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Standard Test Method for Abrasion Resistance of Textile Webbing (Hex Bar Method)[1]

This standard is issued under the fixed designation D6770; 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~~ Scope*

1.1 This test method covers the determination of abrasion resistance of textile webbing using a hex bar abrasion tester.

1.1.1 The resistance is expressed as a percentage of retained ~~break~~breaking strength.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

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/D1776M Practice for Conditioning and Testing Textiles
D4850 Terminology Relating to Fabrics and Fabric Test Methods
D6775 Test Method for Breaking Strength and Elongation of Textile Webbing, Tape and Braided Material
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

~~2.2 *Other Standard:*~~
~~Federal Standard 191A, Method 4108 "Strength and Elongation, Breaking; Textile Webbing, Tape and Braided Items"[3]~~

3. Terminology

3.1 For all terminology relating to Fabrics, refer to Terminology D4850.

~~3.2 The following terms are relevant to this standard: abrasion, abrasion cycle, breaking force, standard atmosphere for preconditioning textiles, standard atmosphere for testing textiles, stroke, in hex bar abrasion testing, webbing.~~

[1] This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.60 on Fabric Test Methods, Specific.
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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**

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

4. Summary of Test Method

4.1 Abrasion resistance is measured by subjecting the specimen to unidirectional reciprocal rubbing over a specific bar under specified conditions of tension, stroke length and time. Resistance to abrasion is evaluated by determining the percent retention of breaking force of an abraded specimen compared to an unabraded specimen.

5. Significance and Use

5.1 The measurement of the resistance to abrasion of textile webbing is very complex. The resistance to abrasion is affected by many factors that include the inherent mechanical properties of the fibers; the dimensions of the fibers; the structure of the yarns; the construction of the webbing; the type, kind, and amount of treatment added to the fibers, yarns, or webbing; the nature of the abradant; the variable action of the abradant over the specimen area abraded; the tension on the specimen; the pressure between the specimen and the abradant; and the dimensional changes in the specimen.

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

5.3 Laboratory tests may be reliable as an indication of relative end use 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, the results should not be relied upon for prediction of performance during actual wear life for specific end uses unless there are data showing the specific relationship between laboratory abrasion tests and actual wear in the intended end use.

~~5.4 While there has not been extensive interlaboratory testing prior to development of this standard, there has been some quality control testing by manufacturers. An intralaboratory test was conducted to initiate this test method, using a single product. This data will be used to determine a preliminary statement on precision and bias. Subsequent to approval of this standard, a formalized interlaboratory procedure will be initiated under the direction of a professional statistician and will produce a research report. Samples used in this controlled test will be representative of end use applications.~~

5.4 These general observations apply to most webbings that are used in automotive, aerospace, industrial, and military applications.

5.5 This test method can be used for acceptance testing of commercial shipments but comparisons should be made with caution because estimates of between-laboratory precision are incomplete.

5.6 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, use samples for such comparative tests that are as homogenous as possible, drawn from the same lot of material as the samples that resulted in disparate results during initial testing, and randomly assigned in equal numbers to each laboratory. The test results from the laboratories involved should be compared using a statistical test for unpaired data, at a probability level chosen prior 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 *Webbing Abrasion Tester*—The webbing abrasion tester consists of a suitable mechanism that will provide a reciprocating motion of the webbing over a standardized hex bar. One end of each specimen is attached to the mechanism and the other end passing over a hexagonal steel rod is attached to a weight. The hexagonal rod is so fixed as to subject the webbing specimen to abrasion on two adjacent edges as the drum moves the specimen across the rod. One example of such a mechanism is a reciprocating drum as illustrated in Fig. 1.

