



Designation: D 4158 – 9201

Standard Test Method Guide for Abrasion Resistance of Textile Fabrics (Uniform Abrasion Method) Abrasion)¹

This standard is issued under the fixed designation D 4158; 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 guide covers the determination of the resistance to abrasion of a wide range of textile materials using the uniform abrasion testing instrument. Fabrics of all types including carpets, garments and nonwovens may be tested under this method.~~

NOTE 1—Other procedures for measuring the abrasion resistance of textile fabrics are given in: Test Methods D 3884, D 3885, D 3886, D 4157, D 4966, and AATCC Test Method 93.

1.1.1 Provisions are provided for testing specimens in dry and wet conditions. Four options for evaluation are included:

- Option 1—Fabric Rupture
- Option 2—Mass Loss
- Option 3—Thickness Loss
- Option 4—Breaking Strength Loss

1.1.2 Provision is provided for testing specimens in the wet state.

1.2 ~~The values stated in either SI units or inch-pound units are to be regarded separately as standard; the values in English standard. Within the text, the inch-pound units are provided as information only and are shown in parentheses. 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 nonconformance with the specification.~~

1.3 ~~This standard guide does not purport to address all of the safety problems, 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:*

¹ This method is under the jurisdiction of ASTM Committee D-13 on Textiles and is the direct responsibility of Subcommittee D13.60 on Fabric Test Methods, Specific. Current edition approved June 15, 1992; Feb. 10, 2001. Published August 1992; May 2001. Originally published as D 4158 – 82. Last previous edition D 4158 – 892.

D 123 Terminology Relating to Textiles²

D 1776 Practice for Conditioning Textiles for Testing²

D 3884– Test– Methods for Abrasion Resistance of Textile Fabrics (Rotary Platform, Double Head Method)³

D 3885 Test Method for Abrasion Resistance of Textile Fabrics (Flexing and Abrasion Method)³

D 3886 Test Method for Abrasion Resistance of Textile Fabrics (Inflated Diaphragm Method) Apparatus³

D 4157 Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)³

D 4966 Test Method for Abrasion Resistance of Textile Fabrics (Martindale Abrasion Tester Method)⁴

D 5035 Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)³

2.2 Other Documents:

AATCC-93, Impeller Tumble Test Method 93, Abrasion Resistance of Fabrics: Accelerator Method⁵

3. Terminology

3.1 Definitions:

3.1.1 *abrasion, n*—the wearing away of any part of a material by rubbing against another surface.

3.1.2 *abrasion cycle, n*—one complete movement of an abradant across the surfaces of a material being abraded.

3.1.2.1 *Discussion*—The complete movement for an abrasion cycle is dependent on the action of the abrasion machine and the test method used. It may consist of one back and forth nondirectional movement, or one circular movement, or a combination of both. For the uniform abrasion method, one cycle is one circular movement or rotation as noted on its counter.

3.1.3 *rotation, n*—one count on the counter which is roughly equivalent to one cycle.

3.2 For definitions of other terms used in these methods, refer to Terminology D 123.

4. Summary of Test Method

4.1 Abrasive action Test

4.1 A specimen is applied mounted in a holder and abraded uniformly in all directions in the plane and about every point of the surface of the specimen about every point in it. specimen. The settings of the machine, instrument, method of mounting specimens, conditions of test (as, dry (conditioned) or wet), and criteria to be used in evaluating abrasive wear in the test, depend upon the nature of the specimen to be tested and the use to be made of the test results. Resistance to abrasion Abrasion resistance for wear is evaluated by various means which are described one or more conditions of destruction, a defined surface damage, loss in Section 12, Evaluation the mass, strength or thickness of A test specimens, or by increased weakness in the sample as shown by a subsequent test by another method, depending on the material or its intended use.

5. Significance and Use

5.1 The resistance to abrasion of textile materials is affected by many factors in a very complex and as yet little understood manner. The abrasion machine covered in this test method provides a very sensitive means for studying results obtained from the influence use of the involved factors. The machine should therefore be used primarily as a research instrument. The results may not only shed much needed light on this complex problem but may also provide information on instrument assist in evaluating these factors relative to the effects wear serviceability of mechanical and chemical treatments on fibers, yarns, and fabrics, and on the influence of variations final textile product in yarn and fabric construction on specific end uses. The resistance to abrasion is affected by many factors that include the inherent mechanical properties of the final textile product. The results fibers; the dimensions of comparative tests the fibers; the structure of the abrasion resistance yarns; the construction of several fabrics of similar types are often very useful in the evaluation fabrics; the type, kind, amount of treatment added to the serviceability fibers, yarns or fabric; the nature of fabrics for a specific end use. In the abradant; the tension on the specimen; the pressure between the specimen and the abradant; and the dimensional changes in the specimen. Experience has shown in many instances, the that relative results obtained with this machine instrument when used on a series of fabrics, agreed well with those obtained by the supplier of the fabrics; based upon performance in end use. The experimenter, however, should be constantly on the alert for However, caution is advised because anomalous results which can be attributed in most instances may occur due to uncontrolled factors in manufacturing or other processes. Specific instances of this type have been described.⁶ Others may^{7,8,9} In any event, anomalous results should be encountered as studied to further understand the machine is used more extensively and complex behavior that may occur as a greater variety result of textiles have been tested. These anomalous results are frequently very fruitful abrasion that may in turn assist in the attainment development of more durable and satisfactory fabrics. As a rule they are not attributable fabrics.

