Designation: D5035 – 11 (Reapproved 2019)

Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)[1]

This standard is issued under the fixed designation D5035; 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 raveled strip and cut strip test procedures for determining the breaking force and elongation of most textile fabrics. Provision is made for wet testing.

1.1.1 The raveled strip test is applicable to woven fabrics while the cut strip test is applicable to nonwoven fabrics, felted fabrics, and *dipped* or coated fabrics.

1.2 This test method is not recommended for knitted fabrics or for other textile fabrics which have high stretch (more than 11 %).

NOTE 1—For the determination of the breaking force and elongation of textile fabrics using the grab test and modified grab test procedures, refer to Test Method D5034.

NOTE 2—For determination of the breaking force and elongation of some specific types of fabrics which use the strip test, refer to Specifications D579 and D580.

1.3 This test method shows the values in both inch-pound units and SI units. Inch-pound units is the technically correct name for the customary units used in the United States. SI units is the technically correct name for the system of metric units known as the International System of Units. The values stated in either acceptable metric units or in other units shall be regarded separately as standard. The values expressed in each system may not be exact equivalents; therefore, each system must be used independently of the other, without combining in any way.

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

1.5 *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]

D76 Specification for Tensile Testing Machines for Textiles
D123 Terminology Relating to Textiles
D579 Specification for Greige Woven Glass Fabrics
D580 Specification for Greige Woven Glass Tapes and Webbings
D629 Test Methods for Quantitative Analysis of Textiles
D1776 Practice for Conditioning and Testing Textiles
D4848 Terminology Related to Force, Deformation and Related Properties of Textiles
D4849 Terminology Related to Yarns and Fibers
D4850 Terminology Relating to Fabrics and Fabric Test Methods
D5034 Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)

3. Terminology

3.1 For definitions of textile terms used in this test method: breaking force, elongation, tensile test, refer to Terminology D4848.

3.2 For definitions of textile terms used in this test method: constant-rate-of-extension, constant rate of load, constant rate of traverse, refer to Terminology D4849.

3.3 For definitions of textile terms used in this test method: cut strip test, raveled strip test, strip test, refer to Terminology D4850.

3.4 For other textile terms used in this test method, refer to Terminology D123.

[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.

4. Summary of Test Method

4.1 A test specimen is clamped in a tensile testing machine and a force applied to the specimen until it breaks. Values for the breaking force and elongation of the test specimen are obtained from machine scales, dials, autographic recording charts, or a computer interfaced with the testing machine.

4.2 This test method describes procedures for carrying out fabric tensile tests using four types of specimen, and three alternative types of testing machines. For reporting, use the following system to identify specific specimen and machine combinations.

4.2.1 *Type of specimen:*

4.2.1.1 1R—25 mm (1.0 in.) raveled strip test

4.2.1.2 2R—50 mm (2.0 in.) raveled strip test

4.2.1.3 1C—25 mm (1.0 in.) cut strip test

4.2.1.4 2C—50 mm (2.0 in.) cut strip test

4.2.2 *Type of tensile testing machine:*

4.2.2.1 E—constant-rate-of-extension (CRE)

4.2.2.2 L—constant-rate-of-load (CRL)

4.2.2.3 T—constant-rate-of-traverse (CRT)

4.2.3 Possible combinations can be identified as follows:

	Type of Tester		
Test Specimen	Constant-Rate-of-Extension	Constant-Rate-of-Load	Constant-Rate-of-Traverse
25-mm (1-in.) raveled strip	1R-E	1R-L	1R-T
50-mm (2-in.) raveled strip	2R-E	2R-L	2R-T
25-mm (1-in.) cut strip	1C-E	1C-L	1C-T
50-mm (2-in.) cut strip	2C-E	2C-L	2C-T

4.2.3.1 For example, 1R-E refers to a 25-mm (1-in.) raveled strip test carried out on a constant-rate-of-extension tensile testing machine.

5. Significance and Use

5.1 The raveled strip test in this test method is considered satisfactory for acceptance testing of commercial shipments of woven textile fabrics because the method has been used extensively in the trade for acceptance testing. The same is true for the cut strip test for felted or nonwoven textile fabrics.

5.1.1 If there are differences of practical significance between reported test results for two laboratories (or more), comparative test should be performed to determine if there is a statistical bias between them, using competent statistical assistance. At a minimum, use the samples for such a comparative test that are as homogeneous 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, 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 for that material must be adjusted in consideration of the known bias.

