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Standard Test Methods for Sampling and Testing Non-Asbestos Fiber-Cement Flat Sheet, Roofing and Siding Shingles, and Clapboards[1]

This standard is issued under the fixed designation C1185; 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 non-asbestos fiber-cement flat sheets, roofing shingles, siding shingles, and clapboards. These products may be smooth or surface textured. These test methods are utilized in evaluating products cited in Specifications C1186, C1225, C1288, and C1325.

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

1.3 *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]

C20 Test Methods for Apparent Porosity, Water Absorption, Apparent Specific Gravity, and Bulk Density of Burned Refractory Brick and Shapes by Boiling Water

C1154 Terminology for Non-Asbestos Fiber-Reinforced Cement Products

C1186 Specification for Flat Fiber-Cement Sheets

C1225 Specification for Fiber-Cement Roofing Shingles, Shakes, and Slates

C1288 Specification for Discrete Non-Asbestos Fiber-Cement Interior Substrate Sheets

C1325 Specification for Non-Asbestos Fiber-Mat Reinforced Cementitious Backer Units

2.2 *ISO Standards:*

ISO 390 Product in Fiber Reinforced Cement Sampling and Inspection[3]

ISO 2859-0 Sampling Procedures for Inspection by Attributes—Part 0: Introduction to the ISO 2859 Attribute Sampling System[3]

ISO 2859-1 Sampling Procedures for Inspection by Attributes—Part 1: Sampling Schemes Indexed by Acceptance Quality Limit (AQL) for Lot-by-Lot Inspection[3]

ISO 3951 Sampling Procedures and Charts for Inspection by Variables for Percent Nonconforming[3]

3. Terminology

3.1 *Definitions:*

3.1.1 Refer to Terminology C1154.

3.1.2 *density*—the mass per unit volume expressed in pounds per cubic foot (lb/ft^3) or kilograms per cubic metre (kg/m^3).

3.1.3 *flexural strength*—the average flexural strength is the average of two perpendicular breaks expressed in pound-force per square inch (megapascals) as calculated from the average breaking load of wet or equilibrium test specimens, loaded as simple beams, with the load applied at the center.

3.1.4 *heat-rain sheets*—fixed to a building frame in accordance with the manufacturer's recommended installation practices. The sheeted frame is then subjected to alternate wetting and heating cycles and any structural alteration of the sheet caused by the test is reported.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *dimensions*—for the purpose of these test methods, the length, width and thickness of fiber-cement flat sheets, roofing shingles, siding shingles, and clapboard are measured under specified conditions.

3.2.2 *moisture content*—for the purpose of these test methods, the percentage of moisture content of the fiber-cement product when conditioned at 50 ± 5 % relative humidity and a temperature of 73 ± 4°F (23 ± 2°C).

[1] These test methods are under the jurisdiction of ASTM Committee C17 on Fiber-Reinforced Cement Products and are the direct responsibility of Subcommittee C17.02 on Non-Asbestos Fiber Cement Products.

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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.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

3.2.3 *moisture movement*—in these test methods, the linear variation in length and width of test specimen, with change in moisture content.

3.2.4 *water absorption*—for the purpose of these test methods, the increase in mass of the test specimen expressed as a percentage of its dry mass after immersion in water for a specified period of time as prescribed.

4. Sampling and Inspection

4.1 Employ sampling procedures providing an acceptable quality level (AQL) of 4 % at a 90 % confidence level with a sample size given by special inspection level S3, except where specific sampling is required by particular test procedures.

4.2 *Acceptable Quality Level (AQL)*—The acceptable quality level (AQL) may be defined as follows:

4.2.1 The maximum percent nonconforming that, for purposes of sampling inspection, can be considered satisfactory as a process or long-term average, and

4.2.2 A quality level which corresponds to relatively high probability (commonly 90 %) of acceptance.

4.3 *Sample Size*—The sample size is determined according to the inspection lot size by the special inspection level S3 of ISO 2589-1 where the inspection is by attributes or special inspection level S3 of ISO 3951 where the inspection is by variables.

