Designation: D 5970 – 96 (Reapproved 2002)

Standard Practice for Deterioration of Geotextiles from Outdoor Exposure[1]

This standard is issued under the fixed designation D 5970; 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 evaluating the deterioration in tensile strength and strain after outdoor exposure.

1.2 The deterioration is assessed as a reduction in strength and strain at failure from the unexposed geotextile.

1.3 The specific location of the light and weather exposure is made on the basis of a site specific decision between the parties involved.

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

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.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 5035 Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)[2]

3. Terminology

3.1 *Definitions:*

3.1.1 *geotextile*—a permeable geosynthetic comprised solely of textiles.

3.1.2 *strain at failure*—the strain of the geotextile at the elongation corresponding to the failure strength. It is expressed as elongation over original gage length.

3.1.3 *strength*—the maximum, or ultimate, stress that a material can withstand. For geotextiles, expressed in units of force per unit width.

3.1.4 *Discussion*—In some geotextiles, after reaching maximum stress, there is a lesser strength that retained. This lesser strength is referred to as the ultimate strength of the geotextile.

3.1.5 *ultraviolet degradation*—the photochemical change induced by exposure to ultraviolet radiation that results in deterioration of the performance characteristics of the polymeric structure.

4. Summary of Test Method

4.1 Geotextile coupons are attached to a test frame oriented 45° from the horizontal and facing due South at designated location for exposure times of 1, 2, 4, 8, 12, and 18 months. Exposure shall begin so as to ensure that material is exposed during the maximum intensity of ultraviolet light of the year. On the continental United States this shall be mid-June.

4.1.1 Unexposed control coupons shall be retained for testing.

4.2 After each exposure time the appropriate coupons are brought into a laboratory for strength determination. The results of these tests are compared to the strength determined for the unexposed coupons. The user may be interested in exposure times other than specified in this test method. These times should be noted in reporting the results.

4.3 The results are presented in the form of various plots.

5. Significance and Use

5.1 Artificial exposure tests or outdoor exposure tests at one location may not be applicable to a project site at another location. This test method evaluates geotextiles under site specific atmospheric conditions over an 18 month period. A degradation curve based on strength, elongation, or modulus, or all of these, may be developed for the geotextile being evaluated.

5.2 This test method can be used for comparative testing of the degradation of geotextiles.

5.3 This test method is considered to be a performance test and as such the responsibility for its performance rests with the specifying or purchasing agency.

NOTE 1—The intent of this procedure is to provide the user of this test method and geotextiles a standard by which to evaluate ultraviolet degradation at a specific site in terms of expected life, not in terms of incident radiation and temperature. If desired, the user may want to have the necessary measurement and recording equipment at each site to do this. However, the expense of doing so at each site may be prohibitive. Therefore, this is not a specific requirement of this test method.

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

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

6. Apparatus

6.1 The frame for holding the coupons during the exposure phase of this test consists of a wooden frame (for example, a sheet of exterior plywood) suitably braced so that it resides at a 45° angle with the horizontal.

6.1.1 The frame is to be unpainted with the surface protected from the effects of water and sunlight by varnishing the surface.

6.1.2 The supported frame is firmly positioned in a location free from obstruction from trees or other sources of shade. It shall face due South. It shall be placed such that no heat or sun light is reflected on it from surrounding buildings. If this is not possible, it shall be noted in the test results report.

6.1.3 The frame shall be suitably anchored using anchors, stakes, or adequate weights on the support legs.

6.2 The geotextiles coupons shall be fastened in such a way so that undue stress, that could result in premature failure of the geotextile, are not induced with care, staples may be used.

7. Sampling

7.1 *Lot Sample*—Divide the product into lots and take one unit per lot as the lot sample.

7.1.1 *Discussion*—This test method is intended to be performed by the purchaser for the purpose of determine geotextile performance under site specific conditions. Should a manufacturer perform this test it is not intended that each manufactured lot be sampled and tested. This is because the test is considered to be time intensive.

7.2 *Laboratory Sample*—Take for the laboratory sample a sample of the geotextile extending the full width of the roll of sufficient length along the selvedge 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 outer or inner wrap may be used.

