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An American National Standard

Standard Test Method for Determining the Traction of Footwear on Painted Surfaces Using the Variable Incidence Tester[1]

This standard is issued under the fixed designation D 5859; 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.

ε[1] NOTE—Per Committee F13 Bylaws, editorially replaced term definitions with reference to Terminology F 1646 in January 2004.

1. Scope

1.1 This test method covers the measurement of the traction of footwear on painted walkway surfaces under both dry and wet conditions in the laboratory and the field.

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

1.3 *This test method 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:*

F 1646 Terminology Relating to Safety and Traction for Footwear[2]

3. Terminology

3.1 See Terminology F 1646 for the following terms used in this test method:

3.1.1 Friction, and

3.1.2 Coefficient of friction.

4. Summary of Test Method

4.1 The variable incidence tester, shown in Fig. 1,[3] operates independent of gravity and is self-powered by a miniature carbon dioxide cartridge. It uses an articulated strut but differs from the James and Hunter machines. Its fluidics actuation applies the load to a slider shoe instantaneously, thereby overcoming the well-known "stiction" problem that arises from the delay between the time the slider is set down onto the surface and the time it starts to slip.

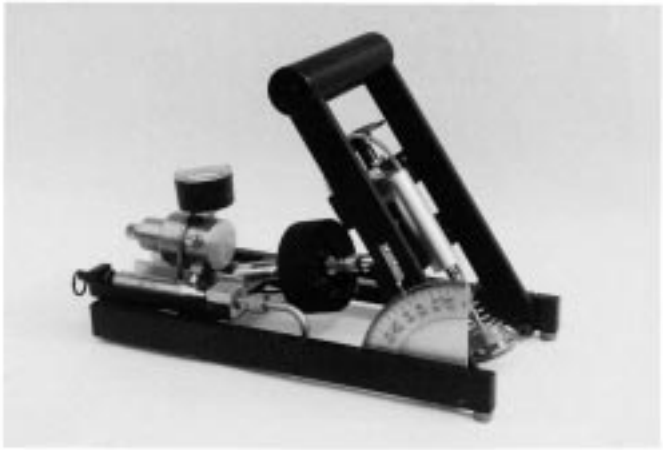

FIG. 1 Variable Incidence Tester

4.2 As the test progresses, the shoe descends, makes contact with the substrate, and continues to be subjected to the constant vertical load, in addition to an increasing horizontal or tangential load, until slip occurs. The tangent of the angle that the tester makes with respect to the vertical, at the instant of slip, is taken to be the ratio of the horizontal and vertical components of the force applied to the shoe and thus the coefficient of friction.

4.3 When slippage occurs, the strut will kick out in an arc. The angle at which slippage just begins to occur, which is read from the protractor scale, is the slip index or the static coefficient of friction.

5. Significance and Use

5.1 The variable incidence tester[3] is a laboratory and field instrument designed to measure the slip resistance of paint or related materials to determine their traction properties in a

[1] This test method is under the jurisdiction of ASTM Committee F13 on Safety and Traction for Footwear and is the direct responsibility of Subcommittee F13.10 on Traction.

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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.

[3] The English XL, is covered by a patent held by William English and is available from William English, Inc., 20500 North River Rd., Alva, FL 33920. It has been found suitable for this use. Interested parties are invited to submit information regarding the identification of acceptable alternatives to this patented item to the Committee on Standards, ASTM Headquarters, 100 Barr Harbor Dr., West Conshohocken, PA 19428-2959. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.

clean and dry state or in the presence of environmental contaminants encountered in situ.

5.2 The indication of this test apparatus is believed to relate slip resistance of the surface tested in the test environment. It does not contemplate floor materials, characteristics of individual human gaits, and other factors besides the floor surface conditions.

5.3 The relative slip resistance of a floor surface may be measured under wet or dry conditions or in the presence of other environmental contaminants using the specific foot assembly.

