



Designation: D 2524 – 95 (Reapproved 2003)

Standard Test Method for Breaking Tenacity of Wool Fibers, Flat Bundle Method— $\frac{1}{8}$ -in. (3.2-mm) Gage Length¹

This standard is issued under the fixed designation D 2524; 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 covers the determination of the breaking tenacity of wool fibers as a flat bundle with a $\frac{1}{8}$ -in. (3.2-mm) clamp separation.

1.2 This test method is especially adapted to the fiber bundle clamps and strength testing instruments specified, but may be used on other tensile testing machines when equipped with appropriate adapters to accommodate the prescribed clamps.

1.3 This test method is applicable to wool in any form which can be hand-combed into small bundles of parallelized fibers.

NOTE 1—Other test methods for measuring breaking tenacity of fiber bundles include Test Methods D 1294, D 1445, and D 540.

1.4 *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.*

1.5 The values stated in inch-pound units are to be regarded as the standard. The SI units in parentheses are provided for information only.

2. Referenced Documents

2.1 ASTM Standards:

D 123 Terminology Relating to Textiles²

D 540 Testing Man-Made Staple Fibers³

D 1294 Test Method for Tensile Strength and Breaking Tenacity of Wool Fiber Bundles—1-in. (25.4-mm). Gage Length²

D 1445 Test Method for Breaking Strength and Elongation of Cotton Fibers (Flat Bundle Method)²

D 1776 Practice for Conditioning Textiles for Testing²

D 2525 Practice for Sampling Wool for Moisture²

¹ This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.13 on Wool and Felt.

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² Annual Book of ASTM Standards, Vol 07.01.

³ Discontinued—See 1973 Annual Book of ASTM Standards, Part 25.

3. Terminology

3.1 Definitions:

3.1.1 *breaking tenacity, n*—the tenacity corresponding to the breaking load.

3.1.1.1 *Discussion*—Breaking tenacity is commonly expressed as grams-force per tex (gf/tex), grams-force per denier (gf/den), millinewtons per tex (mN/tex), or millinewtons per denier (mN/den). Millinewtons are numerically equal to the grams-force times 9.81.

3.1.2 *constant-rate-of-extension (CRE) type tensile testing machine, n*—in tensile testing, an apparatus in which the pulling clamp moves at a uniform rate, and the force-measuring mechanism moves a negligible distance with increasing force, less than 0.13 mm (0.005 in.).

3.1.3 *constant-rate-of-loading (CRL) type tensile testing machine, n*—in tensile testing, an apparatus in which the rate of increase of the force is uniform with time after the first 3 s and the specimen is free to elongate, this elongation being dependent on the extension characteristics of the specimen at any applied force.

3.1.4 *constant-rate-of-traverse (CRT) type tensile testing machine, n*—in tensile testing, an apparatus in which the pulling clamp moves at a uniform rate and the force is applied through the other clamp, which moves appreciably to actuate a force-measuring mechanism, producing a rate of increase of force or extension that is usually not constant and is dependent on the extension characteristics of the specimen.

3.1.5 *gage length, n*—in tensile testing, the length of a specimen measured between the points of attachment to clamps while under uniform tension.

3.1.6 *tenacity, n*—in a tensile test, the force exerted on the specimens based on the linear density of the unstrained specimen.

3.1.6.1 *Discussion*—In textiles, tenacity is considered a property of fabrics and yarns, and tensile strain is the complementary property of fabrics. In direct yarn numbering systems, tenacity is force divided by linear density. In indirect yarn numbering systems, tenacity is force times the reciprocal linear density.

3.1.7 *wool, n*—the fibrous covering of sheep, *Ovis* species.

3.1.7.1 *Discussion*—For the purposes of this method, the word *wool* is used in the generic sense, and includes reprocessed and reused wool as well as *wool* as defined in the *Wool Products Labeling Act* of 1939: “the fiber from the fleece of the sheep or lamb, or hair of the Angora goat or Cashmere goat (and may include the so called specialty fibers from the hair of the camel, alpaca, llama, and vicuna) which has never been reclaimed from any woven or felted wool product.”

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

4. Summary of Test Method

4.1 A bundle of fibers is combed until parallel, placed under a uniform tension sufficient to remove as much crimp as possible without stretching the fibers, and secured in special clamps. The fibers are then cut to a known length, broken in the tensile testing machine, removed from the clamps, and weighed. Breaking tenacity is calculated from the ratio of breaking force to bundle linear density. The length measured under the applied tension is the basis for computing linear density from bundle mass.

