



# Standard Specification for Performance of Non-Asbestos Fiber-Reinforced Cement Shake, Shingle, and Slate Roofing Systems<sup>1</sup>

This standard is issued under the fixed designation C 1459; 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 This specification covers the performance of non-asbestos, fiber-reinforced cement shake, shingle, and slate roofing systems that are of uniform or nonuniform thickness and texture.

1.2 *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.*

1.3 The values stated in inch-pound units are regarded as the standard. The values given in parentheses (SI units) are given for information only.

1.4 This specification does not include details of product installation and workmanship. The manufacturer's installation instructions shall be referred to for details such as slope, interlayment, underlayment, sheathing requirements, exposure, fasteners, and repair or replacement instructions.

1.5 This specification does not address requirements for individual shake, shingle, and slate products, which are covered in Specification C 1225.

1.6 The tests contained in this specification are intended as qualification tests for a roofing system. Changes in product formulation, design, or manufacturing process beyond the ranges allowed in the manufacturer's quality control specifications, shall require subsequent system retesting or written concurrence by an independent testing agency that the changes in formulation, design, or manufacturing process will not be detrimental to system performance.

## 2. Referenced Documents

### 2.1 ASTM Standards:

C 1154 Terminology for Asbestos and Fiber Cement<sup>2</sup>

C 1185 Test Methods for Sampling and Testing Non-Asbestos Fiber-Cement Flat Sheet, Roofing and Siding Shingles, and Clapboards<sup>2</sup>

C 1225 Specification for Non-Asbestos Fiber-Cement Roofing Shingles, Shakes, and Slates<sup>2</sup>

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C-17 on Fiber-Reinforced Cement Products and is the direct responsibility of Subcommittee C17.02 on Non-Asbestos Fiber Cement Products.

Current edition approved Feb. 10, 2000. Published February 2000.

<sup>2</sup> Annual Book of ASTM Standards, Vol 04.05.

E 108 Test Methods for Fire Tests of Roof Coverings<sup>3</sup>

## 3. Terminology

3.1 *Definitions*—Refer to Terminology C 1154.

## 4. Significance and Use

4.1 This specification addresses key performance aspects of fiber-reinforced cement roofing systems. Aspects of performance such as aesthetics, hail resistance, wind resistance, wind-driven rain resistance, and items referenced in 1.4 are not addressed in this specification. Additional properties, which may influence system performance, are addressed in Specification C 1225.

## 5. Performance Requirements

5.1 *Installed Strength Test*—The failure loads for the equilibrium and wet specimens shall be as required in Table 1 when tested in accordance with Section 6.

5.2 *Installed Weight Test*—Determine the weight in accordance with Section 7.

5.3 *Accelerated Aging (Wet/Dry Cycling Test)*—There shall be no signs of additional damage or cracking when examined under 5× magnification, and the ratio of strength (*R*) shall be at least 0.90, when tested in accordance with Section 8.

5.4 *Accelerated Aging (Heat/Rain Test)*—Report any damage or structural alteration caused by the effect of stresses around the fasteners that attach the fiber-reinforced cement products when tested in accordance with the section on Heat/Rain Roof Structures in Test Methods C 1185.

5.5 *Fire-Resistant Roof Test*—Where a specified level of installed roofing system fire resistance is required, testing shall be conducted in accordance with Test Methods E 108 with the results reported in accordance with the provisions described within this specification.

## 6. Strength Test Method

6.1 *Significance and Use*—This test method simulates static flexural loads.

### 6.2 Preparation of Test Specimens:

6.2.1 *Test Specimen Construction*—For each specimen build a test deck of nominal 2 by 4-in. (50 by 100-mm) runners spaced a minimum of 16 in. (400 mm) on center. Install

<sup>3</sup> Annual Book of ASTM Standards, Vol 04.07.

