



Designation: E303 – 22

# Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester<sup>1</sup>

This standard is issued under the fixed designation E303; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers the procedure for measuring surface frictional properties using the British pendulum skid resistance tester. A method for calibration of the tester is included in [Annex A1](#).

1.2 The British pendulum tester is a dynamic pendulum impact-type tester used to measure the energy loss when a rubber slider edge is propelled over a test surface. The tester is suited for laboratory as well as field tests on flat surfaces, and for polish value measurements on curved laboratory specimens from accelerated polishing wheel tests.

1.3 The values measured, BPN = British pendulum (tester) number for flat surfaces and polish values for accelerated polishing wheel specimens, represent the frictional properties obtained with the apparatus and the procedures stated herein and do not necessarily agree or correlate with other slipperiness measuring equipment.

1.4 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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

1.6 *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.*

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee E17 on Vehicle - Pavement Systems and is the direct responsibility of Subcommittee E17.23 on Surface Characteristics Related to Tire Pavement Slip Resistance.

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## 2. Referenced Documents

- 2.1 *ASTM Standards*:<sup>2</sup>  
[E501 Specification for Standard Rib Tire for Pavement Skid-Resistance Tests](#)

## 3. Summary of Test Method

3.1 This test method consists of using a pendulum-type tester with a standard rubber slider to determine the frictional properties of a test surface.

3.2 The test surface is cleaned and thoroughly wetted prior to testing.

3.3 The pendulum slider is positioned to contact a specific length of the test surface prior to conducting the test. The pendulum is raised to a locked position, then released to propel the slider across the test surface.

3.4 A drag pointer indicates the British pendulum (tester) number (BPN). The term pendulum test value (PTV) is synonymous with BPN in the pedestrian surface industry. The greater the friction between the slider and the test surface, the more the swing is retarded, and the larger the BPN reading. Five swings of the pendulum are made for each test surface.

## 4. Significance and Use

4.1 This test method provides a measure of a frictional property, microtexture of surfaces, either in the field or in the laboratory.

4.2 This test method may be used to determine the relative effects of various polishing processes on materials or material combinations.

4.3 The values measured in accordance with this method do not necessarily agree or directly correlate with those obtained utilizing other methods of determining friction properties or skid resistance.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

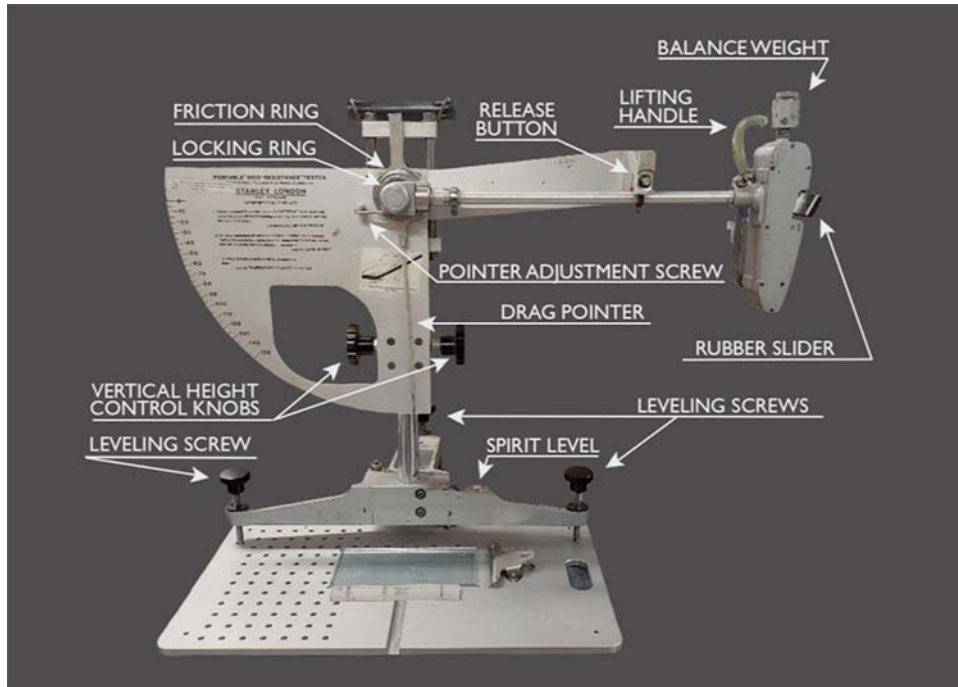


FIG. 1 British Pendulum Tester

NOTE 1—BPN and polish values from similar types of surfaces will not be numerically equal, primarily because of the differences in slide length and surface shape. Theoretical correction of the polish values to obtain numerical equality, either by mathematical manipulation or by use of special measuring scales, is not recommended.

