Designation: D4632/D4632M – 15a

# Standard Test Method for Grab Breaking Load and Elongation of Geotextiles[1]

This standard is issued under the fixed designation D4632/D4632M; 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 is an index test which provides a procedure for determining the breaking load (grab strength) and elongation (grab elongation) of geotextiles using the grab method. This test method is not suitable for knitted fabrics and alternate test methods should be used. While useful for quality control and acceptance testing for a specific fabric structure, the results can only be used comparatively between fabrics with very similar structures, because each different fabric structure performs in a unique and characteristic manner in this test. The grab test methods does not provide all the information needed for all design applications and other test methods should be used.

1.2 Procedures for measuring the breaking load and elongation by the grab method in both the dry and wet state are included; however, testing is normally done in the dry condition unless specified otherwise in an agreement or specification.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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:*[2]

D76/D76M Specification for Tensile Testing Machines for Textiles
D123 Terminology Relating to Textiles
D1776/D1776M Practice for Conditioning and Testing Textiles
D2905 Practice for Statements on Number of Specimens for Textiles (Withdrawn 2008)[3]
D4354 Practice for Sampling of Geosynthetics and Rolled Erosion Control Products(RECPs) for Testing
D4439 Terminology for Geosynthetics
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

## 3. Terminology

3.1 *Definitions:*

3.1.1 *atmosphere for testing geotextiles, n*—air maintained at a relative humidity of 65 ± 5 % relative humidity and temperature of 21 ± 2°C [70 ± 4°F].

3.1.2 *breaking load, n*—the maximum force applied to a specimen in a tensile test carried to rupture.

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

3.1.4 *elongation at break, n*—the elongation corresponding to the breaking load, that is, the maximum load.

3.1.5 *geotextile, n*—any permeable textile material used with foundation, soil, rock, earth, or any other geotechnical material, as an integral part of a man-made product, structure, or system.

3.1.6 *grab test, n—in fabric testing,* a tension test in which only a part of the width of the specimen is gripped in the clamps.

3.1.6.1 *Discussion*—For example, if the specimen width is 101.6 mm [4 in.] and the width of the jaw faces 25.4 mm [1 in.], the specimen is gripped centrally in the clamps.

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

[1] This test method is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.01 on Mechanical Properties.

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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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

3.1.8 For definitions of other terms used in this test method, refer to Terminology D123 or Terminology D4439.

## 4. Summary of Test Method

4.1 A continually increasing load is applied longitudinally to the specimen and the test is carried to rupture. Values for the breaking load and elongation of the test specimen are obtained from machine scales or dials, autographic recording charts, or interfaced computers.

## 5. Significance and Use

5.1 The grab method is applicable whenever it is desired to determine the "effective strength" of the fabric in use, that is, the strength of the material in a specific width, together with the additional strength contributed by adjacent material. There is no simple relationship between grab tests and strip tests since the amount of fabric assistance depends on the construction of the fabric. It is useful as a quality control or acceptance test.

5.2 The procedure in Test Method D4632/D4632M for the determination of grab strength of geotextiles may be used for acceptance testing of commercial shipments, but caution is advised since information about between-laboratory precision is incomplete. Comparative tests as directed in 5.2.1 are advisable.

5.2.1 In case of a dispute arising from differences in reported test results when using the procedures in Test Method D4632/D4632M for acceptance testing of commercial shipments, the purchaser and the manufacturer 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 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 the appropriate Student's *t*-test 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 manufacturer must agree to interpret future test results in the light of the known bias.

5.3 Most geotextile fabrics can be tested by this test method. Some modification of clamping techniques may be necessary for a given fabric, depending upon its structure. Special adaptation may be necessary with strong fabrics, or fabrics made from glass fibers, to prevent them from slipping in the clamps or being damaged as a result of being gripped in the clamps, such as cushioning the clamp or boarding the specimen within the clamp.

5.4 This test method is applicable for testing fabrics either dry or wet. It may be used with constant-rate-of-traverse (CRT) or constant-rate-of-extension (CRE) type tension machines. However, there may be no overall correlation between the results obtained with the CRT machine and the CRE machine. Consequently, these two tension testers cannot be used interchangeably. In case of controversy, the CRE machine shall prevail.

## 6. Apparatus

6.1 *Tensile Testing Machine,* of the constant-rate-of-extension (CRE) or constant-rate-of-traverse (CRT) type with autographic recorder conforming to the requirements of Specification D76/D76M.

