Designation: D 5034 – 95 (Reapproved 2001)

# Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)[1]

This standard is issued under the fixed designation D 5034; 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 grab and modified grab test procedures for determining the breaking strength and elongation of most textile fabrics. Provisions are made for wet testing.

1.1.1 The grab test procedure is applicable to woven, nonwoven, and felted fabrics, while the modified grab test procedure is used primarily for woven fabrics.

1.2 This test method is not recommended for glass fabrics, or for knitted fabrics and 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 raveled strip test procedure and the cut strip test procedure, refer to Test Method D 5035.

1.3 This test method provides 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 stated 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 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 1059 Test Method for Yarn Number on Short-Length Specimens[2]

D 1776 Practice for Conditioning Textiles for Testing[2]

D 5035 Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Force)[3]

## 3. Terminology

3.1 *Definitions:*

3.1.1 *breaking force, n*—the maximum force applied to a material carried to rupture. (Compare *breaking point, breaking strength.* Syn. *force-at-break*.)

3.1.1.1 *Discussion*—Materials that are brittle usually rupture at the maximum force. Materials that are ductile usually experience a maximum force before rupturing.

3.1.2 *breaking load, n*—deprecated term. Use *breaking force.*

3.1.3 *constant-rate-of-extension (CRE) tensile testing machine*—a testing machine in which the rate of increase of specimen length is uniform with time.

3.1.4 *constant-rate-of-load (CRL) tensile testing machine*—a testing machine in which the rate of increase of the load being applied to the specimen is uniform with time after the first 3 s.

3.1.5 *constant-rate-of-traverse (CRT) tensile testing machine*—a testing machine in which the pulling clamp moves at a uniform rate and the load is applied through the other clamp which moves appreciably to actuate a weighing mechanism, so that the rate of increase of load or elongation is dependent upon the extension characteristics of the specimen.

3.1.6 *elongation, n*—the ratio of the extension of a material to the length of the material prior to stretching, expressed as a percent.

3.1.7 *extension, n*—the change in length of a material due to stretching. (Compare *elongation*.)

3.1.8 *grab test, n*—*in fabric testing,* a tensile test in which the central part of the width of the specimen is gripped in the clamps.

3.1.8.1 *Discussion*—For example, if the specimen width is 100 mm (4.0 in.), and the width of the jaw faces 25 mm (1.0 in.), the specimen is gripped in the clamp with approximately 37.5 mm (1.5 in.) of fabric protruding from each side of the jaws.

3.1.9 *modified grab test, n*—in fabric testing, a tensile test in

[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.

Current edition approved May 15, 1995. Published July 1995. Replaces Grab Testing sections of Test Method D 1682 – 90.

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

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

which the control part of the width of the specimen is gripped in the clamps and in which lateral slits are made midlength of the specimen severing all yarns bordering that portion of the specimen held between the two clamps.

3.1.9.1 *Discussion*—The slot modification reduces the *fabric assistance* inherent in the grab test procedure to a practical minimum (see Fig. 1).

3.1.10 *tensile test*, *n*—*in textiles*, a test in which a textile material is stretched in one direction to determine the load-elongation characteristics, the breaking load, or the breaking elongation.

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

## 4. Summary of Test Method

4.1 A 100-mm (4.0-in.) wide specimen is mounted centrally in clamps of a tensile testing machine and a force applied until the specimen breaks. Values for the breaking force and the 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 grab tensile tests using two types of specimens and three alternative types of testing machines. For reporting, use the following identification system of specific specimen and machine combinations.

4.2.1 *Type of specimen:*

4.2.1.1 G—Grab

4.2.1.2 MG—Modified grab

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 |
| Grab | G-E | G-L | G-T |
| Modified Grab | MG-E | MG-L | MG-T |

For example, Test Method D 5034, G-E refers to a grab test carried out on a constant rate-of-extension tensile testing machine.

## 5. Significance and Use

5.1 The grab test procedure in this test method for the determination of breaking force and elongation is considered satisfactory for acceptance testing of commercial shipments of most woven or nonwoven textile fabrics, and the modified grab test procedure is considered satisfactory for acceptance testing of commercial shipments of most woven textile fabrics, since the procedures have been used extensively in the trade for acceptance testing.

5.1.1 In case of disagreement arising from differences in reported test values 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 which are as homogeneous as possible and which are from a lot of material of the type in question. The test specimens should then be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using Student's *t*-test for unpaired data 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 in light of the known bias.

