Designation: D 2261 – 96

Standard Test Method for Tearing Strength of Fabrics by the Tongue (Single Rip) Procedure (Constant-Rate-of-Extension Tensile Testing Machine)[1]

This standard is issued under the fixed designation D 2261; 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 measurement of the tearing strength of textile fabrics by the tongue (single rip) procedure using a recording constant-rate-of-extension-type (CRE) tensile testing machine.

1.1.1 The CRE-type tensile testing machine has become the preferred test apparatus for determining tongue tearing strength. It is recognized that some constant-rate-of-traverse-type (CRT) tensile testing machines continue to be used. As a consequence, these test instruments may be used when agreed upon between the purchaser and the supplier. The conditions for use of the CRT-type tensile tester are included in Appendix X1.

1.2 This test method applies to most fabrics including woven fabrics, air bag fabrics, blankets, napped fabrics, knit fabrics, layered fabrics, pile fabrics. The fabrics may be untreated, heavily sized, coated, resin-treated, or otherwise treated. Instructions are provided for testing specimens with or without wetting.

1.3 Tear strength, as measured in this test method, requires that the tear be initiated before testing. The reported value obtained is not directly related to the force required to initiate or start a tear.

1.4 Two calculations for tongue tearing strength are provided: the single-peak force and the average of five highest peak forces.

1.5 The values stated in either SI units or inch-pound units are to be regarded as the standard. The inch-pound units may be approximate.

1.6 *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 629 Test Methods for Quantitative Analysis of Textiles[2]

D 1776 Practice for Conditioning Textiles for Testing[2]

D 2904 Practice for Interlaboratory Testing of a Textile Test Method That Produces Normally Distributed Data[2]

D 2906 Practice for Statements on Precision and Bias for Textiles[2]

D 4848 Terminology of Force, Deformation and Related Properties of Textiles[3]

2.2 ASTM Adjuncts:

TEX-PAC[4]

3. Terminology

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *cross-machine direction, CD, n*—the direction in the plane of the fabric perpendicular to the direction of manufacture.

3.2.1.1 *Discussion*—This term is used to refer to the direction analogous to crosswise or filling direction in woven fabrics.

3.2.2 *fabric, in textiles, n*—a planar structure consisting of yarns or fibers.

3.2.3 *machine direction, MD, n*—the direction in the plane of the fabric parallel to the direction of manufacture.

3.2.3.1 *Discussion*—This term is used to refer to the direction analogous to lengthwise or warp direction in woven fabrics.

3.2.4 *peak force, in tear testing of fabrics, n*—the maximum force required to break one or more yarn components in a woven or knitted fabric specimen, or break the fiber, the fiber bonds, or fiber interlocks in other manufactured fabric forms.

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[1] This test method is under the jurisdiction of ASTM Committee D-13 on Textiles and is the direct responsibility of Subcommittee D13.60 on Fabric Test Methods, Specific.

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

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

[4] A PC program on floppy disk for analyzing Committee D-13 interlaboratory data are available from ASTM Headquarters. For a 3½-in. disk, request PCN:12-429040-18. For a 5¼-in. disk, request PCN:12-429041-18.

3.2.4.1 *Discussion*—The peak force may consist of a single peak or a series of peaks depending upon the nature of the fabric. Typically for woven fabrics, if a small decrease in force occurs at a time when the force is increasing, it is not considered to peak unless the indicated force exceeds the force required to break a yarn. Lower shifts corresponding to yarn movement do not qualify as peaks since no yarns are broken.

3.2.5 *tearing force, in fabric, n*—the force required to propagate a tear initiated under specified conditions.

3.2.5.1 *Discussion*—The tongue tearing force may be calculated from a single-peak or a multiple-peak force-extension curve.

3.2.6 *tearing strength, in fabrics, n*—the capacity of a fabric to withstand the tearing force required to propagate a tear after its initiation.

4. Summary of Test Method

4.1 A rectangular specimen, cut in the center of a short edge to form a two-tongued (trouser shaped) specimen, in which one tongue of the specimen is gripped in the upper jaw and the other tongue is gripped in the lower jaw of a tensile testing machine. The separation of the jaws is continuously increased to apply a force to propagate the tear. At the same time, the force developed is recorded. The force to continue the tear is calculated from autographic chart recorders or microprocessor data collection systems.