6. Apparatus

6.1 *Variable Incidence Tester*[3]—The tester is constructed as follows:

6.1.1 *Chassis*—A rigid welded aluminum frame fabricated from ⅜ by 1-in. (9 by 25-mm) flat bar fitted with three slip-resistant feet that rest on the test surface.

6.1.2 *Mast Assembly*—A rigid welded aluminum frame fabricated from ¼ by 1-in. (6 by 25-mm) flat bar attached to the chassis with a hinge joint that permits it to be inclined from vertical 90° to 45°.

6.1.3 *Handle*—A 1-in. (25-mm) diameter aluminum tube bolted to the top of the mast assembly that can be used to lift and carry the tester and is grasped to apply a downward force to the tester to prevent sliding on the test surface while operating.

6.1.4 *Actuating Cylinder*—A miniature pneumatic cylinder is mounted to the mast assembly by a hinged joint to permit swinging of the universal foot when slippage occurs.

6.1.5 *Universal Foot Assembly*—A universal joint between the slider disc and the piston rod of the actuating cylinder permits the operating force to apply the slider to the test surface in a manner not unlike the human foot in walking. A coil spring brings the universal foot to approximate neutral alignment following each power stroke.

6.1.6 *Articulated Strut*—The actuating cylinder and universal foot assembly comprise the articulated strut. It is the movement of this assembly about its hinge pin that permits the slippage of the foot.

6.1.7 *Control Valve*—A four-way pneumatic spindle valve attached to the mast assembly actuates the power cylinder and causes it to stroke.

6.1.8 *Pressure System*—The pressure operation of the tester is powered by a compressed gas source mounted on the rear of the chassis. It consists of a miniature liquid carbon-dioxide cartridge supplying high-pressure that is reduced to a working pressure of 40 psi (276 kPa) by a pressure regulator. This regulated pressure is piped to the control valve by tubing that flexes to accommodate mast inclination variations.

7. Test Sensor

7.1 The slider pad[4] is prepared by cutting a disc of 1.25-in. (3.2-cm) diameter elastomer and affixing it to the bottom of the universal foot, sheen side exposed, using epoxy cement or other suitable adhesive.

7.2 The slider pad is then prepared by sanding with 400-grit wet or dry silicon carbide paper in the dry condition, backed by a flat surface, until all the sheen is removed. The edges should be slightly beveled to remove any sharp edges. Sanding particles should then be dusted off with a clean paint brush.

7.3 Following initial preparation, the foot is screwed onto the nut on the universal joint. Screw the joint together until snug and then back off ¼ turn.

8. Reagents and Materials

8.1 *Silicon Carbide Paper*, 400-grit wet or dry.
8.2 *Cleaner.*[5]
8.3 *Standard Slider Pad.*[4]
8.4 *Rags, Sponge or Paper Towels.*
8.5 *Distilled Water.*
8.6 *Hand-Pumped Spray Bottle.*
8.7 *Paint Brush.*
8.8 *Two (2) Part Epoxy Adhesive.*
8.9 *Soft Fiber Bristle Brush.*
8.10 *Double-Stick Tape.*

9. Tester Operational Check

9.1 Place the tester on a flat surface.

9.2 Insert a pressurized gas cartridge into its holder on the chassis and tighten the clamp screw until pressure registers on the gage.

9.3 Cycle the tester twice to verify that the piston shaft moves freely and stabilizes the working pressure.

10. Procedure (Dry)

10.1 The test area or test specimens shall not be less than 2 in.^{2} (5 cm^2).

10.2 Before testing is begun, clean the test surface with a soft fiber bristle brush and cleaner at a dilution rate of one part cleaner to ten parts distilled water. Rinse the surface with distilled water and let air dry.

10.3 Resurface the slider pad after each fill slip tested with 400-grit wet or dry silicon carbide paper, in the dry condition, using a sanding block to back up the paper in a flat configuration. Remove sanding residue with a dry paint brush.

