Designation: C 1704/C 1704M – 09

Standard Test Method for Sampling and Testing Structural Cementitious Panels[1]

This standard is issued under the fixed designation C 1704/C 1704M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 These test methods cover sampling and testing of structural cementitious panels. Structural cementitious panels are non-combustible, water durable, fiber reinforced inorganic composite panels intended for use as structural panels when fastened to supports spaced in accordance with the span rating in inches.

1.2 These test methods are utilized in evaluating products cited in Specification C 1705/C 1705M.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. 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.

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C 1705/C 1705M Specification for Structural Cementitious Panels

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.

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 *non-combustibility*, *adj*—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., and so forth.

3.1.7 *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.

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

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*—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:

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

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.

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

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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. Sampling and Inspection

4.1 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.

5. Test Methods

5.1 *Water Absorption*:

5.1.1 *Significance and Use*—This is routine test. The values are relative. The test is made to determine the tendency of a product to absorb water and determine uniformity of the product.

5.1.2 *Procedure*—Specimens shall be cut from sample panels at or before 28 days after manufacture (wet cast). Specimens shall be minimum 4 by 4 in. (101.6 by 101.6 mm) Specimens shall be cut from the interior area of each sample panel in such a manner that no edge of a specimen is less than 3 in. (76.2 mm) from the original edges of the sample panel. Record the initial weight of each specimen. Submerge the specimens horizontally in 1 in. (25.4 mm) of distilled or deionized water, maintained at a temperature of 70 ±5°F. Position the specimens so that they do not lie flat on the bottom of the container by placing shims underneath the specimens. Ensure that water can reach all faces of the specimens. Remove the specimens from water after 48 ± 2 h. Blot the specimens dry until no free moisture is visible on the surface. A minimum of four specimens shall be prepared. Record the weight of each specimen.

5.1.3 *Calculation and Report*—Calculate the water absorption for each specimen using the following equation:

$$W_A = (W_W - W_I)/W_I \cdot 100 \quad (2)$$

where:

W_A = water absorption (%),
W_W = wet weight of specimen, lb (g), and
W_I = initial weight of specimen, lb (g).

5.1.3.1 The average water absorption of the specimens shall be the arithmetic mean value obtained from testing the four specimens. Report the arithmetic mean of the complete specimen set.

5.1.4 *Precision and Bias*:

5.1.4.1 *Precision*—The precision of the water absorption test procedure in this standard is being determined.

5.1.4.2 *Bias*—The bias for the water absorption test procedure in this standard is being determined.

5.2 *Density*:

5.2.1 *Significance and Use*—This is routine test. The values are relative. The test is made to determine the density of the product and determine uniformity of the product.

5.2.2 *Procedure*—Specimens shall be cut from test panels at or before 28 days after manufacture (wet cast). Specimens shall be minimum 4 by 4 in. (101.6 by 101.6 mm) Specimens shall be cut from the interior area of each sample panel in such a manner that no edge of a specimen is less than 3 in. (76.2 mm) from the original edges of the sample panel. A minimum of four specimens shall be prepared. Record the length, width, thickness, and weight of each specimen.

5.2.3 *Calculation and Report*—Calculate the density for each specimen using the following equation:

$$\text{For inch}-\text{pound units: } D = W_S/[(L \cdot W \cdot t)/1728] \quad (3)$$

where:

D = density of specimen, lb/ft^3,
W_S = weight of specimen, lb,
L = length of specimen, in.,
W = width of specimen, in., and
t = thickness of specimen, in.

$$\text{For SI units: } D = W_S/(L \cdot W \cdot t) \quad (4)$$

where:

D = density of specimen, kg/m^3,
W_S = weight of specimen, kg,
L = length of specimen, m,
W = width of specimen, m, and
t = thickness of specimen, m.

5.2.3.1 The average density of the specimens shall be the arithmetic mean value obtained from testing the four specimens. Report the arithmetic mean of the complete specimen set.

5.2.4 *Precision and Bias*:

5.2.4.1 *Precision*—The precision of the density test procedure in this standard is being determined.

5.2.4.2 *Bias*—The bias of the density test procedure in this standard is being determined.

5.3 *Moment Capacity*:

5.3.1 *Significance and Use*—This is a routine test measuring a primary product characteristic.

5.3.2 *Procedure*:

5.3.2.1 *Preparation of Test Specimens*—Specimens shall be cut from test panels at a time after initial production such that handling the panels will not affect the physical properties of the specimens. Specimens shall be minimum 4 in. (101.6 mm) by 11 in (279.4 mm). A minimum of six specimens shall be cut with the long dimension of the specimen parallel to the long axis of the sample sheet. A minimum of six specimens shall be cut with the long dimension of the specimen perpendicular to the long axis of the sample sheet.

5.3.2.2 *Conditioning*:

(1) Dry—Condition the cut specimens at 75 ± 10°F (24 ± 5°C) and 50 ± 15 % relative humidity for a minimum of 24 h prior to testing.

