Designation: C1353/C1353M – 15a

Standard Test Method for Abrasion Resistance of Dimension Stone Subjected to Foot Traffic Using a Rotary Platform Abraser[1]

This standard is issued under the fixed designation C1353/C1353M; 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 test method covers the establishment of an index of abrasion resistance by determination of loss of volume resulting from abrasion of dimension stone as described in Terminology C119 and is based on Guide G195.

1.2 The values stated in either inch-pound units or SI 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.

1.2.2 *Exception*—As the equipment used in this test method was designed and initially fabricated using dimensions in inch-pound units, the values of equipment dimensions stated in SI units have been given as exact conversions to the nearest 0.1 mm.

1.3 This test method uses a rotary platform abraser to determine the loss in volume of dimension stone caused by abrasion under controlled conditions.

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

1.5 *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]

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

C119 Terminology Relating to Dimension Stone

C121 Test Method for Water Absorption of Slate

C1799 Guide to Dimension Stone Test Specimen Sampling and Preparation

G195 Guide for Conducting Wear Tests Using a Rotary Platform Abraser

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *abraser*—wear testing instrument to evaluate abrasion resistance, also referred to as an abrader.

3.1.2 *abrasion cycle—in abrasion testing*, one or more movements of the abradant across a material surface, or the material surface across the abradant, that permits a return to its starting position. In the case of the rotary platform test method, it consists of one complete rotation of the specimen.

3.1.3 *index of abrasion resistance, n*—a number calculated from the weight loss of a specimen subjected to a given number of revolutions against a standard bonded abrasive wheel.

3.1.4 *resurface*—procedure of cleaning and refreshing the running surface of an abrasive wheel prior to or during use in testing.

3.1.5 *sample, n*—a geometrically regular block of stone.

3.1.6 *test specimen, n*—a flat prism of specified size and shape cut from the submitted sample.

4. Summary of Test Method

4.1 A specimen is abraded using rotary rubbing action under controlled conditions of pressure and abrasive action. The test specimen is mounted on a turntable platform and turns on a vertical axis, against the sliding rotation of two abrading wheels. One abrading wheel rubs the specimen outward toward

[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.

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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.

the periphery and the other, inward toward the center. The resulting abrasion marks form a pattern of crossed arcs over an area of approximately 5 in.^{2} [30 cm^2]. Resistance to abrasion is evaluated by determination of the loss of volume due to abrasion and calculation of an index of abrasion resistance.

5. Significance and Use

5.1 This test method provides a means to quantify the abrasion resistance of dimension stone and may be related to end-use performance, or used to comparatively rank material performance, or both. The resistance of dimension stone to abrasion, as measured on a testing machine in the laboratory, is generally only one of several factors contributing to wear performance as experienced in the actual use of the material. Calculation of predicted life should not be based on specific abrasion data alone.

5.2 The resistance of dimension stone to abrasion may be affected by factors including test conditions; type of abradant; pressure between the specimen and abradant; mounting of the specimen; and type, kind, or amount of finishing materials.

5.3 Abrasion tests utilizing the rotary platform abraser may be subject to variation due to changes in the abradant during the course of specific tests. Depending on abradant type and test specimen, the abrading wheel surface may change (that is, become clogged) due to pick-up of finishing or other materials from test specimens. To reduce this variation, the abrading wheels may require resurfacing.

6. Apparatus

6.1 *Rotary Platform Abraser,* consisting of the elements described in 6.1.1 – 6.1.5 (see Fig. 1).

6.1.1 A removable specimen turntable platform, which includes a rubber pad, clamp plate, centrally located threaded post and nut. The turntable shall be motor driven and mounted so as to produce a circular surface travel of a flat specimen in the plane of its surface. The specimen platform shall rotate with no visible wobble. This can be checked with a dial indicator at the top outer edge of the platform to make sure it runs true within 0.02 in. [0.5 mm].

6.1.2 A motor capable of rotating the turntable platform at a speed of either 72 ± 2 r/min or 60 ± 2 r/min.

6.1.3 A pair of pivoted arms to which the abrasive wheels and accessory weights or counterweights are attached.

6.1.4 A vacuum suction system and vacuum pickup nozzle to remove debris and abrasive particles from the specimen surface during testing. The height of the vacuum pickup nozzle shall be adjustable, and the nozzle will have two ⅜ in. [8 mm] openings. One opening shall be positioned between the two wheels and over the wear path and the other placed diametrically opposite, with 3 in. [76.2 mm] distance between the axes of the two openings. The vacuum suction force at the surface of the specimen shall be sufficient to remove debris and abrasive particles.