## 5. Apparatus

5.1 *British Pendulum Tester* (Fig. 1)—The pendulum with slider and slider mount shall weigh  $1500 \pm 30$  g. The distance of the center of gravity of the pendulum from the center of oscillation shall be  $411 \pm 5$  mm ( $16.2 \pm 0.2$  in.). The tester shall be capable of vertical adjustment to provide a slider contact path of  $125 \pm 1.6$  mm ( $4\frac{15}{16} \pm \frac{1}{16}$  in.) for tests on flat surfaces, and 76 to 78 mm ( $3 \pm \frac{1}{16}$  in.) for tests on polishing wheel specimens. The spring and lever arrangement shown in Fig. 2 shall give an average normal slider load between the 76 mm (3 in.) wide slider and test surface of  $2500 \pm 100$  g, as measured by the method prescribed in Annex A1.

5.2 *Slider*—The slider assembly shall consist of an aluminum backing plate to which is bonded a 6 by 25 by 76 mm ( $\frac{1}{4}$  by 1 by 3 in.) rubber strip for testing flat surfaces, or a 6 by 25 by 32 mm ( $\frac{1}{4}$  by 1 by  $1\frac{1}{4}$  in.) rubber strip for testing curved polishing wheel specimens.

5.2.1 The rubber compound shall be one of the following:

5.2.1.1 Natural rubber meeting the requirements of the Road Research Laboratory,<sup>3</sup> commonly referenced as the TRL slider,

<sup>3</sup> Giles, C. G. Sabey, Barbara E., and Carden, K. W. F., "Development and Performance of Portable Skid-Resistance Tester," *Road Research Technical Paper No. 66*, Road Research Laboratory, Dept. of Scientific and Industrial Research, England, 1964.

Kummer, H. W. and Moore, D. F. "Concept and Use of the British Portable Skid-Resistance Tester," *Report No. 6*, PDH-PSV Joint Road Friction Program, Dept. of Mechanical Engineering, The Pennsylvania State University, State College, PA 16802, June 1963.

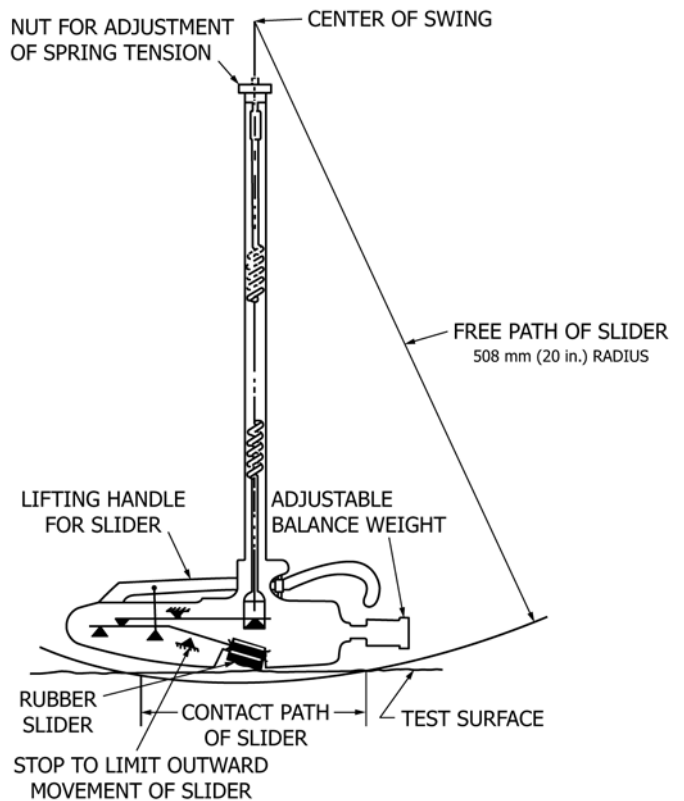


FIG. 2 Schematic Drawing of Pendulum Showing Spring and Lever Arrangement

5.2.1.2 Natural rubber having an international rubber hardness of  $96 \pm 2$ , commonly referenced as "4S" (standard shoe sole simulating) rubber, or

5.2.1.3 Synthetic rubber as specified in Specification E501.

NOTE 2—The Road Research Laboratory rubber is used for testing pedestrian surfaces where bare feet are common. The “4S” rubber is used for testing surfaces where pedestrians would be shod.

5.2.2 New sliders shall be conditioned prior to use by making ten swings on No. 60 grade silicon carbide cloth or equivalent under dry conditions. The swings shall be made with a tester adjusted as in Section 7.

5.2.3 Wear on the striking edge of the slider shall not exceed 3.2 mm ( $1/8$  in.) in the plane of the slider or 1.6 mm ( $1/16$  in.) vertical to it, as illustrated in Fig. 3.

5.2.4 Rubber sliders should be stored at room temperature and out of direct sunlight.

5.2.5 Discard rubber sliders that don’t meet the specified hardness.

### 5.3 Accessories:

5.3.1 Contact path gauge shall consist of a thin ruler, suitably marked for measuring contact path length between 124 and 127 mm ( $4\frac{7}{8}$  and 5.0 in.) or between 75 and 78 mm ( $2\frac{15}{16}$  and  $3\frac{1}{16}$  in.), as required for the particular test.

