Designation: D3389 – 16

Standard Test Method for Coated Fabrics Abrasion Resistance (Rotary Platform Abrader)[1]

This standard is issued under the fixed designation D3389; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This test method covers the determination of the wear resistance of fabrics coated with rubber or plastics to abrasion. The abrasion is measured by mass loss or number of cycles required to wear through the coating to initially expose the base fabric.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1349 Practice for Rubber—Standard Conditions for Testing

D1566 Terminology Relating to Rubber

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

G195 Guide for Conducting Wear Tests Using a Rotary Platform Abraser

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *abrader, n*—a wear testing instrument, also referred to as a rotary platform tester or abraser.

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*—In the case of the rotary platform test method, it consists of one complete rotation of the specimen.

3.1.3 *resurface, v*—the preparation of an abrasive wheel on a resurfacing disc or diamond tool wheel refacer, prior to use or during testing.

3.2 For definitions of other terms used in this test method, refer to Terminology D1566.

4. Summary of Test Method

4.1 Abrasion resistance of fabrics coated with rubber or plastics is measured by subjecting the specimen to the rotary-rubbing action of two abrasive wheels under controlled conditions of pressure by the use of the rotary platform abrader. The test specimen, mounted on a turntable 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 circular pattern of crossed arcs over an area of approximately 30 cm^2. Resistance to abrasion is evaluated by average mass loss, wear index (average mass loss per revolution) or cycles required to wear through the coating to expose the yarn in the base fabric.

5. Significance and Use

5.1 Abrasion resistance tests are intended to measure the wear resistance properties of a material. This may be correlated to expected end use performance.

5.2 The resistance of coated fabrics 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 abrasion cycles) and durability 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. This test method provides a comparative

[1] This test method is under the jurisdiction of ASTM Committee D11 on Rubber and Rubber-like Materials and is the direct responsibility of Subcommittee D11.15 on Degradation Tests.

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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.

***A Summary of Changes section appears at the end of this standard**

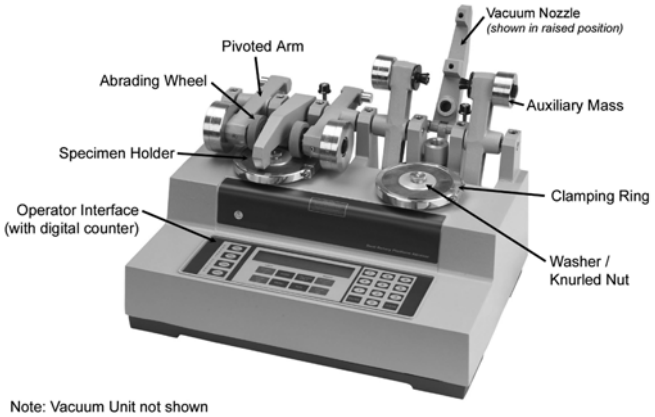


FIG. 1 Rotary Platform Abrader

ranking of material performance, which can be used as an indication of relative end-use performance.

5.3 The resistance of coated fabrics to abrasion may be affected by factors including test conditions, type of abradant, pressure between the specimen and abradant, mounting or tension of the specimen, and type, kind, or amount of finishing materials.

5.4 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.

6. Apparatus

6.1 *Abrasion Apparatus,*[3] as described in Guide G195 and, comprised of a removable flat circular specimen holder turntable, a pair of pivoted arms to which the abrasive wheels are attached, a motor for rotating the specimen holder, a vacuum unit and nozzle for removal of abraded particles during test, and a counter for indicating the revolutions of the specimen holder. See Fig. 1.

6.1.1 The specimen holder turntable shall be mounted to produce a circular surface travel of an essentially flat specimen in the plane of its surface at a uniform angular velocity. The speed of rotation of the turntable shall be 7.5 ± 0.21 rad/s (72 ± 2 rpm) for 110 V/60 Hz or 6.9 ± 0.21 rad/s (60 ± 2 rpm) for 230 V/50 Hz operation.

