Designation: C 1028 – 96

AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method[1]

This standard is issued under the fixed designation C 1028; 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 measurement of static coefficient of friction of ceramic tile or other surfaces under both wet and dry conditions while utilizing Neolite heel assemblies.[2] This test method can be used in the laboratory or in the field.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information purposes only.

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

2. Referenced Documents

2.1 *Rubber Manufacturing Association (RMA) Standard:*

HS-3 Method of Test for Evaluating Adhesive Bondability of Shoe Soling Materials (1975)[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *coefficient of friction*—the ratio of the horizontal component of force required to overcome or have a tendency to overcome friction to the vertical component of the object weight or normal force applied through the object which tends to cause the friction.

3.1.2 *friction*—the resistance developed between the physical contacting surface of two bodies when there is movement or tendency for movement of one body relative to the other parallel to the plane of contact.

3.1.3 *static coefficient of friction*—the ratio of the horizontal component of force applied to a body that just overcomes the friction or resistance to slipping to the vertical component of the weight of the object or force applied to it.

4. Significance and Use

4.1 The horizontal dynamometer pull meter and heel assemblies are designed to determine the static coefficient of friction of tile and like materials.

4.2 The measurement made by this apparatus is believed to be one important factor relative to slip resistance. Other factors can affect slip resistance, such as the degree of wear on the shoe and flooring material; presence of foreign material, such as water, oil, and dirt; the length of the human stride at the time of slip; type of floor finish; and the physical and mental condition of humans. Therefore, this test method should be used for the purpose of developing a property of the flooring surface under laboratory conditions, and should not be used to determine slip resistance under field conditions unless those conditions are fully described.

4.3 Because many variables may enter into the evaluation of slip resistance of a particular surface, this test method is designed to evaluate these surfaces under both laboratory and actual site installation conditions.

4.4 The static coefficient of friction is determined under both wet and dry conditions with Neolite heel assemblies over both unprepared and prepared (cleaned) test surfaces.

5. Apparatus

5.1 *Dynamometer Pull Meter*, horizontal (for example, a Chatillon Gage, Model 80D or DFIS,[4] as shown in Fig. 1).

5.2 *Weight*, 50-lb (22-kg).

5.3 *Standard Neolite Heel Assemblies*, two, one to be used for each of the wet and dry conditions.[5]

5.3.1 Two assemblies made of ¾-in. thick and 8-in. square wood block with 3 in. by 3 in. Neolite material attached[2] (see Fig. 2).

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[1] This test method is under the jurisdiction of ASTM Committee C-21 on Ceramic Whitewares and Related Products and is the direct responsibility of Subcommittee C21.06 on Ceramic Tile.

Current edition approved Feb. 10, 1996. Published April 1996. Originally published as C 1028 – 84 (formerly P 155). Last previous edition C 1028 – 89.

[2] Neolite or an equivalent has been found satisfactory. Neolite is a registered trademark of the Goodyear Tire and Rubber Co., Shoe Product Division, Windsor, VT 05089 and may be obtained from Smithers Scientific Services, Inc., 425 W. Market St., Akron, OH 44303 (Attn: Technical Director). Specify "Neolite (Break-in Compound)," RMA Spec. HS-3, Size 36 by 44 in., 6 irons, Color: Natural 11, Specific Gravity 1.27 ± 0.02, Hardness Shore A93-96.

[3] Available from Rubber Manufacturers Association, 1901 Pennsylvania Ave., NW, Washington, DC 20006. RMA Specification #HS-3.

[4] The Chatillon gage, manufactured by Chatillon, 7609 Business Park Drive, Greensboro, NC 27409-9301 is available from The Scale People, 11872-A Canon Blvd., Newport News, VA 23606-4227.

[5] The standard tile may be obtained from the Tile Council of America or The Scale People. The Neolite heel assembly on all items listed in Section 5 is available as Kit A-160 from The Scale People.

(a) Model DFIS

(b) Chantillon Gauge, Model DPPH200

FIG. 1 Dynamometer Pull Meters

5.3.2 Sheen must be removed from the Neolite surface prior to use. To prepare the assembly surface prior to its initial use, place a sheet of 400 grit wet or dry silicon carbide paper on a flat surface. Sand Neolite material gently by moving the assembly back and forth four times for a distance of about 4 in. (102 mm). Repeat at an angle of 90°. This constitutes one cycle of surface preparation. This procedure is to be repeated for a total of 10 cycles.

5.4 *Standard Tile.*[5]

6. Reagents and Materials

6.1 *Silicon Carbide Paper*, wet or dry, 400 grit.

FIG. 2 Test Assembly

6.2 *Hillyard's Renovator No. 120.*[6]

6.3 *Neolite,*[2] Standard Neolite Cement Liner (see 2.1).

