Designation: D 4594 – 96 (Reapproved 2003)

Standard Test Method for Effects of Temperature on Stability of Geotextiles[1]

This standard is issued under the fixed designation D 4594; 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 provides a procedure for determining the effects of climatic temperature on the tensile strength and elongation properties of geotextiles.

1.2 The effect of temperature on the stability of geotextiles is reported as the change in tensile strength and elongation between tests performed as directed in Test Method D 5035, in the standard atmosphere for testing textiles, and tests performed under conditions at which the geotextile is expected to perform in the field.

1.3 *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.* See 7.1.1-7.1.3.

1.4 The values stated in SI units are to be regarded as the standard. The values stated in inch-pound units are provided for information only.

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 461 Test Methods for Felt[2]

D 1776 Practice for Conditioning Textiles for Testing[2]

D 4354 Practice for Sampling of Geosynthetics for Testing[3]

D 4439 Terminology for Geosynthetics[3]

D 5035 Test Method for Breaking Strength and Elongation of Textile Fabrics (Strip Method)[4]

3. Terminology

3.1 *Definitions:*

3.1.1 *atmosphere for testing geotextiles, n*—air maintained at relative humidity of 50 to 70 % and at a temperature of 21 ± 2°C (70 ± 4°F).

3.1.2 *temperature stability, n—for a geotextile,* the percent change in tensile strength or in percent elongation as measured at a specified temperature and compared to values obtained at the standard conditions for testing geotextiles.

3.2 For definitions of other terms used in this test method, refer to Terminology D 123 and Terminology D 4439.

4. Summary of Test Method

4.1 Specimens of a geotextile are conditioned at selected temperatures in an environmental chamber attached to a tensile testing machine. While maintaining these temperatures, 2 in. cut or ravel strip tensile tests are performed as directed in Test Method D 5035. The same tests are conducted as control under the standard laboratory test conditions. Tensile strength and percent elongation properties obtained at various test temperatures are recorded. Changes in strength characteristics due to the effects of temperature are determined.

4.2 The temperatures used for conditioning and testing the geotextiles are the temperatures at which the geotextile will perform or are typically exposed to in the field.

5. Significance and Use

5.1 This test method is used for evaluating the relative effects of temperature on geotextiles manufactured from different polymers, by a different manufacturing process, or both.

5.2 During shipping and storage, the geotextile may be exposed to abnormal temperatures. The fabric could be tested at these temperatures to determine the detrimental effects of these conditions on the strength properties.

5.3 This test method may also be used to evaluate the cyclic effects of temperature (freeze-thaw), that is, samples can be conditioned to below normal temperatures (below freezing) and then to above normal temperatures (elevated temperatures) for a given number of cycles. Strength characteristics can be determined after these cyclic exposures.

5.4 Most nonwoven, woven, and composite fabric can be tested by this method. Modification of the techniques is likely to be necessary for any fabric having a strength in excess of 179 kg/cm (1000 lb/in.) width. This test method is not recommended for knitted fabrics.

5.5 This test method is an index test method and is not recommended for acceptance testing of commercial shipments, since information on between laboratory precision has not been established. In some cases the purchaser and seller may have to

[1] This test method is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.02 on Endurance Properties.

Current edition approved July 10, 1996. Published November 1996. Originally published as D 4594 – 86. Last previous edition D 4594 – 95.

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

[3] *Annual Book of ASTM Standards,* Vol 04.13.

[4] *Annual Book of ASTM Standards,* Vol 04.09.

test a commercial shipment of one or more geotextiles by the best available method, even though the method has not been recommended for acceptance testing of commercial shipments. A comparative test performed as directed in 5.5.1 may be advisable.

5.5.1 In case of a dispute arising from differences in reported test results when using Test Method D 4594 for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias. As a minimum, the two parties should take a group of test specimens that are as homogenous as possible and that 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 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 the light of the known bias.

6. Apparatus

6.1 *Tensile Testing Machine*, of the constant rate-of-extension (CRE) or constant rate-of-traverse type with automatic recorder conforming to the requirement of Specification D 76.

6.2 *Environmental Chamber*, capable of maintaining a temperature range from − 40 to + 100°C (−40 to + 212°F) and equipped with temperature regulation capable of maintaining the test temperature within ±2°C (±4°F) inside the chamber.

6.3 *Various Tubing and Fittings*, to hook up the gas to the environmental chamber.

6.4 *Thermometer*, capable of measuring the temperature range within which tests are being performed and graduated in a 1°C (2°F) division scale.

7. Materials

7.1 *Liquid Nitrogen*, commercial grade or any other dry medium capable of producing temperature below 0°C (32°F).

