



## Standard Specification for Structural Cementitious Panels<sup>1</sup>

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### 1. Scope

1.1 This specification covers structural cementitious panels. Structural cementitious panels are non-combustible, water durable, fiber reinforced inorganic composite panels intended for use as structural panels. Structural cementitious panels can be used as floor, roof and wall sheathing when fastened to supports spaced in accordance with the appropriate span rating.

1.2 This specification defines minimum performance requirements for structural cementitious sheathing panels with respect to structural performance, dimensional stability performance, dimensional tolerance, noncombustibility, surface burning characteristics, long-term durability, water durability, mold resistance, density, moment capacity and bending stiffness.

1.3 This specification also defines a policy to assure ongoing product quality by detecting changes in panel properties that may adversely affect panel performance. Required audits of quality activities by a third party quality assurance agency are also defined.

1.4 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C27 on Precast Concrete Products and is the direct responsibility of Subcommittee C27.40 on Glass Fiber Reinforced Concrete.

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### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

- C1185 Test Methods for Sampling and Testing Non-Asbestos Fiber-Cement Flat Sheet, Roofing and Siding Shingles, and Clapboards
- C1704/C1704M Test Method for Sampling and Testing Structural Cementitious Panels
- D1037 Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials
- D1761 Test Methods for Mechanical Fasteners in Wood
- D3273 Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
- E84 Test Method for Surface Burning Characteristics of Building Materials
- E136 Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C
- E330 Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
- E661 Test Method for Performance of Wood and Wood-Based Floor and Roof Sheathing Under Concentrated Static and Impact Loads
- G21 Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

### 3. Terminology

#### 3.1 Definitions of Terms Specific to This Standard:

3.1.1 *cross machine direction (XMD), n*—the direction perpendicular to the machine direction.

3.1.2 *edge, n*—edges of a panel refer to the long side of a rectangular panel. For example, on a 4 by 8 ft panel, the edges refer to the sides of the panel that are 8 ft long.

3.1.3 *end, n*—the end of a panel refers to the short side of a rectangular panel. For example, on a 4 by 8 ft panel, the end refers to the side of the panel that is 4 ft long.

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

3.1.4 *fiber reinforced inorganic composite, n*—a composite material composed primarily of inorganic matrix materials reinforced primarily with inorganic fibers. Inorganic aggregates may be combined with the inorganic matrix.

3.1.5 *machine direction (MD), n*—the direction the board travels during manufacture.

3.1.6 *noncombustibility, n*—term intended to describe products that do not ignite and/or burn when subjected to fire. Test methods are generally specified by reputable agencies such as ASTM, Factory Mutual, Underwriters Lab Inc., etc.

3.1.7 *performance standard, n*—a standard for products based on performance. Performance is measured by tests that approximate end-use conditions.

3.1.8 *plant specification, n*—the plant specification is unique to each qualified product under a given performance standard. The specification is used in the plant quality program as audited under the approved quality control program.

3.1.9 *qualification policy, n*—policy that describes the procedures by which a plant may obtain span rating privileges for performance-rated products policy.

3.1.10 *quality assurance policy, n*—policy covering the third-party auditing of plant's quality control program.

3.1.11 *reference value, n*—the numerical value established for the plant specification for a given mechanical or physical property.

3.1.12 *sample average, n*—the average test value, obtained by summing the observations and dividing by the number of tests.

3.1.13 *sample panel, n*—a structural cementitious panel from which test specimens are cut and conditioned as necessary.

3.1.14 *sample standard deviation, n*—a measure of test variation. Calculated as:

$$S = \sqrt{[\sum x^2 - (\sum x)^2/n]/n - 1} \quad (1)$$

where:

$S$  = sample standard deviation,

$x$  = test observation, and

$n$  = number of observations.

3.1.15 *span rating, n*—the recommended maximum center-to-center support spacing in inches for the specified end use under normal use conditions.

3.1.16 *specimen, n*—the individual test piece cut from a sample panel.