² Annual Book of ASTM Standards, Vol 07.01.

³ Annual Book of ASTM Standards, Vol 07.02.

⁴ Available from American Association

⁴ Discontinued- See 2000 Annual Book of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709; ASTM Standards, Vol 07.02.

⁵ Schiefer, H. F. and Krasny, J. F., "Note on the Disintegration

⁵ Available from American Association of Wool in Abrasion Tests," *Textile Textile Chemists and Colorists, P.O. Box 12215, Research Journal*, Vol 19, January 1950, pp. 802–809; *Journal of Research, Nat. Bureau Standards*, Vol 44, January 1950, pp. 9–14 (*Research Paper RP-2054*); Triangle Park, NC 27709.

⁶ Schiefer, H. F., Crean, L. E. F. and Krasny, J. F. "Improved Single Unit Schiefer F., "Note on the Disintegration of Wool in Abrasion Testing Machine," *Tests,* *Journal of Textile Research Journal*, Vol 19, January 1950, pp. 802–809; *Journal of Research, Nat. Bureau Standards*, Vol 42, May, 1949, 44, January 1950, pp. 259–269; *ASTM Bulletin*, No. 159, July 1949, pp. 73–78 9–14 (*FP133 Research Paper RP 2054*).

⁷ The Schiefer machine meets these requirements

5.2 Testing some specimens under “wet” conditions can add another dimension to a faulty operation of the testing machine or carelessness evaluation of some textiles. Such testing under “wet” conditions can help ascertain the operator. These results should not be discarded but should be studied very intensively, for an understanding effect of the factors which cause such anomalous results adds immeasurably to changes in a better understanding fabric’s resistance to this complex problem and to its more intelligent application.

5.2 Test Method D 4158 for abrasion when it becomes wet. This test can also increase the determination uniformity of the abrading action by washing away abrasion resistance debris and preventing the build up of textile fabrics, uniform abrasion method, may be used for broken fibers that can interfere with the acceptance testing proper progression of commercial shipments of textile fabrics but caution the tests.

5.3 This test is advised since technicians may fail to get good agreement between results on certain fabrics. Comparative tests used as directed in 5.2.1 may be desirable.

5.2.1 In case of a dispute arising from differences guide in evaluating textiles in quality control and in research.

5.3.1 If there are differences of practical significance between reported test results when using Test Method D 4158 for acceptance testing of commercial shipments, the purchaser and the supplier should conduct two laboratories (or more), comparative tests should be performed to determine if there is a statistical bias between their laboratories. Competent them, using competent statistical assistance is recommended for the investigation of bias. assistance. As a minimum, the two parties should take a group of test specimens which samples should be used that are as homogeneous as possible and which possible, that are drawn from a lot of the material of from which the type in question. The disparate test specimens should then be results were obtained, and that are randomly assigned in equal numbers to each laboratory for testing. Other fabrics with established test values may be used for this purpose. The average test results from the two laboratories should be compared using Student’s *t*-test and an acceptable statistical test for unpaired data, at a probability level chosen by prior to the two parties before the testing began. series. If a bias is found, either its a cause must be found and corrected, or future test results must be adjusted in consideration of the purchaser known bias.

5.4 This test is unique and is significantly different from any other existing abrading test.

5.5 This test method may also be used as a technique for pretreating material for subsequent testing. For example, a predetermined number of abrasion cycles at specified test conditions may be performed on a series of specimens, which are then subjected to a strength or barrier performance test.

5.6 The resistance of textile materials to abrasion as measured by this guide does not include all the factors which account for wear performance or durability in actual use. While the “abrasion resistance” stated in terms of the number of cycles and “durability” (defined as the ability to withstand deterioration or wearing out in use, including the effects of abrasion) are frequently related. The relationship varies with different end uses, and different factors may be necessary in any calculation of predicted durability from specific abrasion data.

5.6.1 Laboratory tests may be reliable as an indication of relative end-use suitability in cases where the difference in abrasion resistance of various materials is large, but they should not be relied upon for prediction of performance during actual wear life for specific end uses unless there are data showing the specific relationship between laboratory abrasion tests and actual wear in the intended end use.

