



Designation: ~~C241/C241M – 15~~^{e1} C241/C241M – 20

Standard Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic¹

This standard is issued under the fixed designation C241/C241M; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

^{e1} NOTE—Note 3 was removed editorially in August 2015.

1. ~~Scope~~ Scope*

1.1 This test method covers the determination of ~~the~~ abrasion resistance of all types of stones for floors, steps, and similar uses where the wear is caused by ~~the abrasion of~~ foot traffic.

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 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.

1.2.1 *Exception*—The formula for calculation of the result of this test method relies on the use of SI units; all measurements of weight in this test method shall be recorded in SI units. See ~~9.10.1~~ and ~~10.11.1~~.

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~~ safety, health, and ~~health~~ 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

~~C97~~C97/C97M Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone

C119 Terminology Relating to Dimension Stone

~~C1353~~C1353/C1353M Test Method for Abrasion Resistance of Dimension Stone Subjected to Foot Traffic Using a Rotary Platform Abraser

~~C1799~~C1799/C1799M Guide to Dimension Stone Test Specimen Sampling and Preparation

3. Terminology

3.1 *Definitions*—All definitions are in accordance with Terminology C119.

¹ This test method is under the jurisdiction of ASTM Committee C18 on Dimension Stone and is the direct responsibility of Subcommittee C18.01 on Test Methods. Current edition approved May 1, 2015; Nov. 1, 2020. Published July 2015; December 2020. Originally approved in 1950. Last previous edition approved in 2015 as C241-15-15^{e1}. DOI: 10.1520/C0241-C0241M-15E01-10.1520/C0241-C0241M-20.

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 Three stone specimens are mounted in a holder that rotates in the same direction as the grinding lap, but at a different speed. While the grinding lap and the specimen rotate, a loose abrasive grit flows onto the grinding lap to abrade the bottom of the specimens. Each specimen supports a load of 4.4 lb [2000 g], which includes the weight of the specimen holder, but not the specimen itself. The abrasion resistance index, which is proportional to the volume abraded, is calculated for each specimen using the average weight (before and after abrading), the weight loss, and the apparent density.

5. Significance and Use

5.1 This test method is useful in indicating the differences in abrasion resistance between the various building stones. This test method also provides one element in comparing stones of the same type.

NOTE 1—Test Method C1353/C1353M is an alternative method to evaluate abrasion resistance for stone subjected to foot traffic, but is not applicable for hard and coarse-grained stones such as granite. Preliminary assessments by Subcommittee C18.03 indicate it results in similar H_a values as established by this method.

6. Apparatus

6.1 The abrasion testing apparatus shown shall consist of the elements described in Fig. 16.1.1 shall be used. (see Fig. 1 This apparatus consists essentially of a power-driven grinding lap, A, 10 in. [250 mm] in diameter, which is revolved at 45 rpm; three specimen holders, B, with superimposed weights; gears, C, for revolving the specimen; and a means of feeding abrasive at a constant rate to the lap. The guide rings, D, are clamped in position slightly above the specimen holders, and the 2000-g weight bearing on the specimen is the combined weight of the specimen holder, vertical shaft above with the attached spur gear, and a weight hopper, E, containing additional adjustment weights. The frame, F, carrying the guide rings is adjustable vertically to accommodate different specimen thicknesses. Gears, C, are adjusted on the shafts for each specimen thickness, so that they are slightly above the plate, G, throughout the test.

6.1.1 A power-driven grinding lap, A, which is 10 in. [250 mm] in diameter and revolves counter-clockwise at a speed of 45 r/min. Connected to the grinding lap shall be a vertical center drive shaft that includes a gear to drive three shafts with specimen holders;



FIG. 1 Apparatus for Abrasion Resistance Test of Stone

6.1.2 Three shafts, that are located 3 in. [76 mm] rad at 120° from the center drive shaft; can move vertically and include:

6.1.2.1 A detachable specimen holder, B, to secure test specimens as specified in 8.1;

NOTE 2—Fig. 1 shows one of the specimen holders removed from the shaft.

6.1.2.2 A gear, C, to rotate the specimen counter-clockwise at a speed of 22.5 r/min;

6.1.2.3 A weight hopper, D, to which additional mass may be added to achieve the specified load as stated in 6.1.3;

6.1.3 Each shaft shall apply a load of 4.4 ± 0.01 lb [2000 ± 5 g] on the specimen and is the combined mass of the vertical shaft, specimen holder, gear, and weight hopper, but not the specimen itself;

6.1.4 A rigid frame, E, that includes bearing sleeves, F, to ensure the shafts are perpendicular to the grinding lap;

6.1.5 An abrasive grit feeder, G, capable of continuously feeding abrasive to the grinding lap during testing;

6.1.6 A collection bin, H, to collect used abrasive grit.

6.2 Abrasive grit, No. 60 Alundum abrasive (Norton treatment 138S).

6.3 Soft bristle brush, to remove loose particles from the abrasive wheels or surface of the specimen.

6.4 Balance, with a capacity of 1 lb [500 g] and capable of reading to two decimal places.

6.5 Desiccator, containing a drying agent and of sufficient size to contain samples to be tested.

6.6 Diamond saw (cut-off) with diamond-edged blade, cooled and flushed with water.

6.7 Ventilated drying oven.

7. Sampling

7.1 The sample may be selected by the purchaser or his authorized agent but shall represent the average quality of the type or grade of stone under consideration. It shall be of sufficient size to permit the preparation of at least three test specimens, and one face should have the finish to be exposed to traffic. The sample preferably should be 1 in. [25 mm] thick and 8 in. [200 mm] square.