6.1.2 A clamping ring, washer and knurled nut shall be used to secure the specimen to the specimen holder.

6.1.3 The abrasive wheels, which are attached to the free end of independently pivoted arms, shall 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 angle of travel of one wheel periphery being opposite to that of the other. Motion of the abrasive wheels, in opposite directions, shall be provided by rotation of the specimen and the associated friction therefrom.

6.1.4 The apparatus shall be provided with a vertical-force adjustment (auxiliary masses) for varying the vertical force of the abrader wheels on the specimen. The pivoted abrader arms without auxiliary masses or counterweights shall apply a vertical force against the specimen of 2.45 N (250 gf) per wheel. Auxiliary masses may be used to apply a vertical force against the specimen of 4.9 N (500 gf) per wheel or 9.8 N (1000 gf) per wheel. Vertical force references are per arm (not combined), and include the mass of the pivoted arm but not the mass of the abrading wheel.

6.2 *Abrasive Wheels*[3]—A wheel that is 13 mm (0.5 in.) thick and approximately 50 mm (2 in.), but no less than 44.4 mm (1.75 in.) in diameter, which is manufactured in different grades of abrasive quality. The abrasive wheels are either resilient or vitrified based, with both types of wheels consisting of hard particles embedded in a binder material.

6.3 *Auxiliary Apparatus*—Refacing discs such as type S-11[3] or equivalent are required for the resurfacing of resilient-type wheels. A diamond tool wheel refacer is recommended for resurfacing vitrified wheels, and correcting out-of-round wheel conditions.

6.4 *Balance,* suitable for weighing to the nearest 1 mg.

7. Test Specimens

7.1 Unless otherwise specified, make five tests on each sample of coated fabrics.

7.2 Cut circular test specimens approximately 110 mm (4½ in.) in diameter. Punch or drill a 6-mm (¼-in.) hole in the center of the specimen. Take care in cutting out specimens. Use the best portion of the sample to be tested. It should be free of holes, blisters, or other imperfections.

7.3 For thin flexible materials, adhere the specimen to a suitable substrate; use of a cardboard mounting card such as S-36-1[3] has been found to be satisfactory.

NOTE 1—When adhesives are used to adhere the specimen, ensure that it does not have any adverse effect on the specimen. If a solvent-based system is used, allow the assembly to condition a minimum of 12 h or until the assembly maintains constant mass.

8. Conditioning

8.1 Condition the specimens in accordance with Practice D1349.

9. Procedure

9.1 Install the wheels on their respective flanged holders. Selection of abrasive wheels to be made by the interested parties. If no wheel is specified, the H-18 vitrified wheel or equivalent is recommended.

NOTE 2—Abrasion tests utilizing the rotary platform abrader may be subject to variation due to the changes in the abradant during the course of the test. Depending on abradant type and test specimen, the abrading wheel surface may change (that is, become clogged) due to the pick-up of worn materials from test specimens. To reduce this variation, the abrading wheels should be resurfaced according to the manufacturer's recommendations.

[3] The sole source of supply of the apparatus known to the committee at this time is Taber Industries, 455 Bryant Street, North Tonawanda, NY 14120. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

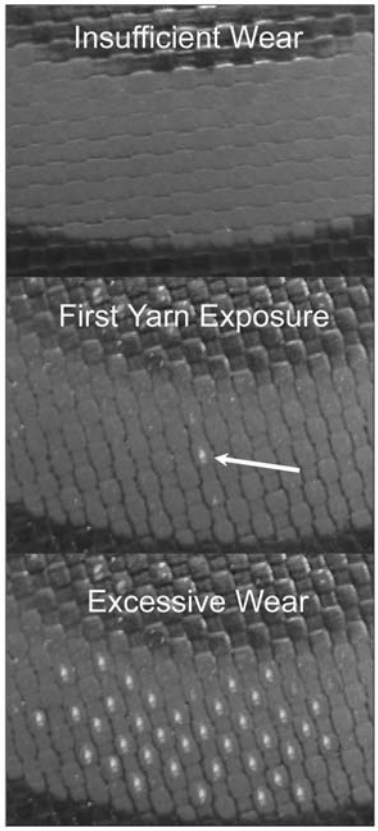


FIG. 2 Wear End Point

9.2 When calculating mass loss, determine the original mass of the specimen or the assembly to the nearest 1 mg.

9.3 Place the test specimen, with its coated side up, over the rubber mat on the specimen holder. Secure the washer and knurled nut in place to hold the center of the specimen. Place the clamping ring over the specimen and tighten the screw of the clamping ring.

