Standard Test Method for Fiber Cohesion in Sliver and Top (Static Tests)[1]

This standard is issued under the fixed designation D 2612; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method describes the measurement of fiber cohesion as the force required to cause initial drafting in a bundle of fibers in sliver and top. The observed cohesive force required to separate the fibers is converted to cohesive tenacity based on the linear density of the specimen.

NOTE 1—For determination of fiber cohesion in dynamic tests, refer to Test Method D 4120.

1.2 The values stated in SI units or other units (in parentheses) are to be regarded separately as standard. The values in each system are not exact equivalents; therefore, each system shall be used independently of the other without any combination.

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:*

D 76 Specification for Tensile Testing Machines for Textiles[2]
D 123 Terminology Relating to Textiles[2]
D 1776 Practice for Conditioning Textiles for Testing[2]
D 2258 Practice for Sampling Yarn for Testing[2]
D 3333 Practice for Sampling Man-Made Staple Fibers, Sliver, or Tow for Testing[3]
D 4120 Test Method for Fiber Cohesion in Roving, Sliver, and Top in Dynamic Tests[3]
D 4848 Terminology for Force and Deformation Properties of Textiles[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *fiber cohesion*, *n*—the resistance to separation of fibers in contact with one another.

3.1.1.1 *Discussion*—This resistance is due to the combined effects of the surface characteristics, length, crimp, finish, and linear density of the fibers. Cohesion should not be confused with adhesion or sticking together as in a glutinous substance.

3.1.2 *cohesive force, n— in sliver and top testing*, the force required to overcome cohesion of a test specimen held in a fixed position between two slowly separating clamps.

3.1.2.1 *Discussion*—In static tests, cohesive force is measured while a test specimen is held in fixed position between two slowly separating clamps. In dynamic tests, cohesive force is the force required to maintain drafting in a roving, sliver, or top.

3.1.3 For definitions of other terms related to force and deformation in textiles, refer to Terminology D 4848. For definitions of other textile terms used in this test method, refer to Terminology D 123.

TABLE 1 Specimens Required in the User's Laboratory Under Conditions of Unknown Variability Based on Estimated Coefficients of Variation, % of the Average

Fiber	Average Number of Specimens	Basis[A]
Cotton	14	ν = 11.2
Man-made	48	ν = 21.0
Wool	25	ν = 15.0[B]

[A] The values for ν are somewhat larger than will usually be found in practice.
[B] This value is based on the opinions of knowledgable users.

4. Summary of Test Method

4.1 The test procedure is based upon the measure of the maximum resisting force when a length of sliver or top is pulled in an axial direction. Specified lengths of sliver or top are placed in the clamps of a tensile testing machine and the maximum force developed during separation of the clamps is recorded. The cohesive tenacity is calculated in terms of the force per unit linear density of the tested specimen. The cohesive tenacity is considered a measure of the cohesion of the fibers in the specimen and is reported in micronewtons/tex (gf/denier).

5. Significance and Use

5.1 Fiber cohesion is related to the resistance to drafting encountered during textile processing and is affected by such fiber properties as surface lubrication, linear density, surface configuration, fiber length, and crimp.

5.2 Fiber cohesion is affected by the alignment of fiber in sliver in addition to the factors listed in 5.1. A half turn of twist in a 140-mm specimen has been found to increase the breaking

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

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

force by 30 % and a full turn by 60 %. For this reason, care must be exercised in precise mounting of specimens.

5.3 For the same reason given in 5.2, card sliver gives a different breaking tenacity than draw sliver of the same fiber. Fibers are more aligned in draw sliver, resulting in lower cohesion.

5.4 Increasing the gage length of test specimens reduces the breaking force and apparent cohesion.

5.5 The mathematical relationship between the observed value for breaking tenacity and processability has not been established, but the observed values can be used in comparing various fiber characteristics on a relative basis.

5.6 This method for measuring fiber cohesion in sliver or top (static tests) is not recommended for acceptance testing because it is an empirical method which must be followed explicitly. Results obtained under other conditions cannot be expected to be comparable.

5.6.1 In some cases, the purchaser and the supplier may have to test a commercial shipment of one or more specific materials by the best available method, even though the method has not been recommended for acceptance testing of commercial shipments. In case of dispute arising from differences in reported test results when using this test method for acceptance testing of commercial shipments, the purchaser and supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias. As a minimum, the two parties should take a group of test specimens, which are as homogeneous as possible and which are from a lot of material of the type in question. Test specimens then should be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using appropriate statistical analysis and a probability level chosen by the two parties prior to testing. If a bias is found, either its cause must be found and corrected or the purchaser and the supplier must agree to interpret future test results with consideration to the known bias.