7.1.1 **Warning**—Since liquid nitrogen is a cryogenic liquid which produces extremely low temperatures when vented to the atmosphere, keep hands clear of open valves and tubings, etc. During testing, use insulated leather gloves to handle samples and to open and close the environmental chamber door. The laboratory should be well ventilated.

7.1.2 Other gases which can be used are helium − 167°C (−269°F), oxygen − 119°C (−183°F), argon − 121°C (−186°F), and carbon dioxide − 62°C (−79°F). Temperatures values listed are the minimum temperatures these gases can attain.

7.1.3 The use of liquid nitrogen is suggested for the test. Nitrogen is less hazardous, more economical than other gases, and also capable of attaining a minimum temperature of − 127°C (−196°F). Oxygen, being a strong oxidizer, should be avoided if possible; otherwise, use cautiously in a well ventilated area away from open flame.

8. Sampling

8.1 *Division into Lots and Lot Sample*—Unless otherwise agreed upon as in an applicable material specification, divide the material into lots and take a lot sample as directed in Practice D 4354. Consider rolls of fabric to be the primary sampling units.

8.2 *Laboratory Sample*—Take for the laboratory sample, a swatch extending the width of the fabric and approximately 1 m (1 yd) 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.

8.3 *Test Specimens*—For the standard conditions and for each test temperature to which the geotextile is to be exposed, cut five specimens at least 50.8 mm (2 in.) wide by 152.4 mm (6 in.) long from each swatch in the laboratory sample with the long dimension of the specimens parallel to the lengthwise direction. Cut five specimens of the same size from each swatch in the laboratory sample with the long dimension of the specimen parallel to the width-wise direction. Prepare the specimens as directed in Test Method D 5035 for ravelled strip test, cut strip test, or both.

9. Test Set-up

9.1 Disconnect the jaw clamps from the tensile testing machine.

9.2 Insert the environmental chamber between cross heads of the machine. Secure firmly to the machine. Connect the jaw clamp back to the machine from inside the chamber.

9.3 Connect the environmental chamber to the liquid nitrogen cylinder, or any other dry medium, and to AC outlet as per manufacturer's instructions (see 7.1.1-7.1.3).

9.3.1 For tests below standard laboratory test conditions, use liquid nitrogen or any other dry medium for sample conditioning and testing, and for tests above standard laboratory test conditions, use the heating element of the environmental chamber.

10. Procedure

10.1 Secure a specimen in the jaws inside the chamber.

10.2 Adjust the temperature of the environmental chamber as required.

10.3 Condition the specimen to the required temperature. The flow of gas is automatically controlled by a solenoid valve. The valve opens and closes to let the gas in to keep constant temperature in the chamber.

10.4 Perform 2-in. cut or 2-in. ravel strip (depending upon the geotextile) tensile test in accordance with Test Methods D 1682 using a machine speed of 305 ± 10 mm/min. (12± ½ in./min).

10.5 Repeat the test sequence of 10.1-10.4 for the remaining samples.

10.6 Adjust the temperature of the environmental chamber and test a second group of specimens at any other required temperature. Repeat the test sequence of 10.1-10.4.

10.7 Test five control samples for each direction at standard laboratory test conditions.

11. Calculation

11.1 Determine the tensile strength and apparent elongation for all specimens.

11.2 Calculate the average tensile strength and average elongation at each test temperature for both the machine direction (warp) and cross-machine direction (fill) specimens.

11.3 Calculate the percent change in tensile strength and elongation for each test temperature, as follows:

$$C = 100(B/A) \quad (1)$$

where:

C = change in tensile strength or elongation, %,
A = average tensile strength or elongation for control specimens conditioned and tested in the standard atmosphere for testing geotextiles, and
B = average tensile strength or elongation for specimens conditioned and tested at a specific test temperature.

NOTE 1—Under normal field conditions, geotextiles will be exposed to the temperatures in the range of − 40 to 49°C (−40 to 120°F). Sometimes during shipping and storage, the geotextile fabric may be exposed to temperatures other than the above range. This test should be performed at the temperatures to which the geotextile will be exposed.

12. Report

12.1 The test report shall include the following information:

12.1.1 State that the tests were performed as directed in Test Method D 4594,

12.1.2 Method of sampling used,

12.1.3 Report the test temperatures,

12.1.4 The average breaking load and average percent apparent elongation for each direction at each test temperature,

12.1.5 The temperature stability for tensile strength and for elongation at each of the test temperatures,

12.1.6 Plots of average breaking load and percent apparent elongation versus test temperature for each direction, and

12.1.7 Description of the material tested.

13. Precision and Bias

13.1 *Precision*—Due to the nature of this test method, no precision statement can be established at present time.

13.2 *Bias*—There is no accepted reference value for the test method, therefore bias cannot be determined.

14. Keywords

14.1 degradation; expansion; geotextile; stability; temperature effects