6.2 *Clamps,* having all gripping surfaces parallel, flat, and capable of preventing slipping of the specimen during a test. Each clamp shall have one jaw face measuring 25.4 by 50.8 mm [1 by 2 in.], with the longer dimension parallel to the direction of application of the load. The other jaw face of each clamp shall be at least as large as its mate. Each jaw face shall be in line, both with respect to its mate in the same clamp and to the corresponding jaw of the other clamp.

## 7. Sampling and Selection

7.1 *Division into Lots and Lot Samples*—Divide the material into lots and take a lot sample as directed in Practice D4354. Rolls of fabric are the primary sampling unit.

7.2 *Laboratory Sample*—Take for the laboratory sample a swatch extending the width of the fabric and approximately 1 m [39.37 in.] along the selvage from each roll in the lot sample. The swatch may be taken from the end portion of a roll provided there is no evidence that it is distorted or different from other portions of the roll. In cases of dispute, take a swatch that will exclude fabric from the outer wrap of the roll or the inner wrap around the core.

7.3 *Test Specimens*—Cut the number of specimens from each swatch in the laboratory sample determined as directed in Section 8. Take no specimens nearer the selvage of fabric edge than 1/20 of the fabric width or 150 mm [6 in.], whichever is the smaller. Cut rectangular specimens 101.6 by 203.2 mm [4 by 8 in.]. Cut the specimens to be used for grab tests in the machine direction with the longer dimension parallel to the machine direction and the specimens to be used for grab tests in the cross-machine direction with the longer dimension parallel to the cross-machine direction. Locate each group of specimens along a diagonal line on the swatch so that each specimen will contain different warp ends and filling picks. Draw a line 37 mm [1.5 in.] from the edge of the specimen running its full length. For woven and reinforced nonwoven fabrics, this line must be accurately parallel to the lengthwise yarns in the specimen.

## 8. Number of Specimens

8.1 Unless otherwise agreed upon as when provided in an applicable material specification, take a number of test specimens per swatch in the laboratory sample such that the user may expect at the 95 % probability level that the test result is no more than 5 % above the true average for each swatch in the laboratory sample for each the machine and cross-machine direction, respectively.

8.1.1 *Reliable Estimate of v*—When there is a reliable estimate of $v$ based upon extensive past records for similar materials tested in the user's laboratory as directed in the method, calculate the required number of specimens using Eq 1, as follows:

$$n = (tv/A)^2 \quad (1)$$

where:

$n$ = number of test specimens (rounded upward to a whole number),

$v$ = reliable estimate of the coefficient of variation of individual observations on similar materials in the user's laboratory under conditions of single-operator precision, %,

$t$ = the value of Student's $t$ for one-sided limits (see Table 1), a 95 % probability level, and the degrees of freedom associated with the estimate of $v$, and

$A$ = 5.0 % of the average, the value of the allowable variation.

8.1.2 *No Reliable Estimate of v*—When there is no reliable estimate of $v$ for the user's laboratory, Eq 1 should not be used directly. Instead, specify the fixed number of 10 specimens for the machine direction tests and 10 specimens for the cross-machine direction tests. The number of specimens is calculated using $v = 9.5$ % of the average for both machine direction and cross-machine direction. These values for $v$ are somewhat larger than usually found in practice. When a reliable estimate of $v$ for the user's laboratory becomes available, Eq 1 will usually require fewer than the fixed number of specimens.

## 9. Conditioning

9.1 Bring the specimens to moisture equilibrium in the atmosphere for testing geotextiles. 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. In general practice, the industry approaches equilibrium from the "as received" side.

NOTE 1—It is recognized that in practice geotextile materials are frequently not weighed to determine when moisture equilibrium has been reached. While such a procedure cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing for a reasonable period of time before the specimens are tested. A time of at least 24 h has been found acceptable in most cases. However, certain fibers may exhibit slow moisture equalization rates from the "as received" wet side. When this is known, a preconditioning cycle, as described in Practice D1776/D1776M, may be agreed upon between contractual parties.

