Designation: D3884 – 22

Standard Guide for Abrasion Resistance of Textile Fabrics (Rotary Platform Abrader Method)[1]

This standard is issued under the fixed designation D3884; 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 guide covers the determination of the abrasion resistance of textile fabrics using the rotary platform abrader.

NOTE 1—Other procedures for measuring the abrasion resistance of textile fabrics are given in Test Methods D3389, D3885, D3886, D4157, D4158, D4685, D4966, and AATCC 93. To determine the abrasion resistance of leather, refer to Test Method D7255.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.2.1 *Exception*—English units are used when referencing rotational speed.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D123 Terminology Relating to Textiles
D1776 Practice for Conditioning and Testing Textiles
D3389 Test Method for Coated Fabrics Abrasion Resistance (Rotary Platform Abrader)
D3885 Test Method for Abrasion Resistance of Textile Fabrics (Flexing and Abrasion Method)
D3886 Test Method for Abrasion Resistance of Textile Fabrics (Inflated Diaphragm Apparatus)
D4157 Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)
D4158 Guide for Abrasion Resistance of Textile Fabrics (Uniform Abrasion)
D4685 Test Method for Pile Fabric Abrasion
D4850 Terminology Relating to Fabrics and Fabric Test Methods
D4848 Terminology Related to Force, Deformation and Related Properties of Textiles
D4966 Test Method for Abrasion Resistance of Textile Fabrics (Martindale Abrasion Tester Method)
D5034 Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)
D5035 Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)
D7255 Test Method for Abrasion Resistance of Leather (Rotary Platform, Abraser Method)
G195 Guide for Conducting Wear Tests Using a Rotary Platform Abraser

2.2 *Other Documents:*

AATCC 93 Abrasion Resistance of Fabrics: Accelerotor Method[3]

3. Terminology

3.1 For all terminology relating to D13.60, Fabric Test Methods, Specific, refer to Terminology D4850. For the definition of breaking force, refer to Terminology D4848.

3.2 *Definitions:*

3.2.1 The following terms are relevant to this standard: abrasion, abrasion cycle, breaking force.

3.2.2 *resurface, v*—procedure of cleaning and refreshing the running surface of an abrasive wheel prior to use or during testing.

3.3 For all other terminology related to textiles, refer to Terminology D123.

[1] This guide is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.60 on Fabric Physical Test Methods B.

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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] Available from American Association of Textile Chemists and Colorists (AATCC), P.O. Box 12215, Research Triangle Park, NC 27709, http://www.aatcc.org.

3.4 *Acronyms:*

3.4.1 *CAMI*—Coated Abrasives Manufacturers Institute

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 turntable platform, turns on a vertical axis, against the sliding rotation of two abrading wheels. The wheels shall be mounted in such a way that when they are in contact with the rotating test specimen, they rotate in opposing directions. One abrading wheel rubs the specimen outward toward the periphery and the other, inward toward the center while a vacuum system removes wear debris generated during the test. 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 13.

5. Significance and Use

5.1 The measurement of the resistance to abrasion of textile and other materials is very complex and may be affected by a number of factors, including:

5.1.1 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.

5.1.2 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.

5.1.3 Changes in the abradant during specific tests.

NOTE 2—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.

5.1.4 The method of evaluation, which may be influenced by the judgment of the operator.

5.2 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.

5.3 Before definite predictions of fabric usefulness can be drawn from an abrasion test as made on the rotary platform 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 rotary platform abrader test.

5.3.1 In making a comparison of different fabrics (that is, of different fibers, weights, etc.) the rotary platform abrader 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 abrasion test, at least as a guide for future testing of these fabrics.

5.3.2 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 rotary platform abrader tester.

5.4 These general observations apply to all types of fabrics, including woven, nonwoven, and knit apparel fabrics, household fabrics, industrial fabrics, and floor coverings.

6. Apparatus

6.1 *Rotary Platform Abrader*[4] (Fig. 1), as described in G195 and consisting of the following elements:

6.1.1 Removable, turntable specimen platform that includes a rubber pad, clamp plate and centrally located threaded post with knurled nut, and clamp ring to secure the specimen. The turntable platform shall be motor driven, and mounted so as to produce circular surface travel of a flat specimen in the plane of its surface.

6.1.2 Motor capable of rotating the turntable platform and specimen at a speed of either 72 r/min ± 2 r/min or 60 r/min ± 2 r/min.