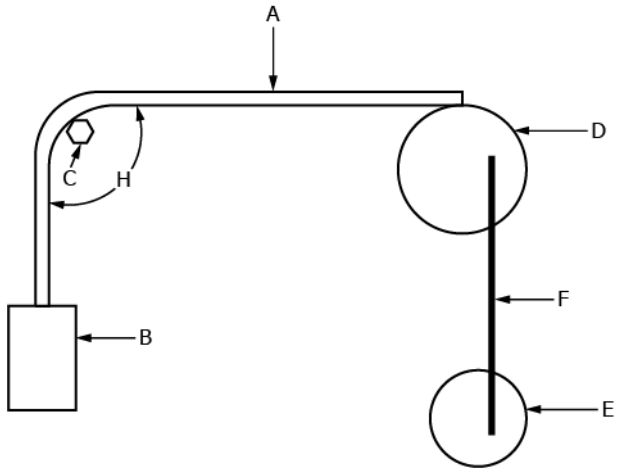

FIG. 1 Webbing Abrasion Tester

6.1.1 Mass "B" shall be 900 ± 60 g (2 lb ± 2 oz) for webbing with breaking strengths up to 4500 N (1000 lb), 1800 ± 60 g (4 lb ± 2 oz) for breaking strengths of 4500 to 13 500 N (1000 to 3000 lb) and 2400 ± 60 g (5.2 lb ± 2 ~~lb~~)oz) for breaking strengths over 13 500 N (3000 lb).

6.1.2 Steel hexagonal rods "C" shall be 6.35 ± 0.03 mm (0.250 ± 0.001 in.) when measured across opposite flat sides and the radius shall be 0.5 ± 0.2 mm (0.020 ± 0.008 in.). The steel shall have a cold drawn finish and a Rockwell Hardness of B-91 to B-101. The edges of the hexagonal rods shall not have any burrs, nicks or scale.

6.1.3 The mechanism "D" shall have a nominal outside diameter of 400 mm (16 in.) or be some mechanism able to produce a reciprocating motion of at least 300 mm (12 in.) over the hex rod with a suitable means for attaching the specimen to be tested without damage to the specimen.

6.1.4 The crank-arm "F" shall be attached to the mechanism "D" and to the driver disk "E" in such a manner that when the specimen is attached to the mechanism, the specimen during the test will oscillate over the hexagonal rod the required distance during each stroke and at the required rate (see 10.4).

6.1.5 The hexagonal rod shall be so placed that specimen "A" with the weight attached to one end and the other end passing over the hexagonal rod and attached to the drive mechanism will form an angle "H" of 85 ± ~~2° "H".~~2°.

6.2 *Tensile Testing Machine*[3], CRE-Type equipped with split-drum webbing clamps as described in ~~Federal~~ Test Method D6775~~191A, Method 4108.~~.

7. Sampling and Test Specimens

7.1 *Lot Sample*—Take a lot sample as directed in the applicable material specification. In absence of such a specification randomly select five rolls or pieces to constitute the lot sample.

7.2 *Laboratory Sampling Unit*—As a laboratory sampling unit take from each roll or piece one piece of webbing that is 2.8 m (3.0 yd) in length.

7.3 *Test Specimens*—From each laboratory sampling unit, cut 2 test specimens 1.4 m (1.5 yd) in length. Mark one specimen "A" for abraded and the other "U" for unabraded.

7.3.1 When the lot or shipment consists of less than 5 rolls or pieces, randomly select 5 test specimens that represent all rolls or pieces in the lot or shipment.

[3] ~~Available from Superintendent of Documents, Government Printing Office, Washington, DC 20402.~~Apparatus and accessories are commercially available.

7.4 Ensure specimens are free of folds, creases, or wrinkles. Avoid getting oil, water, grease, and so forth, on the specimens when handling.

8. Conditioning

8.1 Condition the test specimens to moisture equilibrium for testing in the standard atmosphere for testing textiles in accordance with Practice D1776/D1776M or, if applicable, in the specified atmosphere in which the testing is to be performed.

8.2 In the event of dispute concerning the results of tests that may be affected by the moisture content, test specimens shall be preconditioned by bringing them to approximate moisture equilibrium in the standard atmosphere for preconditioning textiles in accordance with Practice D1776/D1776M.

9. Preparation and Calibration of Test Apparatus

9.1 Ensure the test machine is on a level, sturdy surface and free from vibration.

9.2 For hexagonal rods a manufacturer's certificate of compliance shall be acceptable as to the requirements as described in 6.1.2.

10. Procedure

10.1 Condition the "A" test specimens in the standard atmosphere for testing textiles, in accordance with Section 8.

10.2 Attach the required mass (6.1.1) to one end of the test specimen, pass the other end over the hexagonal rod and attach to the drum. The length of the test specimens shall be adjusted, without altering the original length, so that the test specimens will oscillate across the hexagon rod and each end of the abraded area will be equidistant from the ends of the test specimens.