5.7 The pressure and tension used is varied, depending on the mass and nature of the material and the end use application. Whenever possible all materials that are to be compared with each other should be tested under the same pressure and tension.

5.8 When abrasion tests are continued to total destruction, abrasion resistance comparisons are not practical for fabrics have a different mass because the change in abrasion resistance is not directly proportional to the change in the fabric mass.

5.9 All the test methods and instruments that have been developed for abrasion resistance may show a high degree of variability in results obtained by different operators and in different laboratories; however, they represent the methods most widely used in the industry. Because there is a definite need for measuring the relative resistance to abrasion, this is one of the known bias. several standardized guides and methods that is useful to help minimize the inherent variation in results that may occur.

6. Apparatus and Materials

6.1 The machine,⁷ Uniform Abrasion Tester¹¹, shown in Figs. 1 and 2, consists of an abrading mechanism, specimen supporting mechanism, and driving mechanism. Essentially, the surface of the abradant lies in a plane parallel to the plane surface supporting the specimen and presses upon the specimen. The abradant and specimen rotate in the same direction at very nearly but not quite the same angular velocity (250 rpm) on noncoaxial axes which are parallel to within 0.0025 mm (0.0001 in.).

6.1.1 The small difference in speed is to permit each part of the specimen to come in contact with a different part of the abradant at each rotation. Each rotation is equivalent to one cycle.

6.1.2 The abrading mechanism consists of the abradant mounted at the lower end of a shaft, weights placed upon the upper end of the shaft to produce constant pressure between abradant and specimen throughout the test, lever and cam for raising and

⁷ Schiefer, H. F., Crean, L. E. and is manufactured by Frazier Precision Co., Gaithersburg, Md. Krasny, J. F. “Improved Single-Unit Schiefer Abrasion Testing Machine,” *Journal of Research*, Nat. Bureau Standards, Vol 42, May, 1949, pp. 259–269. *ASTM Bulletin*, No. 159, July 1949, pp. 73–78 (TP133).

⁸ Schiefer, H. F., “Solution of Problem Producing Uniform Abrasion and its Application to the Testing Machine,” *Journal of Research*, Nat. Bureau of Standard Vol. 39, July 1947 (Research Paper R1807).

⁹ Schiefer, H. F., and Wernitz, C. W., “Interpretation of Tests for Resistance to Abrasion of Textiles,” *Textile Research Journal*, Vol XXII No. 1, January 1952.

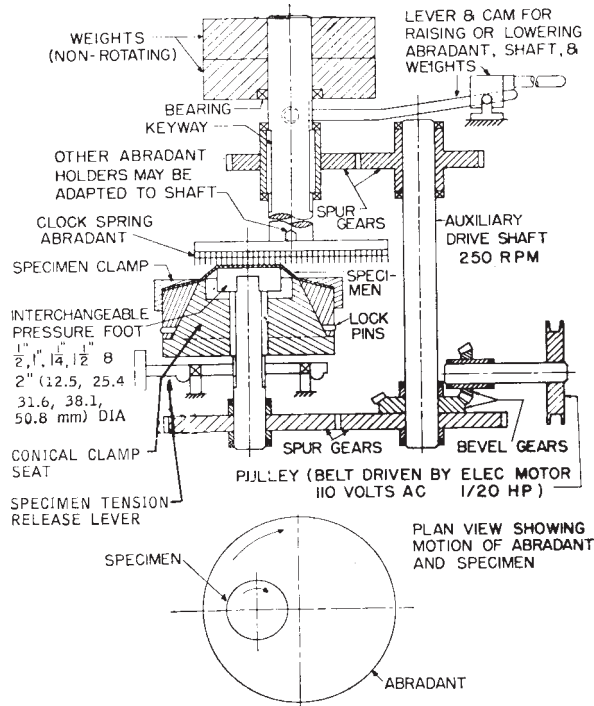


FIG. 1 Schematic Diagram of Uniform Abrasion Testing Machine

lowering the abrasant, shaft, and weights. A counterweight for balancing the abrasant and abrasant shaft is needed when tests are to be carried out at low pressure.

6.1.2.1 Weights, in increments of 500 g (1 lb) that are capable of providing up to a total of 5 kg (10 lb) to the specimen in pressure. Individual weight tolerances are $\pm 1\%$.

