- 3.4 Installation and Use Instructions:** Complete installation details including field cutting and trimming, wall assembly, mechanical and adhesive connection details and requirements, and the quality control measures to be used in the field to control and confirm successful installation. The use instructions shall include the methods used for design and analysis of the assemblies.
- 3.5 Justifying Documentation:** Documentation shall be submitted to justify IAPMO UES recognition of the MCFR Building System. Justification shall include test reports in accordance with Section 4.0 of this criteria, and analysis of the results of testing.
- 3.5.1 Test Reports:** Test reports shall include the applicable information required by the appropriate testing standards. The installation instructions provided in accordance with the requirements of Section 3.4 of this criteria shall be observed by the laboratory to prepare specimens for testing.
- 3.5.2 Testing Laboratories:** Laboratories shall be accredited as complying with ISO/IEC Standard 17025 and specifically recognized by accreditation for the testing conducted in accordance with the standards and protocols reported. The laboratory's accreditation shall be issued by an accreditation body conforming to ISO/IEC 17011 and that is a signatory of the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA).
- 3.5.3 Product Sampling:** The test specimens shall be sampled or verified by an accredited inspection agency or testing laboratory. The sampled product shall be representative of the production ongoing after the sampling has taken place. The tested product specifications shall be within the tolerance limits reported in the quality documentation.

#### 4.0 TESTING AND PERFORMANCE REQUIREMENTS

- 4.1 MCFR Material Tests:** Material shall be sampled from the minimum and maximum thicknesses of MCFR material and shall meet the requirements of the referenced test standard or the conditions of acceptance described in the applicable sections below. A determination shall be made concerning the isotropic/anisotropic nature of the MCFR material. Where the MCFR material is anisotropic, the material orientation of the MCFR building units is a critical consideration in the production, testing, and use of the building system that shall be accounted for.
- 4.1.1 Tensile and Elongation Testing:**
- 4.1.1.1 Specimens:** Tensile testing shall be conducted on the MCFR material prepared in accordance with ASTM D638 for each of the following exposure conditions: control, UV exposure, and freeze-thaw exposure. At least ten replicate specimens shall be tested for each condition.
- 4.1.1.2 Procedure:** Comparative tensile testing shall be conducted on the specimens in accordance with ASTM D638.
- 4.1.1.3 Conditions of Acceptance:** The test results shall demonstrate that the average of the ultimate tensile loads and the elongations of the weathering test and freeze-thaw test specimens are not less than 90 percent of the average of the ultimate tensile load and elongation of the control specimens.
- 4.1.1.4 Results:** The allowable tensile strength shall be obtained by dividing the average ultimate strength of the control specimens by a safety factor of three (3).
- 4.1.2 Flexural Testing:**
- 4.1.2.1 Specimens:** Flexural testing shall be conducted on the MCFR material prepared in accordance with Section 7.2.1 of ASTM D790 for the following exposure conditions: control and freeze-thaw exposure.
- 4.1.2.2 Procedure:** Comparative flexural testing shall be conducted on the specimens in accordance with ASTM D790, Procedure A.
- 4.1.2.3 Conditions of Acceptance:** The test results shall demonstrate that the mean of the ultimate flexural strength of the freeze-thaw test specimens are not less than the 90 percent of the mean of the ultimate flexural strength of the control specimens.
- 4.1.2.4 Results:** The allowable flexural strength shall be obtained by dividing the average ultimate strength of the control specimens by a safety factor of three (3).

**4.1.3 Flexural Creep Testing:**

**4.1.3.1 Specimens:** Testing shall be conducted on at least ten replicate specimens of the MCFR material, prepared in accordance with Section 7.2.1 of ASTM D790, for freeze-thaw exposure condition.

**4.1.3.2 Procedure:** The specimens shall be tested for flexural creep in accordance with ASTM D2990. The tests shall be conducted at 130°F (55°C), and the load chosen shall produce half of the flexural strength as determined per 4.1.2.4 for control specimens. The flexural creep test shall be conducted for 2000 hours.

**4.1.3.3 Conditions of Acceptance:** The maximum creep strain shall be less than 1.0 percent based on a gage length equal to the distance between the supports. If strain exceeds 1.0 percent at 2000 hours, the test shall be repeated with a reduction in the applied load, until 1.0 percent at 2000 hours is achieved. If the applied load that satisfies the criteria of 1.0 percent at 2000 hours is less than the load producing half of the average flexural strength for the control specimens, the flexural strength of the control specimens shall be reduced proportionally by the ratio of the applied load that satisfies the criteria of 1.0 percent at 2000 hours over the load producing half of the flexural strength for the control specimens.

