Designation: ~~C217/C217M – 21~~ C217/C217M – 22

Standard Test Methods for Weather Resistance of Slate[1]

This standard is issued under the fixed designation C217/C217M; 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 two procedures for weather resistance of slate in all outdoor installations by determining the depth of softening after soaking in 1 % sulfuric acid solution by a shear/scratch tester (Test Method A) or by hand scraping (Test Method B).

NOTE 1—These tests are based on the fact that slates containing calcium carbonate undergo a chemical weathering which produces gypsum and carbon dioxide. The swelling action that results causes disintegration of the slate. Oxidation of iron sulfides (such as pyrite) may also adversely affect weathering durability of a slate. The extent of such action on various slates in the test has been found to correlate with the durability of the materials in actual weathering.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C119 Terminology Relating to Dimension Stone
C406/C406M Specification for Roofing Slate
C1799 Guide to Dimension Stone Test Specimen Sampling and Preparation

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in these test methods, refer to Terminology C119.

[1] These test methods are under the jurisdiction of ASTM Committee C18 on Dimension Stone and is the direct responsibility of Subcommittee C18.01 on Test Methods.
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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.

***A Summary of Changes section appears at the end of this standard**

4. Summary of Test Method

4.1 After grinding the faces of the test specimens smooth and finishing with No. 80 abrasive, the specimen is sheared or scraped in a controlled manner and the thickness of the specimen measured. The specimen is then submerged in a 1 % sulfuric acid solution which is replaced with a fresh solution each day, for a total of 7 days. At the end of 7 days, the specimen is removed and washed, and then dried in an oven for 24 h. The opposite face of the specimen is then sheared or scraped and the thickness of the specimen measured. The depth of softening is the depth of a groove made by the shearing tool after acid treatment minus the depth before acid treatment (Test Method A), or the depth of scrape made by the cutting edge of a hand scraping tool after acid treatment minus the depth before acid treatment (Test Method B).

5. Significance and Use

5.1 This test method is useful in indicating the differences in weather resistance between various slates. For comparison of relative slate performance, Specification C406/C406M provides a classification that includes expected service life based on depth of softening. This test method provides one element in the comparison of slates.

6. Apparatus

6.1 *Test Method A only:*

6.1.1 *Shear/Scratch tester,* (see Fig. 1) with the shearing tool, Model S-20[3], or its equivalent. The apparatus includes a removable scale beam that is mounted on a pivotal shaft projecting from an adjustable gage block that can be raised or lowered, corresponding with the thickness of a test specimen up to 0.5 in. [12.7 mm]. The scale beam is set at an angle of 70° referencing the shaft it pivots on. A calibrated weight and sliding weight are mounted on the scale beam to achieve the desired load. Operated by an on/off switch, the motorized turntable rotates counter clockwise at a constant speed of 0.6 ± 0.1 r/min.

6.1.2 *Pencil compass.*

6.2 *Test Method B only:*

6.2.1 *Hand Scraping Tool*—The scraping tool shall be made by grinding down the square edge blade of a metal putty knife to a length of 3 ± ⅛ in. [75 ± 3 mm] and a width of ¾ in. [20 mm]. Prior to every test, the end of the blade shall be ground to a plane surface perpendicular to the length of the tool to form a sharp edge with either side of the blade. These sharp edges are referred to as the "cutting edges."

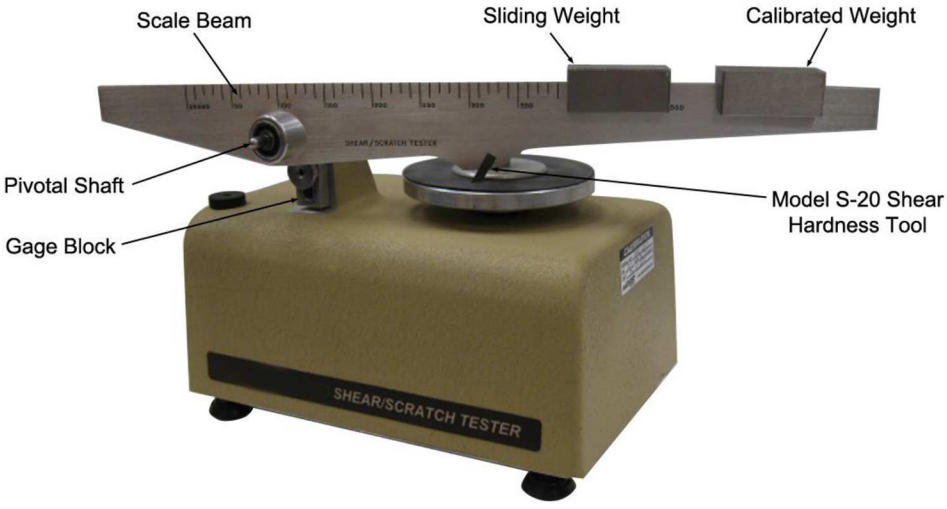

FIG. 1 Shear/Scratch Tester

[3] The sole source of supply known to the committee at this time is Taber Industries, North Tonawanda, NY. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

6.2.2 *Bench Grinder.*

6.2.3 *Balance (optional),* capable of measuring 3 lbf [15 N].