NOTE 1—When a manufacturer's process satisfies a sampling scheme with an AQL of 4 % then this indicates that better than 96 % of the inspected production exceeds the specifications. Under this type of specification the consumer is provided the protection and confidence of a clearly defined lower boundary. This would not be true if acceptance were based solely on the average value of the measured property. Examples of sampling schemes which may be used can be found in documents such as ISO 390, ISO 2859-1, or ISO 3951. Other sampling schemes may be used. Inspection by attributes is a method which consists of determining, for every item of a sample, the presence or absence of a certain qualitative characteristic (attribute) with respect to the applicable specification. It is, in essence, a pass-fail inspection which determines the number of items in a sample that do conform to the specification and the number of those that do not conform. An attribute could be a dimensional measurement, or a flexural strength value, or others that are described in these test methods. Inspection by variable is a method which consists of measuring a quantitative characteristic for each item in a sample. Conformance with the applicable specification is determined from the mean values of the measured properties and the statistical variations of these values above and below the mean. These procedures detail sampling plans to suit all common sampling situations. The sampling plans specify the number of specimens to be taken from each batch and the acceptance/rejection criteria. The specified inspection levels have been selected to suit fiber-cement products, to balance the cost of assessment against confidence in results commensurate with this industry.

5. Flexural Strength (Modulus of Rupture)

5.1 *Significance and Use*—This is a routine test measuring a primary product characteristic used for product grading.

5.2 *Procedure:*

5.2.1 *Preparation of Test Specimens, (Flat Sheets)*—Cut a pair of specimens, each 6 ± 1⁄16 in. (152 ± 1.6 mm) in width and 12 ± 1⁄16 in. (305 ± 1.6 mm) in length, from the interior area of each sample sheet in such a manner that no edge of specimen is less that 3 in. (76 mm) from the original edges of the sheet. The longer dimension of one of the specimens of each pair shall be parallel to the length of the sheet (that is, parallel with the fiber lay), and the other shall be at right angles to it.

5.2.2 *Preparation of Test Specimens, (Roofing Shingles, Siding Shingles, and Clapboards)*—Cut a single specimen 6 ± 1⁄16 in. (152± 1.6 mm) in width and 12 ± 1⁄16 in. (305 ± 1.6 mm) in length from each unit. Cut one half of the specimens in such a manner that the 12-in. (305-mm) dimension of each specimen is parallel to one edge of the shingle or clapboard unit; cut one half of the specimens at right angles thereto.

NOTE 2—Alternate test specimen dimensions and span may be used provided that the ratio of the test span to specimen thickness is not less than 18, and that the actual span used be reported.

5.2.3 *Conditioning:*

5.2.3.1 *Equilibrium Conditioning*—Place the test specimens, for at least four days [thickness< ½ in. (12 mm)] or at least seven days [thickness ≥ ½ in. (12 mm)] in a controlled atmosphere of 73 ± 4°F (23 ± 2°C) and 50 ± 5 % relative humidity and in such a manner that all faces are adequately ventilated.

5.2.3.2 *Wet Conditioning*—Immerse specimens to be tested in wet condition in water at a temperature of 73 ± 7°F (23 ± 4°C) for a period of 48 h minimum. Test the specimens immediately upon removal from the water.

5.2.4 *Test Procedure*—Determine the flexural strength of each specimen by placing the underside of the specimen on supports that cannot exert longitudinal constraints [rocker-type bearing edges, rollers, etc. with a ⅛-in. (3.2-mm) minimum radius and a ½-in. (12.7-mm) maximum radius] and apply the load at mid-span through a similar edge bearing against the finished surface of the specimen. The test span shall be 10 ± 1⁄16 in. (254 ± 1.6 mm) and the load line and support 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. Measure and record the deflection when the maximum load is reached. Increase the load at a uniform deflection rate, such as will result in failure of the specimen between five and thirty seconds. The error in the load reading shall not exceed 1 % of the maximum load.

NOTE 3—Alternate test specimen dimensions and span may be used provided that the ratio of the test span to specimen thickness is not less than 18, and that the actual span used be reported.

5.2.4.1 Measure the specimen thickness, for the flexural test, 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 gage shall have flat parallel anvils of between 0.4-in. (10-mm) and 0.6-in. (15-mm) diameter with an accuracy of ±0.002-in. (±0.05-mm). Determine face-textured product thickness from volume measurement by water displacement using the formula:

$$t = \frac{V}{L \times W} \tag{1}$$

where:

t = specimen thickness, in.,

V = volume, determined by water displacement, in.^{3},
L = length, in., and
W = width, in.

NOTE 4—Alternative methods for determination of average thickness of textured product may be used provided that they can be proven, on average, to yield a thickness measurement within ±2 % of that determined from volume measurement by water displacement.