6.1.3 Pair of pivoted arms to which the abrasive wheels and accessory weights are attached.

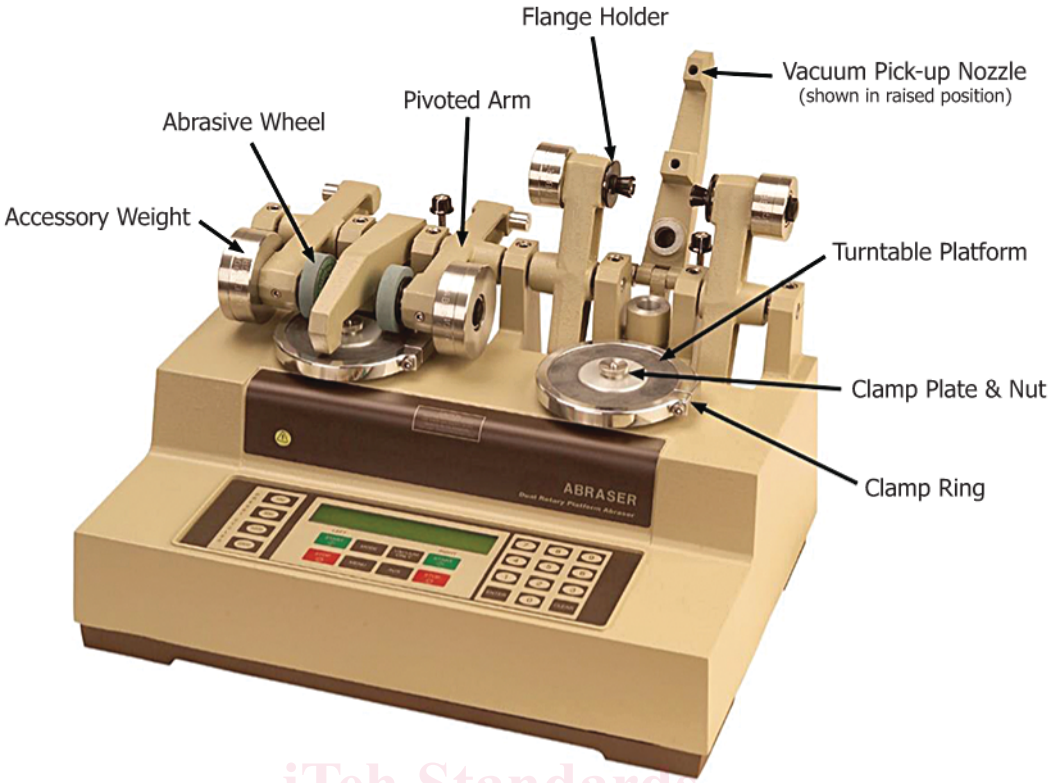
6.1.4 Vacuum suction system and vacuum pick-up nozzle for removal of lint and debris generated during testing. The height of the vacuum nozzle shall be adjustable and the nozzle will have two 8 mm openings – one opening positioned between the two wheels and over the wear path and the other placed diametrically opposite. The distance between the axes of the two openings shall be 76.0 mm ± 1.0 mm.

6.1.5 Counter for indicating the number of abrasion cycles (revolutions of the turntable platform).

6.2 *Abrasive wheels*[4], which are attached to the free end of the pivoted arms and rotate freely about horizontal spindles.

6.2.1 The wheels shall be cylindrical shaped; have an external diameter between 51.9 mm and 44.4 mm; a width of

[4] 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.



NOTE 1—Vacuum suction system not shown.

FIG. 1 Rotary Platform Abrader

12.7 mm ± 0.3 mm; and include an axial hole 16.0 mm ± 0.1 mm to allow the wheel to be mounted to the flanged holder on the pivoted arm. The running surface of the wheel shall be 90° to the side. The wheels are either resilient or vitrified-based with both types of wheels consisting of hard particles embedded in a binder material and are manufactured in different grades of abrasive quality. Other types of wheels, which do not include hard particles embedded in a binder material, may also be used (see Appendix X1).

6.2.2 When resting on the specimen, the wheels will have 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.

6.3 *Accessory Weights,* attached to the pivoted arms to increase or decrease the force at which the wheel is pressed against the specimen, exclusive of the mass of the wheel itself. The pivoted abrader arms without auxiliary weights or counter weights apply a load against the specimen of 250 g per wheel and additional weights can be used to increase the load to 500 g or 1000 g per wheel. A counterweight attachment can be used to reduce the load on the specimen.

6.4 *Auxiliary Apparatus:*

6.4.1 Resurfacing discs (S-11), for resurfacing resilient wheels. The resurfacing disc shall be silicon carbide coated abrasive paper with an average particle size of 92 µm (150 grit CAMI grade), approximately 102 mm in diameter with a 7 mm center hole.

