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An American National Standard

Standard Guide for Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)[1]

This standard is issued under the fixed designation D 3884; 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—The figures were corrected editorially in January 2002.

1. Scope

1.1 This guide covers the determination of the abrasion resistance of textile fabrics using the rotary platform, double-head tester (RPDH).

NOTE 1—Other procedures for measuring the abrasion resistance of textile fabrics are given in Test Methods D 3885, D 3886, D 1775, D 4158, D 4966, and AATCC 61.

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 1775 Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder and Uniform Abrasion Methods)[2]

D 1776 Practice for Conditioning and Testing Textiles[2]

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 4158 Test Method for Abrasion Resistance of Textile Fabrics (Uniform Abrasion Method)[3]

D 4966 Test Method for Abrasion Resistance of Textile Fabrics (Martindale Abrasion Tester)[3]

D 5034 Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)[3]

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

2.2 *Other Documents:*

AATCC 93 Impeller Tumble Method[3]

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*—in *abrasion testing*, one or more movements of the abradant across a material surface, or the material surface across the abradant, that permits a return to its starting position.

3.1.2.1 *Discussion*—The abrasion cycle is dependent on the programmed motions of the abrasion machine and the test standard used. It may consist of one back-and-forth unidirectional movement such as for the rotary platform test method, or a combination of both such as for the inflated diaphragm test method. For the oscillatory cylinder abrasion method, an abrasion cycle consists of one circular movement of the specimen.

3.1.3 *breaking force, n*—the maximum force applied to a material carried to rupture. (Compare *breaking point*, *breaking strength*).

3.2 For definitions of other textile terms used in this test method, refer to Terminology D 123.

4. Summary of Test Method

4.1 A specimen is abraded using rotary rubbing action under controlled conditions of pressure and abrasive action. The test specimen, mounted on a platform, turns on a vertical axis, against the sliding rotation of two abrading wheels. One abrading wheel rubs the specimen outward toward the periphery and the other, inward toward the center. The resulting abrasion marks form a pattern of crossed arcs over an area of approximately 30 cm^2. Resistance to abrasion is evaluated by various means which are described in Section 12.

5. Significance and Use

5.1 The measurement of the resistance to abrasion of textile and other materials is very complex. The resistance to abrasion

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

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

is affected by many factors, such as the inherent mechanical properties of the fibers; the dimensions of the fibers; the structure of the yarns; the construction of the fabrics; and the type, kind, and amount of finishing material added to the fibers, yarns, or fabric.

5.2 The resistance to abrasion is also greatly affected by the conditions of the tests, such as the nature of abradant, variable action of the abradant over the area of specimen abraded, the tension of the specimen, the pressure between the specimen and abradant, and the dimensional changes in the specimens.

5.3 Abrasion tests are all subject to variation due to changes in the abradant during specific tests. The abradant must accordingly be discarded at frequent intervals or checked periodically against a standard. With disposable abradants, the abradant is used only once or discarded after limited use. With permanent abradants that use hardened metal or equivalent surfaces, it is assumed that the abradant will not change appreciably in a specific series of tests. Similar abradants used in different laboratories will not change at the same rate, due to differences in usage. Permanent abradants may also change due to pick up of finishing or other material from test fabrics and must accordingly be cleaned at frequent intervals. The measurement of the relative amount of abrasion may also be affected by the method of evaluation and may be influenced by the judgment of the operator.

5.4 The resistance of textile materials to abrasion as measured on a testing machine in the laboratory is generally only one of several factors contributing to wear performance or durability as experienced in the actual use of the material. While "abrasion resistance" (often stated in terms of the number of cycles on a specified machine, using a specified technique to produce a specified degree or amount of abrasion) 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. Laboratory tests may be reliable as an indication of relative end-use performance in cases where the difference in abrasion resistance of various materials is large, but they should not be relied upon where differences in laboratory test findings are small. In general, they should not be relied upon for prediction of actual wear-life in specific end uses unless there are data showing the specific relationship between laboratory abrasion tests and actual wear in the intended end-use.

5.5 These general observations apply to all types of fabrics, including woven, nonwoven, and knit apparel fabrics, household fabrics, industrial fabrics, and floor coverings. It is not surprising, therefore, to find that there are many different types of abrasion testing machines, abradants, testing conditions, testing procedures, methods of evaluation of abrasion resistance and interpretation of results.