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

5.3 Some modification of technique may be necessary for any fabric having a strength in excess of 200-N/cm (1140-lb/in.) width. Special precautionary measures are provided for use when necessary for strong fabrics.

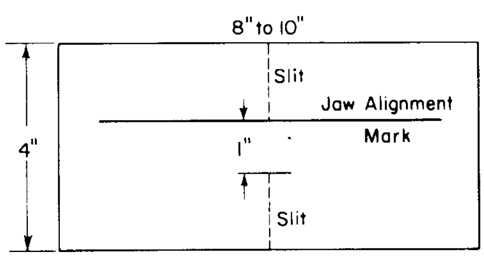
5.4 All of the procedures are applicable for testing fabrics either conditioned or wet.

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 is preferred in these procedures, in cases of dispute, unless there is agreement to the contrary between the purchaser and the supplier, a constant-time-to-break (20 ± 3 s) is to be used.

5.7 The grab test procedure is applicable to the determination of the *effective strength* of the fabric; that is, the strength of the yarns in a specific width together with the fabric assistance from the adjacent yarns. The breaking force determined by the grab procedure is not a reflection of the strength of the yarns actually gripped between clamps and cannot be used for direct comparison with yarn strength determinations. Grab test specimens require much less time to prepare although they require more fabric per specimen. There is no simple relationship between grab tests and strip tests since the amount of fabric assistance depends on the type of fabric and construction variables.

5.8 The modified grab test procedure is applicable to the determination of the breaking force of fabrics with constructions in which the application of tensile stress on raveled strip specimens produces further unraveling. This test method is particularly applicable to high-strength fabrics.



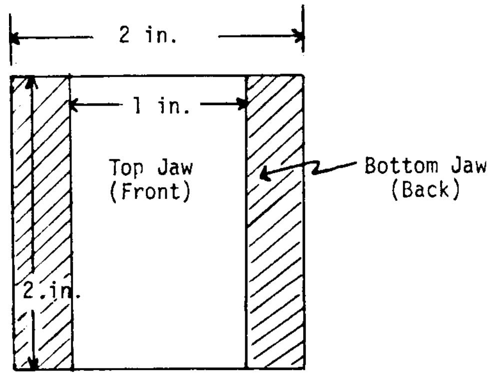

**Metric Equivalents**

| in. | 4 | 8 to 10 |
|---|---|---|
| mm | 100 | 200 to 250 |

**FIG. 1 Illustration of Modified Grab Test Specimens**

## 6. Apparatus, Reagents, and Materials

6.1 *Tensile Testing Machine*, of the CRE, CRL, or CRT type




Metric Equivalents

| in. | 1 | 2 |
|---|---|---|
| mm | 25 | 50 |

**FIG. 2 Schematic Illustration of Jaw Faces for Modified Grab Test**

conforming to Specification D 76, 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 weights 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, gripping surface. The faces shall be parallel and have matching centers with respect to one another in the same clamp and to the corresponding jaw face of the other clamp.

6.2.1 For grab tests, each clamp shall have a front (or top) jaw face measuring 25 ± 1 mm (1.0 ± 0.02 in.) perpendicular to the direction of the application of the force, and not less than 25 nor more than 50 mm (1.0 nor more than 2.0 in.) parallel to the direction of the application of the force (Note 2). The back, or bottom, jaw face of each clamp shall be at least as large as its mate. Use of a larger face for the second jaw reduces the problem of front and back jaw face misalignment.

NOTE 2—Front (or top) faces measuring 25 by 50 mm (1.0 by 2.0 in.) will not necessarily give the same value as 25 by 25-mm (1.0 by 1.0-in.) faces. For many materials, the former are preferable because of the larger gripping area which tends to reduce slippage. While both sizes of gripping surface are permitted, the face sizes used must be the same for all samples in the test and must be recorded in the report.

6.2.2 For modified grab tests, the top (or front) jaw faces shall measure 25 by 50 mm (1.0 by 2.0 in.) or more, with the longer dimension parallel to the direction of load application. The bottom (or back) jaw faces shall measure 50 by 50 mm (2.0 by 2.0 in.) or more. (See Fig. 2.)

6.3 *Metal Clamp*, auxiliary, 170 g (6 oz) with at least 100-mm (4.0-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*, for use in verification of apparatus.[4] (See Annex A1.)