10.3 The edges of each new hexagonal rod shall be identified as 1 through 6, and rotated after each use so that no abrading edges are used more than once. Use edge 1 and ~~two~~2 for one test specimen, edge 3 and 4 for a second test specimen, edges 5 and 6 for a third test specimen, and then discard the rod.

10.4 Oscillate the mechanism so that the test specimens are given a 300 ± 25 mm (12 ± 1 in.) traverse over the rod at the rate of 1 ± .03 strokes (0.5 cycles) per second for 5000 strokes (2500 cycles). One single stroke is 300 ± 25 mm (12 ± 1 in.) in one direction only.

10.5 After the machine has stopped at the predetermined number of cycles remove the test specimens from the abrading machine.

10.6 Continue as directed in 10.2 – 10.5 until all the required specimens have been abraded for each laboratory sampling unit.

10.7 Determine the breaking force of the abraded specimens (A) and the unabraded specimens (U) for each laboratory sampling unit in the lot to the nearest 1 % as directed in ~~Fed-Std-191A,~~Test Method ~~4108~~D6775 set as follows:

10.7.1 Attach the split drum webbing clamps in the tensile tester and set the distance between them to 250 mm (10 in.) center to center.

10.7.2 Set the testing speed to 75 ± 25 ~~mm~~mm/min (3 ± 1 in./min).

11. Calculation

11.1 Calculate the average breaking force for the lot of the abraded test specimens from the results of the laboratory sampling units.

11.2 Calculate the average breaking force for the lot of the unabraded test specimens from the results of the laboratory sampling units.

11.3 Calculate the percentage of retained breaking force to the nearest 1 % for the lot using Eq 1:

$$AR = \frac{100A}{U} \quad (1)$$

where:

AR = abrasion resistance, %,
A = average breaking force of the abraded specimens, N (lb), and
U = average breaking force of the unabraded specimens, N (lb).

~~11.3.1 When data are automatically computer processed, calculations are generally contained in the associated software. It is recommended that computer-processed data be verified against known property values and its software described in the report.~~

12. Report

12.1 Report that the abrasion resistance was determined in accordance with Test Method D6770. Describe the material or product sampled.

12.2 Report the following information for the laboratory sampling unit and for the lot as applicable to a material specification or contract order:

12.2.1 Abrasion resistance, percent retained in breaking force.

12.2.2 Breaking force of abraded test specimens.

12.2.3 Breaking force of unabraded test specimens.

~~12.2.4 For computer-processed data, identify the program (software) used.~~

13. Precision and Bias

~~13.1 An intralaboratory test was conducted for the determination of precision and bias of this test method. The results of the test are attached as Table 1.~~

~~NOTE 1—Because the intralaboratory test included less than the recommended five laboratories, estimates of precision data may be either underestimated or overestimated to a considerable extent and should be used with special caution.~~[4]

13.1 ~~*Precision*—A statement on the~~ The precision of this test method is ~~being developed. The~~ based on an intralaboratory study, conducted to initiate the procedure now recognized as ASTM D6770~~results will be included when available.~~, Test Method for Abrasion Resistance of Textile Webbing (Hex Bar Method). Each of six volunteer laboratories or operators were asked to test one material. Every "test result" represents the average of five individual determinations, and all participants were instructed to report five replicate test results for each material.

13.1.1 *Repeatability limit (r)*—The difference between repetitive results obtained by the same operator in a given laboratory applying the same test method with the same apparatus under constant operating conditions on identical test material within short intervals of time would in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in 20.

13.1.1.1 Repeatability can be interpreted as maximum difference between two results, obtained under repeatability conditions, that is accepted as plausible due to random causes under normal and correct operation of the test method.

13.1.1.2 Repeatability limits are listed in Tables 1 and 2.

[4] ~~Apparatus and accessories are commercially available.~~Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D13-2001. Contact ASTM Customer Service at service@astm.org.