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

5.7 Before definite predictions of fabric usefulness can be drawn from an abrasion test as made on the rotary platform, double-head (RPDH) abrader (Fig. 1), actual end-use trials should be conducted and related to the abrasion test. Different types of wear (for example, wear on men's clothing at cuffs, crotch, etc.) may correspond to different ratings of the RPDH test.

5.8 In making a comparison of different fabrics (that is, of different fibers, weights, etc.) the RPDH test will not always reveal a difference known to exist when the fabrics are actually used. Therefore, end-use trials should be conducted in conjunction with the RPDH abrasion test, at least as a guide for future testing of these fabrics.

5.9 Uncontrolled manufacturing or finishing variations occurring within a fabric or within lots of the same style of fabric can, however, be detected satisfactorily with the RPDH tester.

5.10 Because of the conditions mentioned above, technicians frequently fail to get good agreement between results obtained on the same type of testing instrument both within and between laboratories, and the precision of these test methods is uncertain. This test method is accordingly not recommended for acceptance testing in contractual agreements between purchaser and supplier because of the poor between-laboratory precision of the test method.

5.11 If there are differences of practical significance between reported test results for two laboratories (or more), comparative tests should be performed to determine if there is a statistical bias between them, using competent statistical assistance. As a minimum, the test samples used are to be as homogeneous as possible, drawn from the material from which the disparate test results were obtained, and randomly assigned in equal numbers to each laboratory for testing. The test results from the two laboratories should be compared using a statistical test for unpaired data, at a probability level chosen prior

FIG. 1 Rotary Platform Double Head Abrader

to the testing series. If bias is found, either its cause must be found and corrected, or future test results must be adjusted in consideration of the known bias.

6. Apparatus

6.1 *Rotary Platform, Double-Head (RPDH) Abrader* (Fig. 1),[4] comprised of a housing of compact design, a removable flat-circular specimen holder, a pair of pivoted arms to which the abrasive wheels are attached, a motor for rotating the platform and specimen, a fan for cooling the motor, a vacuum nozzle and vacuum cleaner for removal of lint from specimen, and a counter for indicating the revolutions of the specimen holder. The specimen holder should be mounted so as to produce a circular surface travel of an essentially flat specimen in the plane of its surface.

6.1.1 The abrasive wheels, which are attached to the free end of the pivoted arms, rotate and have, when resting on the specimen, a peripheral engagement with the surface of the specimen, the direction of travel of the periphery of the wheels and of the specimen at the contacting portions being at acute angles, and the angles of travel of one wheel periphery being opposite to that of the other. Motion of the abrasive wheels, in opposite directions, is provided by rotation of the specimen and the associated friction therefrom.

6.1.2 The abrasive wheels[5] are either rubber-based or vitrified-based. Both types of wheels are manufactured in different grades of abrasive quality. The wheels are lead bushed, 13 mm (0.5 in.) thick and approximately 50 mm (2 in.) in diameter. The wheels customarily used for testing textiles are the rubber-base, resilient type composed of abrasive grains cushioned in rubber; consequently, they are distorted during operation of the abrader. Accordingly, the wheels should be mounted as prescribed in 9.1 so as to compensate for this distortion.

6.1.3 Vitrified-base wheels are the hard abrasive type. They may be cut with a diamond point to alter the roughness of the wheel, the stroke of cut determining the degree of grit. The position of these wheels is not critical, but it is recommended that they be set as prescribed in 9.1.

6.2 The specimen holder is supported by an adapter that is motor-driven and provides motion for the circular travel of the specimen holder.

6.2.1 Clamping rings are used to secure the specimen to the specimen holder, one for use with lighter weight fabrics, and a larger one for use with heavier-weight fabrics.

6.3 The RPDH abrader is provided with a load adjustment for varying the load of the abrader wheels on the specimen. The pivoted abrader arms without auxiliary weights or counter weights apply a load against the specimen of 250 g per wheel (exclusive of the mass of the wheel itself). The manufacturer provides additional weights that can be used to increase the load to 500 or 1000 g, and a counterweight attachment that can be used to reduce the load on the specimen to 125 g per wheel.

