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An American National Standard

Standard Test Method for Coefficient of Static Friction of Uncoated Writing and Printing Paper by Use of the Inclined Plane Method[1]

This standard is issued under the fixed designation D4918; 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 describes a procedure for the determination of the coefficient of static friction of paper measured when sliding against itself. The inclined plane procedure is used.

1.2 Although this test method is basic in concept, the precision statement has been developed on uncoated writing and printing papers. While the use of this test method is recommended for those grades only, it may be used with other types of paper giving specific attention to special paper characteristics and with the understanding that the precision may not be the same.

1.3 Static coefficient of friction (COF) relates to the force required to initiate movement between two surfaces while kinetic COF relates to the force required to cause continuation of the movement at uniform speed. Kinetic COF cannot be measured by this test method. Both static and kinetic COF can be measured by Test Method D4917.

1.4 A horizontal plane method is described in Test Method D4917, which gives similar results. The choice of approach depends upon the equipment available and the means of measurement.

1.5 The determination of this characteristic for corrugated and solid fiberboard is described in Test Methods D4521 and D4521. The test methods differ in that, in Test Methods D4521 and D4521, the two specimens are allowed to slip upon one another three times before the angle of inclination is determined, while in this test method, the angle is determined on the first slip.

1.6 *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]

D528 Test Method for Machine Direction of Paper and Paperboard

D585 Practice for Sampling and Accepting a Single Lot of Paper, Paperboard, Fiberboard, and Related Product

D685 Practice for Conditioning Paper and Paper Products for Testing

D1968 Terminology Relating to Paper and Paper Products

D3247 Method of Test for Coefficient of Static Friction of Corrugated and Solid Fiberboard (Horizontal Plane Method)[3]

D3460 Specification for White Watermarked and Unwatermarked Bond, Reprographic, and Laser Printer Cut-Sized Office Papers[3] [3]

D4521 Test Method for Coefficient of Static Friction of Corrugated and Solid Fiberboard (Discontinued 2001)[3]

D4917 Test Method for Coefficient of Static and Kinetic Friction of Uncoated Writing and Printing Paper by Use of the Horizontal Plane Method

3. Terminology

3.1 *Definitions*—Definitions shall be in accordance with Terminology D1968 and the *Dictionary of Paper*.[4]

4. Summary of Test Method

4.1 One specimen of the paper sample is clamped to an inclined plane, the other to a rubber-faced sled. The sled is placed on the inclined plane and the plane raised until the sled begins sliding. The coefficient of static friction is equal to the tangent of the angle at which sliding begins.

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[1] This test method is under the jurisdiction of ASTM Committee D06 on Paper and Paper Products and is the direct responsibility of Subcommittee D06.92 on Standard Documents Relating to Paper and Paper Products.

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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] Withdrawn.

[4] Available from Technical Association of the Pulp and Paper Industry (TAPPI), 15 Technology Parkway South, Norcross, GA 30092, http://www.tappi.org.

5. Significance and Use

5.1 The coefficient of friction of printing and writing papers indicates the ease with which the top or bottom sheet of a stack of paper will slide across the succeeding sheet, such as occurs on the infeed of a sheet-fed printing press or the sheet transport into a copier machine. A minimum coefficient of friction is required to prevent the double-feeding of any sheets.

5.2 Since each sheet is removed from the stack only once, a single slide of each pair of specimens is performed and the value recorded.

6. Apparatus (Fig. 1)

6.1 *Inclined Plane*—A plane surface, hinged so that it can be tilted, with a smooth, incompressible top surface which may be made of metal, wood, plate glass, or plastic having a width at least 25 mm (1 in.) wider than the sled and a length sufficient to permit the sled to move at least 15 mm (⅝ in.). The plane is provided with a clamp at the upper end to fix the test specimen to the plane.

6.2 *Sled*—A 63.5 by 63.5-mm (2.5 by 2.5-in.) metal block with a rubber-faced lower surface weighing a total of 200 g. The size and weight of the metal block are not critical but the sled specified has been found satisfactory. A means for clamping the specimen to the sled is desirable, but is not necessary if the lower surface is faced with soft rubber 3 mm (⅛ in.) thick.

6.3 Means to smoothly increase the inclination of the plane from horizontal through an arc of at least 45° at a rate of 1.5 ± 0.5°/s.