**4.1.4 Compression Testing:**

**4.1.4.1 Specimens:** Testing shall be conducted on at least ten replicate specimens of the MCFR material, prepared in accordance with Section 6.2 of ASTM D695, for the following exposure conditions: control and freeze-thaw exposure.

**4.1.4.2 Procedure:** Comparative compression testing shall be conducted on control and freeze-thaw specimens in accordance with ASTM D695.

**4.1.4.3 Conditions of Acceptance:** The test results shall demonstrate that the mean of the ultimate compressive strength of the freeze-thaw test specimens is not less than the 90 percent of the average ultimate compressive strength of the control specimens.

**4.1.4.4 Results:** The allowable compressive strength shall be obtained by dividing the average ultimate strength of the control specimens by a safety factor of three (3).

**4.1.5 Compressive Creep Testing:**

**4.1.5.1 Specimens:** Testing shall be conducted on at least ten replicate specimens of the MCFR material, prepared in accordance with Section 6.2 of ASTM D695, for freeze-thaw exposure condition.

**4.1.5.2 Procedure:** Compressive testing shall be conducted on freeze-thaw specimens in accordance with ASTM D2990. The tests shall be conducted at 130°F (55°C), and the load chosen shall produce half of the compressive strength determined in Section 4.1.4.3 for the control specimens. The compressive creep test shall be conducted for 2000 hours.

**4.1.5.3 Conditions of Acceptance:** The maximum creep strain shall be less than 1.0 percent based on the height of the specimen as the gage length. If the strain exceeds 1.0 percent at 2000 hours, the test shall be repeated with a reduction in the applied load, until 1.0 percent at 2000 hours is satisfied. If the applied load that satisfies the criteria of 1.0 percent at 2000 hours is less than the load producing half of the average compressive strength determined in Section 4.1.4.3 for the control specimens, the compressive strength of the control specimens shall be reduced proportionally by a reduction factor, which is the ratio of the applied load that satisfies the criteria of 1.0 percent at 2000 hours over the load producing half of the compressive strength determined per Section 4.1.4.3 for the control specimens.

**4.1.6 Freeze-thaw Testing:**

**4.1.6.1 Specimens:** Representative test specimens shall be prepared from the MCFR material and shall be of sufficient size and quantity to allow for conducting tests in accordance with the applicable test standards on both exposed (freeze-thaw specimens) and unexposed material (control specimens). A minimum of ten replicate specimens shall be tested in each exposure condition.

**4.1.6.2 Procedure:** The unexposed specimens shall be maintained at 73°F (23°C) and 50 percent relative humidity (RH) in a dark chamber. The freeze-thaw specimens shall be subjected to a minimum of 10 cycles of freeze-thaw conditioning, with each freeze-thaw cycle consisting of a minimum of eight hours at 120°F (49°C), submersion in room-temperature water for a minimum of eight hours, and a minimum of 16 hours at -20°F (-29°C).