TABLE 1 Failure Loads

Product Type	Minimum Load, lbf (N)							
	Conditioned				Immersed			
	Average <sup>A</sup>		Individual <sup>B</sup>		Average <sup>A</sup>		Individual <sup>B</sup>	
	Initial	Ultimate	Initial	Ultimate	Initial	Ultimate	Initial	Ultimate
Flat shake, shingle, or slate	225 (1k)	300 (1.33k)	200 (0.89k)	250 (1.11k)	215 (0.96k)	250 (1.11k)	200 (0.89k)	225 (1k)

<sup>A</sup> Average value of five consecutive tests.

<sup>B</sup> Minimum individual test value.

nominal 1 by 6-in. (25 by 150-mm) sheathing boards across the runners; provide 5½-in. (140-mm) spaces between the sheathing boards. Solid sheathing is permitted to replace the spaced sheathing boards when testing roofing products which are limited to installation over solid sheathing. Solid sheathing material shall be as specified in the manufacturer's published installation instructions. Roofing products (a minimum of 3 courses) are to be installed on the sheathing in a manner identical to field practices, with maximum weather exposure and side spacing (keyway). The tested assembly is permitted to include underlayment or interlayment, or both, fasteners, and starter course or cant strip. The maximum width of the test specimen is not limited.

#### 6.2.2 Conditioning:

6.2.2.1 *Equilibrium*—Place fully constructed specimens in a controlled atmosphere of  $73 \pm 4^\circ\text{F}$  ( $23 \pm 2^\circ\text{C}$ ) and  $50 \pm 5\%$  relative humidity for 72 h in such a way that all faces are adequately ventilated. When the test specimens are removed from the controlled environment for testing, the testing shall be performed within 30 min.

6.2.2.2 *Wet*—Immerse fully constructed specimens in water at a temperature of  $73 \pm 4^\circ\text{F}$  ( $23 \pm 2^\circ\text{C}$ ) for not less than 48 h. Test the specimens within 30 min of removal from water.

#### 6.3 Test Procedure:

6.3.1 Load test specimens at the mid-span of the roofing products between the spaced sheathing by a nominal 2 by 4-in. (50 by 100-mm) by 12-in. (300-mm) long wood loading beam placed with the nominal 4-in. width in contact with the

specimen surface. Laterally, center the loading beam on the roof covering unit width or on the keyway between roofing products whichever, at the discretion of the testing laboratory, will yield lower values. Report tested locations. See Fig. 1.

6.3.2 An optional dampening pad is permitted to be placed between the loading beam and the test specimen. The dampening pad shall be maximum ½-in. (12-mm) thick felt, foam rubber, flexible urethane foam, or other suitable material.

6.3.3 Conduct five loading tests, in which each load shall be applied to roofing products which have not yet been tested.

6.3.4 Apply the load with a self-aligning fixture at a uniform rate between 200 and 500 lb (90 and 225 kg)/min. Record the initial fracture and ultimate loads to the nearest 5 lb (2.25 kg).

#### 6.4 Report:

6.4.1 Report the average of five initial fracture loads and five ultimate loads for each condition, equilibrium and wet, with a description of the failure.

6.4.2 Use a strip chart recorder, X-Y plotter, or other suitable recording device to provide a graph distinguishing between initial fracture and ultimate loads.

6.4.3 Report the specimen age (in days) at time of installed strength testing.

6.5 *Precision and Bias*—No statement is made about either the precision or bias of this test method since the results merely state whether there is conformance to the conditions of acceptance specified in the test method.