6.1.5 A counter to record the number of abrasion cycles (revolutions) made by the turntable platform.

6.2 *Abrasive Wheels*[3], which are attached to the free end of the pivoted arms and are able to rotate freely about horizontal spindles.

6.2.1 The wheels shall be ½ in. [12.7 mm] thick and have an external diameter of 2 in. [51.9 mm] when new, and in no case less than 1¾ in. [44.4 mm]. The abrasive wheels shall be vitrified based, consisting of hard particles embedded in a binder material. H-22 Calibrade wheels are the required grade of abrasive for this test method.

6.2.2 The internal faces of the abrasive wheels shall be 2^1⁄$_{16}$ in. [52.4 mm] apart and the hypothetical line through the two spindles shall be ¾ in. [19.1 mm] away from the central axis

[3] The sole source of supply of the apparatus known to the committee at this time is Taber Industries, 455 Bryant Street, North Tonawanda, NY, 14120. 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.

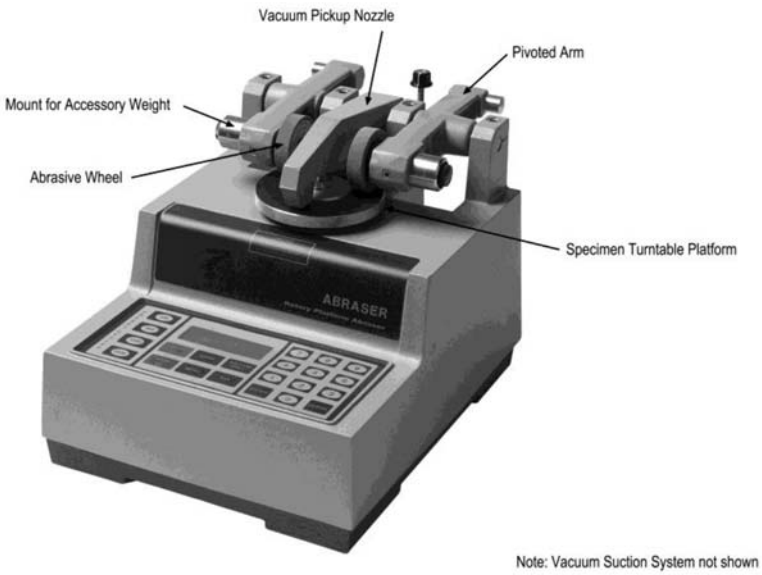

FIG. 1 Rotary Platform Abraser

of the turntable (see Fig. 2). The wheels should be spaced equally on both sides from the wheel-mounting flange to the center of the specimen holder. The distance from the inside of the wheel mounting flange to the center of the specimen holder shall be 1½ in. [38.9 mm].

6.2.3 When resting on the specimen, the wheels will have a peripheral engagement with the surface of the specimen, the direction of travel of the periphery of the wheels and of the specimen at the contacting portions being at acute angles, and the angles of travel of one wheel periphery being opposite to that of the other. Motion of the abrasive wheels, in opposite directions, is provided by rotation of the specimen and the associated friction therefrom.

6.3 *Accessory Weights*[3], to be attached to the pivoted arms to provide a force of 2.2 lb [1000 g], when the wheel is pressed against the specimen, exclusive of the mass of the wheel itself. Accessory weight references are per arm (not combined), and include the mass of the pivoted arm.

6.4 *Auxiliary Apparatus:*

6.4.1 Wheel refacer[3], with a diamond tool for resurfacing vitrified wheels or correcting out of round wheels.

6.4.2 A soft bristle brush, to remove loose particles from the surface of the specimen after testing.

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

6.6 Desiccator containing a drying agent of sufficient size to contain samples to be tested.

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

6.8 Electrically powered drill with tungsten carbide or diamond bit capable of drilling a ¼ in. [6.5 mm] hole (see 7.3) through the specimen. Drill may be cooled and flushed with water if required.

6.9 A ventilated drying oven.

7. Test Specimens

7.1 Three test specimens are required. Each test specimen shall meet the following conditions.

7.2 *Specimen Dimensions*—A slab 4 in. [100 mm] square with a ¼ in. [6.5 mm] hole in the center. If the mass of the specimen exceeds the capacity of the balance, cut off the corners to give a minimum radius of 2 in. [50 mm] and a maximum radius of 2⅜ in. [60 mm].