- 4.1.6.3 Conditions of Acceptance:** Control specimens and exposed specimens shall be visually examined using 5x magnification. Surface changes such as erosion, cracking, crazing, checking and chalking that affect performance are unacceptable.
- 4.2 MCFR Connection Tests:**
- 4.2.1 General:** All mechanical fasteners used to connect the MCFR wall assemblies to roof, floor and foundation, and for attachment of all non-structural components (such as fenestration product, wall covering, thermal barrier, and interior wall finish, as applicable) to the MCFR wall assemblies shall be qualified through testing under this section. The purpose of testing in this section is to determine allowable capacities for the specific connection details tested, and not the general capacities of the fasteners themselves used to fasten other materials.
- 4.2.2 Specimens:** A minimum of five replicate specimens shall be sampled for testing required in this section, unless noted otherwise.
- 4.2.3 Determination of Maximum Load:** The maximum (ultimate) test load shall be based on the average of the five tests provided none of the results vary by more than 15 percent from the average of the five tests. Otherwise the lowest test value shall be used as the maximum test load.
- 4.2.4 Safety Factor:** The allowable load shall be determined by dividing the maximum test load, determined per Section 4.2.3, by a safety factor of three (3), unless noted otherwise.
- 4.2.5 Testing Wall-to-Horizontal-Assembly Connections -Tension and Compression Tests:**
- 4.2.5.1 Specimens:** Five replicate wall-to-horizontal assembly (wall-to-floor or wall-to-roof) connection test specimens shall be tested in tension (causing uplift in walls) and compression (causing axial compression in walls), respectively. Each wall connection test specimen shall consist of two MCFR wall assemblies that are parallel and 48 inches (1219 mm) apart and one 48-inch (1219 mm) span floor/roof assembly connected to the top of both walls. The walls shall be a minimum of 48 inches long (1219 mm), and the height shall be adequate for the purpose of equipment and instrument setup. The wall to floor/roof connections shall simulate the end-use construction for the MCFR wall assembly. The floor/roof assembly shall be sufficiently strong so as not to cause failure in the floor/roof assembly. The bottom of the wall panels shall be firmly attached.
- 4.2.5.2 Procedure:** The tensile or compressive load shall be applied in accordance with ASTM E72, Sections 10.3.1 and 9.3.1, respectively. The load, deflection, and set after each application of the load, measured at the center of the floor assembly and at the edges of each wall at mid span, shall be recorded. At the conclusion of the test, mode of failure, failure load, and graph of load vs. deflection shall be reported.
- 4.2.5.3 Conditions of Acceptance:** The governing limit state shall be one of the limit states related to fastener and/or interaction between fastener and the connected members.
- 4.2.5.4 Results:** The allowable design capacity of the connection shall be obtained by dividing the maximum test load, determined per Section 4.2.5.2, by a safety factor of three (3).
- 4.2.6 Testing Concrete Anchors Attaching Starter Blocks to Concrete Foundations:**
- 4.2.6.1 Purpose:** This testing is intended to evaluate the force transfer between starter blocks and concrete anchors.
- 4.2.6.2 Specimens:** Each test shall be conducted on five replicate specimens for each combination of starter blocks and concrete anchors for each loading condition (tension, shear parallel to the block length, and shear perpendicular to the block length).

**4.2.6.3 Procedures:** Set-up shall consist of one or multiple starter block(s) attached to a suitable concrete substrate, or a SATEC Universal Testing Machine using a single anchor. The anchor shall be installed in concrete in accordance with the applicable evaluation report issued by an ISO/IEC 17065 recognized code evaluation service. MCFR wall units shall be attached to concrete foundations with either adhesive or mechanical anchors recognized in an evaluation report issued by an ISO/IEC 17065 recognized code evaluation service. Other fasteners shall conform to one of the standards prescribed in the appropriate IBC or IRC sections for this condition. The specimens shall be tested applying tension and shear (both parallel and perpendicular to the starting block in the lengthwise direction) to the anchors, as applicable. The forces shall be applied using an appropriate fixture conforming to Section 5.1.1 of ASTM E488. The following actions shall be taken:

- The force in tension shall be applied to the key structure of the starting block.
- The shear force shall be applied using a shear block, which transfers force to the base of the starting block. For lateral shear parallel to the block length direction, the force shall be applied to the short edge of the block.
- For both tension and shear tests, the force that causes bearing failure of the fastener in the starter block or a 1/8-inch (3.18 mm) permanent deformation of the assembly shall be the maximum test load.
- Load shall be applied in ten equal increments at a rate that causes ultimate failure load to be reached in no less than two minutes and no more than three minutes.
- At the start of the test, the deflection measuring devices shall be set to zero.
- After each increment of load application, the load shall be removed, and after a waiting period of no less than one minute and no more than five minutes, the permanent deformation shall be recorded. The deflection/deformation measuring devices shall not be set to zero prior to application of the next load increment.
- Load applications shall be repeated until total failure or until permanent set exceeds 1/8-inch (3.18 mm).

**4.2.6.4 Results:** The governing limit state shall be the interaction between fastener and the MCFR component. The allowable load shall be determined based on the most restrictive of the following:

- 1) Allowable load shall be the maximum test load, determined per Section 4.2.6.3, divided by a safety factor of five (5).
- 2) Allowable load listed in the evaluation report for the concrete anchor.

