



Designation: D 4355 – 9902

Standard Test Method for Deterioration of Geotextiles ~~from by~~ Exposure to ~~Ultraviolet Light~~ Light, Moisture and Water (Xenon-Arc Heat in a Xenon Arc Type Apparatus)¹

This standard is issued under the fixed designation D 4355; 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 determination of the deterioration in tensile strength of geotextiles by exposure to ~~ultraviolet light xenon arc radiation, moisture, and water heat.~~

1.2 The light and water exposure apparatus employs a xenon-arc light source.

1.3 *This standard does not purport to address all of the safety problems, 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 123 Terminology Relating to Textiles²

¹ This test method is under the jurisdiction of ASTM Committee D-35 on Geosynthetics and is the direct responsibility of Subcommittee D35.02 on Endurance Properties. Current edition approved ~~Dec. Feb. 10, 1999; 2002.~~ Published ~~March 2000; May 2002.~~ Originally published as D 4355 – 84. Last previous edition D 4355 – 92-9

~~D-1682 Test Methods 1898 Practice for Breaking Load and Elongation Sampling of Textile Fabric Plastics³~~
~~D-1898 Practice 4439 Terminology for Sampling of Plastics Geotextiles⁴~~
~~D-4439 Terminology for Geotextiles⁵ 5035 Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)⁴~~
~~G 113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials⁵~~

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

³ ~~Discontinued 1992; see 1991 Annual~~

³ *Annual Book of ASTM Standards*, Vol-07.01. Replaced by Test Methods D 5034 and D 5035: 08.01.

⁴ *Annual Book of ASTM Standards*, Vol-08.01: 04.13.

⁵ *Annual Book of ASTM Standards*, Vol-04.09: 14.04.

~~G 151 Practice 141 Guide for Addressing Variability in Exposure Testing on Nonmetallic Materials in Accelerated Test Devices That Use Laboratory Light Sources⁶⁵~~

~~G 1551 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices That Use Laboratory Light Sources⁵~~

~~G 155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials⁵~~

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *geotextile*—any permeable textile material used with foundation, soil, rock, earth, or any other geotechnical engineering related material that is an integral part of a man-made product, structure, or system.

3.2 Definitions:

3.2.1 For definitions of other textile terms used in this test method, refer to Terminology D 123, for geotextile terms refer to Terminology D 4439.

3.2.2 The definitions given in Terminology G 113 are applicable to this standard.

4. Summary of Test Method

~~4.1 Five specimens of a geotextiles for the machine direction and for the cross machine directions are exposed in a xenon arc device for each of the following times: 0 (control specimens), for 150, 300, and 500 h of ultraviolet exposure in a xenon-arc device. h. The exposure consists of 120-min cycles as follows: 90 min of light only at $65 \pm 3^\circ\text{C}$ uninsulated black panel temperature and $50 \pm 5\%$ relative humidity, followed by 30 min of light plus water spray and light.~~

~~4.2 There are five specimens tested for spray.~~

~~4.2 After each total exposure time for each direction. Following period, the exposure time the specimens are subjected to a cut or ravel strip tensile test. Comparing these results to The average breaking strength in each direction is compared with the test results for five unexposed specimens indicates average breaking strength in each direction of the deterioration which has taken place due control specimens. The percent strength retained is plotted versus exposure period to ultraviolet exposure. produce a degradation curve for the specimens from each direction.~~

5. Significance and Use

~~5.1 This procedure tests geotextiles under a standard set method is intended to induce property changes associated with end use conditions, including the effects of conditions of humidity solar radiation, moisture and temperature for three heat. The exposure times, plus unexposed specimens. This test method will enable the user used is not intended to develop a degradation curve for simulate the geotextile being tested. deterioration caused by localized weather phenomena such as atmospheric pollution, biological attack, and salt water exposure.~~

5.2 The relation between time to failure in an exposure conducted in accordance with this test method, and service life in a specific outdoor environment requires determination of an acceleration factor as defined in Terminology G 113. The acceleration factor is material-dependent and is only valid if it is based on data from a sufficient number of separate exterior and laboratory-accelerated exposures so that the results used to relate times to failure in each exposure can be analyzed using statistical methods.

NOTE 1—An example of a statistical analysis using multiple laboratory and exterior exposures to calculate an acceleration factor is described by J. A. Simms.⁶ See Practice G 151 for more information and additional cautions about the use of acceleration factors.