3.1.17 *structural cementitious panel, n*—non-combustible, water durable, fiber-reinforced inorganic composite panels intended for use as structural panels.

3.1.18 *test exposure condition, n*—the condition to which a panel is subjected prior to test. Generally, such conditions are referred to as the dry or wet conditions.

3.1.19 *test specimen, n*—specimens cut from a sample panel that are used for testing.

3.1.20 *water durability, n*—performance of a product after sustained immersion in water for a specified period of time.

#### 4. Performance Specifications for Structural Cementitious Panels

4.1 Structural cementitious panels are fiber-reinforced inorganic composite panels intended for use as structural panels. When used as a floor sheathing panel, structural cementitious panels can be used as a combination subfloor and underlayment (single floor grade) or as a sheathing grade panel, which when used as a floor requires an underlayment panel on top of it. In either case, panels must be fastened to supports spaced in accordance with the panel's span rating. Sections 5 through 13 describe qualification procedures and initial testing required to demonstrate that the panel's performance characteristics meet the requirements of this standard.

#### 5. Structural Performance

5.1 *Concentrated Loads*—Panels shall be tested according to the procedures of Test Method E661 for concentrated static and impact loads. Panels shall conform to the criteria of Tables 1 and 2 for the end use and span shown on the panel.

5.2 *Uniform Loads*—Panels shall be tested according to the procedures of Test Method E330 for uniform loads. Uniform loads shall be applied in both the positive and negative directions. Panels shall conform to the performance values of Table 3 for the end use and span shown on the panel.

**TABLE 1 Sheathing Grade Sheets—Concentrated Static and Impact Test Performance Criteria for Panels Tested According to Test Method E661**

Span Rating, in.	Test Exposure Conditions <sup>A</sup>	Performance Requirements		
		Minimum Ultimate Load, lb [kN]		Maximum Deflection, in. [mm] Under 200-lb Load [0.89 kN]
		Static	Following Impact	
16 [406 mm]	Dry	400 lb [1.78 kN]	400 lb <sup>B</sup> [1.78 kN]	0.125 in. <sup>C</sup> [3.18 mm]
	Wet	400 lb [1.78 kN]	400 lb <sup>B</sup> [1.78 kN]	0.125 in. <sup>C</sup> [3.18 mm]
20 [508 mm]	Dry	400 lb [1.78 kN]	400 lb <sup>B</sup> [1.78 kN]	0.125 in. <sup>C</sup> [3.18 mm]
	Wet	400 lb [1.78 kN]	400 lb <sup>B</sup> [1.78 kN]	0.125 in. <sup>C</sup> [3.18 mm]
24 [610 mm]	Dry	400 lb [1.78 kN]	400 lb <sup>B</sup> [1.78 kN]	0.125 in. <sup>C</sup> [3.18 mm]
	Wet	400 lb [1.78 kN]	400 lb <sup>B</sup> [1.78 kN]	0.125 in. <sup>C</sup> [3.18 mm]

<sup>A</sup> Wet conditioning is exposure to seven days continuous wetting and tested wet.

<sup>B</sup> Impact shall be 75 ft-lb [102 J] for span ratings up to 24 in. o.c [610 mm o.c.].

<sup>C</sup> Criteria apply under both static concentrated load and following impact.

**TABLE 2 Single Floor Grade Sheets—Concentrated Static and Impact Test Performance Criteria for Panels Tested According to Test Method E661**