6.4.2 Wheel refacer, with a diamond tool for resurfacing vitrified based wheels or for correcting uneven wheel wear.

6.4.3 Mounting card (optional), approximately 108 mm round with a 7 mm center hole and one side coated with pressure sensitive adhesive to secure the specimen.

6.4.4 Soft bristle brush, to remove loose fibers and debris from the surface of the abrading wheels.

6.4.5 AATCC Gray Scale for Color Change.

7. Sampling

7.1 Take a lot sample as directed in the applicable material specification, or as agreed upon by the interested parties. 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 long, from each roll or piece of fabric in the lot sample. The laboratory sample should be taken no closer than 1 m from the end of each roll or piece of fabric.

7.2 Sample shipments of garments as agreed upon by the interested parties.

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 the interested parties, 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 In lieu of laboratory samples, specimens may be taken from garment samples as agreed upon by all interested parties.

8.3 Cut specimens approximately 15 cm square. For the specimens to be abraded, cut or punch a 6.5 mm diameter hole in the center of the specimen. When determining residual or average breaking strength, cut an additional five specimens to be reserved for controls.

8.3.1 For fabric widths 125 mm or more, take no specimen closer than 25 mm from the selvage edge. Fabric widths less than 125 mm are not recommended.

8.3.2 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.

8.3.3 When breaking force or strength are to be measured, specimens must be appropriately marked to indicate which is the lengthwise or widthwise direction.

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. Calibration, and Verification of Apparatus

9.1 *Calibration*—Verify calibration of the rotary platform abrader as directed by the equipment manufacturer (see Appendix X2).

10. Standardization of Abrading Wheels

10.1 *Preparation of resilient abrading wheels*—To ensure that the abrading function of the wheels is maintained at a consistent level; prepare the resilient wheels following 10.1.1 – 10.1.5

10.1.1 Prior to testing, ensure the expiration date has not passed. Resilient wheels shall not be used after the date stamped on them.

10.1.2 Mount the selected resilient wheels on their respective flange holders, taking care not to handle them by their abrasive surfaces. Adjust the load on the wheels to the load agreed upon between the interested parties for testing (see 12.5).

10.1.3 Mount the resurfacing disc (S-11) on the turntable platform and affix using the clamp plate and nut, and clamp ring. Lower the abrading heads carefully until the wheels rest on the resurfacing disc. Place the vacuum pick-up nozzle in position and adjust it to a distance of 7 mm ± 1 mm above the surface of the disc.

10.1.4 Set the counter to 'zero' and adjust the vacuum suction force to 100.

TABLE 1 Preparation of Resilient Abrasive Wheels

Wheel Status	Resurfacing Cycles
New	2 resurfacings of 50 cycles
Used	25 or 50 cycles
During Test	50 cycles

10.1.5 If the vacuum system does not turn on automatically at the start of the test, start the vacuum suction and then the turntable. Resurface the wheels by running them for the appropriate number of cycles against the resurfacing disc as shown in Table 1. Each resurfacing disc is good for one 25 or 50 cycle resurfacing operation, after which it must be discarded.

NOTE 3—*New Set of Wheels (break-in procedure)*—Before placing in service a new set of resilient wheels perform two (2) resurfacings of 50 cycles to ensure perfect contact of the abrading faces with the specimen surface. The resurfacing disc is used only once (maximum of 50 cycles), therefore this initial resurfacing of new wheels will require two (2) resurfacing discs.

NOTE 4—*Starting a test with previously used wheels*—Before testing a specimen with previously used wheels, resurface 25 or 50 cycles on a new resurfacing disc. When the previous test was short in duration (<1,000 cycles), resurfacing of 25 cycles is sufficient. When the previous test was 1,000 cycles or more, a resurfacing of 50 cycles is recommended. Wheels that have not been used for an extended period of time may require a break-in resurfacing like a new set of wheels.

NOTE 5—*Resurfacing during testing*—To maintain consistency and avoid clogging of wheel faces, the wheels may need to be cleaned or resurfaced periodically during the test for 50 cycles with a new resurfacing disc.

10.2 *Preparation of vitrified abrading wheels*—Vitrified wheels do not require resurfacing unless the abrading surface becomes clogged, chipped or out of round. A diamond tool wheel refacer should be used to correct any of these conditions.

11. Conditioning

11.1 Condition the test specimens to moisture equilibrium for testing in the standard atmosphere for testing textiles in accordance with Practice D1776 or, if applicable, in the specified atmosphere in which the testing is to be performed.

12. Procedure

12.1 Unless otherwise specified, test the conditioned specimens in the standard atmosphere for testing general textiles, which is 20 °C ± 2 °C and 65 % ± 5 % relative humidity.

12.2 When calculating mass loss, weigh the specimen to the nearest 1 mg. If using a mounting card, weigh after the specimen has been affixed to the card and conditioned.