5.2.1 The deterioration curve obtained from the results of this test method enables the user to determine the tendency of a geotextile to deteriorate when exposed to ~~ultraviolet light xenon arc radiation, water and water. heat.~~

5.3 Variation in results may be expected when operating conditions are ~~not operated varied~~ within the accepted limits of this test method. Its intended use is as a qualitative assessment of the presence of ultraviolet inhibitors, and comparison of that influence between products. However, no inference to the time of stability should be implied by the test results ~~as correlation to the relation between time duration and outdoor exposure. Outdoor tests are recommended exposure.~~

NOTE 2—Information on sources of variability and on strategies for ~~addressing variability in the design, execution and data analysis of laboratory accelerated exposure tests is found in Guide G 141.~~

5.3.1 If it becomes necessary for the purchaser and seller to use this test method for acceptance testing, the statistical bias, if any, between the purchaser's and seller's laboratories should be determined. Such comparison is to based on specimens randomly drawn from the sample of geotextile being evaluated.

5.3.2 In such cases, 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 the testing started. 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 *Xenon-Arc Apparatus*, of either Type BH or Type C, as described in with daylight filters conforming to Practices G 151 and G 155.

NOTE 3—Previous versions of this standard referenced in Practice G 26 which describes specific equipment designs of xenon arc devices. Practice G 26 has been replaced by Practice G 151, which gives performance criteria for all devices that use laboratory light sources, plus Practice G 155, which gives requirements for exposure of nonmetallic materials in xenon arc devices.

6.1.1 The apparatus must be capable of exposing the specimens to cycles of light only, followed by ~~water spray and light under controlled atmospheric conditions.~~

6.1.2 ~~The apparatus is to be equipped with an inner and outer borosilicate filter glass moisture as described in Practices G 151 and G 155. water spray.~~

6.2 *Strength Testing Apparatus*, conforming to that described for a 2-in. cut or ravel strip test, as described in Test Methods ~~D 1682. D 5035.~~

7. Sampling

7.1 *Lot Sample*—As a lot sample for acceptance testing, take at random the number of rolls of fabric directed in an applicable material specification or other agreement between the purchaser and the supplier. Consider rolls of fabric to be the primary sampling units. If the specification requires sampling during manufacture, select the rolls for the lot sample at uniformly spaced time intervals throughout the production period.

NOTE 24—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, so as 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*—Take for the laboratory sample a sample extending the full width of the fabric of sufficient length along the selvage from each sample roll such that the requirements of 8.1 are met. The sample shall exclude material from the outer wrap of the roll or the inner wrap around the core unless the sample is taken at the production site, at which point inner and outer wrap material may be used.

8. Specimen Preparation

8.1 Take two, one-metre square portions from the laboratory sample. Each shall be no closer to the selvage than 1/10 the sample width. One is to be used for machine direction specimens, the other for cross machine direction specimens.

NOTE 5—Since the thickness of a specimen may markedly affect test results, thickness of the replicate specimens shall be within ± 10% of the nominal dimensions. This is especially important when mechanical properties are being investigated.

8.2 Use template illustrated in Fig. 1 to identify potential specimens from which the actual specimens are drawn. To select these actual specimens randomly draw 20 specimens from both the machine and cross directions measuring 50 by 150 mm (2 by 6 in.) from the one-metre square portions of each laboratory sample as directed in Practice D 1898.

9. Procedure

9.1 Operate the xenon-arc test apparatus as directed in Practices G 151 and G 155. Expose test specimens to the following cycle:

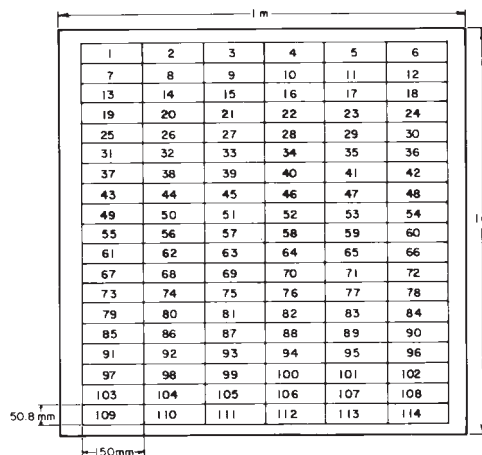


FIG. 1 Specimen Selection Template

90 min of light only at $65 \pm 2.5^\circ\text{C}$ ($149 \pm 5^\circ\text{F}$) uninsulated black panel temperature, and $50 \pm 5\%$ relative humidity, followed by 30 min of light and water spray.

9.1.1 ~~When radiometers capable~~

NOTE 6—Immersion in water during exposure to light is one of monitoring discrete portions of a continuous spectrum are available, set the methods specified in Practices G 151 and G 155 for providing moisture to specimens. It can be substituted for water spray if equivalency is demonstrated, or the geotextile will be immersed in water in its final installation.