5.3.2 Miscellaneous equipment such as water container, surface thermometer, and brush are recommended.

## 6. Test Specimen

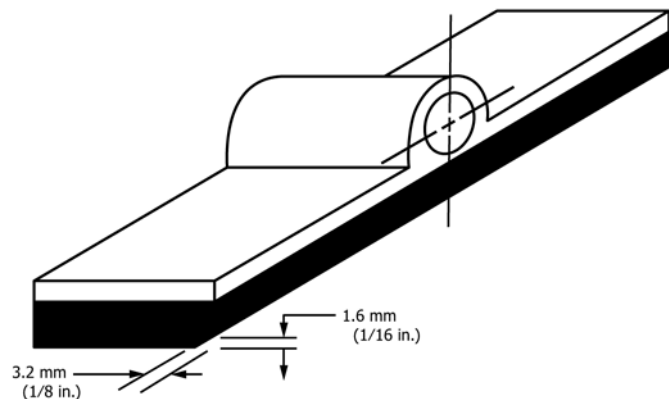
6.1 *Field*—Field test surfaces shall be free of loose particles and flushed with clean water. The test surface does not have to be horizontal, provided the instrument can be leveled in working position using only the leveling screws and the pendulum head will clear the surface.

6.2 *Laboratory*—Laboratory test panels shall be clean and free of loose particles and shall be held rigidly so as not to be moved by the force of the pendulum.

6.2.1 Flat laboratory test panels shall have a test surface of at least 89 by 152 mm ( $3\frac{1}{2}$  by 6 in.).

6.2.2 Accelerated laboratory polishing wheel specimens shall have a test surface of at least 44 by 89 mm ( $1\frac{3}{4}$  by  $3\frac{1}{2}$  in.) and shall be curved in the arc of a circle 406 mm (16 in.) in diameter.

6.3 *Verification Surface*—A verification surface shall be used at a regular interval to ensure proper operation and accuracy of the pendulum tester. The verification surface shall have a known value against which the results are compared.



**FIG. 3 Slider Assembly Illustrating the Maximum Wear on Striking Edge**

NOTE 3—Several commonly used verification surfaces are available to include: Float glass (BPN 4S value of 5 to 10), 3 mil polyester film made of 3  $\mu$ m aluminum oxide, commonly referred to as pink lapping film (BPN 4S value of 59 to 64), conditioned Pavigres tile available from many European pendulum manufacturers (BPN 4S value of 32 to 36), or No. 60 grade silicon carbide cloth (BPN 4S value of  $85 \pm 10$ ).

## 7. Preparation of Apparatus

7.1 *Leveling*—Level the instrument accurately by turning leveling screws until the bubble is centered in the spirit level.

7.2 *Zero Adjustment*—Raise pendulum mechanism by loosening locking knob (directly behind pendulum pivot) and turn vertical height control knob(s) to allow slider to swing free of test surface. Tighten locking knob firmly. Place pendulum in raised and locked position and rotate the drag pointer counterclockwise until it comes to rest against adjustment screw on pendulum arm. Release pendulum and note drag pointer reading. If reading is not zero, loosen locking ring and rotate friction ring on bearing spindle slightly and lock again. Repeat test and adjust friction ring until the pendulum swing consistently carries drag pointer to zero.

### 7.3 Slide Length Adjustment:

7.3.1 With pendulum hanging free, place manufacturer-supplied spacer under adjusting screw of lifting handle. Lower pendulum so edge of slider just touches surface. Lock pendulum head firmly, raise lifting handle, and remove spacer.

7.3.2 Raise slider by lifting handle, move pendulum to right, lower slider, and allow pendulum to move slowly to left until edge of slider touches surface. Place gauge beside slider and parallel to direction of swing to verify length of contact path. Raise slider using lifting handle and move pendulum to left, then slowly lower until slider edge again comes to rest on surface. If the length of the contact path is not between 124 and 127 mm ( $4\frac{7}{8}$  and 5.0 in.) on flat test specimens, or between 75 and 78 mm ( $2\frac{15}{16}$  and  $3\frac{1}{16}$  in.) on curved polishing wheel specimens, measured from trailing edge to trailing edge of the rubber slider, adjust by raising or lowering instrument with the height control knob. Lift pendulum and lock in the ready-to-release position. Rotate the drag pointer counterclockwise until it comes to rest against adjustment screw on pendulum arm.

NOTE 4—Operational best practice includes observations of the following aspects of the pendulum tester prior to and during measurements:

- (1) No obvious damage to any part of the pendulum, main tube support, or face plate;
- (2) Leveling screws are easy to operate and function properly;
- (3) Release knob operates properly, and the pendulum arm’s catch does not rub or snag in the catch block;
- (4) Pendulum foot is parallel to the front two feet and frame;
- (5) Drag pointer is straight, undamaged, and swings with uniform friction;
- (6) Friction adjustment rings operate and lock properly;
- (7) Counterweight on the foot is complete and secure; and
- (8) Slider spring is in place and slider can rotate on the support rod.

7.4 *Slider Preparation*—Condition the slider by making three swings on No. 60 grade silicon carbide cloth or equivalent under dry conditions. The swings shall be made with a tester adjusted as in Section 7.