5.3 *Calculation and Report:*

5.3.1 Calculate the flexural strength for each specimen by the following equation:

$$R = \frac{3\,PL}{2\,bd^2} \tag{2}$$

where:

R = flexural strength, psi (MPa),
P = maximum load, lb (N),
L = length of span, in. (mm),
b = width of specimen, in. (mm), and
d = average thickness, in. (mm).

The average flexural strength of the specimen pair shall be the arithmetic mean value obtained in the two directions. Report the arithmetic mean value of each pair.

5.3.2 It shall be the option of the manufacturer to report the handleability index of his product. Handleability index values are relative and are used to determine the capability of the material to be handled without breaking. An increase in handleability index means increased ease of handling. For each sheet direction, calculate handleability index using the formula:

$$U = \frac{0.5\,P\Delta}{t} \tag{3}$$

where:

U = handleability index, in.-lb/in. (mm-N/mm),
P = breaking load, lb (N), in each direction at a span of 10 in. (254 mm),
Δ = ultimate deflection, in. (mm), under center loading at a span of 10 in. (254 mm), and
t = thickness of the test specimen, in. (mm).

5.3.3 Calculate the breaking moment (roofing products only) for each sample specimen by the following equation:

$$M = \frac{P\,L}{4\,b} \tag{4}$$

where:

M = breaking moment, ft-lbf/ft (N-m/m),
P = maximum load, lbf (N),
L = length of span, ft (m), and
b = width of specimen, ft (m).

Report the arithmetic mean value for the sample specimen group.

5.4 Calculate the modulus of elasticity (interior substrate sheets only) for each sample specimen by the following equation:

$$E = \left(P_2 - P_1\right) \times L^3/4bd^3\left(y_2 - y_1\right) \tag{5}$$

where:

E = modulus of elasticity, psi (N/mm^2),
P_2 and P_1 = loads, lb (N), taken from two points within the linear section of the plot,
$y_2$and y_1 = deflections, in. (mm) corresponding to the loads selected,
b = width of specimen, in. (mm),
d = thickness of specimen, in. (mm), and
L = length of span, in. (mm).

5.5 *Precision and Bias:*

5.5.1 *Precision*—The precision of the procedure in Test Methods C1185 for measuring flexural strength is being determined.

5.5.2 *Bias*—Since there is no accepted reference material suitable for determining the bias for the procedure in Test Methods C1185 for measuring flexural strength, no statement on bias is being made.

6. Density

6.1 *Significance and Use*—The uniformity of density results are used for quality control assurance.

6.2 *Procedure:*

6.2.1 *Preparation of Test Specimen*—Use a test specimen from the flexural test or a specimen of equivalent dimension.

6.2.2 *Testing Procedure*—Determine the volume of the specimen by any method capable of giving a result accurate to within 2 % of the results obtained by the water displacement method. Determine the mass by drying out the test specimen in an oven at 194 ± 4°F (90 ± 2°C) until the difference between two consecutive weighings, at intervals not less than two hours, is less than 0.1 % by mass.

NOTE 5—Water displacement can be obtained per Test Methods C20, in which volume (V) of the test specimen is obtained in cubic centimetres by subtracting the suspended weight (W) from the saturated weight (S), both in grams as follows:

$$V = W - S \tag{6}$$

where:

V = volume, cm^3,
W = saturated weight, g, and
S = suspended weight, g.

This assumes that 1 cm^3 of water weighs 1 g. This is true within about three parts in 1000 for water at room temperature. Suspended weight (S) is obtained for each test specimen by suspending the specimen in a loop or halter of AWG gage No. 22 (0.644 mm) copper wire hung from one arm of the balance. The balance shall be previously counter balanced with the wire in place and immersed in water to the same depth as is determining the suspended weight, blot each specimen lightly with a moistened smooth linen or cotton cloth to remove all drops of water from the surface, and determine the saturated weight (W) in grams by weighing in air to the nearest 0.1 g.

6.3 *Calculation and Report*—Calculate and report the density of the specimen in pounds per cubic foot (lb/ft^3) using the equations:

$$\text{density} = \frac{W}{V} \times \frac{1}{454} \times \frac{1728}{1} \tag{7}$$

where:

W = dry mass of specimen, g, and
V = volume, in.^{3},

or in kilograms per cubic metre (kg/m^3) using the equation: