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Designation: D 4158 – 92

Standard Test Method for Abrasion Resistance of Textile Fabrics (Uniform Abrasion Method)[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 covers the determination of the resistance to abrasion of a wide range of textile materials using the uniform abrasion testing machine.

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, and AATCC 93.

1.2 The values stated in SI units are to be regarded as standard; the values in English units are provided as information only and are not exact equivalents.

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

D 123 Terminology Relating to Textiles[2]

D 1776 Practice for Conditioning Textiles for Testing[2]

D 3884 Test Method 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)[3]

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

2.2 *Other Documents:*

AATCC 93, Impeller Tumble Method[4]

3. Terminology

3.1 *Definitions:*

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

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

4. Summary of Test Method

4.1 Abrasive action is applied uniformly in all directions in the plane of the surface of the specimen about every point in it. The settings of the machine, method of mounting specimens, conditions of test (as, dry 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 is evaluated by various means which are described in Section 12, Evaluation of Abrasion.

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 the influence 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 the effects of mechanical and chemical treatments on fibers, yarns, and fabrics, and on the influence of variations in yarn and fabric construction on the properties of the final textile product. The results of comparative tests of the abrasion resistance of several fabrics of similar types are often very useful in the evaluation of the serviceability of fabrics for a specific end use. In many instances, the relative results obtained with this machine 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 anomalous results which can be attributed in most instances to uncontrolled factors in manufacturing or other processes. Specific instances of this type have been described.[5,6] Others may be encountered as the

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[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.

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[2] *Annual Book of ASTM Standards*, Vol 07.01.

[3] *Annual Book of ASTM Standards*, Vol 07.02.

[4] Available from American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709.

[5] Schiefer, H. F. and Krasny, J. F., "Note on the Disintegration of Wool in Abrasion Tests," *Textile 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*).

[6] Shiefer, H. F., Crean, L. E. and 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*).

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machine is used more extensively and a greater variety of textiles have been tested. These anomalous results are frequently very fruitful in the attainment of more durable and satisfactory fabrics. As a rule they are not attributable to a faulty operation of the testing machine or carelessness of the operator. These results should not be discarded but should be studied very intensively, for an understanding of the factors which cause such anomalous results adds immeasurably to a better understanding to this complex problem and to its more intelligent application.

5.2 Test Method D 4158 for the determination of the abrasion resistance of textile fabrics, uniform abrasion method, may be used for the acceptance testing of commercial shipments of textile fabrics but caution is advised since technicians may fail to get good agreement between results on certain fabrics. Comparative tests as directed in 5.2.1 may be desirable.

5.2.1 In case of a dispute arising from differences in reported test results when using Test Method D 4158 for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias. As a minimum, the two parties should take a group of test specimens which are as homogeneous as possible and which are from a lot of material of the type in question. The test specimens should then be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using Student's *t*-test and an acceptable probability level chosen by the two parties before the testing began. If a bias is found, either its cause must be found and corrected or the purchaser and the supplier must agree to interpret future test results in the light of the known bias.

6. Apparatus

6.1 The machine,[7] 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 0.0025 mm (0.0001 in.). 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.

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

6.1.2 The specimen-supporting mechanism provides for tension mounting of thinner, more flexible materials and rigid

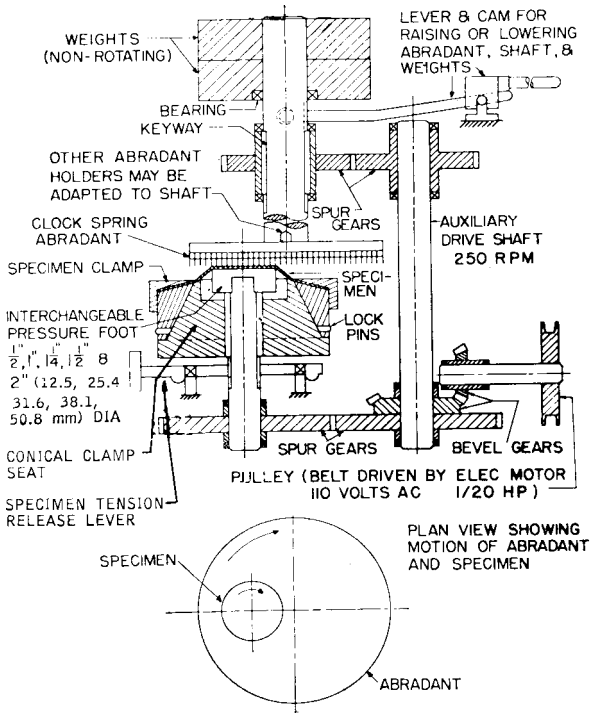


FIG. 1 Schematic Diagram of Uniform Abrasion Testing Machine

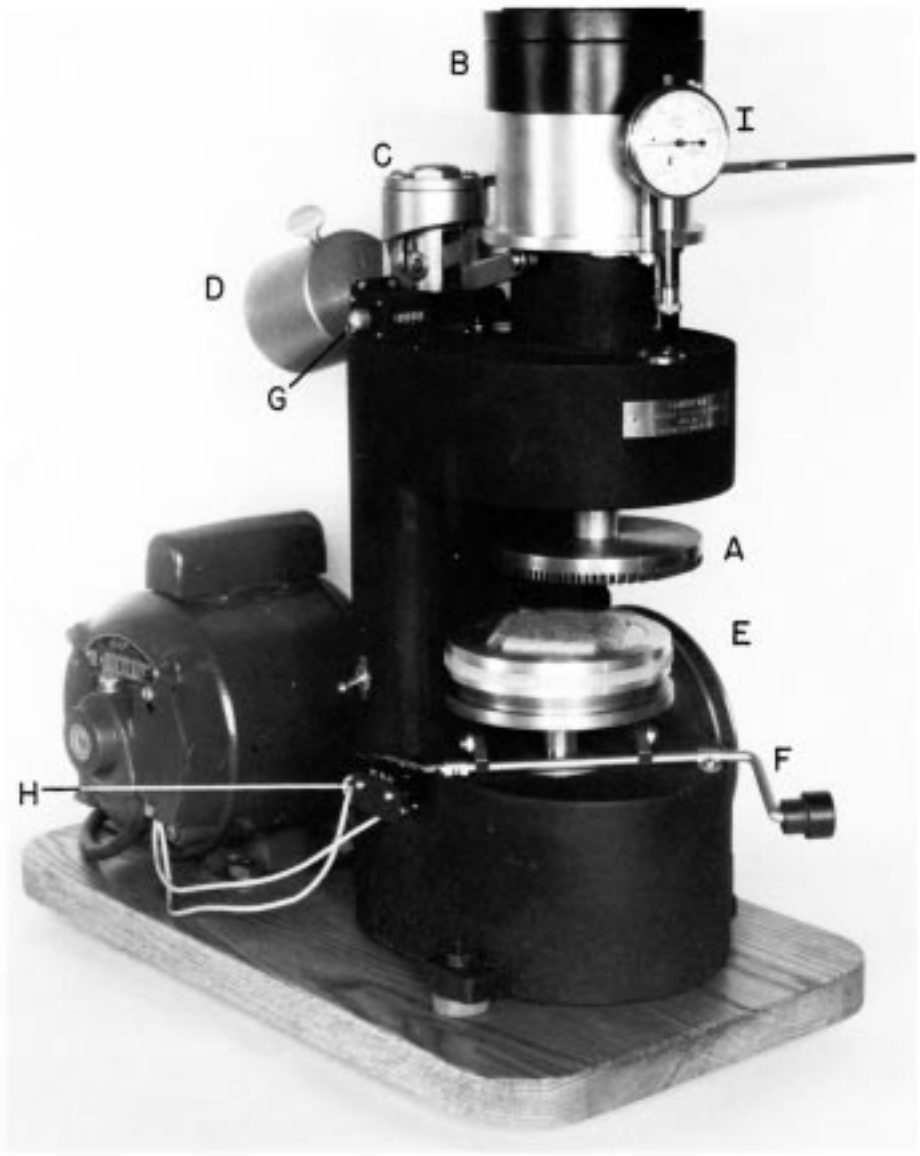
mounting of thick, stiff materials. For the first, a plastic pressure foot 12.7, 25.4, 31.3, 38.1, 50.8 mm (½, 1, 1¼, 1½, or 2 in.) in diameter, as called for, shall be mounted at the upper end of the specimen shaft to fix the area of the specimen to be abraded. A conical clamp seat fitted to the shaft 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 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 of the clamp seat, for example, by adding auxiliary weights. For rigid mounting of thick, stiff cloths such as carpeting and felts, the specimen clamp and mounting aids shown in Fig. 4 shall be used and the assembly screwed onto the specimen shaft in place of the presser foot and specimen clamp seat (*E*, Fig. 2).