Span Rating, in.	Test Exposure Conditions <sup>A</sup>	Performance Requirements		
		Minimum Ultimate Load, lb [kN]		Maximum Deflection, in. [mm] Under 200-lb Load [0.89 kN]
		Static	Following Impact	
16 [406 mm]	Dry	550 lb [2.45 kN]	400 lb <sup>B</sup> [1.78 kN]	0.078 in. <sup>C</sup> [1.98 mm]
	Wet	550 lb [2.45 kN]	400 lb <sup>B</sup> [1.78 kN]	0.078 in. <sup>C</sup> [1.98 mm]
20 [508 mm]	Dry	550 lb [2.45 kN]	400 lb <sup>B</sup> [1.78 kN]	0.094 in. <sup>C</sup> [2.39 mm]
	Wet	550 lb [2.45 kN]	400 lb <sup>B</sup> [1.78 kN]	0.094 in. <sup>C</sup> [2.39 mm]
24 [610 mm]	Dry	550 lb [2.45 kN]	400 lb <sup>B</sup> [1.78 kN]	0.108 in. <sup>C</sup> [2.74 mm]
	Wet	550 lb [2.45 kN]	400 lb <sup>B</sup> [1.78 kN]	0.108 in. <sup>C</sup> [2.74 mm]

<sup>A</sup> Wet conditioning is exposure to seven days continuous wetting and tested wet.

<sup>B</sup> Impact shall be 75 ft-lb [102 J] for span ratings up to 24 in. o.c. [610 mm o.c.].

<sup>C</sup> Criteria apply under both static concentrated load and following impact.

**TABLE 3 Uniform Load Performance Criteria for Panels Tested per Test Method E330**

Span Rating, in.	Test Exposure Conditions <sup>A</sup>	Average Deflection Under Load <sup>B,C</sup>	Minimum Ultimate Uniform Load, psf [kPa]
16 [406 mm]	Dry or Wet	0.044 in. [1.12 mm] @ 100 psf [4.79 kPa]	330 psf [15.8 kPa]
20 [508 mm]	Dry or Wet	0.053 in. [1.35 mm] @ 100 psf [4.79 kPa]	330 psf [15.8 kPa]
24 [610 mm]	Dry or Wet	0.067 in. [1.70 mm] @ 100 psf [4.79 kPa]	330 psf [15.8 kPa]

<sup>A</sup> Wet conditioning is exposure to seven days continuous wetting and tested wet.

<sup>B</sup> Deflection of sheathing relative to framing.

<sup>C</sup> Specimen tested in 2 span condition.

**5.3 Fastener Holding**—For lateral fastener loads, panels shall be tested according to the procedures of Test Methods **D1761**, using the sections applicable to lateral fastener load testing. For withdrawal loads, panels shall be tested according to Test Methods **D1037**, using the sections applicable to withdrawal load testing. Panels shall conform to the criteria of **Table 4** for the end use and thickness shown on the panel.

## 6. Stability Performance

**6.1 Linear Expansion**—Panels shall be tested according to Test Methods **C1185**, using the section applicable to linear expansion. Linear expansion of the structural panel shall not exceed 0.1 %, in either the machine or cross machine direction. Testing shall be initiated 28 days after panel production.

**6.2 Thickness Swell**—Panels shall be tested according to Test Methods **D1037**, Method B. Thickness swell of the floor sheathing panel shall not exceed 3 %. Testing shall be initiated 28 days after panel production.

**6.3 Water Absorption**—Panels shall be tested according to Test Method **C1704/C1704M**, using the section applicable to water absorption. Water absorption of the floor sheathing panel shall not exceed 15 % when tested at the age of 28 days.

**6.4 Panel Freeze/Thaw**—Panels shall be tested in accordance with Test Methods **C1185**, using the section applicable to panel freeze/thaw. Panels shall retain a minimum of 75 % of the control strength values after 50 cycles, in either the machine or cross machine direction. Testing shall be initiated at 28 days after panel production.

## 7. Dimensional Tolerance and Squareness of Panels

**7.1 Length and Width**—A tolerance of  $\pm \frac{1}{8}$  in. [ $\pm 3.2$  mm] shall be allowed on specified length and/or width.

**7.2 Thickness**—A tolerance of  $\pm \frac{1}{32}$  in. [ $\pm 0.8$  mm] for specified thicknesses.

**7.3 Squareness and Straightness**—Panels shall be square within  $\frac{1}{64}$  in. [0.4 mm] per lineal foot of panel length, as measured along the diagonals. All panels shall be manufactured so that a straight line drawn from one corner to the adjacent corner is within  $\frac{1}{16}$  in. [1.6 mm] of the panel edge.