5.2 The method is not recommended for knitted fabrics because of their high stretch.

5.3 Some modification of the techniques may be necessary for any fabric having a strength in excess of 200 N/cm (1140 lbf/in.) width. Special precautionary measures are provided for use when necessary with strong fabrics, or fabrics made from glass fibers (see Specification D579), to prevent them from slipping in the clamps or being damaged as a result of being gripped in the clamps.

5.4 All of the procedures are applicable for testing fabrics either conditioned or wet.

5.5 Comparison of results from tensile testing machines operating on different principles is not recommended. When different types of machines are used for comparison testing, constant time-to-break at 20 ± 3 s is the established way of producing data. Even then the data may differ significantly.

5.6 Although a constant-rate-of-extension tensile testing machine is preferred in these methods, in cases of dispute, unless there is agreement to the contrary between the purchaser and supplier, a constant-time-to-break (20 ± 3 s) is to be used.

5.7 The raveled strip procedure is applicable to the determination of the force required to break a specific width of fabric. The breaking force information on woven fabrics is particularly useful for comparison of the effective strength of the yarns in the fabric with the combined strength of an equal number of the same yarns which are not woven. The procedure is not recommended for fabrics having fewer than 20 yarns across the width of the specimen. If a 20-yarns-per-specimen width cannot be obtained with a 25-mm (1-in.) strip, a 50-mm (2-in.) strip should be used. In general, the observed force for a 50-mm (2-in.) specimen is not double the observed force for a 25-mm (1-in.) specimen and the results should be reported as observed on a 50-mm (2-in.) strip without mathematical adjustment to 25 mm (1 in.). If a fabric cannot be raveled readily, use either a cut strip or grab procedure.

5.8 The cut strip procedure is applicable to heavily fulled fabrics, woven fabrics that cannot be readily raveled, felted fabrics and nonwoven fabrics. This procedure is not recommended for fabrics which can be raveled because the yarns at the edges tend to unravel during testing. The recommendation regarding the minimum number of yarns in a woven specimen discussed in 5.7 for raveled strips applies equally to cut strips.

6. Apparatus, Reagents, and Materials

6.1 *Tensile Testing Machine,* of the CRE, CRL, or CRT type conforming to Specification D76, with respect to force indication, working range, capacity, and elongation indicator and designed for operation at a speed of 300 ± 10 mm/min (12 ± 0.5 in./min); or, a variable speed drive, change gears, or interchangeable loads as required to obtain the 20 ± 3 s time-to-break (see 5.5 and 5.6).

6.2 *Clamps and Jaw Faces*—Each jaw face shall be smooth, flat, and with a metallic or other agreed upon surface. The faces shall be parallel and have machining centers with respect to one another in the same clamp and to the corresponding jaw face of the other clamp.

6.2.1 For all strip tests or for narrow fabrics and tapes being tested full width, each jaw face shall measure at least 10 mm (0.5 in.) wider than the specimen being tested and at least 25 mm (1.0 in.) in the direction of the applied force.

6.3 *Metal Clamp,* auxiliary, weighing 170 g (6.0 oz) with 100-mm (4-in.) width anvils.

6.4 *Distilled Water,* for wet testing.

6.5 *Nonionic Wetting Agent,* for wet testing.

6.6 *Container,* for wetting out specimens.

6.7 *Standard fabrics*[3], for use in verification of apparatus. (See Annex A1.)

6.8 *Pins,* stainless-steel, 10-mm (⅜-in.) diameter by 125 mm (5 in.) long, two required if used.

7. Sampling

7.1 *Lot Sample*—Take a lot sample as directed in the applicable material specification. In the absence of such a specification randomly select the rolls or pieces that constitute the lot sample using the following schedule:

Number of Rolls, 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 of the rolls or pieces

NOTE 3—An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls of fabric and between specimens from a swatch from a roll 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*—From each roll or piece of fabric taken from the lot sample, cut at least one laboratory sample the full width of the fabric and 1 m (1 yd) along the selvage (machine direction).

NOTE 4—Results obtained on small hand samples or swatches can only be considered as representative of the sample swatch submitted and cannot be assumed to be representative of the fabric piece from which the hand sample or swatch was taken.

7.3 *Test Specimens*—From each laboratory sample, take five specimens from the warp (machine) direction and eight specimens from the filling (cross) direction (if tested) for each testing condition.

7.3.1 Testing conditions include the following:

7.3.1.1 *Warp or Machine Direction*—Standard conditions for testing textiles,

7.3.1.2 *Warp or Machine Direction*—Wet at 21°C (70°F),

7.3.1.3 *Filling or Cross Direction*—Standard conditions for testing textiles, and

7.3.1.4 *Filling or Cross Direction*—Wet at 21°C (70°F).