**TABLE 1 Values of Student's *t* for One-Sided Limits and the 95 % Probability[A]**

| df | One-Sided | df | One-Sided | df | One-sided |
|---|---|---|---|---|---|
| 1 | 6.314 | 11 | 1.796 | 22 | 1.717 |
| 2 | 2.920 | 12 | 1.782 | 24 | 1.711 |
| 3 | 2.353 | 13 | 1.771 | 26 | 1.706 |
| 4 | 2.132 | 14 | 1.761 | 28 | 1.701 |
| 5 | 2.015 | 15 | 1.753 | 30 | 1.697 |
| 6 | 1.943 | 16 | 1.746 | 40 | 1.684 |
| 7 | 1.895 | 17 | 1.740 | 50 | 1.676 |
| 8 | 1.860 | 18 | 1.734 | 60 | 1.671 |
| 9 | 1.833 | 19 | 1.729 | 120 | 1.658 |
| 10 | 1.812 | 20 | 1.725 | | 1.645 |

[A] Values in this table were calculated using Hewlett Packard HP 67/97 Users' Library Programs 03848D, "One-Sided and Two-Sided Critical Values of Student's *t*' and 00350D, "Improved Normal and Inverse Distribution." For values at other than the 95 % probability level, see published tables of critical values of Student's *t* in any standard statistical text. Further use of this table is defined in Practice D2905.

9.2 Specimens to be tested in the wet condition shall be immersed in water maintained at a temperature of 21 ± 2°C [70 ± 4°F]. The time of immersion must be sufficient to wet-out the specimens thoroughly, as indicated by no significant change in strength or elongation following a longer period of immersion, and at least 2 min. To obtain thorough wetting, it may be necessary or advisable to add not more than 0.05 % of a nonionic neutral wetting agent to the water.

## 10. Procedure

10.1 Test the conditioned specimens in the standard atmosphere for testing in accordance with Section 9.

10.2 Set the distance between the clamps at the start of the test at 75 ± 1 mm [3 ± 0.05 in.]. Select the load range of the testing machine such that the maximum load occurs between 10 and 90 % of full-scale load. Set the machine to operate at a speed of 300 ± 10 mm/min [12 ± 0.5 in./min].

10.3 Secure the specimen in the clamps of the testing machine, taking care that the long dimension is as nearly as possible parallel to the direction of application of the load. Be sure that the tension in the specimen is uniform across the clamped width. Insert the specimen in the clamps so that approximately the same length of fabric extends beyond the jaw at each end. Locate the jaws centrally in the widthwise direction by having the line which was drawn 37 mm [1.5 in.] from the edge of the specimen run adjacent to the side of the upper and lower front jaws which are nearest this edge. This ensures that the same lengthwise yarns are gripped in both clamps.

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

NOTE 2—The decision to discard a break shall 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 so-called jaw break, any break occurring within 5 mm [¼ in.] of the jaws which results in a value below 80 % of the average of all the other breaks shall be discarded. No other break shall be discarded unless it is known to be faulty.

NOTE 3—It is difficult to determine the precise reason for breakage of test specimens near the edge of the jaws. If breaks are caused by damage to the specimen by the jaws, then the results should be discarded. If, however, they are merely due to randomly distributed weak places in specimens, the results should be considered perfectly legitimate. In some cases, breaks may be caused by a concentration of stress in the area adjacent to the jaws. If this occurs, the specimen is prevented from contracting in width as the load is applied. In such cases, a break near the edge of the jaws is inevitable and shall be accepted as a characteristic of the geotextile when tested by this test method.

10.5 Start the tensile testing machine and the area measuring device, if used, and continue running the test to rupture. Stop the machine and reset to the initial gage position. Record and report the test results for each direction separately.

10.6 If fabric manifests slippage in the jaws, the jaw faces, but not the jaw dimensions, may be modified. If a modification is used, the method of modification should be stated in the report.

10.7 Unless otherwise specified, measure the elongation of the fabric at any stated load by means of a suitable autographic recording device, at the same time the breaking strength is determined. Measure the elongation from the point where the curve leaves the zero loading axis to a point of corresponding force in millimetres [inches].

## 11. Calculation

11.1 *Breaking Load*—Calculate the breaking load by averaging the value of breaking load for all accepted specimen results. The breaking load shall be determined separately for the machine direction specimens and cross-machine direction specimens.

11.2 *Apparent Elongation*—Calculate the apparent elongation at the breaking load or at other specified loads by averaging the values of apparent elongation for all accepted specimen results. The apparent elongation shall be determined separately for the machine direction specimens and cross-machine direction specimens and expressed as the percentage increase in length, based upon the initial nominal gage length of the specimen. Report this as the apparent elongation.

NOTE 4—The observed elongation calculated as a percentage of the initial nominal gage length of the specimen should be referred to as "apparent elongation." Because the actual length of fabric stretched is usually somewhat greater than this initial length due to pull-out of fabric from between the jaws, elongation calculated on initial length may be somewhat in error, depending upon the amount of this pull-out.

## 12. Report

12.1 Report the following information:

12.1.1 State that the tests were performed as directed in Test Method D4632/D4632M. Describe the material(s) or product(s) sampled and the method of sampling used.