## 8. Noncombustibility

**8.1** Panels shall be tested according to Test Method **E136** at an age of 28 days. Panel specimens shall be demonstrated to be non-combustible per the requirements of Test Method **E136**.

**TABLE 4 Fastener Performance Criteria Under Lateral and Withdrawal Loads for Structural Cementitious Panels Tested per Test Methods D1761 (Lateral Loads) and Test Methods D1037 (Withdrawal Loads)**

End Use	Panel Thickness, in.	Screw Size	Test Exposure Condition	Performance Requirements for Minimum Ultimate Load, lb [N]		
				Lateral	Withdrawal	
Structural Cementitious Panels	Single Floor or Sheathing Grade	Greater than ½ [12.7 mm]	#8, 1-5⁄8 in. [41.3 mm]	Dry	210 lb [0.93 kN]	20 lb [89 N]
				Wet	160 lb [0.71 kN]	15 lb [67 N]

## 9. Surface Burning Characteristics

9.1 Panels shall be tested according to Test Method **E84** for surface burning characteristics at an age of 28 days. Test specimens shall achieve a 0 flame spread and a maximum smoke developed of 5.

## 10. Long-Term Durability

10.1 Panels shall be tested per Test Methods **C1185**, using the section applicable to long-term durability, with conditioning initiated at an age of 28 days after production. A minimum retention of 75 % of maximum load and maximum deflection values shall be achieved for the wet conditioned specimens compared to the control samples. Testing shall be conducted in both the machine and the cross machine directions.

## 11. Water Durability

11.1 Panels shall be tested per Test Methods **C1185**, using the section applicable to water durability, at an age of 28 days in an as-is and wet condition. Wet specimens shall retain a minimum of 70 % of the maximum load and maximum deflection compared to the as-is samples. Testing shall be conducted in both the machine and the cross machine directions.

## 12. Mold Resistance

12.1 Panels shall be tested for mold resistance per Test Method **D3273** and Practice **G21**. Test specimens shall have a mold resistance value of 10 when tested per Test Method **D3273** and a mold resistance value of 1 or less when tested per Practice **G21**. In both cases, testing shall be initiated at 28 days after production of the panels.

## 13. Density

13.1 Panels shall be tested for density in accordance with Test Method **C1704/C1704M**, using the section applicable to density. Testing shall be initiated at 28 days after production of the panels. Density shall be 70 pcf [1124 kg/m<sup>3</sup>] minimum.

## 14. Sampling and Inspection

14.1 Panel samples shall be selected in sufficient quantity to enable statistical analysis. Test specimens prepared from panel samples shall be sufficient in number to enable statistical analysis.

## 15. Quality Assurance

### 15.1 General:

15.1.1 The purpose of this section is to assure product quality by detecting changes in panel properties that may adversely affect panel performance. In all cases, the specifications to which the panels are tested shall comply with Sections 5 through 13 of this standard.

15.1.2 Plant quality documentation shall specify statistical sampling methods to verify that the small-specimen moment capacity and stiffness values given in **Tables 5 and 6** of this standard are met at a confidence level of 95 % or more. Small-specimen moment capacity and bending stiffness tests are described in **15.2** and **15.3**.

15.1.3 A third-party quality assurance agency shall audit quality activities and perform periodic quality checks.

15.2 *Moment Capacity*—Panels shall be tested for moment capacity in accordance with Test Method **C1704/C1704M**, using the section applicable to moment capacity. Testing shall be initiated at 28 days after production of the panels. Panels shall conform to the performance values defined in **Table 5**.

15.3 *Bending Stiffness*—Panels shall be tested for bending stiffness in accordance with Test Method **C1704/C1704M**, using the section applicable to bending stiffness. Testing shall be initiated at 28 days after production of the panels. Panels shall conform to the performance values defined in **Table 6**.