6.4 *Auxiliary Apparatus*—Resurfacing disks, of carborundum-coated paper, are provided for resurfacing of rubber-base wheels. A stiff brush is provided for the removal of loose particles from the surface of the wheels. (Compressed air is recommended for cleaning vitrified-base wheels.)

6.5 *Abrasion Wheel Resurfacing Device*, for resurfacing uneven wheel wear.

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 7.1.1. Consider rolls or pieces of fabric to be the primary sampling unit.

7.1.1 Take a laboratory sample that is the full width of the fabric and at least 50 cm (approximately 20 in.) long, from each roll or piece of fabric in the lot sample. The laboratory sample should be taken no closer than 1 m (1 yd) from the end of each roll or piece of fabric.

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

8. Number and Preparation of Test Specimens

8.1 If the number of specimens to be tested is not specified by a material specification or an agreement between purchaser and seller, test five specimens.

8.1.1 If the number of specimens to be tested exceeds the number of laboratory samples, randomly select those laboratory samples from which more than one test specimen will be taken. If not, test one specimen per laboratory sample.

8.2 Take specimens from garment samples as agreed upon by all interested parties.

8.3 Cut ten specimens approximately 15 cm (6 in.) square, five for abrasion tests and five reserved for controls. For the five specimens to be abraded, fold each one twice into a square and using a die or shears, cut off the folded corner to form a 6-mm (¼-in.) diameter hole in the center of the specimen.

8.3.1 For the widths 125 mm (5 in.) or more, take no specimen closer than 25 mm (1 in.) from the selvage edge.

8.3.2 For fabric widths less than 125 mm (5 m), use the entire width for specimens.

8.3.3 Cut specimens representing a broad distribution diagonally across the width of the laboratory sampling unit. Take lengthwise specimens from different positions across the width of the fabric. Take widthwise specimens from different positions along the length of the fabric.

8.3.4 Ensure specimens are free of folds, creases, or wrinkles. Avoid getting oil, water, grease, etc. on the specimens when handling.

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

9. Preparation, Calibration, and Verification of Apparatus

9.1 *Wheel Position*—The mounted position of rubber-base wheels, with respect to the center of the specimen holder, is critical. The lateral distance from the left-hand wheel mounting

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

[5] The sole source of supply of the apparatus known to the committee at this time is Taber Industries, 455 Bryant St. North Tonawanda, NY 14120. If you are aware of alternate suppliers, please provide this information to ASTM headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.

flange to the center of the specimen holder should be 25.8 mm (1 1⁄64 in.) (see Dimension *A* in Fig. 2); and from the same point to the right-hand wheel mounting flange, the distance should be 27.4 mm (1 5⁄64 in.) (see Dimension *B* in Fig. 2). Since the position of vitrified-base abrasive wheels with respect to the center of the specimen holder is not critical, it is recommended for convention that they should be equally spaced on both sides, 26.6 mm (1 3⁄64 in.) (see Dimensions *A* and *B* in Fig. 2) from the wheel mounting flange to the center of the specimen holder.

9.2 *Wheel Bearings*—The abrader wheel bearings, that is, the two pairs of bearings installed in the free end of the pivoting arms to support the abrader wheels, should not stick when caused to spin rapidly by a quick driving motion of the forefinger. The degree of freedom of rotation of these bearings, however, is not critical.

9.3 *Platform Position*—The vertical distance from the center of the pivot point of the abrader arms to the top of the specimen holder should be approximately 25 mm (1 in.). This measurement is specified to prevent the possibility of errors incurred by installing a thrust bearing or the like to support the specimen platform. Adaptations should be made to maintain that the platform will remain at the above specified level. The specimen platform should rotate in the plane of its surface. If it fails to do so and exhibits a tendency to wobble, the holder and adapter should be replaced or a thrust bearing installed to support the specimen holder.

9.4 *Platform Speed*—The platform should rotate at approximately 70 rpm.