#### **4.2.7 Testing Fastener Tension and Shear Capacity**

**4.2.7.1 Purpose:** The purpose of this testing is to determine the connection capacities of specific fasteners connecting the MCFR wall assembly to wood bucks used as a point of attachment of fenestration products. The tested fastener tension and shear capacities are used in accordance with this criteria.

**4.2.7.2 Specimens:** For each combination of fasteners and MCFR wall assemblies, a minimum of five replicate specimens shall be tested for static tension, static shear, fatigue tension, and fatigue shear, respectively. The test substrate shall consist of one or more stacked wall units. Three fasteners shall be installed at specified distances from the edge, at the minimum spacing to be recognized.

**4.2.7.3 Procedure:** Each class of fastener for which recognition is sought shall be tested in groups of three simultaneously; the following actions shall be taken:

- Testing shall be performed to failure in tension, shear, and fatigue resistance in accordance with this section.
- The fatigue test shall be conducted in tension and shear at loads ranging from zero to one-quarter of the failure load obtained during the static tension and static shear tests. The loading frequency shall be 6Hz or less. The anchor displacement shall be measured continuously up to the maximum load during the first loading, and then after 9000 load cycles.
- At the conclusion of the fatigue test, the fastener shall be tested to failure load to determine residual capacity.

**4.2.7.4 Conditions of Acceptance:** Residual capacity in tension and shear after the fatigue test shall be greater than 50 percent of failure loads determined in tension and shear testing, respectively.

**4.2.7.5 Results:** The allowable load for each screw class shall be obtained by dividing the maximum test load, determined per Section 4.2.7.3, in tension and shear, by a safety factor of five (5).

#### **4.3 MCFR Assembly Tests**

**4.3.1 General:** All MCFR wall assembly test specimens shall be constructed with MCFR wall units assembled using adhesive and/or fasteners. The adhesives shall be applied and cured in accordance with the adhesive manufacturer's published instructions.

#### **4.3.2 Wall Compression Tests:**

**4.3.2.1 Specimens:** Three replicate assemblies of each MCFR wall assembly shall be tested.

**4.3.2.2 Procedures:** Tests shall be conducted per ASTM E72, Section 9. The compressive load shall be applied with an eccentricity of  $t/6$ , where  $t$  represents the thickness of the wall assembly. The following actions shall be taken:

- For recognition of an allowable design compression capacity, a load equal to two times the allowable design compression capacity shall be held for a period of 24 hours. At the completion of the 24-hour period, the loads shall be removed, and permanent deformations recorded. The MCFR wall assembly shall continue to be subjected to increasing loads until failure occurs. Each load increment shall be held for a period of five minutes, and recovery shall be recorded after each load increment.
- In applying compression loads, particular attention shall be paid to the following statement in Section 9.3.1 of ASTM E72: "Apply the load uniformly along a line parallel to the inside face, and one-third the thickness of the specimen from the inside face."

**4.3.2.3 Conditions of Acceptance:** The allowable axial compression load shall be based on the most restrictive of the strength and deflection requirements as follows:

- 1) The permanent deformation (wall axial deformation) of each tested assembly at the conclusion of the 24-hour period shall be equal to or less than 1/8 inch (3.2 mm).
- 2) The maximum lateral deflection at allowable load shall be less than the wall height/240. This deflection shall be measured at wall mid-height.

**4.3.2.4 Results:** The maximum (ultimate) test load shall be based on the average of three tests provided none of the results vary by more than 15 percent from the average of the three, otherwise the lowest test value shall be used as the maximum test load. The maximum test load may be based on the average of five tests regardless of the variation in test results. The allowable axial compression load shall be based on a safety factor of three (3) applied to the maximum (ultimate) test load.

#### **4.3.3 Wall Out-of-plane Flexural Tests (Uniform Transverse Load Tests):**

**4.3.3.1 Specimens:** Three replicate assemblies of each MCFR wall assembly shall be tested.

**4.3.3.2 Test Procedure and Requirements:** Tests shall be conducted per ASTM E72, or E330 Section 12, and the following requirements:

- The vertical edges of the wall system shall be free to deflect, such that the span of the test wall assembly is parallel to the vertical edges. The ends of each wall assembly, perpendicular to the test span, shall be provided with continuous support during the load tests, and shall be representative of field installation.
- The "bag method" or vacuum chamber loading may be used.
- Positive and negative pressure conditions shall be tested.
- All assemblies shall be loaded in increments to failure with deflections taken to obtain deflection and set characteristics. Application of load and duration of load application shall be in accordance with Sections 4.2 and 4.3 of ASTM E72, respectively. Where preloading is applied, the loading, deflection and recovery shall be noted. The amount of preloading shall not exceed 10 percent of the final allowable load.