9.1.1 Unless otherwise specified, maintain the minimum level of irradiance at the control point to produce $0.35 \pm W/(m^2 \cdot nm \text{ bandpass}/nm)$ at 340 nm. ~~When this capability~~ If the exposure device is not available, wattage settings shall be as defined in Practice G 155. ~~equipped with irradiance control, follow the device manufacturer's recommendations to produce this irradiance.~~ for the equivalent 300-400 nm or 300-800 nm broad band irradiances and tolerances, consult the manufacturer for the specification.

NOTE 37—Practice G 155 does not specify a particular irradiance level. Various options are listed in Table X3.1 of the appendix in Practice G 155. However, as the historical records of testing of geotextiles are based on the irradiance of $0.35 W/m^2/nm$ at 340 nm, this shall be the standard for Test Method D 4355.

9.2 Randomly assign five specimens for each direction from each laboratory sample to each of the following exposure times: 0 (unexposed), 150, 300, and 500 clock hours. Place fifteen specimens from each direction from each laboratory sample in the apparatus, such that the side most likely to be exposed to the effects of ultraviolet light solar radiation will be exposed to radiation in the apparatus.

9.3 Rotate the positions of the specimens in accordance with Practice G 155.

9.4 At the end of each exposure time, remove the appropriate five specimens for each direction for cut or ravel strip tensile testing.

NOTE 8—Specimens should not be removed from the exposure apparatus for more than 24 h and then returned for additional test since this does not produce the same results on some materials as tests run without this type of interruption. Report the elapsed time for any specimens for which exposure was interrupted for more than 24 h.

9.5 Determine the breaking strength in kilonewtons per metre (pounds-force per inch) of five unexposed (control) specimens and five exposed specimens from each exposure time interval, for each direction, from each laboratory sample as directed in Method ~~D 1682~~ D 5035 using a 2-in. width strip, except, a CRE or a CRT type testing machine shall be operated at 305 ± 10 mm ($12 \pm \frac{1}{2}$ in.) unless specified otherwise. The distance between clamps shall be 75 ± 1 mm (3 ± 0.05 in.). There may be no overall correlation between the results obtained with the CRE machine and the CRT machine. Consequently, these two breaking load testers cannot be used interchangeably. In case of controversy, the CRE method shall prevail.

10. Calculation

10.1 Calculate the average breaking strength for all exposed and unexposed (control) specimens for each direction.

10.2 Calculate the percent loss of strength from the unexposed specimens for the average results of each exposure time for each direction.

10.3 For the groups of five specimens from the unexposed specimens and the specimens exposed at various times, calculate the standard deviation and coefficient of variation for the strip tensile strength.

11. Report

11.1 The test report shall include the following information:

11.1.1 That the tests were made as directed in Test Method D 4355,

11.1.2 A full description of the specimens and their origin,

11.1.3 Any full details of sampling not included in 7,

11.1.4 Any details of specimen preparation not included in 8,

11.1.5 Type and model of exposure device and light source,

11.1.6 Type and age of filters at the beginning of the exposure and whether the filters were changed during exposure,

11.1.7 If required, irradiance in $W/m^2 \cdot nm$, or radiant exposure in J/m^2 , at the sample plane and the wavelength region in which the measurements were made,

11.1.7.1 Do not report irradiance or radiant exposure unless direct measurements were made during exposure,

11.1.8 Type of black or white panel thermometer, or both if used, and exact position of the thermometer if not located on the specimen plane,

11.1.9 Description of specimen repositioning, if used,

11.1.10 Exposure periods and the elapsed time for any specimens for which the exposure was interrupted for more than 24 h,

11.1.11 The total exposure times, along with the total irradiance at respective clock hour intervals, and the number of cycles as defined in 9.3.1.1,

11.1.3.1.2 A listing of the test results for the unexposed (control) and for each exposure time, for the machine and cross machine direction, consisting of individual breaking strength test results, and their average, and their standard deviation and coefficient of variation,

11.1.413 A listing of the percent of the average unexposed (control) strength retained for each exposure time for each direction, and

11.1.514 A plot of average breaking strength versus exposure time for each direction.

12. Precision and Bias

12.1 *Precision*—The precision of this test method is being established.

12.2 *Bias*—~~No justifiable statement can be made on the bias of this test method as the deterioration cannot be established by~~ because no material having an accepted referee methods reference value is available.

13. Keywords

13.1 accelerated weathering; degradation; deterioration; geotextiles; solar radiation; xenon arc

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