12.3 *Mounting of Specimen*—Place the test specimen face up, unless otherwise specified, over the rubber pad on the turntable platform. Lightly secure the clamp plate and knurled nut in place to hold the center of the specimen. Place the clamp ring over the specimen and turntable platform 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 turntable platform by pulling on corners and edges of fabric, then tighten the clamp ring further. Push the ring all the way down over the edge of the specimen platform, thus putting tension on the fabric as it is secured. Finish tightening the clamp plate and nut, and finally, tighten the clamp ring. Avoid buckling the fabric when

tightening. Trim off excess fabric around the edges unless mass loss is being calculated.

12.3.1 For specimens that require resilient wheels to be resurfaced during the test, a mounting card shall be used to prevent the integrity of the test from being jeopardized when removing and replacing the specimen.

NOTE 6—It is important that the specimen be mounted such that it is completely flat and remains flat when subjected to abrasion. A mounting card may be used for this purpose. Clean the back of the specimen with a soft bristle brush to remove any loose debris, and attach to the mounting card ensuring the mounted specimen is free of folds, creases, or wrinkles.

12.4 *Selection of Wheels*—The abrasive wheels are manufactured in different grades and selection of which wheel type to use must be agreed upon by the interested parties. A wheel selection guide is presented in Appendix X1 to help with this selection process.

12.5 *Load*—The load to use is dependent on the type of textile fabric being tested, and should be agreed upon by the interested parties. See Appendix X1.

12.6 *Vacuum Suction*—The rotary platform abrader vacuum system is used to clean the specimen of debris and abrasive particles during the test. The vacuum suction force should be adjusted to lift the abraded particles, but not lift the specimen. A setting of 100 should be used, unless otherwise agreed upon by the interested parties. Position the nozzle 7 mm ± 1 mm above the specimen surface.

12.7 *Number of Revolutions*—The number of abrasion cycles 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 strength due to abrasion, loss in mass due to abrasion, or occurrence of yarn breakdown). The number of abrasion cycles should be predetermined by mutual agreement.

12.8 Lower the abrading heads carefully onto the surface of the specimen. Start the rotary platform abrader and subject the test specimen to abrasion for the specified number of cycles. If cycles to a specific end point is used as the evaluation criteria (see 13.6), it may be necessary to stop the instrument at intervals during the test to examine the test specimen.

12.9 Due to uneven wear and clogging of the surface crevices with fiber particles, sizing, finishing materials, and the like, the abrading wheels may need to be resurfaced or cleaned at established intervals during tests (see Section 10), the frequency depending on the type of material being tested and the type of wheel used. A soft bristle brush may be sufficient to remove loose debris and abraded material that adheres to the abrasive wheels.

12.10 After testing, raise the abrader arms and vacuum nozzle then remove the specimen for evaluation. If desired, the turntable platform may be removed from the tester by lifting straight up. This will permit a closer inspection of the specimen prior to removal from the turntable platform.

13. Interpretation of Results

13.1 After the specimens have been abraded to the set number of cycles or other specified end-point, evaluate as directed in 13.2 – 13.6 as appropriate.

13.2 *Residual Breaking Force*—If residual breaking force is required, calculate the individual breaking force of the abraded specimens and the unabraded specimens to the nearest 0.5 kg significant digits. Use Test Method D5034 or D5035, as appropriate, except that the distance between clamps shall be 25 mm and path of the abrasion on the abraded specimen is horizontally placed midway between the clamps of the machine.

13.3 *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 for the laboratory sampling unit and for the lot.

13.4 *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, and
B = average breaking force of the abraded specimen, g.

13.5 *Mass Loss*—Determine the mass loss as the difference between the masses before and after abrasion. This loss may be reported as weight loss in mg or expressed as a percentage of the before abrasion as shown in Eq 2.

$$L = 100\,\frac{(A - B)}{A} \tag{2}$$

where:

L = mass loss, %,
A = mass of specimen before abrasion, mg, and
B = mass of specimen after abrasion, mg.

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

13.6 *Evaluation for Visual Changes*—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: 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 rating system (such as a five-step rating).

NOTE 7—Ranking the abrasion damage as *(1)* no effect; *(2)* slight; *(3)* noticeable; *(4)* objectionable; *(5)* severe, is one example of a five-step rating scale.

13.6.1 *Option 1*—The end point (rupture) is reached on a woven fabric when two or more yarns have broken, or on a knitted or nonwoven fabric when a hole appears. Calculate abrasion resistance as the average cycles to rupture of five specimens for each sampling unit and for each lot. The size of the hole shall be agreed upon by the interested parties.