7.3.2 When using the constant-time-to-break technique and unfamiliar fabrics, prepare two or three extra specimens to establish the proper rate of loading (speed for testing).

NOTE 5—Reinforcing fabric systems generally need to demonstrate a compatibility with the properties of the system being reinforced. This comes with an understanding that this compatibility may be influenced by such factors as stress and strain orientation. It is therefore suggested that the option of testing in off-axis orientations, such as ±45°, be considered to verify suitability for applications where stresses and strains are known to exist in orientations other than along the direction of the primary axes.

8. Conditioning

8.1 *For Conditioned Testing:*

8.1.1 If the samples have a higher moisture content than the moisture present when at equilibrium in the standard atmosphere for testing textiles, precondition as directed in Practice D1776.

8.1.2 Bring samples to moisture equilibrium in the standard atmosphere for testing textiles as directed in Practice D1776. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 h does not exceed 0.1 % of the mass of the specimen.

NOTE 6—It is recognized that, in practice, materials are frequently not weighed to determine when moisture equilibrium has been reached. While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested. As a guide, the following conditioning periods are suggested:

Fiber	Minimum Conditioning Period, h[4]
Animal Fibers (for example, wool and regenerated proteins)	8
Vegetable Fibers (for example, cotton)	6
Viscose	8
Acetate	4
Fibers having a regain less than 5 % at 65 % relative humidity	2

8.2 *For Wet Testing:*

8.2.1 Specimens to be tested in the wet condition shall be immersed in water at room temperature until thoroughly wetted (Note 7). To thoroughly wet a specimen, it may be necessary to add not more than 0.05 % of a nonionic wetting agent to the water. A test of any specimen shall be completed within 2 min after its removal from the water.

NOTE 7—The material has been thoroughly wet out when it has been determined that additional immersion time does not produce any additional changes in breaking strength of test specimens. This method of determination must be used in cases of dispute; however, for routine testing in the laboratory, it may be sufficient to immerse the material 1 h.

8.2.2 The procedures in this test method should be used with caution when testing fabrics that do not wet out uniformly and thoroughly because of the presence of sizing, oil, protective coatings, or water repellents.

8.2.3 When the strength of wet specimens without sizing, water repellents, etc. is required, before preparing the test specimens, treat the material as directed in Test Methods D629, using appropriate de-sizing, etc. procedures, that will not affect the normal physical properties of the fabric.

9. Preparation of Specimens

9.1 *General:*

9.1.1 Cut specimens with their long dimensions parallel either to the warp (machine) direction or to the filling (cross) direction, or cut specimens for testing both directions as required. If off-axis specimens are to be prepared, cut specimens with the appropriate orientation(s). Preferably, specimens

[3] Apparatus and accessories are commercially available.

[4] These periods are approximate and apply only to fabrics, spread out in single thickness, and exposed to freely moving air in the standard atmosphere for testing textiles. Heavy or coated fabrics may require conditioning periods longer than those suggested. If a fabric contains more than one fiber, it should be conditioned for the period required by the fiber component which requires the most time (for example, 8 h for a wool and acetate blend).

for a given fabric direction should be spaced along a diagonal of the fabric to allow for representation of different warp and filling yarns, or machine and cross direction areas, in each specimen. When possible, filling specimens should contain yarn from widely separated filling areas. Unless otherwise specified, take specimens no nearer to the selvage or edge of the fabric than one tenth of the width of the fabric (see 7.3.2).

9.1.2 Ribbons and other narrow fabrics which are 50 mm (2 in.) or less wide are usually tested full width.

9.2 *Raveled Strip Test—1R, 25 mm (1 in.):*

9.2.1 Cut each specimen either 35 mm (1.5 in.) or 25 mm (1 in.) plus 20 yarns, whichever is wider, by at least 150 mm (6 in.) long (Note 8). The long dimension should be accurately parallel to the direction of testing and force application.

NOTE 8—The length of the specimen depends on the type of clamps being used. The specimen should be long enough to extend through the clamps and project at least 10 mm (0.5 in.) at each end. The specimen length may be calculated using Eq 1or Eq 2:

$$\text{Specimen length, mm} = C + 2W \tag{1}$$

$$\text{Specimen length, in.} = K + 2W \tag{2}$$

where:

C = constant based on a gauge length of 75 mm + 20 mm for projections beyond clamp, 95 mm,
K = constant based on a gauge length of 3 in. + 1 in. for projections beyond clamps, 4 in., and
W = jaw face width in direction of load, mm (in.).