6.4 *Rags, Sponge, or Paper Towels.*

6.5 *Water*, distilled.

7. Calibration (Dry)

7.1 Because many variables are associated with this test procedure, it is important that the operator calibrates the Neolite Heel Assembly surface with the Standard Tile each time the test is performed.

7.2 For uses other than the initial use, resurface the assembly with 400 grit wet or dry silicon carbide paper, four cycles.

7.3 Determine the total weight, *W*, of the 50-lb (22-kg) weight plus the Neolite Heel Assembly.

7.4 Clean the Standard Tile with Hillyard's Renovator.

7.5 Place the Neolite Heel Assembly and the 50-lb (22-kg) weight on the Standard Tile surface. Using a dynamometer, determine the force required to set the test assembly in motion. Record the highest reading.

7.6 Make a total of four pulls, each perpendicular to the previous pull.

7.7 Calculate the dry calibration factor as follows:

$$X_D = 0.71 - \frac{R_D}{NW} \quad (1)$$

where:

X_D = dry calibration factor,
R_D = sum of the four recorded dry force readings, lb (kg),
N = number of pulls (4), and
W = weight of heel assembly plus 50-lb (22-kg) weight, lb (kg).

NOTE 1—The 0.71 factor is the static coefficient of friction value as determined by an ASTM Round Robin on April 2, 1987.

8. Test Procedure (Dry)

8.1 Test the following surfaces:

8.1.1 The test area or separate test specimens shall not be less than 4 by 4 in. (102 by 102 mm). Bond the separate test

[6] Available from Hillyard, Inc., P.O. Box 909, St. Joseph, MO 64502.

specimens of small-sized tile, such as 1 by 1 in. (25 by 25 mm) and 2 by 2 in. (51 by 51 mm) to a suitable surface to provide the 4 by 4 in. or larger size.

8.1.2 Test the surface in the as-received condition.

8.2 To prepare the heel assembly surface, prior to adding the 50-lb (22-kg) weight, resurface with 400 grit wet or dry silicon carbide paper on a flat surface for one cycle.

8.3 Resurface the heel assembly after each tile or surface area to be tested.

8.4 Place the 50-lb (22-kg) weight assembly with Neolite material attached on the test surface. Using a dynamometer, determine the force required to set the test assembly in motion. Record the highest reading.

8.5 Four pulls perpendicular to the previous pull on each of three surface areas or three test specimens constitute the twelve necessary readings to calculate the static coefficient of friction.

8.6 Record all readings.

9. Calibration (Wet)

9.1 It is important that the operator calibrates the assembly surface each time the test is performed. Repeat the procedure in 7.2-7.5 with one exception: Saturate the surface with distilled water and repeat the calibration with the surface wet, keeping the surface saturated.

9.2 Calculate the wet calibration factor as follows:

$$X_W = 0.47 - \frac{R_W}{NW} \tag{2}$$

where:

X_W = wet calibration factor,
R_W = sum of the four recorded wet force readings, lb or kg,
N = number of pulls (4), and
W = weight of heel assembly plus 50-lb (22-kg) weight, lb (kg).

NOTE 2—The 0.47 factor is the static coefficient of friction value as determined by an ASTM Round Robin on April 2, 1987.

10. Test Procedure (Wet)

10.1 Repeat the procedure in 8.2 and 8.5 with one exception: Saturate the surface with distilled water and repeat the test with the surface wet, keeping the surface saturated.

10.2 Record all readings.

11. Test Procedure Using Prepared Test Specimens

11.1 Test the prepared test specimens, both wet and dry, after cleaning the test specimens with Hillyard's Renovator.

12. Calculation

12.1 Calculate the static coefficient of friction as follows:

12.1.1 *Dry*:

$$F_D = (R_D/NW) + X_D \tag{3}$$

12.1.2 *Wet*:

$$F_W = (R_W/NW) + X_W \tag{4}$$

where:

F_D = static coefficient of friction for dry surface,
F_W = static coefficient of friction for wet surface,
R_D = total of the 12 dry force readings, lb (kg),
R_W = total of the 12 wet force readings, lb (kg),
N = number of pulls (12),
X_D = dry calibration factor,
X_W = wet calibration factor, and
W = total weight of the heel assembly plus 50-lb (22-kg) weight, lb (kg).

13. Report

13.1 Report the following information:

13.1.1 Type of tile or surface and

13.1.2 The individual and average static coefficient of friction for:

13.1.2.1 dry surfaces (both as-received and after cleaning) and

13.1.2.2 wet surfaces (both as-received and after cleaning).

14. Precision and Bias

14.1 *Precision*—The standard deviation between the data obtained from six laboratories was 0.07 for the dry calibrated values and 0.05 for the wet calibrated values.

14.2 *Bias*—No data are available on measurements versus standard.