6. Apparatus and Material

6.1 *Tensile Testing Machine*, a constant-rate-of-specimen-extension (CRE) type, conforming to Specification D 76, having adequate response characteristics to properly record the load-elongation curve of the sliver under test. The capacity of the machine must be selected for the maximum force to fall within 50 to 90 % of full scale.

6.2 *Balance*, having a capacity of at least 10 g and a sensitivity of 0.01 g.

6.3 *Clamps*, preferably pneumatically operated, with faces at least 12.5 mm (0.5 in.) wider than the test specimen, in the dimension perpendicular to the direction of load application, and at least 25 mm (1.0 in.) in the dimension parallel to the direction of load application.

6.4 *Mounting Template*—A sheet of paper approximately 215 by 280 mm (8.5 by 11 in.), or a longer length when the specimen length exceeds 280 mm with a 75-mm (3.0 in.) diameter hole cut in the center is used as a mounting board. Two gage reference lines, separated by a distance equal to the desired specimen length, are drawn across the short dimension of the paper. The hole is centered between the two reference gage lines.

6.5 *Tape*, cellophane adhesive or masking type, 13-mm (0.5-in.) wide.

7. Sampling

7.1 *Lot Sampling*—As a lot sample for acceptance testing, take at random the number of shipping containers directed in the applicable material specification or other agreement between the purchaser and supplier, such as an agreement to use Practice D 3333 or Practice D 2258. Consider shipping containers to be the primary sampling units.

NOTE 2—An adequate specification or other agreement between the purchaser or supplier requires taking into account the variability between shipping units, between packages, ends or other laboratory sampling unit within a shipping unit if applicable, and within specimens from a single package, end or other laboratory sampling unit to provide a sampling plan with a meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quantity level.

7.2 *Laboratory Sample*—As a laboratory sample for acceptance testing, take at random from each shipping container in the lot sample the number of laboratory sampling units as directed in an applicable material specification or other agreement between purchaser and supplier such as an agreement to use Practice D 3333 or Practice D 2258. Preferably, the same number of laboratory sampling units are taken from each shipping container in the lot sample. If differing numbers of laboratory sampling units are to be taken from shipping containers in the lot sample, determine at random which shipping containers are to have each number of laboratory units drawn.

7.2.1 Each laboratory sampling unit should be at least 100 m (100 yd) long.

7.3 *Test Specimens*—From each laboratory sampling unit, take one specimen. If the standard deviation determined for the laboratory sample is more than a value agreed upon between the purchaser and supplier, continue testing one specimen from each unit in the laboratory sample until the standard deviation for all specimens tested is not more than the agreed to value or, by agreement, stop testing after a specified number.

8. Preparation of Test Specimens

8.1 Take the test specimens at random from the laboratory sample to be tested. Take care that the specimen is neither stretched nor distorted.

8.2 For slivers produced on a short-fiber processing system, such as the cotton system, take specimens having a length equal to the nominal staple length plus 4.0 in. (100 mm). For top produced on a long-fiber system of processing, such as the worsted system, take specimens having a length equal to the fiber length determined from a fiber sorting, plus 4.0 in. (100 mm).

8.2.1 Use the staple length determined by a classer using the hand-stapling technique in the case of cotton, or assigned by the fiber producer to man-made fibers developed for processing on the cotton system. For wool or man-made fibers with great variability in their length distribution and developed for process on a long-fiber system, use the fiber length which is longer than 95 % of the fibers in the specimen.

8.3 Place the test specimen (sliver or top), approximately 12 in. (300 mm) in length or longer when necessary, on the paper mount described in 6.4, parallel to the longer dimension of the paper mount and across the center of the 3.0-in. (approximately 75-mm) diameter hole.

8.4 Fasten the test specimen to the paper mount with strips of adhesive cellophane tape, placed so that the edges of the strips nearer the hole are aligned with the two marks designating the desired specimen length. Fasten the test specimen to the paper mount with as little slack as possible; however, take care to avoid distortion or stretching of specimen. Also, mount the test specimen with no twist in the sliver. By noting the striations in the sliver produced by the card or draw frame trumpet, the specimen can be rotated and placed on the mounting template without twist.