6.1.3 The specimen-supporting mechanism provides for tension mounting of thinner, more flexible materials and rigid mounting of thick, stiff materials. For the first, a plastic pressure foot—12.7, 25.4, 31.3, 38.1, 50.8 12.5, 25, 31, 38, or 50 mm ($\frac{1}{2}$, 1, $1\frac{1}{4}$, $1\frac{1}{2}$, or 2 in.) in diameter, as called for, prescribed, shall be mounted at the upper end of the specimen shaft to fix the area of the specimen to be abraded. A conical clamp seat, fitted to the shaft, rotates with it but is free to move vertically on the shaft. A cam is provided for raising and lowering the clamp seat. The specimen clamp shown unassembled in Fig. 3 fits on the seat (C, Fig. 3) and can be fastened to it by merely rotating it slightly to engage the two pins in the slots. The clamp and specimen assembly can be removed quickly for examining the specimen and measuring the wear and returned to the machine without unclamping the specimen. When the clamp seat is lowered by turning the cam, the combined weight mass of the clamp seat and specimen clamp is suspended by the specimen over the presser foot. This places the specimen under constant tension throughout the test with take-up of any stretch in the specimen. Different tensions may be applied to the specimen by changing the weight mass of the clamp seat, for example, by adding auxiliary weights as in 6.1.2.1. For rigid mounting of thick, stiff cloths fabrics such as carpeting and some felts; use the specimen clamp and mounting aids shown in Fig. 4 shall be used and. Screw the assembly-screwed onto the specimen shaft in place of the presser foot and specimen clamp seat (E, Fig. 2).

6.1.34 The driving mechanism consists of a motor-driven auxiliary drive shaft connected to the abrasant shaft and specimen shaft by spur gears.

6.1.4 The machine

6.1.5 The instrument shall be equipped with (1) a resettable counter (G, Fig. 2) resettable to indicate the number of rotations in a test; (2) a sensitive microswitch (H, Fig. 2) to stop the machine automatically when a tension-suspended specimen is worn through; A thickness gage (I, Fig. 2), when specified, for indicating is available to measure changes in thickness of the specimen during a the test.

6.1.5.1 Alternately the instrument may be equipped with a programmable counter that will stop the instrument upon reaching a preset number of rotations.

6.1.6 Abradant—The working surface of the abrasant disk shall—Shall be sufficiently greater in diameter than the specimen supporting the surface that the latter lies entirely inside the periphery of the abrasant during a test. A spring steel blade abrasant (B, Fig. 3), which is essentially constant in its action for a long period of use, shall be used for woven, felted, pile, and knitted fabrics and a cross-cut tungsten tool steel blade abrasant (A, Fig. 3) for coated fabrics, unless otherwise specified in the material specification.—E

¹¹ A suitable tester is the Schiefer Uniform Abrasion Tester manufactured by the Frazier Precision Instrument Co., Inc., 925 Sweeney Drive, Hagerstown, Maryland 21740.



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| <p>A—Abradant.
 B—Weights on abradant shaft.
 C—Cam and lever system for raising the abradant shaft, abradant, and weights.
 D—Counterweight for balancing abradant and abradant shaft when tests are to be made at low pressures.</p> | <p>E—Specimen in place ready for test.
 F—Cam for raising and lowering the specimen clamp seat
 G—Counter.
 H—Microswitch.
 I—Thickness gage.</p> |
|--|---|

FIG. 2 Uniform Abrasion Testing Machine

6.1.6.1 Abrasion tests are subject to variations due to changes in the abradant during specific tests. The spring steel blade abradant and the cross-cut tungsten tool steel blade abradant are considered permanent abradants that have a hardened metal surface. It is assumed that the abradant will not change appreciably in a specific series of tests, but obviously similar abradants used in different laboratories will not likely change at the same rate due to differences in usage. Permanent abradants may also change due to pick-up of treatments or other material from test fabrics and must accordingly be cleaned at frequent intervals. Consequently, depending upon its usage, the abradant must be checked periodically against a standard.

6.1.6.2 *Stoddard Solvent*, or equivalent degreasing agent, for cleaning steel blade.

6.1.6.3 *Hazards*—Working with Stoddard solvent may be hazardous. When using Stoddard solvent wear safety glasses; avoid prolonged skin contact; if splashed in eyes, flush thoroughly with water and consult physician, perform operations under a fume hood with the exhaust on; store in an approved, label safety can; dispose of used Stoddard solvent as directed by city, state or federal ordinances, as required. Refer to the manufacturer's Safety Data Sheets (MSDS) for information on handling, use storage and disposal of material and reagents used with this guide.

6.1.7 The standard abrasives, emery cloth, sandpaper, duck, canvas, or other cloth in a suitable holder may be needed as an



A—Cross-cut tungsten tool steel blade abradant.

B—Spring steel blade abradant.

C—Specimen clamp seat.

D—Template, which is placed under E to bulge the specimen when mounting it.

E—Base of specimen clamp, over which specimen is placed.

F—Pressure ring, which is placed on specimen.

G—Outer ring which is screwed down over F to hold the assembly together.

FIG. 3 Abradants; Specimen Clamp Seat; Template and Clamp for Thinner Flexible Cloths Which Are to Be Held in the Machine Under Tension

abradant for some materials as agreed upon between the purchaser and the supplier. Other abradants may also be used.