6.8 *Pins*, stainless-steel, 10-mm (3⁄8-in.) diameter by 125 mm (5 in.) long. Two are 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 take 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 rolls or pieces |

NOTE 3—An adequate specification or other agreement between the purchaser and the 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 (swatches) can only be considered as representative of the sample swatch and cannot be assumed to be representative of the fabric piece from which the hand sample (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.

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 (or speed for testing).

## 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 D 1776.

8.1.2 Bring samples to moisture equilibrium in the standard atmosphere for testing textiles as directed in Practice D 1776. 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 5—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

[4] Plain weave and sateen standard fabrics are available from Testfabrics, Inc., P.O. Drawer O, Middlesex, NJ 08846.

specimens are tested. As a guide the following conditioning periods are suggested:

| Fiber | Minimum Conditioning Period, h[5] |
|---|---|
| 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 6). 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 wet specimen shall be completed within two minutes after its removal from the water.

NOTE 6—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 for 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 D 629, using appropriate de-sizing or finish removal 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 if required. Preferably, specimens 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).

9.2 *Grab Test, G*:

9.2.1 Cut each specimen 100 ± 1 mm (4 ± 0.05 in.) wide by at least 150 mm (6 in.) long (Note 7) with the long dimension parallel to the direction of testing and force application.

NOTE 7—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 1 or Eq 2:

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

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

where:

$C$ = constant based on a gage length of 75 + 20 mm for projections beyond the clamp, 95 mm,

$K$ = constant based on a gage length of 3 + 1 in. for projections beyond the clamps, 4 in., and

$W$ = jaw face width in direction of force, mm (in.).

9.2.2 Draw a line on the specimen which is parallel to the long direction (and along a yarn of woven fabric) and located 37 ± 1 mm (1.5 ± 0.02 in.) in from the edge of one side of the specimen.

9.3 *Modified Grab Test, MG*:

9.3.1 Cut and mark modified grab specimens as directed in 9.2.1 and 9.2.2.

9.3.1.1 For alternative high-strength fabric method of specimen clamping, cut specimens at least 400 mm (16.0 in.) long and mark as directed in 9.2.2.

9.3.2 Cut slits in the sides of each specimen, about midway between the two ends and perpendicular to the yarn component being tested, severing all long yarns except those comprising the central 25 ± 1 mm, (1.0 ± 0.02 in.) as shown in Fig. 1.

9.3.2.1 When the number of yarns per inch is less than 25, the nearest whole number of yarns just less than those comprising 25-mm (1.0-in.) (by physical count) shall be left uncut and the test results shall be adjusted to the 25-mm (1.0-in.) count.

9.4 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 8). Number each specimen at both ends and then cut the specimens, in half crosswise, 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 versus wet breaking force because both specimens of a pair contain the same test yarns (channel/cross direction).

NOTE 8—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 machine according to the manufacturer's instructions and using the conditions given in 10.1.2-10.1.4. (See Annex A1.)

10.1.2 Set the distance between the clamps (gage length) at 75 ± 1 mm (3.0 ± 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.

[5] 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).

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 a paper and carbon sandwich.

NOTE 9—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 grab test to be used and comparing the data with that given for the standard fabric. Verification of the system on at least a weekly basis is recommended. In addition, the total operating system should be verified whenever there are changes in the loading system (especially an increase) or clamping mechanism.

10.3.2 Select the standard fabric which has breaking force and elongation in the range of interest.

10.3.3 Prepare standard fabric test specimens as directed in Section 9.

10.3.4 Check for adequacy of clamping pressure by mounting a specimen and marking the inner jaw face-to-fabric junctions. Break the specimen and watch for movement of either line away from the junction to indicate slippage. If slippage occurs, adjust the air pressure of pneumatic clamps or be prepared to tighten manual clamps more when testing. If pressures cannot be increased without causing jaw breaks, other techniques for eliminating slippage, such as jaw cushioning or specimen tabbing, will be necessary.

10.3.5 Test the standard fabric specimens as directed in Section 11.

10.3.6 Calculate the breaking force and elongation, the averages and the standard deviations as directed in Section 12.

10.3.7 Compare the data with previous data. If the average is outside the tolerances established, recheck the total system to locate the cause for the deviation.