9.4 Install auxiliary mass as agreed upon by the interested parties. If no load is specified, 9.8 N (1000 gf) per wheel is recommended. The quality and the thickness of the coating may influence the required vertical force needed to measure the wear resistance of the coating.

9.5 Adjust the vacuum suction and nozzle height as agreed upon between the interested parties. If none is provided, use a vacuum nozzle height of 6.5 mm (0.25 in.) above the specimen surface, with a vacuum level of 70.

9.6 Lower mounted wheels onto the specimen surface.

9.7 The tester is equipped with a counter that operates in conjunction with the specimen holder turntable. Set the counter at zero.

9.8 Start the abrader and run to the end point, or the required number of cycles as specified by the interested parties. Do not abrade through the base fabric. This test method is for determining the wear resistance properties of the coating only.

9.8.1 Periodically stop the test to remove any abrasive particles left on the specimen surface. A frequency of 300 cycles is recommended. A soft-bristle brush or compressed air may be used for this purpose.

9.8.2 To test to the end point, it shall be defined as that point when the first yarn is exposed (see Fig. 2). To determine end point, the test must be stopped periodically so the specimen can be inspected. The frequency of these inspections should be determined by the interested parties. For those materials with a known number of expected abrasion cycles, inspect the specimen after completing 80 % of the expected abrasion cycles every 50, 25 or 10 revolutions as needed until the end point is reached.

NOTE 3—End point is defined as a visible spot where the coating has worn away and the base fabric is exposed. Because of the difficulty in stopping the test at the exact moment when this occurs, the size of the exposed base fabric may vary. The typical size ranges from 0.5 to 1.0 mm^2. Once this end point is reached, the test is terminated.

9.8.3 Use of a lighted magnifying glass is suggested for determining first yarn exposure.

9.9 Test no less than five specimens for each sample, unless otherwise agreed upon in 7.1.

9.10 At the conclusion of each test, remove any debris left on the specimen surface using a soft-bristle brush or compressed air.

9.11 Record the number of cycles and, when required, determine the mass of the specimen or the assembly, to the nearest 1 mg.

9.12 Using a clean cloth wipe the specimen holder rubber mat after each test.

10. Calculation

10.1 *Mass Loss*—Change in mass caused by abrasion. Weigh the specimen after abrasion and compute mass loss, *L*, of the test specimen as follows:

$$L = A - B \tag{1}$$

where:

A = original mass of test specimen before abrasion, g
B = final mass of test specimen after abrasion, g

10.2 Use the following formula to determine wear index, *I*, (mass loss per revolution in mg) for each specimen:

$$I = \frac{(A - B) \times 1000}{C} \tag{2}$$

where:

A = original mass of test specimen before abrasion, g
B = final mass of test specimen after abrasion, g
C = number of abrasion cycles recorded

Example:

12.3596 Original Mass, g
12.2829 Final Mass, g
0.0767 Mass Loss, g for 500 revolutions

$$I = \frac{(0.0767) \times 1000}{500} = 0.153$$

10.3 Average the test results.

TABLE 1 Mass Loss (grams)

Sample	Average[A]	Repeatability Standard Deviation	Reproducibility Standard Deviation	Repeatability Limit	Reproducibility Limit
	$\bar{x}$	S_r	S_R	r	R
Material A	0.2285	0.0317	0.0515	0.0888	0.1443
Material B	0.0718	0.0130	0.0214	0.0365	0.0600
Material C	0.0743	0.0139	0.0230	0.0389	0.0645
Material D	0.0503	0.0243	0.0270	0.0680	0.0755

[A] The average of the laboratories' calculated averages.