5. Significance and Use

5.1 This test method is considered satisfactory for acceptance testing of commercial shipments since current estimates of between-laboratory precision are acceptable, and the test method is used extensively in the trade for acceptance testing.

5.1.1 In case of a dispute arising from differences in reported test results when using this test method for acceptance testing of commercial shipments, the purchaser and the 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 that are as homogeneous as possible and that are from a lot of fabric 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 the appropriate statistical analysis and an acceptable probability level chosen by the two parties before testing is begun. 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.

5.2 The force registered in a tear test is irregular, and as a consequence, empirical methods have had to be developed to obtain usable values related to tear strength. In spite of the empirical nature of the reported values, the values are considered to reflect comparative performance of similar fabrics tested and measured in the same way. No known procedure is available that can be used with all fabrics to determine the minimum tearing strength.

5.3 Depending on the nature of the specimen, the data recording devices will show the tearing force in the form of a peak or peaks. The highest peaks appear to reflect the strength of the yarn components, fiber bonds, or fiber interlocks, individually or in combination, needed to stop a tear in a fabric of the same construction. The valleys recorded between the peaks have no specific significance. The minimum tearing force, however, is indicated to be above the lowest valleys.

5.4 Most textile fabrics can be tested by this test method. Some modification of clamping techniques may be necessary for a given fabric due to its structure. Strong fabrics or fabrics made from glass fibers usually require special adaptation to prevent them from slipping in the clamps or being damaged as a result of being gripped in the clamps.

5.5 The CRE-type is the preferred tensile testing machine. This test method allows the use of the CRT-type tensile machine when agreed upon between the purchaser and the supplier. There may be no overall correlation, however, between the results obtained with the CRT-type machine and the CRE-type machine. Consequently, these two tensile testers cannot be used interchangeably unless the degree of quantitative correlation has been established between the purchaser and the supplier. In any event, the CRE-type machine shall prevail.

6. Apparatus

6.1 *Tensile Testing Machine*, of the CRE-type conforming to the requirements of Specification D 76 with autographic recorder, or automatic microprocessor data gathering system.

6.2 *Clamps*, having all jaw surfaces parallel, flat, and capable of preventing slipping of the specimen during a test, and measuring at least 25 by 75 mm (1 by 3 in.) with the longer dimension perpendicular to the direction of application of the force.

6.2.1 The use of hydraulic pneumatic clamping systems with a minimum of 50 by 75-mm (2 by 3-in.) serrated or rubber jaw faces having a clamping force at the grip faces of 13 to 14 kN (2900 to 3111 lbf) is recommended. Manual clamping is permitted providing no slippage of the specimen is observed.

6.2.2 For some materials, to prevent slippage when using jaw faces other than serrated, such as rubber-faced jaws, the jaw faces may be covered with a No. 80 to 120 medium-grit emery cloth. Secure the emery cloth to the jaw faces with pressure-sensitive tape.

6.3 *Cutting Die or Template*, having essentially the shape and dimensions shown in Fig. 1.

7. Sampling and Test Specimens

7.1 *Lot Sample*—As a lot sample for acceptance testing,

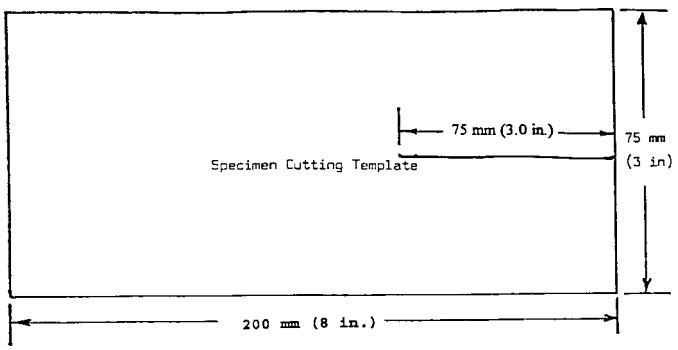

FIG. 1 Template for Marking and Cutting Tongue Tear Specimens, All Tolerances ±0.5 %

randomly select the number of rolls or pieces of fabric directed in an applicable material specification or other agreement between the purchaser and the supplier. Consider the rolls or pieces of fabric to be the primary sampling units. In the absence of such an agreement, take the number of fabric rolls specified in Table 1.