6.3 *Both Test Methods:*

6.3.1 *Thickness Measuring Device,* such as a point micrometer with ratchet stop mechanism, to measure to nearest 0.0001 in. [0.002 mm].

6.3.2 *Container,* such as a glass vessel, which is chemically compatible with sulfuric acid solution.

6.3.3 *Drying Oven,* capable of operation at 221 °F ± 4 °F [105 °C ± 2 °C], for drying specimens.

6.3.4 *Chemical Resistant Gloves,* for handling test specimens when performing the acid soak.

7. Reagents

7.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society where such specifications are available.[4] Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.2 *Sulfuric acid (H_2SO_4)*—1 % solution.

NOTE 2—*Example*—A convenient means of determining the amount of H_2SO_4 required for the test is as follows: Suppose one has 96 % H_2SO_4 (sp gr 1.84) and the volume of diluted acid necessary for the test is 2000 mL. Let X equal the weight of 96 % H_2SO_4 required. Then:

$$\frac{0.96X}{X + 2000} = 0.01 \quad (1)$$

From this equation, X is determined as 21.05 g. The volume of this weight of 96 % H_2SO_4 is 21.05/1.84 = 11.4 mL. (The error due to assuming the weight of 1 mL of water as 1 g is not appreciable.)

NOTE 3—The ~~1%~~ 1 % sulfuric acid dilution is dependent on the concentration of the stock solution.

8. Test Specimens

8.1 Prepare not less than three specimens, each a minimum of 2 in. by 4 in. [50 mm by 100 mm] measured along the cleavage faces, for determining the depth of softening in a 1 % solution of sulfuric acid. The 2 in. by 4 in. [50 mm by 100 mm] faces shall be ground smooth and finished with No. 80 abrasive. Specimens cut from sheared or punched slate shall have no saw cut nearer than 1 in. [25 mm] from the edges or nail holes.

NOTE 4—Refer to Guide C1799 for additional information on selecting, preparing, and conditioning test specimens.

9. Conditioning

9.1 Dry the specimens for 48 h in a ventilated oven at a temperature of 140 °F ± 4 °F [60 °C ± 2 °C]. At the 46th, 47th and 48th hour, weigh the specimens to ensure that the weight is the same. If the weight continues to drop, continue to dry the specimens until there are three successive hourly readings with the same weight.

10. Procedure – Test Method A (Shear/Scratch Tester)

10.1 Draw with a pencil compass, on each specimen, an arc of a circle of the same radius as that made by the shearing tool. Mark the arc at four points spaced approximately 36° apart to identify the position for taking thickness measurements, as indicated in

[4] Reagent Chemicals, American Chemical Society Specifications, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see Analar Standards for Laboratory Chemicals, BDH Ltd., Poole, Dorset, U.K., and the United States Pharmacopeia and National Formulary, U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.

Fig. 2. Measure and record the thickness at each point to the nearest 0.0001 in. [0.002 mm], then average the four readings to determine the initial thickness ($t_{initial}$). All measurements are to be taken normal to the surface of the specimen.

NOTE 5—In lieu of measuring specimen thickness before and after scraping, groove depth may be measured directly using surface metrology equipment.

10.2 Secure the specimen to the Shear/Scratch Tester, and level the scale beam. With a 2.2 lbf [10 N] load on the shearing tool, test each specimen along the penciled arc by rotating the turntable in a counter clockwise direction.

10.3 Repeat the thickness measurements at the same four points specified in ~~9.1~~10.1, then average the four readings to determine the thickness after shearing ($t_{after\ testing}$). To determine the depth of groove made by the shearing tool, use the following equation:

$$\text{Depth of Groove (Scraping)} = t_{initial} - t_{after\ testing} \quad (2)$$

10.4 Place the specimens in a glass vessel or other container that is chemically compatible, and completely cover with 1 % sulfuric acid solution (see 7.2). Space the specimens in the container so that the acid has free access to the 2 in. by 4 in. [50 mm by 100 mm] faces. Pour off the acid solution each day and replace with fresh solution. At the end of 7 days remove the specimens from the acid, thoroughly wash with water, and dry for 24 h at 221 °F ± 4 °F [105 °C ± 2 °C].

10.5 When the specimens have cooled, repeat the same procedure as outlined in ~~9.1~~10.1 – ~~9.3~~10.3 on the faces opposite to those scored before exposure to the sulfuric acid solution.

NOTE 6—Thickness measurements are taken after the acid soak and before testing, because in some cases, there is swelling of the specimen that could result in an erroneous depth of softening measurement.

11. Procedure – Test Method B (Hand Scraping)

11.1 Before each specimen is scraped, sharpen the cutting edges of the hand scraping tool. See 6.2.1.

11.2 On at least three specimens, locate the center by drawing the diagonals of the rectangle. Measure and record the thickness before scraping ($t_{initial}$) to the nearest 0.0001 in. [0.002 mm].

