



Designation: D4595 – 17

## Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method<sup>1</sup>

This standard is issued under the fixed designation D4595; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This test method covers the measurement of tensile properties of geotextiles using a wide-width strip specimen tensile method. This test method is applicable to most geotextiles that include woven fabrics, nonwoven fabrics, layered fabrics, knit fabrics, and felts that are used for geotextile application.

1.2 This test method covers the measurement of tensile strength and elongation of geotextiles and includes directions for the calculation of initial modulus, offset modulus, secant modulus, and breaking toughness.

1.3 Procedures for measuring the tensile properties of both conditioned and wet geotextiles by the wide-width strip method are included.

1.4 The basic distinction between this test method and other methods for measuring strip tensile properties is the width of the specimen. Some fabrics used in geotextile applications have a tendency to contract (neck down) under a force in the gage length area. The greater width of the specimen specified in this test method minimizes the contraction effect of those fabrics and provides a closer relationship to expected geotextile behavior in the field and a standard comparison.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.6 *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:*<sup>2</sup>

[D76 Specification for Tensile Testing Machines for Textiles](#)  
[D123 Terminology Relating to Textiles](#)  
[D579 Specification for Greige Woven Glass Fabrics](#)  
[D1776 Practice for Conditioning and Testing Textiles](#)  
[D2905 Practice for Statements on Number of Specimens for Textiles \(Withdrawn 2008\)](#)<sup>3</sup>  
[D4439 Terminology for Geosynthetics](#)

### 3. Terminology

3.1 *atmosphere for testing geotextiles, n*—air maintained at a relative humidity of  $65 \pm 5\%$  and a temperature of  $21 \pm 2^\circ\text{C}$  ( $70 \pm 4^\circ\text{F}$ ).

3.2 *breaking toughness, T, (FL<sup>-1</sup>), Jm<sup>-2</sup>, n*—for geotextiles, the actual work-to-break per unit surface area of material.

3.2.1 *Discussion*—Breaking toughness is proportional to the area under the force-elongation curve from the origin to the breaking point (see also work-to-break). Breaking toughness is calculated from work-to-break, gage length, and width of a specimen.

3.3 *corresponding force, F<sub>c</sub>, n*—the force associated with a specific elongation on the force-per-unit-width strain curve. (Syn. load at specified elongation, LASE.)

3.4 *geotechnical engineering, n*—the engineering application of geotechnics.

3.5 *geotechnics, n*—the application of scientific methods and engineering principles to the acquisition, interpretation, and use of knowledge of materials of the earth's crust to the solution of engineering problems.

3.5.1 *Discussion*—Geotechnics embraces the fields of soil mechanics, rock mechanics, and many of the engineering aspects of geology, geophysics, hydrology, and related sciences.

<sup>1</sup> 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.

Current edition approved June 1, 2017. Published June 2017. Originally approved in 1986. Last previous edition approved in 2011 as D4595 – 11. DOI: 10.1520/D4595-17.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

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

3.7 *initial tensile modulus,  $J_p$ , ( $FL^{-1}$ ),  $Nm^{-1}$ , n—for geotextiles*, the ratio of the change in tensile force per unit width to a change in strain (slope) of the initial portion of a force-per-unit-width strain curve.

3.8 *offset tensile modulus,  $J_o$ , ( $FL^{-1}$ ),  $Nm^{-1}$ , n—for geotextiles*, the ratio of the change in force per unit width to a change in strain (slope) below the proportional limit point and above the tangent point on the force-elongation curve.

3.9 *proportional limit, n*—the greatest stress which a material is capable of sustaining without any deviation from proportionality of stress to strain (Hooke's law).

3.10 *secant tensile modulus,  $J_{sec}$ , ( $FL^{-1}$ ),  $Nm^{-1}$ , n—for geotextiles*, the ratio of change in force per unit width to a change in strain (slope) between two points on a force-per-unit-width strain curve.

3.11 *tangent point, n—for geotextiles*, the first point of the force-elongation curve at which a major decrease in slope occurs.

3.11.1 *Discussion*—The tangent point is determined by drawing a tangent line passing through the zero axis and the proportional elastic limit. The point from the zero-force axis that the force-elongation curve first touches that tangent line is the tangent point.

3.12 *tensile modulus,  $J$ , ( $FL^{-1}$ ),  $Nm^{-1}$ , n—for geotextiles*, the ratio of the change in tensile force per unit width to a corresponding change in strain (slope).

3.13 *tensile strength, n—for geotextiles*, the maximum resistance to deformation developed for a specific material when subjected to tension by an external force.

3.13.1 *Discussion*—Tensile strength of geotextiles is the characteristic of a sample as distinct from a specimen and is expressed as force per unit width.

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

3.15 *wide-width strip tensile test, n—for geotextiles*, a uniaxial tensile test in which the entire width of a 200-mm (8.0-in.) wide specimen is gripped in the clamps and the gage length is 100 mm (4.0 in.).

3.16 *work-to-break,  $W$ , ( $LF$ ), n—in tensile testing*, the total energy required to rupture a specimen.