- Allowable loads determined from these tests shall be limited to the sizes, materials and spans of the tested assemblies and may be used for shorter spans or heights, but extrapolation to greater spans, heights or loads is not permitted. As an alternate, additional full-scale testing shall include the maximum and minimum assembly spans intended for recognition. No extrapolation beyond these spans or corresponding loads will be permitted.
- Where tests are not conducted to failure, the highest load achieved for each test will be assumed as ultimate.

**4.3.3.3 Conditions of Acceptance:** The allowable uniform transverse load shall be based on the most restrictive of the strength and deflection requirements. With the allowable wind load imposed, the average deflection of the tested assemblies shall comply with IBC Table 1604.3. This deflection shall be measured at the wall assembly's mid-height.

**4.3.3.4 Results:** The maximum (ultimate) test load shall be based on the average of three tests provided none of the results vary by more than 15 percent from the average of the three, otherwise the lowest test value shall be used as the maximum test load. The allowable uniform transverse load shall be based on a safety factor of three (3) applied to the maximum (ultimate) test load.

#### **4.3.4 Wall Tension Tests:**

**4.3.4.1 Specimens:** Three replicate assemblies of each MCFR wall assembly shall be tested.

**4.3.4.2 Procedure:** Tests shall be conducted per ASTM E72, Section 10, and the following requirements:

- Attachment of the test specimens shall be configured such that failure will not occur in the connection of the test apparatus to the top and bottom of the wall assembly. The tension force shall be applied at the underside of the horizontal assembly.
- Where tests are not conducted to failure, the highest load achieved for each test will be assumed as ultimate.
- In addition to the standard reporting and certification of test results, observations shall be reported, and photographs shall be taken of specimen response at significant stages of the loading process and submitted for review.

**4.3.4.3 Conditions of Acceptance:** At failure (or maximum load), the governing limit state shall not be related to wall end connections.

**4.3.4.4 Results:** The maximum (ultimate) test load shall be based on the average of three tests provided none of the results vary by more than 15 percent from the average of the three, otherwise the lowest test value shall be used as the maximum test load. The allowable axial tension load shall be based on a safety factor of three (3) applied to the maximum (ultimate) test load.

#### **4.3.5 Wall Static Racking Shear Tests (In-plane Shear Tests):**

**4.3.5.1 Specimens:** Three replicate assemblies of each MCFR wall assembly shall be tested. The wall shall be attached to a rigid base in a manner consistent with the field installation including anchor type, size, and spacing. The top and loading edge of the specimen may be reinforced with steel plates to avoid distortion.

**4.3.5.2 Procedure:** Tests shall be conducted in accordance with the general guidelines of ASTM E564, in the following manner:

- The wall test specimen shall have an aspect ratio of 1:1.
- Supplemental tests shall be conducted where the wall specimen shall be subjected to simultaneously applied vertical compression loads and in-plane shear loads, where recognition is sought for this loading condition in the evaluation report. The vertical compression shall be applied before beginning the in-plane shear load testing.
- The applied vertical compression load shall be maintained throughout the test and need not exceed the allowable or service (unfactored) axial compression load that will be recognized in the evaluation report. The vertical compression load shall be applied uniformly along a line parallel to the inside face, which is centered at one-third the thickness of the specimen from the inside face on the top surface of the specimen.



- The vertical compression load may be applied as stationary loading.
- The test data shall be reported as required in ASTM E564 for load-deflection curve, vertical load, ultimate shear strength, vertical and horizontal displacements, and shear stiffness.
- For the combined shear and vertical load tests, the applied vertical compression load shall be maintained at the completion of the lateral loading.

#### 4.3.5.3 Conditions of Acceptance:

- 1) The percent recovery shall be greater than 75 percent at the allowable in-plane shear load, where the percent recovery R is defined as:

$$R=100*(1-s/\Delta),$$

Where's is permanent horizontal shear deformation, and  $\Delta$  is horizontal shear displacement as determined in Section 3.3.5 of ASTM E564.