9. Conditioning

9.1 Precondition as directed in Practice D 1776. Bring the specimen to moisture equilibrium in the standard atmosphere for testing textiles, which is 70 ± 2°F (21 ± 1°C) and 65 ± 2 % relative humidity. Assume that moisture equilibrium is reached when two successive weighings made at least 2 h apart differ no more than 0.5 % in weight.

10. Procedure

10.1 Test adequately conditioned specimens in the standard atmosphere for testing textiles.

10.2 Set the crosshead gage length of the textile testing machine 0.5 in. (12.7 mm) shorter than the test specimen length (see 8.2) to allow the test specimen to be placed in the clamps with enough slack to prevent stretching. Adjust the rate of crosshead travel of the testing machine to 10 in. (254 mm)/min. Adjust the rate of chart travel so that the load-extension curve utilizes a distance of at least 2.0 in. (50 mm) along the extension axis of the chart.

10.3 Place the test specimen in the clamps of the testing machine in such a manner that the innermost edge of one of the adhesive strips holding the test specimen to the paper mount is aligned with the bottom edge of the top clamp. Align the innermost edge of the second adhesive strip with the top edge of the bottom clamp. With a pair of shears, cut across the 8.5-in. (215-mm) dimension of the paper mount on a line with the center of the hole so that the paper mount is completely severed, leaving only the test specimen subject to load application. Operate the machine to make a load-extension curve of the test specimen. From this curve read the cohesive force to the nearest 0.1 gf from the maximum point of the curve along the load axis of the chart.

10.4 Remove the broken portions of the test specimen from the clamps. Sever each portion along the innermost edges of the adhesive strips and weigh both portions, recording the weight to the nearest 0.01 g.

11. Calculation

11.1 Calculate the drafting tenacity of individual specimens in milligrams-force per tex (Note 3) using Eq 1 as follows:

$$DT = F \times L/1000\ M \quad (1)$$

where:

DT = drafting tenacity, mgf/tex,
F = cohesive force, gf,
L = specimen length, mm, and
M = specimen mass, g.

NOTE 3—To calculate breaking tenacity in micronewtons per tex (μN/tex), multiply milligrams-force per tex (mgf/tex) by 9.81.

11.2 Calculate the average cohesive force of all specimens to the nearest 1 mgf/tex.

11.3 If requested, calculate the standard deviation or coefficient of variation, or both, for each set of test specimens.

12. Report

12.1 State that the specimens were tested as directed in ASTM Test Method D 2612. Describe the material(s) or product(s) sampled and the method of sampling used. Include fiber type, staple length, nominal linear density of the fibers in the sliver or top, crimp of the fibers (if known), and type of sliver (card or draw).

12.2 Report the following information:

12.2.1 Number of specimens tested,

12.2.2 The cohesive force and the drafting tenacity for each laboratory sampling unit and for the lot, and

12.2.3 Coefficient of variation for each set of test specimens, if calculated.

12.2.4 Any modification to the test.

13. Precision and Bias

13.1 *Test Data*—No recent interlaboratory test has been conducted using this method. A test was run on two materials by one operator. The components of variance, expressed as coefficients of variation, are given in Table 2.

13.2 *Precision*—For the components of variance listed in Table 2, two averages of observed values should be considered significantly different at the 90 % probability level if the difference equals or exceeds the critical differences given in Table 3.

NOTE 4—The tabulated values of the critical differences should be considered to be a general statement, particularly with respect to between-laboratory precision. Before a meaningful statement can be made about two specific laboratories, the amount of statistical bias, if any, between them must be established, with each comparison being based on recent data obtained on randomized specimens from one sample of the material to be tested.

13.3 *Bias*—The value for the cohesive force and drafting tenacity only can be defined in terms of a specific test method. Within this limitation, Test Method D 1612 has no known bias.

14. Keywords

14.1 fiber cohesion; textile fibers; textile strand

TABLE 2 Components of Variance as Coefficients of Variation, % of the Average

Fiber	Single-Operator Component
Cotton	8.0
Man-made	15.0

TABLE 3 Critical Differences,[A,B] % of the Grand Average, for the Conditions Noted

Fiber	Number of Observations in Each Average	Single-Operator Precision
Cotton	1	18.6
	5	8.3
	10	5.9
	25	3.7
Man-made	1	34.9
	5	15.6
	10	11.0
	25	7.0

[A] The critical differences were calculated using $t = 1.645$, the standard normal deviate for the 90 % probability level.

[B] To convert the tabulated values of the critical differences to units of measure, multiply the average of the two specific sets of data being compared and divide by 100.