7.3 *Specimen Thickness*—The standard material thickness that can be evaluated with the rotary platform abraser is ¼ in. [6.5 mm] or less. For materials thicker than ¼ in. [6.5 mm] but less than ½ in. [13 mm], an extension nut such as type S-21[3] or equivalent may be used (requires ⅜ in. [9.5 mm] center hole). Alternatively, an arm height extension kit[3] will permit testing of specimens up to 1.5 in. [40 mm] in thickness (requires ½ in. [13 mm] center hole).

7.4 The upper surface of the specimens shall be flat with either a finish as required for the test or ground and smoothed with 120 mesh grit. Rough surfaces, such as thermal, bush-hammered, gang-sawn, and cleft finishes, are not suitable for testing in accordance with this test method.

NOTE 1—Refer to Guide C1799 for additional information on selecting, preparing, and conditioning test specimens.

8. Procedure

8.1 Determine the bulk specific gravity (ρ) of the specimens in accordance with Test Methods C97 or C121 for slate. Bulk specific gravity testing shall be performed, using a modified specimen geometry, on the same specimens to be used for the abrasion resistance tests.

8.2 Condition the specimens by drying in an oven at a temperature of 140°F ± 4°F [60°C ± 2°C] for 48 h. Cool in a

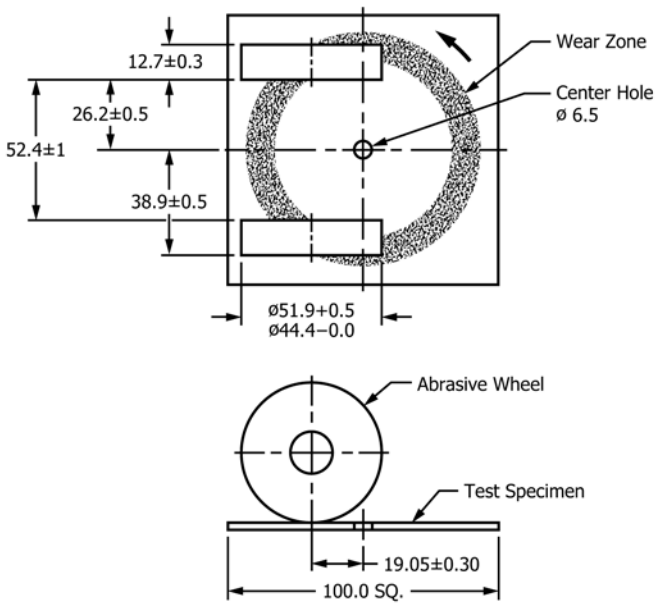

FIG. 2 Diagrammatic Arrangement of Rotary Platform Abraser Test Set-up

desiccator. The test specimens shall remain in the desiccator until tested. Tests should not begin unless the relative humidity is 45 to 55 % and the temperature is at 72 ± 4°F [22 ± 3°C].

8.3 Weigh the test specimens (w_o) to the nearest 0.01 g.

8.4 Place the test specimen on the table of the abraser with the surface to be tested uppermost and secure in place.

8.5 Perform test work in a controlled environment, space, or room.

8.6 Set the vacuum cleaner-extractor to 90 to 100 % capacity. Lower and adjust the vacuum pick-up nozzle so the orifice is a distance of 1⁄16 to 1⁄8 in. [1 to 2 mm] above the test surface.

NOTE 2—Ensure that the vacuum suction force will remove the abraded particles. Wear debris left on the specimen surface may influence the results.

8.7 *Preparation of Vitrified Abrading Wheels*—Vitrified wheels do not require resurfacing unless the abrading surface becomes clogged, chipped or out of round. A wheel refacer shall be used to correct any of these conditions.

8.8 Mount the accessory weight to provide a load of 2.2 lb [1000 g] on each abrasive wheel and gently lower the wheels onto the surface of the test specimen.

8.9 Start the rotary platform abraser and subject the test specimen to abrasion for 1000 revolutions. Gently brush the abrasive wheels while the test specimen is rotating to assist in the removal of loose dust and prevent clogging the abrasive wheels.