3.16.1 *Discussion*—For geotextiles, work-to-break is proportional to the area under the force-elongation curve from the origin to the breaking point, and is commonly expressed in joules (inch-pound force).

3.17 *yield point, n*—the first point of the force-elongation curve above the proportional (linear) section at which an increase in elongation occurs without a corresponding increase in force.

3.18 For terminology of other terms used in this test method, refer to Terminology D123 and Terminology D4439.

## 4. Summary of Test Method

4.1 A relatively wide specimen is gripped across its entire width in the clamps of a constant rate of extension (CRE) type tensile testing machine operated at a prescribed rate of extension, applying a longitudinal force to the specimen until the specimen ruptures. Tensile strength, elongation, initial and secant modulus, and breaking toughness of the test specimen can be calculated from machine scales, dials, recording charts, or an interfaced computer.

## 5. Significance and Use

5.1 The determination of the wide-width strip force-elongation properties of geotextiles provides design parameters for reinforcement type applications, for example design of reinforced embankments over soft subgrades, reinforced soil retaining walls, and reinforcement of slopes. When strength is not necessarily a design consideration, an alternative test method may be used for acceptance testing. Test Method D4595 for the determination of the wide-width strip tensile properties of geotextiles may be used for the acceptance testing of commercial shipments of geotextiles, but caution is advised since information about between-laboratory precision is incomplete (Note 6). Comparative tests as directed in 5.1.1 may be advisable.

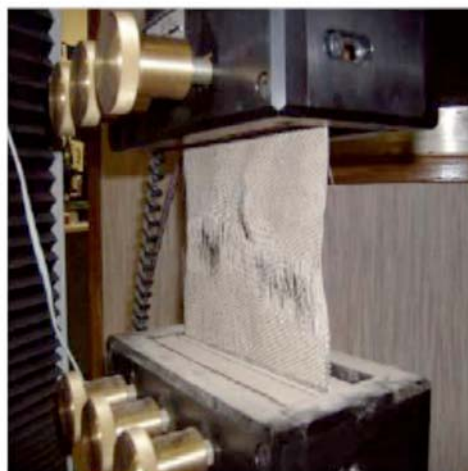
5.1.1 In cases of a dispute arising from differences in reported test results when using Test Method D4595 for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias. At 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 the testing began. 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 Most geotextiles can be tested by this test method. Some modification of clamping techniques may be necessary for a given geotextile depending upon its structure. Special clamping adaptations may be necessary with strong geotextiles or geotextiles made from glass fibers to prevent them from slipping in the clamps or being damaged as a result of being gripped in the clamps. Specimen clamping may be modified as required at the discretion of the individual laboratory, provided a representative tensile strength is obtained. In any event, the procedure described in Section 10 of this test method for obtaining wide-width strip tensile strength must be maintained.

5.3 This test method is applicable for testing geotextiles either dry or wet. It is used with a constant rate of extension-type tension apparatus.



a. Wedge clamps



b. Curtis "Geo-Grips"

FIG. 1 Wedge Clamps

5.4 The use of tensile strength test methods that restrict the *clamped* width dimension to 50 mm (2 in.) or less, such as the ravel, cut strip, and grab test procedures, have been found less suitable than this test method for determining design strength parameters for some geotextiles. This is particularly the case for nonwoven geotextiles. The wide-width strip technique has been explored by the industry and is recommended in these cases for geotextile applications.

5.4.1 This test method may not be suited for some woven fabrics used in geotextile applications that exhibit strengths approximately 100 kN/m or 600 lbf/in. due to clamping and equipment limitations. In those cases, 100-mm (4-in.) width specimens may be substituted for 200-mm (8-in.) width specimens. On those fabrics, the contraction effect cited in 1.4 is minimal and, consequently, the standard comparison can continue to be made.

## 6. Apparatus and Reagents

6.1 *Tensile Testing Machine*—A constant rate of extension (CRE) type of testing machine described in Specification D76 shall be used. When using the CRE-type tensile tester, the recorder must have adequate pen response to properly record the force-elongation curve as specified in Specification D76.

6.2 *Clamps*—The clamps shall be sufficiently wide to grip the entire width of the sample and with appropriate clamping power to prevent slipping or crushing (damage).

6.2.1 There are several types of clamp designs available. Three basic clamp design examples are shown in Figs. 1-3. These designs have been used in the laboratory and have provided reproducible tensile strengths. These clamps may be modified to provide greater ease and speed of clamping. In any event, caution must be taken to ensure the type material and dimensions of the clamp are adequate for the user's expected fabric strength. Additional guidance is given in Appendix X5.

6.2.2 *Size of Jaw Faces*—Each clamp shall have jaw faces measuring wider than the width of the specimen, 200 mm (8 in.), and a minimum of 50-mm (2-in.) length in the direction of the applied force.

6.3 External extensometers or other external means of measurement are encouraged for all tests where modulus is to be measured. In this case, the distance between the moving feet of the extensometer determines the gage length for use in elongation calculations and not test speed. Examples of contact and noncontact extensometers are shown in Figs. 5-7. Please see Note 6 and Appendix X5.