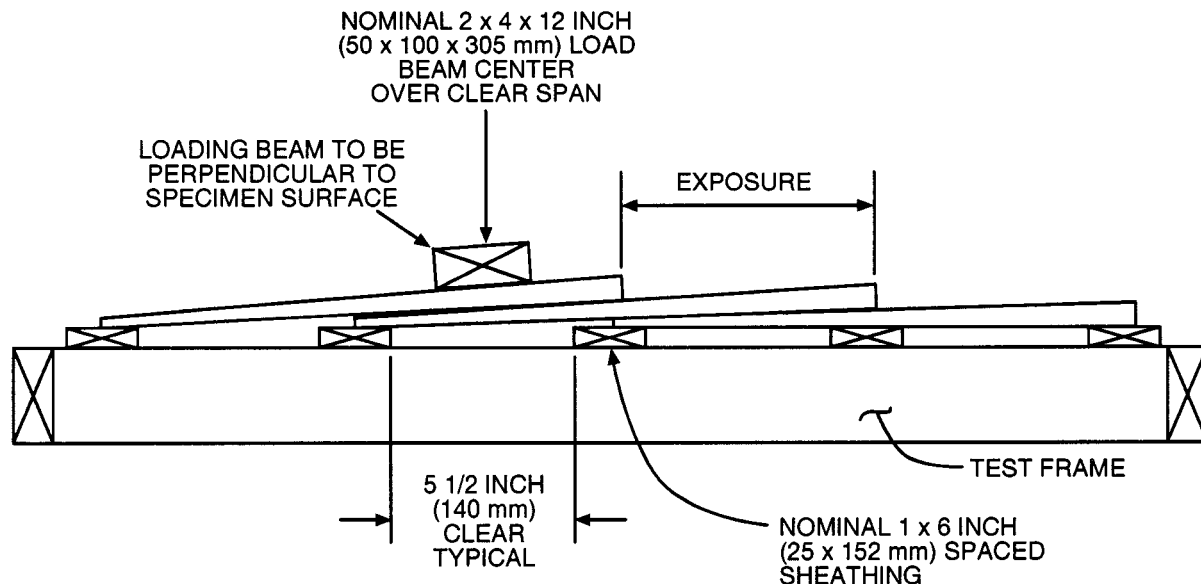


FIG. 1 Test Specimen

## 7. Installed Weight Test Method

**7.1 Significance and Use**—This test method is used to assess the weight of the roof system, as a function of potential moisture gain associated with rainfall. Since some products can gain moisture and become heavier, this test method is used to determine the weight of the roof system for loading design purposes. Products that are intended for use with a coating are tested without the coating. They are tested in this manner because a test method to assess long-term durability of the coating does not exist. In the absence of the coating, increased moisture gain can occur. It is this condition that is assessed by this test method.

### 7.2 Preparation of Test Specimens:

**7.2.1** Provide a suitable frame with a 3:12 pitch. Construct a test frame with metal C studs or equivalent so that the open-spaced sheathing is installed at a maximum clear span recommended by the product manufacturer. The test frame shall be a minimum of 40 in. (1000 mm) wide and 50 in. (1270 mm) in length. Record the weight of the test frame, to the nearest ¼ lb (0.1 kg), and designate it ( $W_f$ ).

**7.2.2** Before any testing is started, confirm by appropriate methods of analysis that there are no surface sealer treatments (of any type) present on the specimens to be evaluated.

### 7.2.3 Conditioning:

**7.2.3.1** Prior to installing the product on the test deck, condition the test specimens within the limits of  $73 \pm 4^\circ\text{F}$  ( $23 \pm 2^\circ\text{C}$ ) and a relative humidity of  $50 \pm 5\%$  for 28 days. The test specimens used to construct the test deck should be separated from each other during conditioning to allow free air circulation around all surfaces.

**7.2.4** Install the conditioned product on the test frame, with maximum weather exposure and side spacing (keyway) in accordance with the manufacturer's published installation instructions.

**7.2.5** Prior to positioning the test deck for testing, place a calibration deck or other suitable panel in the test chamber for calibrating the water intensity. The entire surface of the test deck is to be wetted with sufficient overlap coverage so that all areas of the deck are exposed to a rainfall intensity of 6 in. (152 mm)/h. Use rain gages and flowmeters to calibrate the system. Furthermore, the test deck shall be divided into a 10 by 10-in. (250 by 250-mm) grid system with the rain pattern being measured in each sector so as to ensure a uniform water distribution over the entire surface of the test deck. Maintain the temperature of the water in the line to the spray nozzle at  $70 \pm 10^\circ\text{F}$  ( $21 \pm 5^\circ\text{C}$ ). After calibrating the rainfall intensity, remove the calibration panel and install the test deck.