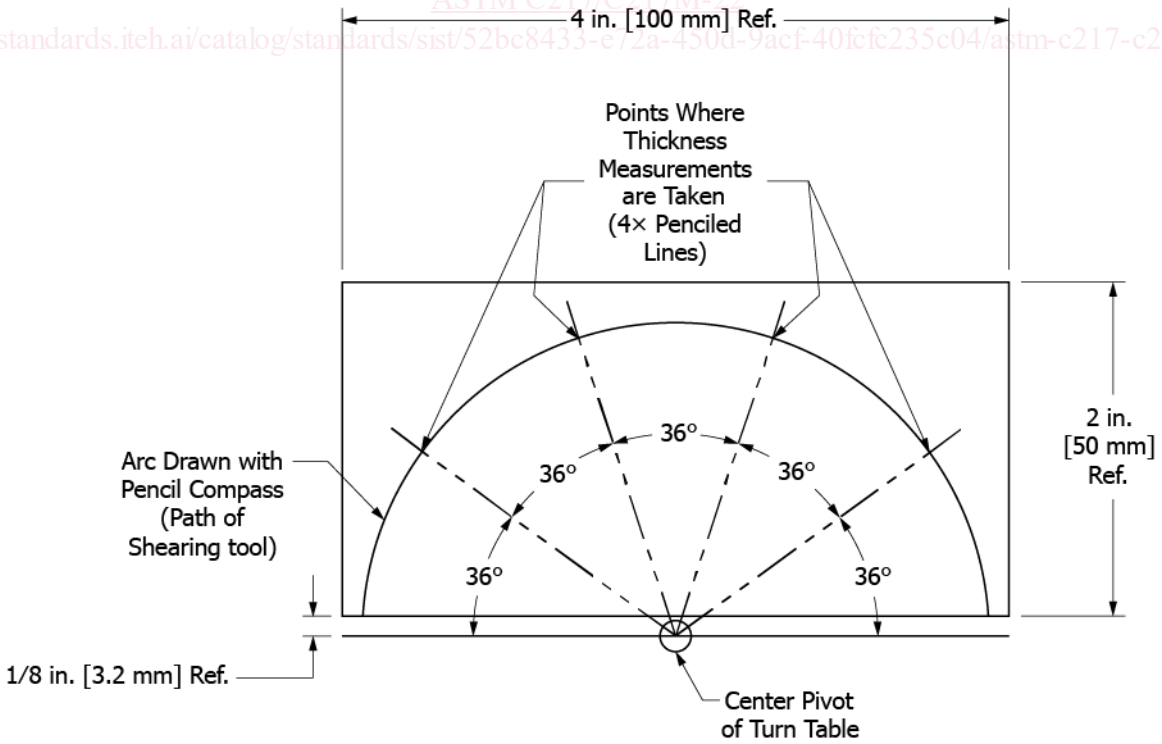

FIG. 2 Diagram of Slate Specimen Prepared for Test with Shear/Scratch Tester

11.3 Hold the blade on the top surface of the specimen at an angle of approximately 30°. Apply approximately a 3 lbf [15 N] pressure on the "cutting edge" (Note 7) and move the cutting edge forward about 1½ in. [40 mm] for each stroke. The resulting scrape should be located approximately equidistant from the center point.

NOTE 7—In this test the pressure on the blade is estimated but not definitely controlled. The following guide in applying the proper pressure is suggested: Grasp the handle of the tool in the same way as in scraping a specimen. Press a "cutting edge" on the weighing table of a small platform scale, see Fig. 3. The pressure on the tool and also the amount of bending of the blade required to achieve 3 lbf [15 N] are used as criteria in judging the pressure to apply in the test. This seemingly crude test gives reasonably concordant results for the reason that the softened layer of slate is easily scraped off but the sound slate underneath is removed very slowly. Since the specified number of strokes is considerably more than necessary to remove the softened layer, it is more important to apply a constant pressure than one of a definite amount.

11.4 Following the same path, make eight strokes with one cutting edge and eight with the other.

11.5 Measure the thickness at the same point to determine the depth of the scrape made by the hand scraping tool, ($t_{after\ testing}$). To determine the depth of scrape made by the hand scraping tool, use the equation in ~~9.3~~10.3.

11.6 Place the specimens in a glass vessel or other container that is chemically compatible, and completely cover with 1 % sulfuric acid solution (see 7.2). Space the specimens in the container so that the acid has free access to the 2 in. by 4 in. [50 mm by 100 mm] faces. Pour off the acid solution each day and replace with fresh solution. At the end of 7 days remove the specimens from the acid, thoroughly wash with water, and dry for 24 h at 221 °F ± 4 °F [105 °C ± 2 °C].

11.7 When the specimens have cooled, repeat the same procedure as outlined in ~~10.2~~11.2-~~10.5~~11.5 on the faces opposite to those scraped before the acid treatment. (See Note 5 and Note 6.)

12. Calculations

12.1 Calculate the depth of softening (Δt) for each specimen as follows:

$$\Delta T = (t_2 - t_1) \tag{3}$$

FIG. 3 Slate Specimen Prepared for Test with Hand Scraping