TABLE 2 Loss Per Revolution (grams)

Sample	Average[A]	Repeatability Standard Deviation	Reproducibility Standard Deviation	Repeatability Limit	Reproducibility Limit
	$\bar{x}$	S_r	S_R	r	R
Material A	0.2113	0.0390	0.0573	0.1091	0.1604
Material B	0.4414	0.1144	0.1471	0.3202	0.4120
Material C	0.6171	0.1377	0.1764	0.3857	0.4940
Material D	0.6827	0.4099	0.4403	1.1477	1.2328

[A] The average of the laboratories' calculated averages.

TABLE 3 Cycles to Failure

Sample	Average[A]	Repeatability Standard Deviation	Reproducibility Standard Deviation	Repeatability Limit	Reproducibility Limit
	$\bar{x}$	S_r	S_R	r	R
Material A	1124.2	184.2	294.4	515.9	824.3
Material B	170.8	39.0	55.2	109.3	154.7
Material C	131.5	51.3	68.8	143.5	192.5
Material D	83.9	25.4	33.0	71.2	92.5

[A] The average of the laboratories' calculated averages.

11. Report

11.1 Report the following information:

11.1.1 Test conditions,

11.1.2 Number of specimens tested,

11.1.3 Type of wheels,

11.1.4 Vertical force used,

11.1.5 Mass loss, g, or wear index (mass loss per revolutions, mg), or both, if required, and

11.1.6 Total revolutions or cycles until first yarn exposure occurred.

12. Precision and Bias[4]

12.1 The precision of this test method is based on an interlaboratory study conducted in 2009. Nine laboratories participated in this study. Each of the labs was asked to report seven replicate test results for three different analyses, on a total of four materials. Every "test result" reported represents a single determination or measurement. Practice E691 was followed for the design and analysis of the data.

12.1.1 *Repeatability Limit (r)*—Two test results obtained within one laboratory shall be judged not equivalent if they differ by more than the "r" value for that material; "r" is the interval representing the critical difference between two test results for the same material, obtained by the same operator using the same equipment on the same day in the same laboratory.

12.1.1.1 Repeatability limits are listed in Tables 1-3.

12.1.2 *Reproducibility Limit (R)*—Two test results shall be judged not equivalent if they differ by more than the "R" value for that material; "R" is the interval representing the critical difference between two test results for the same material, obtained by different operators using different equipment in different laboratories.

12.1.2.1 Reproducibility limits are listed in Tables 1-3.

12.1.3 The above terms (repeatability limit and reproducibility limit) are used as specified in Practice E177.

12.1.4 Any judgment in accordance with the statements in 12.1.1 and 12.1.2 would have an approximate 95 % probability of being correct.

12.2 *Bias*—At the time of the study, there was no accepted reference material suitable for determining the bias for this test method, therefore no statement on bias is being made.

12.3 The precision statement was determined through statistical examination of 692 results, from nine laboratories, reporting up to seven replicate analyses, on a total of four different materials, which were described as:

Material A: PVC Coated Polyester
Material B: PVC Coated Polyester
Material C: Vinyl Coated Polyester

[4] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: D11-1106.

Material D: Vinyl Coated Polyester

To judge the equivalency of two test results, it is recommended to choose the material closest in characteristics to the test specimen.

13. Keywords

13.1 abrasion; coated fabrics; mass loss; plastics; rotary platform abrader; rubber; Taber; wear

APPENDIX

(Nonmandatory Information)