### 7.3 Test Procedure:

**7.3.1 Wetting Cycle**—Wet the deck continuously for 6 h followed by a 12-h rest period within the rain chamber. No air movement over the deck by fans or blowers or by any other means is permitted. Follow the first complete cycle with a second 6-h wetting cycle, but do not continue with the rest procedure. Determine and record the weight of the test deck within 10 min after the second 6-h wetting cycle to the nearest ¼ lb (0.1 kg), and designate the weight as ( $W_{10}$ ).

**7.3.2 Drying Cycle**—After determination of the wet weight, place the complete test deck assembly in a drying oven and dry

until constant weight is obtained. Constant weight is defined as when two consecutive weighings, separated by 2 h in a convection air drying oven at  $150 \pm 10^\circ\text{F}$  ( $66 \pm 5^\circ\text{C}$ ), change by not more than ½ lb (0.2 kg). Designate dry weight as ( $W_{fd}$ ), and record to the nearest ¼ lb (0.1 kg).

### 7.4 Report:

**7.4.1** Report the wet installed weight and the dry installed weight where:

Initial weight of the test frame	$= (W_f), \text{ lb.}$
Weight of test frame plus roofing product, 10 min after completion of the second rain cycle	$= (W_{10}), \text{ lb.}$
Weight of test frame plus roofing product, after drying to constant weight	$= (W_{fd}).$
Test deck area	$= A_{sf}, \text{ ft}^2.$

**7.4.2** Calculate the wet and dry installed weight as follows:

$$\begin{aligned} \text{Wet installed weight, lb/ft}^2(10 \text{ min after second rain cycle}) &= \frac{W_{10} - W_f}{A_{sf}} \\ \text{dry installed weight, lb/ft}^2 &= \frac{W_{fd} - W_f}{A_{sf}} \end{aligned}$$

**7.5 Precision and Bias**—Since there is no accepted reference material suitable for determining the bias for the procedure in this test method, no statement on bias is being made.

## 8. Accelerated Aging (Wet/Dry Cycling Test Method)

**8.1 Significance and Use**—This test method evaluates the effect of induced wet/dry stresses around the fasteners that attach the fiber-reinforced cement products.

**8.2 Preparation of Test Specimens**—Six samples of fiber-reinforced cement roofing product shall be drawn at random from the stock of finished product.

**8.2.1 Conditioning**—Divide the sampled products to form two sets of paired specimens and condition at  $73 \pm 4^\circ\text{F}$  ( $23 \pm 2^\circ\text{C}$ ) and  $50 \pm 5\%$  relative humidity for 28 days.

### 8.3 Test Procedure:

**8.3.1** Submit the first set of three samples (control) to saturated flexural strength test in accordance with the section on Flexural Strength (Modulus of Rupture) in Test Methods C 1185.

**8.3.2** Install separately the second set of three samples on a rigid wooden frame utilizing fasteners in accordance with the manufacturer's installation instructions. Examine the fastener area under  $5\times$  magnification to determine the extent of damage.

**8.3.3** Subject the specimens to 50 cycles of immersion for 24 h in water at  $68 \pm 4^\circ\text{F}$  ( $21 \pm 2^\circ\text{C}$ ) followed by 24 h in a forced-air oven at  $158 \pm 5^\circ\text{F}$  ( $70 \pm 2^\circ\text{C}$ ). Each cycle comprises 24 h in the water followed by 24 h in the oven.

**8.3.4** At the conclusion of the 50 cycles, examine the fastener area under  $5\times$  magnification to determine the extent of any additional damage and submit the second set of three samples to saturated flexural strength test in accordance with Test Methods Section 5 of ASTM C 1185.

### 8.4 Calculation and Report:

**8.4.1** Calculate and report the percent of the strength averaged for the set undergoing wet/dry cycles ( $Wda$ ) to the strength averaged for the control or reference set ( $Wdr$ ).

$$R = Wda / Wdr \times 100 \quad (1)$$

8.5 *Precision and Bias*—No statement is made about either the precision or bias of this test method since the result merely states whether there is conformance to the criteria for success specified in the test method.

## 9. Keywords

9.1 fiber-cement; fiber-reinforced cement; fire-resistant; heat/rain test; installed strength; installed weight; qualification testing; restricted frame; roofing; shake; shingle; slate; tile; wet/dry cycling

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