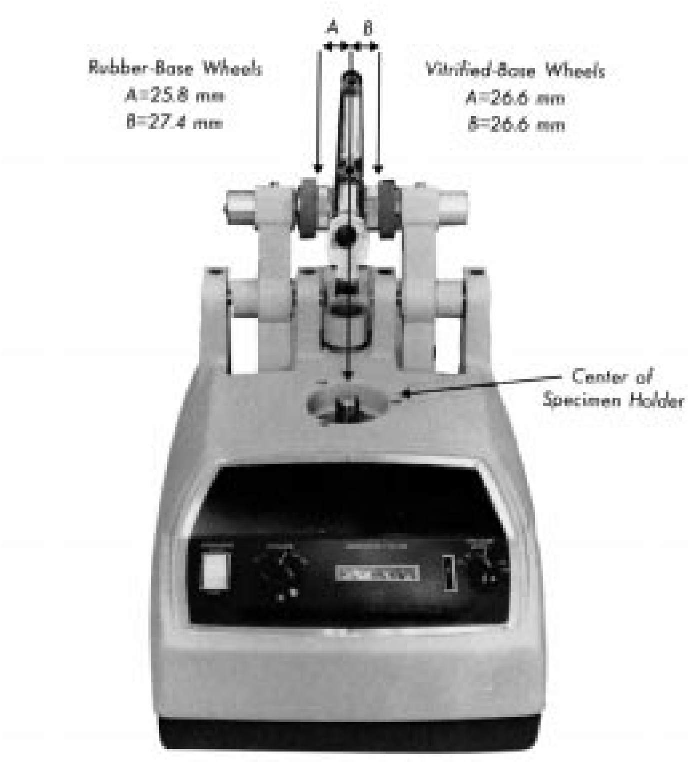

FIG. 2 Position of Abrasive Wheels on Rotary Platform Double Head Abrader

9.5 *Load Adjustment, Counterweight*—A counterweight attachment is provided with the RPDH abrader to reduce the load of the abrader wheels on the specimen. The use of this counterweight is not recommended, because studies have indicated variability in results due to the unequal counterweighting of the individual arms.

9.6 *Selection of Wheels for Test*:

9.6.1 Since variations exist in abrasive quality between and within rubber-base wheels of the same grade, a method should be followed in the selection of wheels for a particular test that will reduce this variation. Test all rubber-base wheels individually on a selected reference fabric known to have a minimum of variation in its abrasion resistance. Group the wheels in sets of three pairs such that the average abrasiveness of the three falls within a specified tolerance. Then use the wheels in sets as established.

9.6.2 In the use of vitrified-base wheels, both wheels of the pair to be used should be similar in abrasion characteristics. Check this on a selected reference fabric. Once a satisfactory pair is obtained, it may be used for an indefinite period without changing its abrasive quality provided neither wheel becomes clogged with finishing material, which is not easily removed.

10. Conditioning

10.1 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 textiles. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 h does not exceed 0.1 % of the mass of the specimen, as directed in Practice D 1776.

11. Procedure

11.1 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 *Mounting of Specimen*—Place the test specimen face up, unless otherwise specified, over the rubber mat on the specimen holder. Lightly secure the clamp plate and knurled nut in place to hold the center of the specimen. Place the ring clamp over the specimen and holder with the screw of the clamp at one end of the warp, partly tighten it, and push half way down. Draw fabric taut over the specimen holder by pulling on corners and edges of fabric, then tighten the clamp ring further, and push the ring all the way down over the edge of the holder, thus putting tension on the fabric as it is secured on holder. Then finish tightening the clamp plate and nut, and finally, retighten the clamp ring. Avoid buckling the fabric when tightening. Trim off excess fabric around the edges.

11.3 *Number of Revolutions*—The number of revolutions of the table to which the specimen is to be subjected will depend on the type of material being tested, the type of abrader wheels used, and the type of test employed, such as that based on loss in breaking load due to abrasion and loss in mass due to abrasion or occurrence of yarn breakdown. The number of cycles should be predetermined by mutual agreement.

11.4 *Cleaning of Specimen*—Clean the specimen of lint and abrasive particles on a scheduled basis. A vacuum cleaner or a brush may be used for this purpose. Do not remove the specimen from the specimen holder until the entire test is completed. Wipe the rubber mat clean after each test. If the tester is equipped with a suction nozzle, position the nozzle 0.8 mm (1⁄32 in.) to 1.6 mm (1⁄16 in.) above the specimen surface. The vacuum force should be adjusted to lift the abraded particles, but not lift flexible specimens.