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

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

6.1.5 *Abradant*—The working surface of the abradant disk shall be sufficiently greater in diameter than the specimen

[7] The Schiefer machine meets these requirements and is manufactured by Frazier Precision Co., Gaithersburg, Md.



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.
E—Specimen in place ready for test.
F—Cam for raising and lowering the specimen clamp seat
G—Counter.
H—Microswitch.
I—Thickness gage.

FIG. 2 Uniform Abrasion Testing Machine

supporting the surface that the latter lies entirely inside the periphery of the abradant during a test. A spring steel blade abradant (*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 abradant (*A*, Fig. 3) for coated fabrics, unless otherwise specified in the material specification. Emery cloth, sandpaper, duck, canvas, or other cloth in a suitable holder may be specified.

7. Sampling

7.1 Take a lot sample as directed in the applicable material specification, or as agreed upon by the purchaser and seller. In the absence of such a specification or other agreement, take a laboratory sample as directed in 7.2.

7.2 Take a laboratory sample from each roll or piece of fabric in the lot sample. The laboratory sample should be full width and at least 50 cm (approximately 20 in.) long and should not be taken any closer to the end of the roll or piece of fabric than 1 m (1 yd).

7.3 Sample shipments of garments as agreed upon by purchaser and seller.

8. Selection and Number of Test Specimens

8.1 In the absence of any applicable material specifications, take five specimens from each sample to be tested.

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

9. Preparation of Specimens

9.1 The size and shape of the the test specimen depend upon the textile product being tested. For woven fabrics and similar thin flexible materials, it is convenient to cut circular specimens with a die. Dies 61.28, 86.66, and 96.89 mm (2.413, 3.412, and 3.815 in.) in diameter have been found convenient because the weight in grams of such specimens when multiplied by 10, 5, and 4, respectively, gives the weight of the fabric in ounces per square yard. The smallest die is especially well suited for cutting specimens from the heel, toe, and sole of socks. The specimens for carpets, rugs, and thick felts has the shape of a cross, each cross-arm being 50.8 mm (2 in.) wide and 114.3 mm (4½ in.) long and the area abraded being 50.8 mm (2 in.) square.

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 the conditioned specimens in the standard atmosphere for testing textiles, which is 21 ± 1°C (70 ± 2°F) and 65 ± 2 % relative humidity.

11.2 Mount the specimen in an appropriate clamp (as prescribed in the material specifications) for the particular product being tested. Insert the clamp in the machine and lock it 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 the prescribed amount (Note 2) by the use of the counterweight or the addition of auxiliary weights, or both.

11.2.1 Set the counter at zero and start the test.

11.2.2 After a specified number of rotations of abrasion stop the machine, lift the abradant from the specimen, using the cam specifically provided; for tension-suspended specimens, remove the tension from the specimen, using another cam specifically provided and remove the clamp with specimen for visual examination or quantitative measurement of the amount of abrasion, or both.

11.2.3 Replace the clamp and specimen in the machine and repeat the above procedure as many times as desired, or for

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

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 on a dial during the test. Take thickness readings as frequently as necessary to obtain a well-defined abrasion curve.

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 total load of the abradant on the specimen 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 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 mm (1¼ in.) in diameter have been found suitable for testing a wide range of woven textiles, using a spring steel blade abradant. It has also been found advisable to make 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 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, to 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.

NOTE 3—The logarithm to the base ten of the number of rotations of abrasion to the destructive end point of the specimen has been found more representative of the relative resistance to abrasion of some textiles than the number of rotations.

13. Report

13.1 State that the specimens were tested as directed in ASTM Test Method D 4158 (Uniform Abrasion Method). Describe the material or product sampled and the method of sampling used.

13.2 Depending on the test option used, report the following information:

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

13.2.2 Condition of the specimens (in equilibrium with the standard atmosphere for testing textiles, or water immersed).

13.2.3 Cycles required to give specific destruction, and

13.2.4 If any other means of evaluating the effect of abrasion are used, describe the specific method employed.

14. Precision and Bias

14.1 *Precision*—The precision of Test Method D 4158 Uniform Abrasion Method, for measuring the abrasion resistance of textile fabrics is being established.

14.2 *Bias*—No justifiable statement can be made on the bias of Test Method D 4158 Uniform Abrasion Method, for measuring the abrasion resistance of textile fabrics since the true value of the property cannot be established by an accepted referee test method.

15. Keywords

15.1 abrasion

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