7. Sampling and Test Specimens

7.1 Lot Sample—For acceptance testing, take a lot sample as directed in the applicable material specification, or as agreed upon by the purchaser and seller, other contract. In the absence of such a specification or other agreement, take a laboratory lot sample as directed from 10 percent of the rolls or garments in 7.2.

7.2 Take the shipment rounded off to the next higher number.

7.1.1 Test sample garments as agreed upon by the purchaser and supplier.

7.1.2 Laboratory Sampling Unit—As a laboratory sampling unit take from each roll or rolls at least one full-width piece of fabric that is 1 m (1 yard) in length along the salvage (machine direction), after removing a first 1 m (1 yard) length. For fabric components of fabricated systems use the entire system.

7.1.2.1 Each garment is a laboratory sampling unit.

7.2 Test Specimens—From each laboratory sampling unit, cut five test specimens. If tests are to be performed on wet specimens, cut a second set of five specimens. If breaking strength of unabraded specimens is required, prepare five additional specimens as directed in Test Method D 5035 except modify the dimensions to agree with the dimensions to be used for the abraded specimens. Specimen preparation need not be carried out in the standard atmosphere for testing or proceed as per 8.1.1. Label to maintain specimen identity.

7.2.1 For pile yarn floor coverings, rugs and a thick felts, prepare specimens in the shape of a cross, with each cross-member of 50 cm (approximately 20 mm (2 in.)) long wide and should not be taken any closer to 115 mm (4.5 in.) long. See Fig. 4.

NOTE 2—The actual area of the specimen that is abraded in 50 mm (2 in.) square.

7.2.2 For other materials, prepare circular specimens have diameter of eighth 61, 86 or 97 mm (2.4, 3.4 or 3.8 in.).

NOTE 3—For convenience, the roll weight of the specimens with 61, 86 or 97 mm diameters when multiplied by the factors 10, 5 and 4 respectively provides the mass of the fabric in ounces per square yard. For the mass of the fabric in grams per square meter multiply the ounces per square yard by 33.906.



A—Specimen.
B—Base of clamp.
C—Clamping plate.
D—Outer ring.

E—Pressure disk.
F—Assembly in screw press for forcing C down over specimen in order to tighten D and hold specimen firmly on the base.

FIG. 4 Specimen Clamp and Mounting Aids for Thick, Stiff Cloth Such as Carpeting and Felts, Which Are to Be Mounted Rigidly

7.2.3 For fabric widths 125 mm (5 in.) or more, take no specimen closer than ~~4~~ 25 mm (1 ~~yd~~ in.) from the selvage edge.

7.32.4 ~~S~~For fabric widths less than 125 mm (5 in.) use the entire width.

7.2.5 Cut specimens representing a broad distribution diagonally across the width of ~~g~~ the laboratory sampling unit. Ensure specimens are free of folds, creases, or wrinkles. Avoid getting oil, water, greased up, etc. on ~~by~~ the specimens when handling.

7.2.6 If the fabric has a pattern, ensure that the specimens are a representative sampling of the pattern.

8. ~~S~~Conditioning

8.1 Dry test for specimens which are not to be wet tested in an atmosphere in which testing is to be performed.

8.1.1 Precondition the samples or specimens by bringing them to approximate moisture equilibrium in the standard atmosphere for preconditioning as directed in Practice D 1776. Equilibrium is considered to have been reached when the increase in mass of Test Specimens

8.1 ~~In the absence~~ specimen in successive weighings made at intervals of ~~any applicable material specifications~~, take five ~~not less than 2 hours~~ does not exceed 0.1 % of the mass of the specimen.

8.2 Wet test for specimens ~~from each sample~~ that are to be wet tested.

8.2.1 Specimens to be wet tested do not need preconditioning or conditioning in a standard atmosphere before testing. (See 10.2.2 for the wetting treatment.)

9. Preparation of Specimens

9.1 ~~The size and shape~~ Calibration of the ~~the~~ Test Apparatus

9.1 Ensure test specimen depend upon the textile product being tested. For woven fabrics and similar thin flexible materials, it machine is convenient to cut circular specimens with on a die. Dies 61.28, 86.66, level, sturdy table or base and 96.89 mm (2.413, 3.412, free from vibration.

9.2 Prepare, operate and-3-815 verify calibration of the abrasion tester using directions supplied by manufacturer.

9.3 For new working blades, standardize by first abrading a 61 mm (2.4 in.) in diameter have been found convenient because the weight in grams specimen of such specimens when multiplied by 10, 5, and 4, respectively, gives standardizing fabric for 20,000 cycles under pressure of 4.5 kg (10 lb.). Continue this procedure until the weight difference between the average of the fabric in ounces per square yard. The smallest die master blade and the working blade is especially well suited for cutting specimens from 25 % or less. In addition, this procedure should be used to verify and standardize the-h working blade on a regular schedule, such as weekly or monthly depending upon use. If working blades cannot be maintained within the 25 % limit, discard or return to the manufacturer to be reground and calibrated.