## 11. Procedure

11.1 Mount the specimen in the clamp jaws with the previously drawn parallel line (see 9.2.2 and 9.3.1) adjacent to the side of the upper and lower front, or top, jaws which is nearest this edge, and with approximately the same length of fabric extending beyond the jaw at each end. The parallel line serves as a guide to ensure that the same lengthwise yarns of woven fabrics are gripped in both clamps and that the force application is not at an appreciable angle to the test direction of nonwoven fabrics. The tension on the specimen should be uniform across the clamp width.

11.1.1 For high-strength fabrics where the specimen cannot be satisfactorily held in clamps, place each specimen around pins and between jaws as illustrated in Fig. 3, using jaw padding if necessary. Tighten the clamps to distribute the holding pressure along the clamping surface of the top (front) jaw. Clamps which are too tight will produce breaks at the front of the jaws; clamps which are too loose will cause slippage or breaks at the back of the jaws.

11.2 Elongation depends on the initial specimen length which is affected by any pretension applied in mounting the specimen in the testing machine. If measurement of specimen elongation is required, mount the specimen in the upper clamp of the machine, and apply a uniform pretension, not to exceed 0.5 % of the full-scale load, to the bottom end of the specimen before gripping the specimen in the lower clamp.

11.2.1 To achieve uniform and equal tension, attach an auxiliary clamp (6.3) to the bottom of the specimen and at a point below the lower clamp of the testing machine. Tighten the lower clamp and remove the auxiliary clamp.

11.3 Mark across the specimen at the front inner edge of each jaw to check for specimen slippage. When slippage occurs, the mark will move away from the jaw edge.

11.4 Operate the machine and break the specimen.

11.5 Read the breaking force, and elongation if required, from the mechanism provided for such purpose (see 11.2). Record warp and filling (machine and cross) direction results separately.

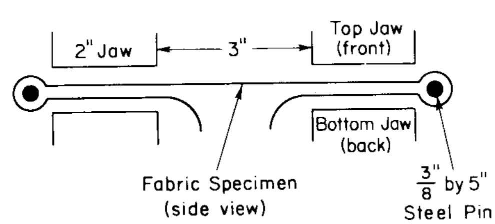
11.5.1 For some testing machines, data may be obtained using an interfaced computer.

11.6 If a specimen slips in the jaws, or breaks at the edge of or in the jaws, or if for any reason the result falls markedly below the average for the set of specimens, discard the result and take another specimen. Continue this until the required number of acceptable breaks have been obtained.

NOTE 10—The decision to discard a break should be based on observation of the specimen during the test and upon the inherent variability of the fabric. In the absence of other criteria for rejecting a *jaw break*, any break occurring within 5 mm (0.25 in.) of the jaws which results in a value below 50 % of the average of all the other breaks should be discarded. No other break should be discarded unless it is known to be faulty.

11.7 If a fabric manifests any slippage in the jaws or if more than 25 % of the specimens break at a point within 5 mm (0.25 in.) of the edge of the jaw, one of the modifications, listed below, may be tried. If any of these modifications are used, state the method of modification in the report.

11.7.1 The jaws may need to be padded.




Metric Equivalents

| in. | 2 | 3 | ⅜ by 5 |
|---|---|---|---|
| mm | 50 | 75 | 10 by 125 |

**FIG. 3 Illustration of Specimen Placement for Modified Grab Method**

11.7.2 The fabric may need to be coated under the jaw face area.

11.7.3 The jaw face may need to be modified.

NOTE 11—It is difficult to determine the precise reason for certain specimens to break near the edge of the jaws. If such a break is caused by damage to the specimen by the jaws, then the results should be discarded. If, however, the break is due merely to randomly distributed weak places, it is a legitimate result. In some cases, it may also be caused by a concentration of stress in the area adjacent to the jaws because the jaws prevent the specimen from contracting in width as the force is applied. In such cases, a break near the edge of the jaw is inevitable and should be accepted as a characteristic of the particular test method. This is often the case when testing fabrics using the grab procedure.

11.8 If the breaking force of wet specimens is to be corrected for shrinkage, determine the yarn number of conditioned yarns and wet yarns after drying and conditioning, using Test Method D 1059.

## 12. Calculation

12.1 *Breaking Force*—For each laboratory sample and testing condition, calculate the average of the breaking force observed for all acceptable specimens, that is, the maximum force exerted on the specimen as read directly from the testing machine indicating mechanism.