NOTE 1—An adequate specification or other agreement between the purchaser and the supplier requires taking into account the variability between rolls or pieces of fabric and between specimens from a swatch from a roll or piece of fabric to provide a sampling plan with a meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.2 *Laboratory Sample*—For acceptance testing, take a swatch extending the width of the fabric and approximately 1 m (1 yd) along the machine direction from each roll or piece in the lot sample. For rolls of fabric, take a sample that will exclude fabric from the outer wrap of the roll or the inner wrap around the core of the roll of fabric.

7.3 *Test Specimens*—From each laboratory sampling unit, take five specimens from the machine direction and five specimens from the cross-machine direction, for each test condition described in 9.1 and 9.2, as applicable to a material specification or contract order.

7.3.1 *Direction of Test*—Consider the short direction as the direction of test.

7.3.2 *Cutting Test Specimens*—Cut rectangular specimens 75 by 200 mm (3 by 8 in.). Use the cutting die or template described in 6.3 and shown in Fig. 1. Take the specimens to be used for the measurement of machine direction with the longer dimension parallel to the cross-machine direction. Take the specimens to be used for the measurement of the cross-machine direction with the longer dimension parallel to the machine direction. Make a preliminary cut 75 mm (3 in.) long at the center of the 75-mm (3-in.) width as shown in Fig. 1. When specimens are to be tested wet, take the specimens from areas adjacent to the dry test specimens. Label to maintain specimen identity.

7.3.2.1 In cutting the specimens, take care to align the yarns running in the long direction parallel with the die such that when the slit is cut, the subsequent tear will take place between these yarns and not across them. This precaution is most important when testing bowed fabrics.

7.3.2.2 Take specimens representing a broad distribution across the width and length, preferably along the diagonal of the laboratory sample, and no nearer the edge than one tenth its width. Ensure specimens are free of folds, creases, or wrinkles. Avoid getting oil, water, grease, and so forth, on the specimens when handling.

8. Preparation of Test Apparatus and Calibration

8.1 Set the distance between the clamps at the start of the test at 75 ± 1 mm (3.0 ± 0.05 in.).

TABLE 1 Number of Rolls or Pieces of Fabric in the Lot Sample

Number of Rolls or Pieces in Lot, Inclusive	Number of Rolls or Pieces in Lot Sample
1 to 3	all
4 to 24	4
25 to 50	5
over 50	10 % to a maximum of 10 rolls or pieces

8.2 Select the full-scale force range of the testing machine such that the maximum force occurs between 10 and 90 % of full-scale force.

8.3 Set the testing speed to 50 ± 2 mm/min (2 ± 0.1 in./min). When agreed upon between the purchaser and the supplier, the testing speed may be set to 300 ± 10 mm/min (12 ± 0.5 in./min).

8.4 Verify calibration of the tensile testing machine as directed in the manufacturer's instructions.

8.5 When using microprocessor automatic data gathering systems, set the appropriate parameters as specified in the manufacturer's instructions and Specification D 76.

9. Conditioning

9.1 *Condition 1, Standard Testing Conditioning*:

9.1.1 Precondition the specimens by bringing them to approximate moisture equilibrium in the standard atmosphere for preconditioning textiles as specified in Practice D 1776, unless otherwise specified in a material specification or contract order.

9.1.2 After preconditioning, bring the test specimens to moisture equilibrium for testing in the standard atmosphere for testing textiles as specified in Practice D 1776 or, if applicable, in the specified atmosphere in which the testing is to be performed, unless otherwise specified in a material specification or contract order.

9.2 *Condition 2, Wet Specimen Testing Conditioning*:

9.2.1 When desizing treatments are specified prior to wet testing, use desizing treatments that will not affect the normal physical property of the fabric as specified in Test Method D 629.

9.2.2 Submerge the specimens in a container of distilled or deionized water at ambient temperature until thoroughly soaked (see 9.2.2.1).

9.2.2.1 The time of immersion must be sufficient to wet out the specimens as indicated by no significant change in tearing force followed by longer periods of immersion. For most fabrics this time period will be about 1 h. For fabrics not readily wet out with water, such as those treated with water-repellent or water-resistant materials, add a 0.1 % solution of a nonionic wetting agent to the water bath.