NOTE 3—The preferred number of revolutions is 1000 regardless of the stone type. Some stones may wear through before 1000 revolutions. For these stones, the equipment should be stopped when the wear has reduced the thickness by 70 to 80 %. Stop the test if the abrasive wheels become excessively worn. If the test is stopped before 1000 revolutions are completed, state the reason in the test report.

8.10 Remove the specimen carefully from the table, brush clean the dust and abrasive grains, and weigh (w_1).

9. Calculation

9.1 Calculate the index of abrasion resistance as follows:

$$I_w = \frac{36.75}{w_o - w_1} \times \rho \times \frac{n}{1000}$$

where:

I_w = index of abrasion resistance,
w_o = initial weight of test specimen, g
w_1 = weight of test specimen after 1000 revolutions, g
ρ = bulk specific gravity, and
n = number of revolutions actually run during the test.

NOTE 4—The formula for determining I_w requires the use of SI units. Attempting to use this formula with inch-pound units will result in erroneous values for I_w.

NOTE 5—Test results from hard and coarse-grained stones such as granite should be viewed with caution. Hard stones may both polish and abrade, thus resulting in an increase in the indicated value of I_w. Coarse-grained stones may exhibit a wider than normal variation of I_w results in addition to polishing and abrading because of differences in hardness between grains.

10. Report

10.1 Report the following information for each test specimen:

10.1.1 Identification number and source of sample,

10.1.2 Commercial name or description of stone and surface tested,

10.1.3 Date of test,

10.1.4 Identity of test operator,

10.1.5 Identification number of each test specimen,

10.1.6 Value of bulk specific gravity used in the calculations,

10.1.7 Index of abrasion resistance of each test specimen and average of the three test specimens,

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

10.1.9 Identification of the operator and laboratory carrying out the test,

10.1.10 The relative humidity of the test area, and

10.1.11 The actual number of revolutions run. If the test was stopped before 1000 revolutions were completed, state the reason.

10.1.12 Any deviation from the procedure described in this test method.

11. Precision and Bias

11.1 *Precision*—Not enough data exists that will serve as a basis for preparing a precision statement.

11.2 *Bias*—There is no accepted reference material, therefore, no bias statement can be made.

12. Keywords

12.1 abraser; abrasion resistance; dimension stone; rotary platform; Taber abraser

APPENDIX

X1. CALIBRATION VERIFICATION

X1.1 To facilitate the verification of calibration of the Taber Abraser, a kit is available that provides a fast, reliable system check. This kit is not meant as a substitute for regular instrument calibration. Procedure in the kit allow the user to verify:

X1.1.1 *Wheel Alignment and Tracking*—The wheels should be spaced equally on both sides from the wheel-mounting flange to the center of the specimen holder. When resting on the specimen, the wheels will have a peripheral engagement with the surface of the specimen, the direction of travel of the periphery of the wheels and of the specimen at the contacting portions being at acute angles, and the angles of travel of one wheel periphery being opposite to that of the other. Wheel internal faces shall be 2.063 ± 0.004 in [52.4 ± 1.0 mm] apart and the hypothetical line through the two spindles shall be 0.750 ± 0.002 in. [19.05 ± 0.3 mm] away from the central axis of the turntable (Fig. 2).

X1.1.2 *Wheel Bearing Condition*—The Taber Abraser wheel bearings should be able to rotate freely about their horizontal spindles and not stick when the wheels are caused to spin rapidly by a quick driving motion of the forefinger.

X1.1.3 *Vacuum Suction Force*—Air pressure in the suction device must not be lower than 55 in. of water column [137 millibar], as measured by a suction gage.

NOTE X1.1—Vacuum suction force may be influenced by the condition of the collection bag, which must be emptied or replaced on a regular basis. Any connection or seal leaks will also influence suction force.

X1.1.4 *Turntable Platform Position*—The vertical distance from the center of the pivot point of the Taber Abraser arms to the top of the turntable platform should be approximately 1 in. [25 mm]. The turntable platform shall rotate substantially in a plane with a deviation at a distance of 0.0625 in. [1.6 mm] from its periphery of not greater than ±0.002 in. [±0.051 mm].

X1.1.5 *Turntable Speed*—The turntable should rotate at the speed stated in 6.1.2.

X1.1.6 *Load*—The accessory mass marked 500 g shall weigh 250 ± 1 g and the accessory mass marked 1000 g shall weigh 750 ± 1 g.