12.2 *Measurement of Apparent Elongation*—Unless some other force is specified, measure the apparent elongation of acceptable specimens at the breaking force. Measure the increase in length from the start of the force-extension curve to a point corresponding with the breaking force, or other specified force, as shown on the autographic record. Calculate the apparent elongation as the percentage increase in length based on the gage length (initial nominal testing length of the specimen).

12.2.1 For each testing situation, calculate the average apparent elongation at the breaking force or other specified force, of acceptable specimens.

NOTE 12—The elongation calculated as a percentage of the gage length for the specimen should be referred to as the *apparent elongation* because the actual length of fabric between the jaws is usually greater than the gage length. This difference in length is frequently due to fabric pull-out from between the jaws. Thus, elongation, calculated on the gage length, has an error which is dependent upon the amount of pull-out.

12.3 *Corrected Breaking Force of Wet Specimens*:

12.3.1 If for any reason it is necessary to make allowances for shrinkage in obtaining wet breaking force by the grab procedure only, calculate the wet breaking force using Eq 3:

$$S = (L \times C)/W \tag{3}$$

where:

$S$ = corrected breaking force of wet specimens,
$L$ = breaking force of conditioned specimens,
$C$ = yarn count of conditioned specimens, and
$W$ = yarn of wet specimens.

12.3.2 A similar correction may be needed when comparing the breaking forces of conditioned specimens of a fabric after a wet finishing treatment with that of the same fabric before finishing if the finishing has caused shrinkage.

## 13. Report

13.1 State that the specimens were tested as directed in Test Method D 5034. Describe the material or product sampled and the method of sampling used.

13.2 Report the following information for each laboratory sample:

13.2.1 The average breaking force for specimens giving acceptable breaks, for each testing condition,

13.2.2 The average percent apparent breaking elongation of acceptable specimens for each test condition, if requested,

13.2.3 Number of specimens tested for each test condition,

13.2.4 Type of test specimen and testing machine used,

13.2.5 Maximum force obtainable in the range used for testing,

13.2.6 Pretension if used,

13.2.7 Size of jaw faces used,

13.2.8 Type of padding used in the jaws, modification of specimen gripped in the jaws, or modification of jaw faces, if any,

13.2.9 Number of yarns in the clamping area, if less than 25,

13.2.10 Average time required to break, if applicable, for all specimens giving acceptable breaks,

13.2.11 Conditioned or wet testing, or both,

13.2.12 In the case of tests on wet specimens, whether allowance was made for shrinkage, and

13.2.13 Whether sizing or finishes have been removed, and, if so, by what procedure.

## 14. Precision and Bias

14.1 *Interlaboratory Test Data*—An interlaboratory test was conducted in 1991 in which randomly-drawn samples of three materials were tested in each of three laboratories. Two operators in each laboratory each tested ten specimens of each material using Test Method D 5034. Five of the ten specimens were tested on one day and five specimens were tested on a second day. Tests were separately conducted in laboratories at the standard atmosphere for testing textiles separately using the Constant-Rate-Of-Extension (CRE) and the Constant-Rate-Of-Traverse (CRT) types of tensile testers. In addition, tests were conducted at 72F and 50 % Relative Humidity using the Constant-Rate-Of-Extension (CRE) type tester. The components of variance for breaking strength expressed as standard deviations were transformed to percent coefficient of variation and are listed in Table 1. There were sufficient differences related to the type of tensile tester, material tested, and test conditioning to warrant listing the components of variance and the critical differences separately. The three classes of fabrics were: S/441 cotton filter fabric, S/9407R plain weave standard break fabric, and S/9408R sateen standard break fabric.

14.2 *Precision*—For the components of variance reported in Table 1, 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.

NOTE 13—Since the interlaboratory test included only three laboratories, estimates of between-laboratory precision should be used with special caution.