11.5 *Resurfacing and Cleaning of Wheels*—Due to uneven wear and clogging of the surface crevices with fiber particles, sizing, finishing materials, and the like, the abrading wheels should be resurfaced or cleaned at established intervals during tests, the frequency depending on the type of material being tested and the type of wheel used. Rubber-base wheels wear unevenly during use and clog up as the abrading progresses, thus requiring resurfacing and cleaning at appropriate intervals. Resurfacing disks (carborundum-coated paper) of various degrees of coarseness are available for this purpose. These are mounted on the resurfacing platform which replaces the specimen holder on the center shaft. A stiff brush may be used for removing loose particles from the surface of the wheels.

11.5.1 *Breaking in New Wheels*—A new set of rubber-base wheels must be refaced twice for 50 cycles, using one refacing disk for each 50 cycles. Wheel color should be uniform after the two refacings. If it is not, reface a third time using another refacing disk.

11.5.2 Adopt a resurfacing and cleaning schedule for tests on various materials. Abrade the specimen for a specified number of revolutions, such as 300 (or some other number, depending on the surface being abraded), after which resurface the wheels with the abrasive paper for 25 cycles and then brush clean. Again replace the specimen and continue the sequence of abrading and resurfacing to completion of the test. The resurfacing disks should be used for only 50 cycles and then discarded. In some cases, particularly on stiff or abrasive fabrics, rubber-based wheels and vitrified wheels may wear unevenly, and may require refacing with the wheel refacing unit prior to any use of the S-11 resurfacing disc.

11.6 Vitrified-base wheels may become accidentally chipped or marred or crevices of the surface may become clogged. When surface crevices become clogged, clean particles using an air hose during the test. If cleaning is difficult or surfaces are marred or chipped resurface, using the wheel resurfacing unit. Resurface at specified intervals, such as 300 cycles, depending upon the nature of the wheel surface clogging. If clogging is rapid and severe, consider using a different type of abrasive wheel.

12. Interpretation of Results

NOTE 2—This guide does not recommend any specific interpretation of results but does provide procedures commonly used by industry. As a guide, no precision or bias have been determined.

12.1 After the specimens have been abraded to the set number of cycles or other specified end-point, evaluate as directed in 12.2-12.5 as appropriate.

12.2 *Residual Breaking Force*—If residual breaking force is required, calculate the individual breaking force of the individual abraded specimens and the unbraded specimens to the nearest 0.5 kg (lb) significant digits. Use Test Method D 5034 and D 5035, as appropriate, except that the distance between clamps shall be 25 mm (1 in.) and path of the abrasion on the abraded specimen is horizontally placed midway between the clamps of the machine.

12.3 *Average Breaking Strength*—If average breaking strength is required, calculate the average breaking strength of the abraded specimens and the unabraded specimens separately to the nearest 0.5 kg (1 lb) for the laboratory sampling unit for the lot.

12.4 *Percent Loss in Breaking Strength*—If percent breaking strength is required, calculate the percentage loss in breaking strength to the nearest 1 % as the abrasion resistance separately for each the lengthwise and widthwise directions using Eq 1, for the laboratory sampling unit and for the lot.

$$AR = 100(A - B)/A \tag{1}$$

where:
AR = abrasion resistance, %,
A = average breaking force of the unabraded specimens, g (lb), and
B = average breaking force of the abraded specimen, g (lb).

12.5 *Cycles to a Specific End-Point*—When the abrasion test end-point is described in a material specification or contract order, the end-point may consist of a pass/fail criteria. The criteria may include: loss in breaking strength, yarn breakage, loss in coating, loss of luster, napping, pilling, color loss, or other changes in appearance. In those cases, the abraded sample is usually compared to a known standard of the material tested. Aesthetic evaluations should be made using an agreed upon five-step rating system.

13. Report

13.1 State that the specimens were tested as directed in Test Method D 3884. Describe the product sampled and the method of sampling used for the laboratory sampling.

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

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

13.2.2 Residual breaking load,

13.2.3 Percentage loss in breaking load,

13.2.4 Average cycles to failure on the other end point.

13.2.5 If any other means of evaluating the effect of abrasion are used, describe evaluation criteria used to obtain failure or other end point.

14. Keywords

14.1 abrasion; rotary platform; textile fabric