5. Significance and Uses

5.1 Test Method D 2524 for testing wool fibers for tenacity is considered satisfactory for acceptance testing when the participating laboratories, using a reference wool, have shown acceptable between-laboratory precision. It is recommended that any program of acceptance testing be preceded by an interlaboratory check in the laboratory of the purchaser and the laboratory of the seller on replicate specimens of samples of the material to be evaluated. In cases of dispute, the statistical bias, if any, between the laboratory of the purchaser and the seller should be determined with each comparison being based on testing randomized specimens from one sample of material of the type being evaluated.

5.2 Values obtained from flat bundle tenacity show a good correlation with values obtained from single fiber tests and require much less time.

5.3 The basic differences between the procedures described in Test Method D 2524 and those described in Test Method **D 1294** lie in the manner of clamping the bundles and the shorter gage length employed. The special clamps used in this method allow quicker and easier bundle preparation; however, for Test Method **D 1294** no special clamps are required. Closer agreement with single fiber tenacity is also obtained with Test Method D 2524 than when using the procedure in Test Method **D 1294**.

5.4 As the observed tenacity of fibers depends in part on the type of tensile testing machine used and the time required to break the specimen, results obtained with the different types of machines which may be used in this method will not necessarily agree. The machines specifically designed for bundle testing are CRL testers which operate at a loading rate of 1 kgf/s and therefore reach the breaking force at variable times in the order of 5 s. CRE and CRT type machines would be expected to produce somewhat different results not only because of the inherent difference in operation but because CRE and CRT type machines are to be operated at a rate to achieve the breaking load in 20 s.

6. Apparatus and Materials

6.1 *Tensile Testing Machine*, having a capacity of at least 7 kgf (70 N), equipped to accommodate the specified flat bundle clamps. For CRL testing machines,⁴ the rate of loading is specified as 1 kgf/s (10 N/s). For CRE and CRT machines, select a rate of operation which will reach the breaking force in an average time of 20 ± 3 s.

6.1.1 In case the CRE or CRT testing machine is not capable of operating as specified in **6.1**, select a rate so as to reach the breaking force in an average time as close to 20 s as possible and report the average time to break.

NOTE 2—There may be no overall correlation between the results obtained with the CRE, CRT or CRL type testing machines. Consequently, these three machines cannot be used interchangeably.

6.2 *Balance*, suitable for weighing 2 to 6 mg with a sensitivity of 0.02 mg.

6.3 *Flat Bundle Clamps and Accessories*, including the following components:

NOTE 3—Pressley clamps and accessories have been found satisfactory for this purpose.⁵ Adapters to fit the clamps to various tensile testing instruments are also available or can be fabricated.

6.3.1 *Clamps*, having a total thickness of 0.465 ± 0.001 in. (11.8 ± 0.03 mm) and a 0.125 ± 0.001 -in. (3.2 ± 0.03 -mm) spacer.

6.3.2 *Clamp Vise*, with a device to indicate approximately 8 lbf-in. (0.9 N-m) torque.

6.3.3 *Clamp Wrench*.

6.4 *Coarse Comb*, approximately 8 teeth per in. (3 per 10 mm).

6.5 *Fine Comb*, approximately 50 teeth per in. (20 per 10 mm).

6.6 *Black Paper*, to hold bundles.

6.7 *Shearing Knife or Razor Blade*.

6.8 *Tweezers*.

6.9 *Torque Wrench or Friction Disk Wrench*, to indicate approximately 8 lbf-in. (0.9 N-m) torque (optional).

6.10 *Standard Wool Top Sample*⁶, having an assigned breaking tenacity of 11.4 gf/tex (112 mN/tex).

NOTE 4—The standard wool top sample, USDA Lot 58-27, has a breaking tenacity (based on single fiber tests) of 11.4 ± 0.6 gf/tex, at the 95 % probability level.

7. Sampling

7.1 *Division into Lots*—Treat a single shipment of a single fiber type as a lot.

7.2 *Lot Sample*—As a lot sample for acceptance testing, take at random the number of shipment containers directed in an applicable material specification or other agreement between the purchaser and the supplier, such as an agreement to use Practice **D 2525**. Consider shipping containers to be the primary sampling units.

⁴ The Stelometer, manufactured by the Special Instruments Laboratory, Inc., 312 W. Vine St., Knoxville, TN 37901; and the Clemson Tester (no longer available) have been found satisfactory for this purpose.

⁵ Available from J. M. Doebrich and Co., P. O. Box 2789, Tucson, AZ 85702.

⁶ Available from the Wool and Mohair Laboratory, Livestock and Seed Division, AMS, U.S. Department of Agriculture, 711 “O” Street, Gaithersburg, MD 20878.