TABLE 1 Raw Data from Intralaboratory Test

		Material 1—Before Abrasion	Material 2—After Abrasion					
	Lab.	Opr.	Test 1	Test 2	Test 3	Test 4	Test 5	Opr.
Set 1	1	4.720	4.820	4.600	4.700	4.600	23.440	4.6
	2	4.600	4.720	4.700	4.720	4.680	23.420	4.6
	3	4.580	4.720	4.720	4.560	4.720	23.300	4.6
	4	4.740	4.740	4.520	4.720	4.740	23.460	4.5
	5	4.700	4.660	4.600	4.700	4.680	23.340	4.6
	6	4.600	4.680	4.500	4.480	4.540	22.800	4.3
	Lab Sum						139.760	
Set 2	1	4.600	4.720	4.600	4.720	4.680	23.320	4.4
	2	4.680	4.700	4.660	4.700	4.640	23.380	4.5
	3	4.660	4.720	4.660	4.660	4.640	23.340	4.4
	4	4.760	4.740	4.640	4.660	4.380	23.180	4.5
	5	4.680	4.700	4.740	4.620	4.680	23.420	4.5
	6	4.640	4.720	4.740	4.840	4.780	23.720	4.6
	Lab Sum						140.360	
Set 3	1	4.680	4.720	4.700	4.700	4.680	23.480	4.5
	2	4.620	4.600	4.680	4.680	4.620	23.200	4.5
	3	4.560	4.740	4.560	4.680	4.720	23.260	4.6
	4	4.740	4.680	4.720	4.580	4.460	23.180	4.6
	5	4.700	4.700	4.660	4.620	4.700	23.360	4.5
	6	4.700	4.720	4.760	4.720	4.720	23.620	4.5
	Lab Sum		140.120					
Set 4	1	4.820	4.680	4.680	4.660	4.700	23.540	4.5
	2	4.700	4.720	4.660	4.700	4.700	23.480	4.5
	3	4.680	4.480	4.700	4.720	4.680	23.260	4.3
	4	4.720	4.800	4.740	4.680	4.680	23.620	4.5
	5	4.680	4.700	4.680	4.580	4.660	23.300	4.5
	6	4.660	4.700	4.740	4.580	4.600	23.280	4.6
	Lab Sum						140.480	
Set 5	1	4.620	4.580	4.680	4.720	4.600	23.200	4.5
	2	4.580	4.660	4.700	4.700	4.680	23.320	4.5
	3	4.720	4.640	4.640	4.660	4.620	23.280	4.5
	4	4.500	4.680	4.620	4.660	4.620	23.080	4.4
	5	4.480	4.760	4.640	4.580	4.700	23.160	4.5
	6	4.680	4.700	4.660	4.700	4.720	23.460	4.2
	Lab Sum						139.600	
Grand Total							700.220	

TABLE 1 Breaking Force (thousands of lb)

NOTE 1—Units are in thousands of pounds; for example 4.6687 = 4668.7 lb.

Material	Number of Laboratories	Average[A]	Repeatability Standard Deviation	Reproducibility Standard Deviation	Repeatability Limit	Reproducibility Limit
	n	$\bar{x}$	s_r	s_R	r	R
Textile Webbing – Unabraded	6	4.6687	0.0374	0.0374	0.1047	0.1047
Textile Webbing – Abraded	6	4.4903	0.0774	0.0776	0.2168	0.2173

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

Units are in Thousands of Pounds; for example, 4.820 = 4,820 lb.

13.1.2 *Reproducibility limit (R)*—The difference between two single and independent results obtained by different operators applying the same test method in different laboratories using different apparatus on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in 20.

13.1.2.1 Reproducibility can be interpreted as maximum difference between two results, obtained under reproducibility conditions, that is accepted as plausible due to random causes under normal and correct operation of the test method.

13.1.2.2 Reproducibility limits are listed in Tables 1 and 2.

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

13.1.4 Any judgment in accordance with statement 13.1.1 would normally have an approximate 95% probability of being correct, however the precision statistics obtained in this ILS must not be treated as exact mathematical quantities which are applicable to all circumstances and uses. The limited number of laboratories reporting replicate results essentially guarantees that there will be times when differences greater than predicted by the ILS results will arise, sometimes with considerably greater or smaller frequency than the 95% probability limit would imply. Consider the repeatability limit as a general guide, and the associated probability of 95% as only a rough indicator of what can be expected.

13.2 *Bias*—~~The procedure of this test method provides a test value that can be defined only in terms of this test method. There is no independent, referee method by which bias may be determined. No known bias has been determined~~ At the time of the study, there was no accepted reference material suitable for determining the bias for this test ~~method.~~method, therefore no statement on bias is being made.

13.3 The precision statement was determined through statistical examination of 90 results, from 6 laboratories, on 1 material type.

14. Keywords

14.1 hex-bar abrasion ~~resistance~~resistance; webbing