9.3.1 Resøerve standardized master blades to verify working blades. (Economically, it is good practice to maintain a working master blade to verify the working blades. The specimens for carpets, rugs, and thick felts has working master blade can then be verified to the shape of standardized master blade on a cross, each cross-arm being 50.8 mm (2 in.) wide and 114.3 mm (4½ in.) long and less frequent basis, such as a year.)

9.4 Rinse the area abraded being 50.8 mm (2 in.) square. abradant blade in a degreasing solvent after each test.

10. Conditioning

10.1 For specimens which are not to be wet tested, precondition the specimens by bringing them to approximate moisture equilibrium in the standard atmosphere for preconditioning, then bring the specimens to moisture equilibrium for testing in the standard atmosphere for testing. Equilibrium is considered to have been reached when the increase in weight of the specimen in successive weighings made at intervals of not less than 2 h does not exceed 0.1 % of the weight of the specimen.

10.2 Specimens to be wet tested do not need to be either preconditioned or conditioned before testing.

11. Procedure

11.1 For specimens which are not to be wet tested, test

10.1 Standard Test (Dry):

10.1.1 Test the conditioned specimens in the standard atmosphere for testing textiles; which is $21 \pm 1^\circ\text{C}$ ($70 \pm 2^\circ\text{F}$) and $65 \pm 2\%$ relative humidity.

10.1.2 If abrasion resistance is to be based on a loss of the mass of the test specimens, mass the test specimen to the nearest milligram and record the weight before starting the test and again after completion of the test.

10.1.3 If abrasion resistance is to be based on thickness changes, measure and record the thickness in millimeter (or thousands of an inch) after mounting but before starting the test and again after concluding the test.

10.1.4 Mount the specimen in an appropriate clamp (as prescribed in the materials specifications) for the particular product being tested. Insert the clamp in the machine tester and lock it the clamp in position. In testing a tension-suspended specimen, apply a constant tension to the specimen to stretch it uniformly over the presser foot that determines the exact area to be abraded. Lower the abradant on the specimen and adjust the load to force on the prescribed amount (Note 2) by specimen as directed in a material specification using the use of the counterweight or the addition of auxiliary weights, or both:

11.2.1 Set both. In the counter at zero and start the test.

11.2.2 After a specified number absence of rotations of abrasion stop the machine, lift the abradant from the specimen, using the cam specifically provided; for tension-suspended a material specification refer to 10.1.4.1.

10.1.4.1 Using spare specimens, remove the tension from the specimen, using another cam specifically provided determine and remove adjust the clamp with specimen for visual examination or quantitative measurement size of the amount of abrasion, or both.

11.2.3 Replace the clamp presser foot and specimen in the machine and repeat the above procedure as many times as desired, or for tension-suspended specimens continue the test to the destructive end point, at which instant the machine is stopped automatically.

11.2.4 In the case of carpets, rugs, and thick felts, read the thickness of the specimen total force (including abradant) on a dial during the test. Take thickness readings as frequently as necessary specimen to obtain produce a well-defined test duration that exceeds 1000 rotations (cycles) for materials that exhibit a low abrasion curve-resistant and that is less than 20,000 rotations (cycles) for materials that exhibit a high abrasion resistant. (See Notes 3 and 4.)

NOTE 2—In the measurement of the comparative resistance to abrasion of several similar types of textiles, it is desirable to adjust the size of the presser foot and the 4—A spring steel blade abradant with a total load force of the abradant on the specimen 45 N (10 lbs.) applied to such values that the duration of the test of the least-resistant material exceeds 1000 rotations, or that the duration of the test of the most-resistant material is of the order of 20 000 rotations. In the case of carpets specimen and rugs, the range is of the order of 1000 to about 100 000 rotations. A total load of 4.54 kg (10 lb) and an abraded area 31.8 of 32 mm (1¼ (1.25 in.) in diameter have been found suitable as a starting point for testing a wide range of woven textiles, using a spring steel blade abradant. textile fabrics. It has also been found is advisable to make conduct tests at several loads.

11.3 In wet abrasion tests, thoroughly wet the specimen by immersion in water prior to mounting in the clamp.

11.3.1 After each 1000 rotations of abrasion, stop the machine different forces and flood the abraded area with an excess of water.

11.3.2 A continuous and more uniform wetting can be accomplished by supplying water continuously during the test, under a constant pressure head; several abrasants to determine the center of the abraded-area through a small hole in the presser foot and specimen shaft.