(2) Wet—Submerge the specimens in water, maintained at a temperature of 70 ± 5°F. Position the specimens so that they do not lie flat on the bottom of the container. Ensure that water

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can reach all faces of the specimens. Remove the specimens from water after 48 ± 2 h. Blot the specimens dry until no free moisture is visible on the surface. Immediately commence with the test procedure as described in 5.3.2.3.

5.3.2.3 *Test Procedure*:

(1) Specimens shall be tested in the face-up and face-down orientations. The face-up orientation in the flexural testing corresponds to the orientation of the specimen in which its cast surface (during manufacture) is in flexural tension. The face-down orientation in the flexural testing corresponds to the orientation of the specimen in which its cast surface (during manufacture) is in flexural compression. A minimum of three specimens shall be tested in the face-up orientation, with the long dimension of the specimen parallel to the long axis of the sample sheet. A minimum of three specimens shall be tested in the face-up orientation, with the long dimension of the specimen perpendicular to the long axis of the sample sheet. A minimum of three specimens shall be tested in the face-down orientation, with the long dimension of the specimen parallel to the long axis of the sample sheet. A minimum of three specimens shall be tested in the face-down orientation, with the long dimension of the specimen perpendicular to the long axis of the sample sheet

(2) Determine the moment capacity of each specimen by placing the specimen on supports that cannot exert longitudinal constraints [rocker-type bearing edges, rollers, and so forth, with a ⅛-in. (3.2-mm) minimum radius and ½-in. (12.7-mm) maximum radius] and applying the load at mid-span through similar edge bearing against the other surface of the specimen. The test span shall be 10 ± 1/16 in. (254 ± 1.6 mm) and the load line and supports shall be parallel. Mount a dial micrometer reading to 0.01 in (0.25 mm) or an equally sensitive apparatus, to bear on the loading member or on the specimen at mid-span to determine the deflection of the specimen at the center of the test span. Apply load at a crosshead speed of 0.25 to 1.00 in./min. Record the load versus deflection plot until specimen failure. The maximum load attained in the test is recorded as the breaking load.

(3) Measure the specimen thickness at four points along the line of break for an average result. This measurement may be completed either before or after load testing. The thickness gauge shall have an accuracy of ±0.002-in. (±0.05-mm).

5.3.3 *Calculation and Report*—Calculate the moment capacity for each specimen using the following equation:

$$\text{For inch–pound units: } M = (PL/4) \cdot (12/b) \quad (5)$$

where:

M = moment capacity, lbf-in./ft width,
P = breaking load, lbf,
L = length of span, in., and
b = specimen width, in.

$$\text{For SI units: } M = (PL/4) \cdot (1/b) \quad (6)$$

where:

M = moment capacity, N-m/m width,
P = breaking load, N,
L = length of span, m, and
b = specimen width, m.

5.3.4 The average moment capacity of the specimens shall be the arithmetic mean value obtained from the two orientations, face-up and face-down. Report the arithmetic mean of the complete specimen set. Report the arithmetic mean of dry and wet tests separately.

5.3.5 *Precision and Bias*:

5.3.5.1 *Precision*—The precision of the moment capacity test procedure in this standard is being determined.

5.3.5.2 *Bias*—The bias for the moment capacity test procedure in this standard is being determined.

5.4 *Bending Stiffness*:

5.4.1 *Significance and Use*—This is a routine test measuring a primary product characteristic.

5.4.2 *Procedure*:

5.4.2.1 *Preparation of Test Specimens*—Same as 5.3.2.1.

5.4.2.2 *Conditioning*—Same as 5.3.2.2.

5.4.2.3 *Test Procedure*—Same as 5.3.2.3.

5.4.3 *Calculation and Report*—Calculate the bending stiffness for each specimen using the following equation:

$$\text{For inch–pound units: } B = [((P_2 - P_1) \cdot L^3) / (48 \cdot (y_2 - y_1))] \cdot (12/b) \quad (7)$$

where:

B = bending stiffness, lb-in.^{2}/ft width,
P = breaking load, lbf,
L = length of span, in,.
b = specimen width, in.,
P_1 *and* P_2 = loads taken from two points within the initial linear section of the load-displacement plot, lbf, and
y_1 *and* y_2 = deflections corresponding to the loads P_1 and P_2, respectively, in.

$$\text{For SI units: } B = [((P_2 - P_1) \cdot L^3) / (48 \cdot (y_2 - y_1))] \cdot (1/b) \quad (8)$$

where:

B = bending stiffness, N-m^2/m width,
P = breaking load, N,
L = length of span, m.
b = specimen width, m,
P_1 *and* P_2 = loads taken from two points within the initial linear section of the load-displacement plot, N, and
y_1 *and* y_2 = deflections corresponding to the loads P_1 and P_2, respectively, m.

5.4.3.1 The average bending stiffness of the specimens shall be the arithmetic mean value obtained from the two orientations, face-up and face-down. Report the arithmetic mean of the complete specimen set.

5.4.4 *Precision and Bias*:

5.4.4.1 *Precision*—The precision of the bending stiffness test procedure in this standard is being determined.

5.4.4.2 *Bias*—The bias for the moment capacity test procedure in this standard is being determined.

6. Keywords

6.1 bending stiffness; density; moment capacity; quality assurance; sampling, inspection; structural cementitious panel; structural performance

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