9.2.2 Ravel each specimen to give a testing width of 25 mm (1 in.) by removing an approximately equal number of yarns from each side, or 10 yarns from each side, depending upon the width cut in 9.2.1.

9.2.3 If, by mutual consent, it is agreed to perform a test on strips containing less than 20 yarns across the width to be tested, the actual number of yarns shall be stated in the report.

NOTE 9—Under some circumstances it may be necessary to ravel the strip to a constant number of yarns instead of a constant width. This number shall never be less than 20 mm (0.75 in.) and the width never less than 15 mm (0.5 in.). This technique is particularly useful when comparing the breaking force of a conditioned fabric after a wet finishing operation in which shrinkage has taken place with that of the same fabric before finishing. Such a procedure may be used by mutual consent of the interested parties.

9.3 *Raveled Strip Test—2R, 50 mm (2.0 in.):*

9.3.1 Cut each specimen either 65 mm (2.5 in.) or 50 mm (2.0 in.) plus 20 yarns, whichever is wider, by at least 150 mm (6 in.) long (Note 8). The long dimension should be parallel to the direction for which the breaking force is required.

9.3.2 Ravel each specimen to give a testing width of 50 mm (2.0 in.) by removing an approximately equal number of yarns from each side, or 10 yarns from each side, depending upon the width cut in 9.3.1 (Note 9).

9.4 *Cut Strip Test—1C, 25 mm (1 in.):*

9.4.1 Cut each specimen 25 ± 1 mm (1 ± 0.02 in.) wide by at least 150 mm (6 in.) long with the long dimension accurately parallel to the direction of testing and force application (Notes 8 and 9).

9.5 *Cut Strip Test—2C, 50 mm (2 in.):*

9.5.1 Cut each specimen 50 ± 1 mm (2 ± 0.02 in.) wide by at least 150 mm (6 in.) long with the long dimension accurately parallel to the direction for which the breaking force is required (Notes 8 and 9).

9.6 When the breaking force of wet fabric is required in addition to that of conditioned fabric, cut one set of specimens with each test specimen twice the normal length (Note 10). Number each specimen at both ends and then cut the specimens, in half cross-wise, to provide one set for determining the conditioned breaking force, and another set for determining the wet breaking force. This allows for breaks on paired specimens which leads to more direct comparison of conditioned vs. wet breaking force because both specimens of a pair contain the same test yarns (nonwoven fabric channel and cross direction areas).

NOTE 10—For fabrics which shrink excessively when wet, it will be necessary to cut the test specimens to allow for longer wet breaking force specimens than conditioned breaking force specimens.

10. Preparation, Calibration, and Verification of Apparatus

10.1 *Tensile Testing Machine:*

10.1.1 Prepare the testing machine according to the manufacturer's instructions and using the conditions given in 10.1.2 – 10.2.4 (see Annex A1).

10.1.2 Set the distance between the clamps (gauge length) at 75 ± 1 mm (3 ± 0.05 in.).

10.1.3 Select the force range of the testing machine for the break to occur between 10 and 90 % of full scale force. Calibrate or verify the testing machine for this range.

10.1.4 Set the testing machine for a loading rate of 300 ± 10 mm/min (12 ± 0.5 in./min) unless otherwise specified.

10.2 *Clamping System:*

10.2.1 Check the jaw face surfaces for flatness and parallelism.

10.2.2 Make a four-ply sandwich of white tissue paper, two soft carbon papers placed back-to-back and a second white paper (or fold the first white paper over the two carbons).

10.2.3 Mount the paper-carbon sandwich in the clamps with normal pressure.

10.2.4 Remove the paper-carbon sandwich and examine the jaw face imprint for uniformity of carbon deposition on the tissue paper.

10.2.5 If the imprint is incomplete or off-size, make appropriate adjustments of the clamp gripping system and recheck the clamping system with the paper-carbon sandwich.

NOTE 11—Some sources of clamping irregularities are surface contact, metal surface, or jaw coating-cover surface, condition, and pressure application.

10.3 *Verification of the Total Operating System of the Apparatus:*

10.3.1 Verify the total operating system (loading, extension, clamping, and recording or data collecting) by testing specimens of standard fabrics for breaking force and elongation by the type of strip test to be used and comparing the data with that given for the standard fabrics. Verification of the system on at least a weekly basis is recommended. In addition, the total