12. Evaluation of Abrasion

12.1 The initial measurement of the unabraded specimen shall be made in the manner prescribed in the material specifications. The quantity measured depends upon the type of material being tested and may be thickness, weight, electrical capacitance, absorption of beta emission from a radioactive surface, or other appropriate quantity. This quantity shall be again measured after a specified number of rotations of abrasion. The measured values may be plotted against the number of rotations of abrasion, and the resulting abrasion curve for each specimen tested may be drawn. The abrasion index of each specimen as specified for the particular material tested may be calculated for the abrasion curve. In some tests, the number of rotations of abrasion to the destructive end point of the specimen may give an adequate evaluation of the resistance to abrasion and it may be specified in some material specifications. most satisfactory combination.

NOTE 3—The logarithm. 5—For coated fabrics, a cross cut tungsten tool steel blade abrasant has been found suitable.

NOTE 6—For carpets and rugs, the end point can range from 1000 to 100,000 rotations.

10.1.5 Set the counter at zero and start the test.

10.1.5.1 If the model with a cut off counter is used, set the counter at the predetermined end point and start the test.

10.1.6 Take thickness readings as frequently as necessary to obtain a well-defined abrasion curve, and include a reading at the end as well as at the start of the test while the abrader and specimen are still in place. (Stop the instrument to take readings.)

10.1.7 Place the clamp and specimen in the tester and continue the abrasion for the required number of rotations of cycles. For tension supported specimens, continue the abrasion test until the machine automatically stops at failure.

10.1.8 Replace the clamp and specimen in the tester and continue the abrading as many times as needed or for tension-suspended specimens. Continue the test to the destructive end point, at which point the machine will stop automatically.

10.1.8.1 If the specimen was a test for wear deterioration for automatic machine determined abrasion end point, record the number of cycles.

10.1.8.2 If abrasion resistance is based on mass loss, weigh the specimen to the nearest milligram and record the mass.

10.1.8.3 If breaking strength after a predetermined number of cycles is to be obtained, determine as directed in Test Method D 5035 modifying the test specimen as needed. Ensure the abraded area is centered in the specimen and midway between the clamps of the tensile tester. Also test a like number of unabraded specimens.

10.1.9 Test the remaining specimens.

10.1.10 In the case of carpets, rugs and thick felts read the thickness of the specimen on the dial during the test.

10.2 Wet Test—Mount the test specimens as directed in section 9.1 except wet the specimens as directed in sections 10.2.1-10.2.4.

10.2.1 Prior to wetting each specimen, weigh to the nearest 0.001 g or measure the thickness to the nearest 0.001 mm (0.025 in.) or both, as applicable.

10.2.2 Thoroughly wet the specimen by immersion in water to a wet equilibrium.

10.2.2.1 The time of immersion must be sufficient to wet out the specimens thoroughly as indicated by no further change in mass when two successive weighings less than 15 minutes apart do not differ more representative than 0.1 % of the mass of the sample. For fabrics not readily wet out with water add a 0.1 % solution of a nonionic wetting agent to the water bath.

10.2.2.2 In tests where the object of the wet test is to wash away debris with a constantly dripping or flowing stream of water, the permission (10.2.2) above is not necessary. This action is particularly applicable where debris accumulation alters the dry abrading action of the abrader.

10.2.3 After each 1000 rotations of abrasion, stop the machine and flood the abraded area with an excess of water.

10.2.3.1 A continuous and more uniform wetting can be accomplished by supplying water continuously during the test, under a constant pressure head by means of a directed stream or constant drip.

10.2.4 At the end of the test:

10.2.4.1 If the abrasion resistance is based on mass loss, dry the specimen and recondition it as directed in 8.1. Weigh the specimen to the nearest milligram.

10.2.4.2 If the specimen was a test for wear deterioration for automatic machine determined abrasion end point, record the number of some textiles than cycles.

10.2.4.3 If the abrasion resistance is based on thickness loss, measure the thickness to the nearest millimeter before removing and record the value.

10.2.4.4 Record the number of cycles.

10.2.5 Test the remaining specimens.

11. Calculation and Evaluation

11.1 The most appropriate option to use depends on the fabric to be tested. Trial and error or experience with fabric will determine the best option. The abrasion resistance of textile fabrics is commonly measured by one of the following procedures:

11.2 Standard options for evaluating abrasion using the Uniform Abrader:

11.2.1 *Option 1 (Wear)*—The end point (rupture) is reached on a woven fabric when two or more threads have broken or on a knitted fabric when a hole appears or when the abrader automatically stops due to the destruction of the sample. Calculate abrasion resistance as the average rotations to rupture of five specimens for each sampling unit and for each lot.

11.2.2 *Option 2 (Mass Loss)*—The difference in mass before and after abrasion due to abrasion for a specified number of cycles.

11.2.2.1 Calculate abrasion resistance, percent mass loss, for individual specimens to the nearest 0.01 % using Eq 1.

$$TL = 100 \frac{(A-B)}{A} \quad (1)$$

where:

TL = mass loss, %,

A = mass of the specimen before abrasion mg, and

B = mass of the specimen after abrasion, mg.

