Designation: ~~C241/C241M – 20~~ C241/C241M – 21

Standard Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic[1]

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.

1. Scope*

1.1 This test method covers the determination of abrasion resistance of all types of stones for floors, steps, and similar uses where the wear is caused by 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 10.1 and 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, 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]

C97/C97M Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone
C119 Terminology Relating to Dimension Stone
C1353/C1353M Test Method for Abrasion Resistance of Dimension Stone Subjected to Foot Traffic Using a Rotary Platform Abraser
C1799/C1799M Guide to Dimension Stone Test Specimen Sampling and Preparation

3. Terminology

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

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.~~

[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 ~~Nov. 1, 2020~~Nov. 15, 2021. Published ~~December 2020~~December 2021. Originally approved in 1950. Last previous edition approved in 2015 as C241–15$^{\varepsilon 1}$. DOI: 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**

rotating specimen holders. 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 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 shall consist of the elements described in 6.1.1 to 6.1.6 (see Fig. 1).

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;

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~~holders (see Note 3~~a speed of 22.5 r/min;~~);

NOTE 3—The original instrument this test method is based on, includes specimen holders that rotate in the same direction as the grinding lap (counter-clockwise) at a speed of 22.5 r/min.

FIG. 1 Apparatus for Abrasion Resistance Test of Stone

6.1.2.3 *A weight hopper, D*, to which additional ~~mass~~weights 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~~which is the combined ~~mass~~load 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).~~138S), or equivalent.

NOTE 4—The abrasive grit Norton treatment 138S is now referred to as Norton 3001 60 Grit 38a Alundum (white fused alumina).

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 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 5—Refer to Guide 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 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 between 1/32 in. to 1/16 in. [1 mm to 2 mm].

NOTE 6—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 ¾ in. [19 mm] thick, the load would be increased by the ~~mass~~weight of the missing ¼ in. [6 mm] thickness of the ~~specimen~~specimen.

9. Conditioning

9.1 Dry the specimens for 48 h in a ventilated oven at a temperature of 140 ± 4 °F [60 ± 2 °C]. At the 46th, 47th, and 48th hour, weigh the specimens to ensure that the ~~mass~~weight is within ±0.05 g. If the ~~mass~~weight continues to drop, continue to dry the specimens until there are three successive hourly readings 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 each test 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 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.~~weight.

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 C97/C97M.

NOTE 7—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 8—Bulk density is determined in the same way as the density procedure of Test Method C97/C97M. However, the abraded specimen is thinner than that required by Test Method C97/C97M and the specimen is not soaked for 48 h. Consequently, the density may not be exactly the same as determined by Test Method C97/C97M.

11. Calculation

11.1 Calculate the abrasion resistance of each specimen as follows (Note ~~7~~9):

$$H_a = 10.95G(2000+W_s)/2000\ W_a \quad (1)$$

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 9—The abrasive hardness value, H_a, is the reciprocal of the volume of material abraded multiplied by 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 10—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 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,

12.1.6 Value of bulk specific gravity used in the calculations,

12.1.7 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,

12.1.8 Presence of any defect or surface feature likely to have influenced the result,

12.1.9 The temperature and relative humidity of the test area,

12.1.10 The rotational direction of the grinding lap; and rotational speed and direction of the specimen holders,