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[4] Neolite®, registered trademark with Goodyear Tire and Rubber Company is a suitable slider material. This sensor material may be obtained from Smithers Scientific Services Inc., 425 West Market Street, Akron, OH 44303. Specify" Standard Neolite® Liner," Nominal size, 6 by 6 in.; 3.78 irons (2 mm), color, Natural 11; specific gravity, 1.27 ± 0.02; hardness Shore A, 93–96.

[5] Hillyard's Renovator® #120, available from Hillyard, Inc., 302 North 4th Street, St. Joseph, MO 64502, has been found suitable for our testing.

10.4 Place the tester on a flat surface. If individual tiles or other flooring fragments are to be tested, they must be positioned securely against sliding and in the same plane as the surface that supports the three soft feet on the underside of the tester chassis, and the tester must be positioned so that the sensor will impact the intended test area when it is actuated.

10.5 The tester is actuated by grasping it by the handle and depressing the control valve palm button while simultaneously pressing downward on the handle to prevent movement of the chassis across the floor or test surface.

10.6 Without moving the position of the chassis, progressively increase the inclination of the mast by turning the hand wheel, increasing the strut angle, after each stroke, until the point of slippage occurs. By experimentation, find the angle at which slippage just begins to occur, then read the slip index from the protractor scale and record the value observed. On dry surfaces, the slip index is the static coefficient of friction by National Institute of Standards Technology definition.

10.7 In the course of performing 10.6, cycle the tester quickly. Since slipping in human ambulation occurs within a fraction of a second, do not apply the force vector for more than a second of duration. When slippage occurs, it will be obvious. The strut will kick out in an arc, and the power cylinder will extend to its full stroke. Release of the control valve will cause the piston rod to retract fully, ready for its next stroke.

10.8 Rotate the orientation of the tester 90° after each of a series of four (4) tests, recording each value indicated. Averaging the four readings will give the coefficient of friction or slip index for a given floor section.

11. Procedure (Wet)

11.1 Preparation of the slider pad is similar to the procedure specified in Section 11, except that it is not normally necessary to recondition the slider pad after each test, unless there is some reason to suspect that the slider pad is becoming polished or there is a build up of contamination on the surface of the slider pad. In such cases, prepare the surface of the slider pad as set forth in Section 11 before proceeding.

11.2 Saturate the surface to be tested with distilled water from the spray bottle prior to each stroke of the tester.

11.3 Record and average the four (4) readings taken from the four different orientations (as in the dry test procedure, 10.8) to obtain the slip resistance index for the wet surface.

12. Field Testing Procedure

12.1 Proceed in accordance with the operational check and test procedures as set forth in Sections 10, 11 and 12, rotating the tester 90° after each measurement and test the surface in its "as is" condition.

12.2 Sloped surfaces, such as ramps, are tested in the same manner as level surfaces since the apparatus is independent of gravity.

12.3 When testing stairs, install the stair attachment to the under side of the chassis and adjust its height to the dimension of the riser height so that the tester is supported in a level position when its front soft feet, on the underside of the chassis, are placed on the nosing of the tread. The tester will then be in a head-on position so that the actuation force will be parallel to the direction of pedestrian travel on the stairs.

13. Environmental Conditions

13.1 For all tests performed in the dry state, record the ambient temperature, relative humidity, and other relevant conditions under which the test is conducted.

14. Report

14.1 Report the following information of testing operations:

14.1.1 Type of floor surface and material mounted on the slider pad,

14.1.2 Individual and average friction values for:

14.1.2.1 Dry surface testing, and

14.1.2.2 Wet surface testing, and

14.1.2.3 Prevailing environmental conditions and surface contaminants encountered in situ when tests are performed in field.

15. Precision and Bias

15.1 Precision and bias of this test method are being determined.

16. Keywords

16.1 coefficient of friction; dry surface testing; friction; slip resistance; slip-resistance tester; wet surface testing