11.2.2.2 Calculate the average abrasion resistance, percent mass loss of each sampling unit and for the lot.

11.2.3 *Option 3 (Thickness Loss)*—The difference in thickness before and after abrasion due to abrasion for a specified number of cycles or the number of cycles needed to produce a specified reduction in thickness as shown by the thickness gauge. Thickness can also be determined by evaluating before the test and after dismounting after the appropriate number of cycles.

11.2.3.1 Calculate abrasion resistance, percent thickness loss for individual specimens to the nearest 1 mm (0.02 in.) using Eq 2.

$$TL = 100 \frac{(A-B)}{A} \quad (2)$$

where:

TL = mass loss, %,

A = thickness of the specimen before abrasion mm (in.), and

B = thickness of the specimen after abrasion, mm (in.).

11.2.3.2 Calculate the average abrasion resistance, percent thickness loss for each sampling unit and for the lot.

11.2.3.3 Calculate abrasion resistance, actual thickness loss, for individual specimens to the nearest 1 mm (0.02 in.) using Eq 3.

$$TL = 100 (A-B) \quad (3)$$

where:

TL = thickness loss, mm (0.02 in.),

A = thickness of the specimen before abrasion mm (in.), and

B = thickness of the specimen after abrasion, mm (in.).

11.2.3.4 Calculate the average abrasion resistance, actual thickness loss for each sampling unit and for the lot.

11.2.4 *Option 4 (Percentage Loss in Breaking Strength)*—Determine the breaking strength of specimens abraded for a specified number of cycles, using Test Method D 5035, breaking force/elongation by raveled strip/cut strip procedure. The abraded area of the specimens should be in the central portion of the raveled strip and be placed midway between the clamps of the tensile tester.

11.2.4.1 Calculate the average breaking strength of the abraded specimens rounded to three significant digits for the laboratory sampling unit and for the lot.

11.2.4.2 Calculate the average breaking strength of the unabraded specimens rounded to three significant digits for the laboratory sampling unit and for the lot.

11.2.4.3 Calculate the percentage loss in breaking strength to the nearest 1 % as the abrasion resistance using Eq 4, for the laboratory sampling unit and for the lot.

$$AR_{BS} = 100 \frac{(A-B)}{A} \quad (4)$$

where:

AR_{BS} = abrasion resistance, % loss in breaking strength,

A = average breaking strength of the unabraded specimens, g (lb.), and

B = average breaking strength of the abraded specimens, g (lb.).

12. Report

132.1 State that the specimens were tested as directed in ~~ASTM Test Method D 4158 (Uniform Abrasion Method): Guide D 4156~~. Describe the materials or product sampled, the option used and the method of sampling used.

~~13.2 Depending on~~

~~12.2 Report the test option used, report the following information:~~

~~13.2.1 Type of abrasant used; and load adjustment or counter weight, if used.~~

~~13.2.2 Condition of information for the specimens (in equilibrium with the standard atmosphere laboratory sampling unit and for testing textiles, or water immersed);~~

~~13.2.3 Cycles the lot as required for the option used.~~

~~12.2.1 abrasion resistance, number of cycles to give specific destruction, and~~

~~13.2.4 If any other means rupture.~~

~~12.2.2 abrasion resistance, percent loss in breaking strength and direction of evaluating the effect test.~~

~~12.2.3 breaking strength of abraded test specimens.~~

~~12.2.4 breaking strength of unabraded test specimens.~~

~~12.2.5 abrasion resistance, mass loss.~~

~~12.2.6 abrasion resistance, thickness loss in mm (in.) and percent.~~

~~12.2.7 abradant type, tension and pressure applied.~~

~~12.2.8 evaluation option used and any modifications to the test.~~

~~12.3 If any modification to the test and values obtained using the modification are used, describe the specific method employed and the results.~~

143. Precision and Bias

~~14.1 Precision—The precision~~

~~13.1 A pilot investigation was run in 1999 on a single test instrument. It was shown that an interaction between fabric construction and type of Test Method D 4158 Uniform Abrasion Method, for measuring abradant had profound effect on the abrasion resistance of textile fabrics test results. It was concluded by the subcommittee, that while confidence between labs and equipment may be low, meaningful results for research and process control is being established.~~

~~14.2 possible on single tests.~~

~~13.2 Bias—No justifiable statement can be made on the bias of Test Method D 4158 Uniform Abrasion Method; this Guide for measuring the abrasion resistance of textile fabrics since because the true value of the property has not been established by an accepted referee test method.~~

154. Keywords

~~154.1 abrasion; abrasion resistance; carpets; floor coverings; nonwoven; pile; rugs; textile; textile fabrics; uniform; yarn~~

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