12.1.2 The average grab breaking load for specimens cut in each direction, for all specimens giving acceptable breaks.

12.1.3 The average grab percent apparent elongation of specimens cut in each direction, for all specimens giving acceptable breaks, if required. Identify this as "apparent breaking elongation," or "apparent elongation at x lb load," as required by the test specifications.

12.1.4 Number of specimens tested in each direction.

12.1.5 Condition of specimens (wet or dry).

12.1.6 Type of testing machine used.

12.1.7 Maximum load obtainable in the range used for testing.

12.1.8 Type of padding used in jaws, modification of specimen gripped in the jaws, or modification of jaw faces, if used.

12.1.9 Any modifications of sample specimens as manufactured, or test method as described.

## 13. Precision and Bias[4]

13.1 *Precision*—The precision of this test method is based on an interlaboratory study of D4632/D4632M, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles, conducted in 2013. Ten laboratories tested a total of four different geotextile samples for elongation and tensile strength at rupture. Every "test result" represents an individual determination. All labs were asked to report triplicate test results for each material tested. Practice E691 was followed for the design and analysis of the data; the details are given in ASTM Research Report No. RR:D35-1021.

13.1.1 *Repeatability Limit (r)*—Two test results obtained within one laboratory shall be judged not equivalent if they differ by more than the "r" value for that material; "r" is the interval representing the critical difference between two test results for the same material, obtained by the same operator using the same equipment on the same day in the same laboratory.

13.1.1.1 Repeatability limits are listed in Tables 2 and 3.

13.1.2 *Reproducibility limit (R)*—Two test results shall be judged not equivalent if they differ by more than the "R" value for that material; "R" is the interval representing the critical difference between two test results for the same material, obtained by different operators using different equipment in different laboratories.

13.1.2.1 Reproducibility limits are listed in Tables 2 and 3.

13.1.3 The above terms (repeatability limit and reproducibility limit) are used as specified in Practice E177.

13.1.4 Any judgment in accordance with statements 13.1.1 and 13.1.2 would have an approximate 95 % probability of being correct.

13.2 *Bias*—At the time of the study, there was no accepted reference material suitable for determining the bias for this test method, therefore no statement on bias is being made.

[4] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D35-1021. Contact ASTM Customer Service at service@astm.org.

**TABLE 2 Maximum Elongation at Rupture (%)**

| Material | Average[A] | Repeatability Standard Deviation | Reproducibility Standard Deviation | Repeatability Limit | Reproducibility Limit |
|---|---|---|---|---|---|
| | $\bar{x}$ | $S_r$ | $S_R$ | r | R |
| Woven Slit Tape Stabilization Geotextile | 25.24 | 0.85 | 5.37 | 2.39 | 15.02 |
| Heavy Weight Nonwoven Geotextile | 79.20 | 1.72 | 12.39 | 4.81 | 34.70 |
| Light Weight Nonwoven Geotextile | 79.03 | 2.66 | 6.00 | 7.44 | 16.79 |
| Woven Mono/Slit Tape Reinforcement Geotextile | 22.43 | 0.84 | 4.92 | 2.35 | 13.78 |

[A] The average of the laboratories' calculated averages.

**TABLE 3 Maximum Tensile at Rupture (*lbf*)**

| Material | Average[A] | Repeatability Standard Deviation | Reproducibility Standard Deviation | Repeatability Limit | Reproducibility Limit |
|---|---|---|---|---|---|
| | $\bar{x}$ | $S_r$ | $S_R$ | r | R |
| Woven Slit Tape Stabilization Geotextile | 168.23 | 7.43 | 17.35 | 20.81 | 48.57 |
| Light Weight Nonwoven Geotextile | 425.27 | 20.81 | 26.25 | 58.28 | 73.49 |
| Heavy Weight Nonwoven Geotextile | 131.51 | 10.27 | 10.27 | 28.75 | 28.75 |
| Woven Mono/Slit Tape Reinforcement Geotextile | 377.04 | 11.10 | 22.79 | 31.08 | 63.80 |

[A] The average of the laboratories' calculated averages.

13.3 The precision statement was determined through statistical examination of 240 reported results, from ten laboratories, on four materials. These four materials were identified as the following:

Woven Slit Tape Stabilization Geotextile
Light Weight Nonwoven Geotextile
Heavy Weight Nonwoven Geotextile
Woven Mono/Slit Tape Reinforcement Geotextile

13.4 To judge the equivalency of two test results, it is recommended to choose the material closest in characteristics to the test material.