- 2) There shall be no cracking of MCFR components comprising the wall assembly, and no adhesive joint failure at the allowable racking shear load.
- 3) The average of three specimens lateral drift (total horizontal displacement of the top of the wall measured with respect to the test apparatus as defined in ASTM E564) at ultimate shear strength shall be equal to or less than L/180, where L is the height (unsupported length) of the MCFR wall specimens.

**4.3.5.4 Results:** The maximum (ultimate) test load shall be based on the average of three tests provided none of the results vary by more than 15 percent from the average of the three, otherwise the lowest test value shall be used as the maximum test load. The allowable in-plane shear strength shall be based on a safety factor of three (3) applied to the ultimate shear strength.

#### 4.4 MCFR Fire Tests

4.4.1 ASTM D1929

4.4.2 ASTM D2843

4.4.3 ASTM E84 or UL 723

##### 4.4.3.1 Interior Wall Finish Material Surface Burning Tests (Interior Walls Only):

**4.4.3.1.1 Testing Requirement:** The interior finishes of walls shall be tested in accordance with ASTM E84 or UL 723. The test specimens shall replicate the MCFR wall assemblies.

**4.4.3.1.2 Conditions of Acceptance:** The tested wall finish material shall be classified as Class A, B or C in accordance with IBC Section 803.1.1.

4.4.4 ASTM E119 or UL 263

4.4.5 ASTM E136

4.4.6 NFPA 286

#### 4.5 MCFR Optional tests

4.5.1 UV tests

**4.5.2 Optional UV Exposure Weathering Testing** (required if recognition is sought for exposure of the MCFR Wall Assemblies for a period exceeding 90 days)

**4.5.2.1 Specimens:** A minimum of ten replicate specimens shall be tested in each exposure condition, unexposed and UV exposed.

**4.5.2.2 Procedures:** The unexposed specimens shall be maintained at 73°F (23°C) and 50 percent relative humidity (RH) in a dark chamber; whereas the specimens for UV exposure weathering shall be conditioned and tested in accordance with ASTM D2565 and ASTM G155 utilizing cycle No.1 or cycle No.2 for a minimum duration of 1000 hours.

- 4.5.2.3 Conditions for Acceptance:** Control specimens and exposed specimens shall be visually examined using 5× magnification. Surface changes such as erosion, cracking, crazing, checking and chalking that affect performance are unacceptable.
- 4.5.3** Sound tests
- 4.5.4** Insulation tests

## **5.0 DESIGN**

MCFR Building Systems shall be designed and installed in accordance with the evaluation report and the applicable codes. Design plans, specifications, engineering calculations, and other construction documentation specifying the use of an MCFR Building System shall be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is built. The documents shall be submitted to the building code official for approval.

## **6.0 QUALITY CONTROL**

- 6.1** A complete description of the quality management system used in the factory to manufacture the MCFR shall be provided. The manufacturer's Quality Management System shall comply with the IAPMO UES minimum requirements for manufacturer' quality management systems (IAPMO ES-010).
- 6.2** A complete and descriptive set of installation instructions shall be provided for MCFR use in the field.
- 6.3** Inspections of manufacturing facilities are required by agencies accredited in accordance with ISO/IEC 17020 or ISO/IEC 17065.
- 6.4** Inspection frequency shall be a minimum of 2 per year.

## **7.0 EVALUATION REPORT RECOGNITION**

The evaluation report shall include at a minimum the following:

- 7.1** Basic information required by Section 3.0 of this criteria, including product description, installation procedures, and packaging and identification of the MCFR wall units, adhesives and fasteners.
- 7.2** A statement that the MCFR wall assemblies used as a lateral force-resisting system shall be limited to Seismic Design Categories (SDCs) A and B.
- 7.3** A statement that MCFR wall assemblies used below-grade are beyond the scope of this criteria.
- 7.4** Design methods to be used for design of MCFR assemblies for use by design professionals and verification of adequate use of the MCFR Building System.
- 7.5** Limitations for use of the MCFR Building Systems including storage and protection from the elements.
- 7.6** A statement that MCFR material shall not be exposed outdoors for more than 90 days, unless testing has been done in accordance with Section 4.5.1.
- 7.7** Surface burning characteristics (Class A, B, or C), depending on results from Section 4.4.3
- 7.8** Fire resistance rating, depending on results from Section 4.4.4