10. Procedure

10.1 Test the conditioned specimens in the standard atmosphere for testing textiles, which is 21 ± 1°C (70 ± 2°F) and 65 ± 2 % relative humidity, unless otherwise specified in a material specification or contract order.

10.2 Secure the specimen in the clamp jaws with the slit edge of each tongue centered in such a manner that the originally adjacent cut edges of the tongues form a straight line joining the centers of the clamps and the two tongues present opposite faces of the fabric to the operator.

10.2.1 For wet testing, remove a specimen from the water, and immediately mount it on the testing machine in the normal setup. Perform the test within 2 min after removal of the specimen from the water. If more than 2 min elapse between taking the wet specimen from the water bath and starting the tensile testing machine, discard the specimen and take another.

10.3 Start the machine and record the tearing force on the

recording device. The tearing force may increase to a simple maximum value, or may show several maxima and minima, as shown in Fig. 2.

10.4 After the crosshead has moved to produce approximately 6 mm (0.25 in.) of fabric tear, record the single-peak force or multiple-peak forces, as indicated for the type fabric and tearing action observed. Stop the crosshead motion after a total tear of approximately 75 mm (3 in.) or the fabric has torn completely, and return the crosshead to its starting position.

10.4.1 If a fabric slips in the jaws or if 25 % or more of the specimens break at a point within 5 mm (0.25 in.) of the edge of the jaw, then (*1*) the jaws may be padded; (*2*) the fabric may be coated under the jaw face area; or (*3*) the jaw face may be modified. If any of the preceding modifications are used, state the method of modification in the report.

10.4.2 If 25 % or more of the specimens break at a point within 5 mm (0.25 in.) of the edge of the jaw or does not tear substantially lengthwise after making the modifications described in 9.9, consider the fabric untearable by this test method.

10.5 Record if the tear occurs crosswise to the direction of applied force.

10.6 Remove the tested specimen and continue as directed in 10.2-10.5 until five specimens have been tested for each testing direction and condition from each laboratory sampling unit.

11. Calculation

11.1 *Tearing Force, Individual Specimens*—Calculate the tongue tearing force for individual specimens to the nearest 0.1 mN (0.1 lbf) using readings directly from the data collection system using Option 1 or Option 2 as indicated by the tearing action of the material, unless otherwise agreed upon between the purchaser and the supplier.

11.1.1 *Option 1, Average of Five Highest Peaks*:

11.1.1.1 For fabrics exhibiting five peaks or more, after the first 6 mm (0.25 in.) of tear, determine the five highest peak forces to the nearest 0.1 mN (0.1 lbf).

11.1.1.2 Calculate the average of these five highest peak forces.

11.1.2 *Option 2 Single-Peak Force*—For fabrics exhibiting less than five peaks, record the highest peak force as the single-peak force to the nearest 0.1 mN (0.1 lbf).

11.2 *Tearing Strength*—Calculate the tongue tearing strength as the average tearing force for each testing direction and condition for each laboratory sampling unit and for the lot.

11.3 *Standard Deviation, Coefficient of Variation*—Calculate when requested.

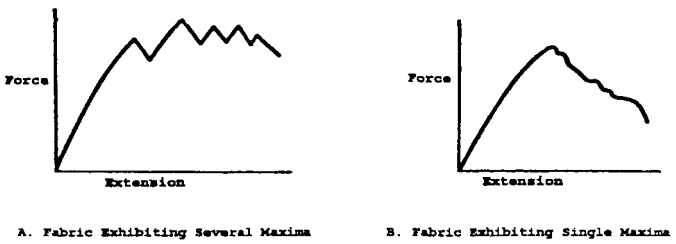

FIG. 2 Typical Tongue Tearing Force-Extension Curves for Individual Specimens

11.4 *Computer-Processed Data*—When data are automatically computer-processed, calculations generally are contained in the associated software. Record values as read from the direct-reading scale to the nearest 0.1 mN (0.1 lbf). In any event, 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 tongue tearing strength was determined in accordance with Test Method D 2261. Describe the material or product sampled and the method of sampling used.