NOTE 14—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

**TABLE 1 Breaking Strength Grab Test**
**Components of Variance, Coefficient of Variation, %**

| Fabric Type and Test Atmosphere | Type Machine | Grand Average Pounds | Single-Operator Component | Within-Laboratory Component | L |
|---|---|---|---|---|---|
| *Filter Fabric* | | | | | |
| 72F, 65 % RH | CRE | 61.4 | 4.1 | 3.8 | 0 |
| 72F, 50 % RH | CRE | 63.4 | 3.9 | 1.1 | 0 |
| 72F, 65 % RH | CRT | 64.6 | 2.1 | 0 | 0 |
| *Plain Weave Fabric* | | | | | |
| 72F, 65 % RH | CRE | 112 | 3.7 | 1.4 | 0 |
| 72F, 50 % RH | CRE | 116 | 4.0 | 2.8 | 0 |
| 72F, 65 % RH | CRT | 118 | 4.0 | 2.3 | 0 |
| *Sateen Fabric* | | | | | |
| 72F, 65 % RH | CRE | 240 | 3.1 | 1.3 | 2 |
| 72F, 50 % RH | CRE | 241 | 4.6 | 5.6 | 0 |
| 72F, 65 % RH | CRT | 247 | 2.4 | 0.7 | 1 |

**TABLE 2 Breaking Strength Grab Test**
**Critical Difference for Conditions Noted, % of Average**

| Fabric Type and Test Atmosphere | Type Machine | Number of Observations in Each Average | Single-Operator Precision | Within-Laboratory Precision | Between Laboratory Precision |
|---|---|---|---|---|---|
| *Filter Fabric* | | | | | |
| 72F, 65 % RH | CRE | 2 | 8.1 | 13.3 | 13.3 |
| | | 5 | 5.1 | 11.7 | 11.7 |
| | | 10 | 3.6 | 11.2 | 11.2 |
| 72F, 50 % RH | CRE | 2 | 7.6 | 8.1 | 8.1 |
| | | 5 | 4.8 | 5.6 | 5.6 |
| | | 10 | 3.4 | 4.5 | 4.5 |
| 72F, 65 % RH | CRT | 2 | 11.1 | 11.1 | 11.1 |
| | | 5 | 7.0 | 7.0 | 7.0 |
| | | 10 | 5.0 | 5.0 | 5.0 |
| *Plain Weave Fabric* | | | | | |
| 72F, 65 % RH | CRE | 2 | 7.4 | 8.3 | 8.3 |
| | | 5 | 4.7 | 6.0 | 6.0 |
| | | 10 | 3.3 | 5.0 | 5.0 |
| 72F, 50 % RH | CRE | 2 | 7.9 | 11.1 | 11.1 |
| | | 5 | 4.5 | 9.3 | 9.3 |
| | | 10 | 3.5 | 8.7 | 8.7 |
| 72F, 65 % RH | CRT | 2 | 7.9 | 7.9 | 10.1 |
| | | 5 | 5.0 | 5.0 | 8.1 |
| | | 10 | 3.5 | 3.5 | 7.3 |
| *Sateen Fabric* | | | | | |
| 72F, 65 % RH | CRE | 2 | 6.0 | 7.0 | 9.1 |
| | | 5 | 3.8 | 5.2 | 7.8 |
| | | 10 | 2.7 | 4.4 | 7.3 |
| 72F, 50 % RH | CRE | 2 | 9.0 | 17.7 | 17.7 |
| | | 5 | 5.7 | 16.3 | 16.3 |
| | | 10 | 4.0 | 15.8 | 15.8 |
| 72F, 65 % RH | CRT | 2 | 4.6 | 5.0 | 6.6 |
| | | 5 | 2.9 | 3.5 | 5.5 |
| | | 10 | 2.1 | 2.8 | 5.1 |

them must be established, with each comparison being based on recent data obtained on specimens taken from a lot of material of 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.

14.3 *Bias*—The true values of breaking strength by the grab test can only be defined in terms of a specific test method. Within this limitation, the procedure in Test Method D 5034 for measuring breaking strength by the grab procedure has no known bias.

## 15. Keywords

15.1 breaking-strength; elongation; fabric; nonwoven fabric; woven fabric

## ANNEX

### (Mandatory Information)

### A1. ERROR AND LOW PRECISION IN TENSILE TESTING

A1.1 Some of the most common sources for error and causes for low precision in tensile testing are given in the following sections.

A1.1.1 Failure to recheck the tester zero after changing load cell or scale.

A1.1.2 Failure to make sure each test is started at the zero point due to application of excessive tension on the specimen as it is mounted and clamped for testing.

A1.2 One of the most serious problems, of which many users are unaware, is faulty clamping mechanisms. Many calibration/verification procedures for tensile testing machines, whether performed by the manufacturer's representative or the user, check for gage length and loading variability, and speed, but do not check out the total operating system which also includes the clamping mechanism.

A1.3 Use of standard fabrics with known breaking strengths serve as a means for verifying the total operating system.