### 15.4 Auditing:

#### 15.4.1 Audit:

15.4.1.1 A third-party Quality Auditor shall make random, unannounced visits to the plant for the purpose of auditing the plant quality records. During these visits, the third-party Quality Auditor shall audit the plant quality control records and issue a certificate of compliance if the records indicate that the plant has substantially met its obligations per the plant Quality Control Manual.

15.4.1.2 Optionally, prior to issuance of a certificate of compliance, the auditor may also select samples for testing according to procedures in the QC Manual and may require that the testing be conducted at an independent third party laboratory and the results be submitted to them for evaluation.

15.4.2 *Maintenance of Audit Records*—The plant shall maintain records of all audits conducted and certificate of compliance issued by the auditor.

**TABLE 5 Minimum Dry and Wet Moment Capacity, lb-in./ft [N-m/m] Machine and Cross Machine Directions Tested According to Test Methods **C1185****

Panel	Thickness, in.	Span, in.	Dry Moment Capacity, MM lb-in./ft width [N-m/m]		Wet Moment Capacity, MM lb-in./ft width [N-m/m]	
			Stress Applied in Machine Direction	Stress Applied in Cross Machine Direction	Stress Applied in Machine Direction	Stress Applied in Cross Machine Direction
Structural Sheathing	3/4	16 oc	1450 lb-in./ft width	1450 lb-in./ft width	1015 lb-in./ft width	1015 lb-in./ft width
	[19 mm]	[406 mm]	[537 N-m/m]	[537 N-m/m]	[376 N-m/m]	[376 N-m/m]
Structural Sheathing	3/4	19.2 oc	1450 lb-in./ft width	1450 lb-in./ft width	1015 lb-in./ft width	1015 lb-in./ft width
	[19 mm]	[508 mm]	[537 N-m/m]	[537 N-m/m]	[376 N-m/m]	[376 N-m/m]
Structural Sheathing	3/4	24 oc	1450 lb-in./ft width	1450 lb-in./ft width	1015 lb-in./ft width	1015 lb-in./ft width
	[19 mm]	[610 mm]	[537 N-m/m]	[537 N-m/m]	[376 N-m/m]	[376 N-m/m]

**TABLE 6 Average Dry Bending Stiffness Capacity for Panels Tested According to Test Methods C1185**

Panel Type	Thickness, in.	Span, in.	Bending Stiffness, EI lb-in. <sup>2</sup> /ft width [N-m <sup>2</sup> /m]	
			Stress Applied Parallel to Long Axis	Stress Applied Perpendicular to Long Axis
Structural Sheathing	¾ [19 mm]	16 oc [406 mm]	223 000 lb-in. <sup>2</sup> /ft width [2100 N-m <sup>2</sup> /m]	223 000 lb-in. <sup>2</sup> /ft width [2100 N-m <sup>2</sup> /m]
Structural Sheathing	¾ [19 mm]	19.2 oc [508 mm]	223 000 lb-in. <sup>2</sup> /ft width [2100 N-m <sup>2</sup> /m]	223 000 lb-in. <sup>2</sup> /ft width [2100 N-m <sup>2</sup> /m]
Structural Sheathing	¾ [19 mm]	24 oc [610 mm]	223 000 lb-in. <sup>2</sup> /ft width [2100 N-m <sup>2</sup> /m]	223 000 lb-in. <sup>2</sup> /ft width [2100 N-m <sup>2</sup> /m]

## 16. Keywords

16.1 bending stiffness; density; dimensional tolerance; inspection; long-term durability; mold resistance; moment capacity;

noncombustibility; quality assurance; sampling; stability performance; structural cementitious panel; structural performance; surface burning; water durability

## RELATED MATERIAL

2003 International Building Code (IBC), International Code Council  
 ICBO ES Acceptance Criteria for Quality Control Manuals (AC 10)  
 ICBO ES Acceptance Criteria for Test Reports and Product Sampling (AC 85)

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes  
 MIL-STD-414 Sampling Procedures and Tables for Inspection by Variables for Percent Defective

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