6.4 Means to indicate the angular displacement of the plane to within 0.5°.

6.5 Means to determine if the plane is level in all directions at the start of the test and adjustable legs to allow leveling adjustment.

6.6 *Paper Cutter*, to cut test specimens.

7. Sampling and Test Specimen Preparation

7.1 The sample, selected in accordance with Practice D585, should be in the form of a finished ream or a "lift'' sample from a roll. A lift is a stack of sheets about 1.3 cm (½ in.) cut from a roll.

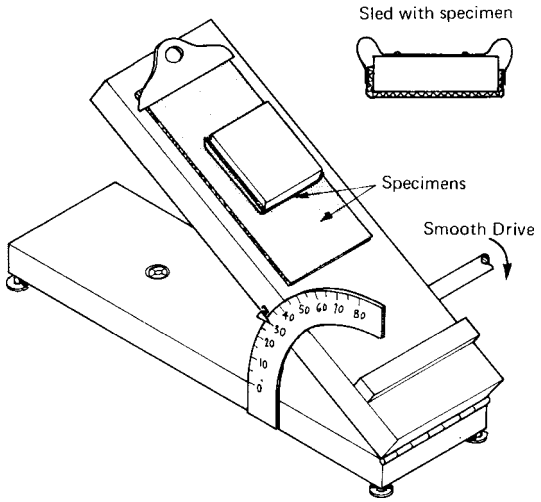

FIG. 1 Schematic of Inclined Plane Apparatus

7.1.1 Transfer of small quantities of oil or grease to the sample or test specimen during sampling, test specimen preparation, or testing can lower the measured values determined using this test method. Handle samples and test specimens by the edges wherever possible, and wear clean, dry cloth gloves for all sample handling applications in Sections 7 and 8.

7.2 Precondition, condition, and test in the atmospheres described in Practice D685.

7.3 Cut the sample into test specimen pairs as follows:

7.3.1 *Finished Ream Sample*:

7.3.1.1 *With Machine Direction COF*—Lift off a stack of six consecutive sheets, identify the machine direction and the felt (or top) side of the top sheet, and cut two specimens from each sheet: one 100 by 215 mm (4 by 8.5 in.) and the other 75 by 130 mm (3 by 5 in.). Cut the specimens so that the machine direction is parallel to the long dimension. Stack the two sets of specimens in separate piles, maintaining the same order of sheets as in the ream. Take the top sheet off the pile of larger specimens and discard. Use the second large specimen with the first small specimen, the third large specimen with the second small specimen, and so on, performing the test with five pairs of specimens from consecutive sheets. There will be one left-over small specimen (sixth) which can be discarded.

7.3.1.2 *Across Machine Direction COF*—Follow directions given in 7.3.1.1, except: Cut the specimens so that the machine direction is parallel to the shorter dimension.

7.3.2 *Lift Sample*:

7.3.2.1 *With-Machine Direction COF*—Lift off a stack of seven consecutive sheets, identify the machine direction and the felt (or top) side of the top sheet, and cut two specimens from each sheet: one 100 by 215 mm (4 by 8.5 in.) and the other 75 by 130 mm (3 by 5 in.). Cut the specimens so that the machine direction is parallel to the longer dimension. Discard the top sheet from each stack and test five pairs of specimens. Each pair is from the same sheet. Discard the bottom sheets.

7.3.2.2 *Across-Machine Direction COF*—Follow directions given in 7.3.2.1 except: Cut the specimens so that the machine direction is parallel to the shorter dimension. Discard the top sheet from each stack and test five pairs of specimens. Each pair is from the same sheet. Discard the bottom sheets.

8. Procedure

8.1 Check and adjust the instrument so that it is level in both directions, either through the use of a spirit level or a leveling device incorporated in the instrument.

8.2 *With-Machine Direction COF*—Select the set of specimens cut with the grain direction parallel to the long dimension, 7.3.1.1 or 7.3.2.1.

8.2.1 Place the larger specimen (100 by 215 mm (4 by 8.5 in.)) on the plane, with the top (felt) side upward, sliding the 100-mm (4-in.) edge under the clamp. Handle the paper specimens by the edges only.

8.2.2 Place the smaller specimen (75 by 130 mm (3 by 5 in.)) on top of the larger, with the wire side facing down, and grain directions parallel. Butt a 75-mm (3-in.) edge up to the clamp, and place the front 130-mm (5-in.) edge 0.6 cm from the edge of the plane. Place the sled on the top of the smaller specimen.