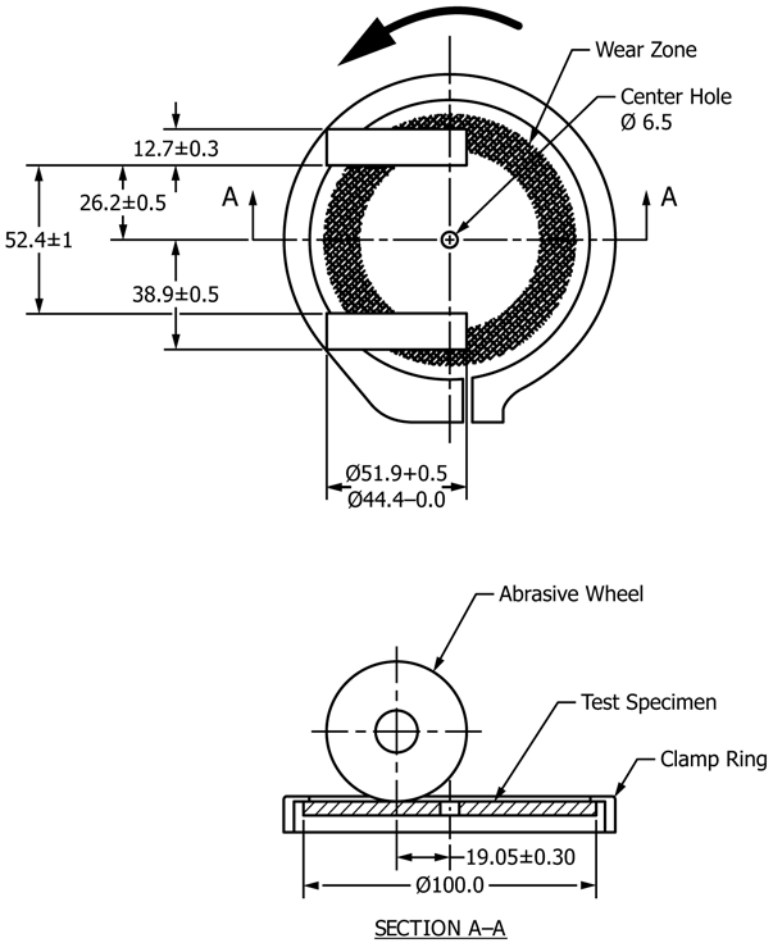
X1. CALIBRATION VERIFICATION

X1.1 To facilitate the verification of calibration of the Taber abrader, a kit is available[3] that provides a fast reliable system check. This kit is not meant as a substitute for regular instrument calibration. Procedures in the kit allow the user to verify:

X1.1.1 *Wheel Alignment and Tracking*—The wheels should be spaced equally on both sides from the wheel-mounting flange to the center of the specimen holder. 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. Wheel internal faces shall be 52.4 ± 1.0 mm apart and the hypothetical line through the two spindles shall be 19.05 ± 0.3 mm away from the central axis of the turntable. (Fig. X1.1).

X1.1.2 *Wheel Bearings Condition*—The Taber abrader wheel bearings should be able to rotate freely about their horizontal spindles and not stick when the wheels are caused to spin rapidly by a quick driving motion of the forefinger.

X1.1.3 *Vacuum Suction Force*—Air pressure in the suction device must not be lower than 137 millibar (55 in. of water column), as measured by a suction gauge.



NOTE 1—This schematic shows the proper wheel position in relation to the turntable platform.

FIG. X1.1 Diagrammatic Arrangement of Taber Abrader Test Set-Up

NOTE X1.1—Vacuum suction force may be influenced by the condition of the collection bag, which must be emptied or replaced on a regular basis. Any connection or seal leaks will also influence suction force.

X1.1.4 *Turntable Platform Position*—The vertical distance from the center of the pivot point of the Taber Abraser arms to the top of the turntable platform should be approximately 25 mm. The turntable platform shall rotate substantially in a plane with a deviation at a distance of 1.6 mm (1⁄16 in.) from its periphery of not greater than 0.10 mm (0.004 in.).

X1.1.5 *Turntable Speed*—The turntable should rotate at the speed stated in 6.1.1.

X1.1.6 *Load*—The accessory mass marked 500 g shall weigh 250 ± 1 g and the accessory mass marked 1000 g shall weigh 750 ± 1 g.

SUMMARY OF CHANGES

Committee D11 has identified the location of selected changes to this standard since the last issue (D3389 – 15) that may impact the use of this standard. (Approved April 15, 2016.)

(1) Replaced referenced standard Practice D618 with Practice D1349.

Committee D11 has identified the location of selected changes to this standard since the last issue (D3389 – 10) that may impact the use of this standard. (Approved July 1, 2015.)

(1) Added Section 3 – Terminology.
(2) Expanded Section 5 – Significance and Use.
(3) Referenced Guide G195 for the description of the abrasion apparatus to 6.1.
(4) Add mass loss equation to 10.1 and change mass loss per revolution to wear index in 10.2.