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

12.2.1 Tongue tearing strength for each testing direction and condition as requested.

12.2.2 Calculation option used, single-peak force or average of five highest peak forces.

12.2.3 Condition of the specimens when tested with or without wetting.

12.2.4 When calculated, the standard deviation or the coefficient of variation.

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

12.2.6 Make, model, and capacity of testing machine.

12.2.7 Type of clamps used.

12.2.8 Any modification of this test method.

13. Precision and Bias

13.1 *Summary*—In comparing two averages, the differences should not exceed the single-operator precision values shown in Table 2 for the respective number of tests in and for materials having averages similar to those shown in Table 3 for the respective number of tests and for fabrics having averages similar to those shown in Table 2 95 out of 100 cases when all the observations are taken by the same well-trained operator using the same piece of equipment and specimens randomly drawn from the sample of material. Larger differences are likely to occur under all other circumstances.

TABLE 2 Tongue Tear Strength, lb Critical Differences for the Conditions Noted[A]

Materials[B]	Number of Observations in Each Average	Single-Operator Precision	Within-Laboratory Precision	Between-Laboratory Precision
S/1016H, Material 2	1	1.85	2.38	2.64
	2	1.31	1.99	2.29
	5	0.83	1.71	2.05
	10	0.59	1.60	1.97
S/28305, Material 7	1	10.55	11.55	19.77
	2	7.46	8.79	18.31
	5	4.72	6.62	17.38
	10	3.34	5.72	17.05
S/9407R, Material 12	1	5.74	5.74	6.43
	2	4.06	4.06	4.99
	5	2.57	2.57	3.88
	10	1.82	1.82	3.43

[A] The critical differences were calculated using $t = 1.960$, which is based on infinite degrees of freedom.

[B] Refer to 13.2 for additional description.

TABLE 3 Tongue Tear Strength, lb

Materials[A]	Grand Average	Components of Variance Expressed as Standard Deviations[B]		
		Single-Operator Component	Within-Laboratory Component	Between-Laboratory Component
Woven Fabrics				
S/1016H, Material 2	5.3	0.41	0.54	0.67
S/28305, Material 7	54.4	3.81	1.68	5.79
S/9407R, Material 12	13.7	2.07	0.00	1.04

[A] Refer to 13.2 for additional description.

[B] The square roots of the components of variance are being reported to express the variability in the appropriate units of measure rather than as the squares of those units of measure.

13.2 *Interlaboratory Test Data*—An interlaboratory test was run in 1994–1995 in which randomly drawn samples of three materials were tested in each of five laboratories. Two operators in each laboratory each tested eight specimens of each fabric using this test method. Four of the eight specimens were tested on one day, and four specimens were tested on a second day. Analysis of the data was conducted in accordance with Practices D 2904 and D 2906 and the adjunct Tex-Pac. The components of variance for tongue tear strength expressed as standard deviations were calculated to be the values listed in Table 3. The three fabric types were:

Material 2—S/1016H, 2/1 Basket Plain Weave Sheeting, With Spun Yarns
Material 7—S/28305, Plain Weave, Continuous Filament Yarns
Material 12—S/9407R, Plain Weave

13.3 *Precision*—For the components of variance reported in Table 3, two averages of observed values should be considered significantly different at the 95 % probability level if the difference equals or exceeds the critical differences listed in Table 2 for tongue tear strength. There were sufficient differences related to the fabric type and structure to warrant listing the components of variance and the critical differences separately. Consequently, no multi-fabric comparisons were made.

NOTE 2—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 specimens taken from a lot of fabric to the type being evaluated so as to be as nearly homogeneous as possible, and then randomly assigned in equal numbers to each of the laboratories.

13.4 *Bias*—The value of tongue tear strength can only be defined in terms of a test method. Within this limitation, this test method has no known bias.

14. Keywords

14.1 fabric; strength; tearing tongue

APPENDIX

(Nonmandatory Information)

X1. CONDITIONS WHEN USING CRT-TYPE TENSILE TESTERS

X1.1 General

X1.1.1 The following information is provided for determining tongue tearing strength using the CRT-type tensile tester with this test method. See 1.1.1.

X1.1.2 *Tensile Testing Machine*, of the CRT type conforming to the requirements of Specification D 76 with autographic recorder, or automatic microprocessor data gathering systems.

X1.1.3 Set the testing speed to 300 ± 10 mm/min (12 ± 0.5 in./min). Disengage the pawls from the rachet to render them inoperative.

X1.1.4 Report that the tongue tearing test was determined using a CRT-type tensile tester.