6.4 *Area-Measuring Device*—Use an integrating accessory to the tensile testing machine or a planimeter.

6.5 *Distilled Water and Nonionic Wetting Agent*, for wet specimens only.

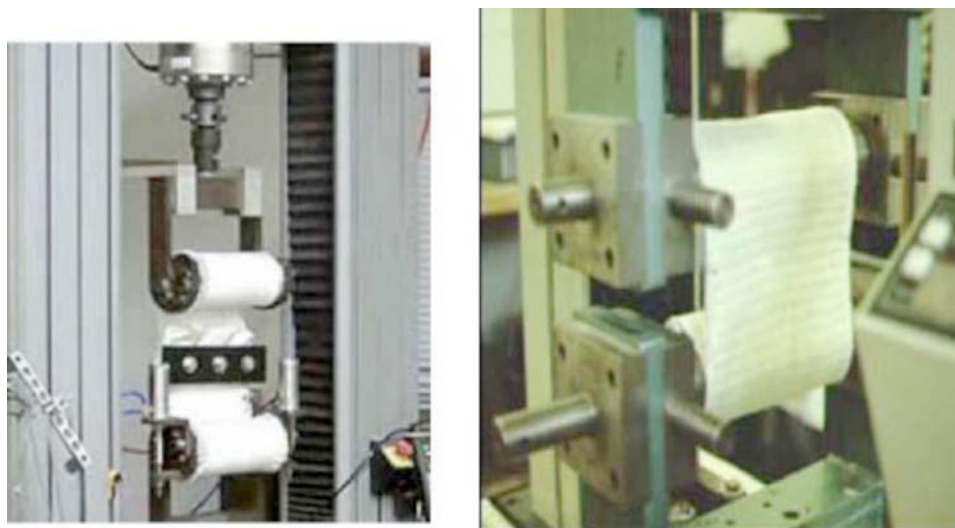
## 7. Sampling

7.1 *Lot Sample*—For the lot sample, take rolls of geotextiles as directed in an applicable material specification, or as agreed upon between the purchaser and the supplier.

NOTE 1—The extent of the sampling for wide-width strip tensile properties is generally defined in an applicable order or contract. Among the options available to the purchaser and the supplier is for the purchaser to accept certification by the manufacturer that the material in question meets the requirements agreed upon by the two parties, and what the basis for the certification is, such as, historical data generated from material manufactured under the same conditions.

7.2 *Laboratory Sample*—For the laboratory sample, take a full-width swatch from each roll in the lot sample. The sample may be taken from the end portion of a roll, provided there is no evidence it is distorted or different from other portions of the roll. In cases of dispute, take a sample that will exclude fabric from the outer wrap of the roll or the inner wrap around the core.





a. Capstan Clamps

b. Roller Grips

FIG. 2 Inserts for Wedge Clamps

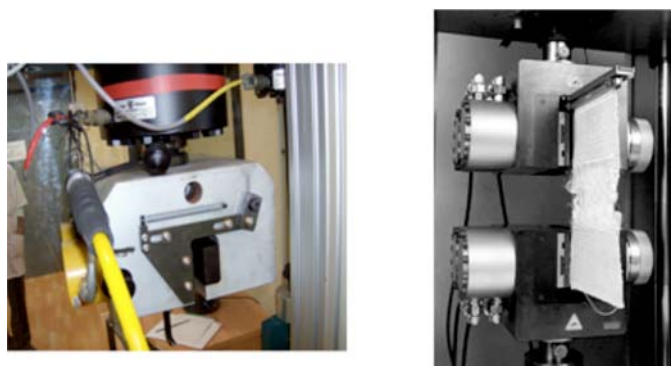


FIG. 3 Roller Clamps

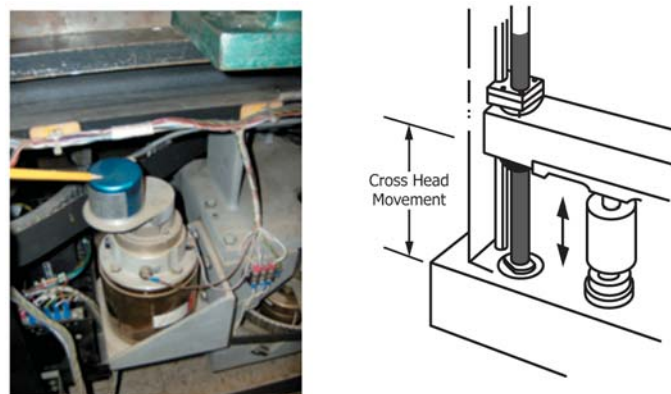


FIG. 4 End View of Composite of Clamp, Insert, and Threaded Rod

**7.3 Test Specimens**—For tests in the machine direction and the cross-machine direction, respectively, take from each swatch in the laboratory sample the number of specimens directed in Section 8. Take specimens at random from the

laboratory sample, with those for the measurement of the machine direction tensile properties from different positions across the geotextile width, and the specimens for the measurement of the cross-machine direction tensile properties from