NOTE 3—Refer to Guide [E1799/C1799/C1799M](#) for additional information on selecting, preparing, and conditioning test specimens.

8. Test Specimens

8.1 At least three specimens 2 in. [50 mm] square and preferably 1 in. [25 mm] in thickness shall be sawed from the sample. ~~The sharp edges sample and include any surface finish. One 2 in. [50 mm] square face shall have the finish to be evaluated, the other faces may have saw marks but should not be cut in a manner that fractures the stone. The edges of the surface to be tested shall be rounded by grinding to a radius of approximately between $\frac{1}{32}$ in. [1 mm] in order to prevent to $\frac{1}{16}$ crumpling during the test.~~ in. [1 mm to 2 mm].

NOTE 4—Specimens of other thicknesses may be utilized by adjusting the load specified in 6.1.3, so the load applied to the abrading face is the same as it would be if the specimen were 1 in. [25 mm] thick. For example, a specimen $\frac{3}{4}$ in. [19 mm] thick the load would be increased by the mass of the missing $\frac{1}{4}$ in. [6 mm] thickness of the specimen

9. Conditioning

9.1 Dry the specimens for 48 h in a ventilated oven at a temperature of $140 \pm 4^{\circ}\text{F}$ [$60 \pm 2^{\circ}\text{C}$]. At the 46th, 47th, and 48th hour, weigh the specimens to ensure that the ~~weight is the same.~~ mass is within ± 0.05 g. If the ~~weight~~ mass continues to drop,



continue to dry the specimens until there are three successive hourly readings ~~with the same weight, within ±0.05 g.~~ After removing the specimens from the oven, cool them to room temperature in a desiccator before testing them. The test specimens shall remain in the desiccator until tested.

10. Procedure

10.1 Weigh ~~the each test specimens~~ specimen to the nearest 0.01 g; then place them in the abrasion testing apparatus with the finished face in contact with the grinding lap and abrade for 225 revolutions of the grinding lap with ~~No. 60 Alundum abrasive (Norton treatment 138S). Remove the specimens from the apparatus, brush them free of dust, and weigh to the same precision as for the original weights.~~ the abrasive grit.

10.2 Remove the specimens from the apparatus, brush them free of dust, and weigh to the same precision as for the original mass.

10.3 Place the specimens in water for an hour or more, surface dry them with a towel, and weigh again. Weigh the specimens in water and calculate the bulk specific gravity as described in Test Methods ~~E97C97/C97M.~~

NOTE 5—Humidity affects the results to some extent in that the rate of grinding is higher for higher humidity. For this reason it is advisable to make the test when the relative humidity is between 30 and 40 %.

NOTE 6—~~A new abrasion resistance test has been adopted using the Taber Abraser (Test Bulk density is determined in the same way as the density procedure of Test Method E1353C97/C97M for Abrasion Resistance of Dimension Stone by the Taber Abraser). Preliminary assessments indicate H. However, the abraded specimen is thinner than that, values established required by Test Method E241C97/C97M appear to be similar to values produced and the specimen is not soaked for 48 h. Consequently, the density may not be exactly the same as determined by Test Method E1353C97/C97M, however more data are currently being studied by Subcommittee C18.03.~~

11. Calculation

11.1 Calculate the abrasion resistance of each specimen as follows (Note 47):

$$H_a = 10.95G(2000 + W_s) / 2000 W_a \tag{1}$$

where:

H_a = abrasive hardness value,

G = bulk specific gravity of the sample,

W_s = average weight of the specimen (original weight plus final weight divided by 2), in g, and

W_a = loss of weight during the grinding operation, in g.

NOTE 7—The abrasive hardness value, H_a , is the reciprocal of the volume of material abraded multiplied by ~~ten~~ 10.95. The superimposed weight on the specimen is 2000 g and this is augmented by the weight of the specimen itself. The correction for the weight of the specimen, included in the formula, is based on the fact that the rate of abrasion is directly proportional to the weight. By basing the abrasive resistance values on the volumes, rather than the weights abraded, a better comparison is obtained for materials that vary considerably in bulk density.

NOTE 8—The formula to determine abrasive hardness values (H_a) was modified in 2015 when the supply of the No. 60 Alundum abrasive was found to be more aggressive than the original, resulting in lower abrasive hardness values (H_a) than when Test Method C241 was initially established.

12. Report

12.1 ~~The average of the tests on individual specimens, expressed to two significant figures, shall be reported as the abrasive resistance of the sample, but all results shall be reported as information. The report shall identify the type and grade of stone, its source, and the approximate date of removal from the quarry.~~ Report the following:

12.1.1 Date,

12.1.2 Testing agency,

12.1.3 Personnel responsible for reporting the test results,

12.1.4 Identification of the samples, including name and location of the quarry, date when sample was taken and trade name or description of stone,

12.1.5 Identification number of each test specimen,