7.3 See Fig. 1 for explanation of sample versus coupon versus specimen.

8. Test Coupon Preparation

8.1 Cut six test coupons for each exposure time in the machine direction 300 by 180 mm (12 by 7 in.) from the laboratory sample. The shortest measurement shall be in the machine direction:

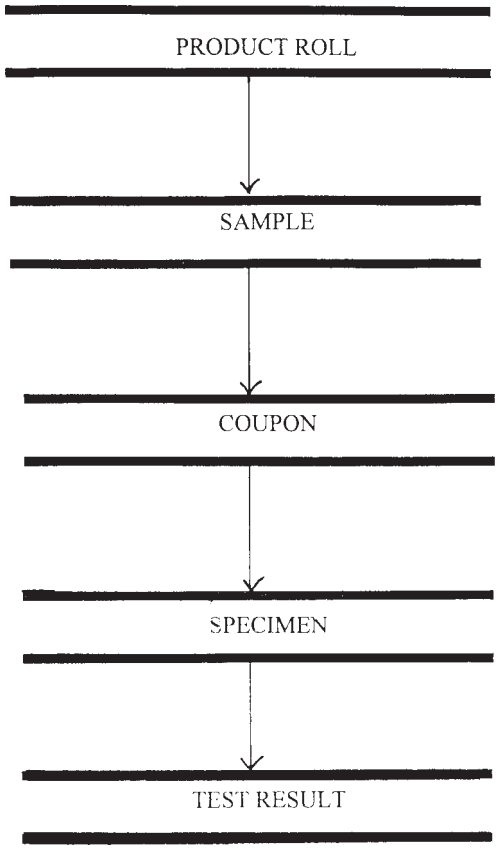
	Machine or Cross Machine Direction					
Control	1C1	1C2	1C3	1C4	1C5	1C6
Month 1	1M(CM)1	1M2	1M3	1M4	1M5	1M6
Month 2	2M1	2M2	2M3	2M4	2M5	2M6
Month 18	18M1	18M2	18M3	8M4	18M5	18M6

8.1.1 Repeat 8.1 for the cross machine direction, with the shortest measurement in the cross machine direction.

8.2 Cut six test coupons from each direction to be used as control coupons. These will act as the control specimens for all exposure times. Place the control coupons in a black polyethylene bag, and seal to prevent deterioration of the control samples due to exposure to ultraviolet light. Store the bag with the coupons in a cool, dry location.

9. Procedure

9.1 Firmly attach the six coupons for exposure to the outdoor test frame as described in 6.2. In the case of staples being used, locate them in the outer 25 mm (1 in.) of the coupon, with approximately four staples per each 300 mm (12 in.) width, and three staples along each 180 mm (7 in.) length.



NOTE 1—Product roll is from the manufacturer. Samples are cut from the product roll. Coupons for outdoor exposure are cut from samples. Specimens for tensile testing are cut from coupons.

FIG. 1 Relation Between Sample, Coupon, Specimen

NOTE 2—If a full sheet of plywood, 1200 by 2400 mm (4 by 8 ft), is used, seven sets of coupons can be attached to the frame. This will allow an approximately 25 mm (1 in.) space around each sample. See lower photograph of Fig. 1.

NOTE 3—The long dimension of the frame and the coupons attached to the frame shall run parallel to the surface on which the frame rests.

9.2 Obtain appropriate weather information, such as average and mean temperatures, amount of rainfall, cloud cover versus sunlight, from the nearest national weather station.

9.3 After each appropriate length of exposure, that is, 1, 2, 4, 8, 12, and 18 months, remove the appropriate coupons from the frame and bring them to the laboratory.

9.3.1 Condition the coupons in the standard atmosphere for testing geosynthetics.

9.4 Trim the outer 25 mm (1 in.) of the long dimension from each side of the coupon such that the remaining sample measures 250 mm (10 in.) in width. Dispose of the trim material.

9.5 Carefully cut the remaining 250 mm (10 in.) wide coupon into five 50 mm (2 in.) wide, strip tensile test specimens. The specimens will measure 180 mm (7 in.) long.

9.6 Determine the breaking strength in kilonewtons per metre (pounds force per inch) of the control coupons, as

directed in Test Method D 5035 using a 50 mm (2-in.) width strip, except, a CRE or CRT type testing device shall be operated at 305 ± 10 mm/min (12 ± ½ in./min) unless specified otherwise. The distance between the 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.

9.6.1 Determine the breaking strength of the exposed specimens from each exposure time, as directed in Test Method D 5035 using a 50 mm (2-in.) width strip, except, a CRE or CRT type testing device shall be operated at 305 ± 10 mm/min (12 ± ½ in./min) unless specified otherwise. The distance between the 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.

9.7 Record elongation at break.

10. Calculation

10.1 Determine the average ultimate force and elongation for each exposure time.

10.2 Calculate the average strength for each exposure time as follows:

$$T_{avg} = P_{avg}/w \quad (1)$$

where:

T_{avg} = average strength in units of force per unit width kN/m (lbf/in.),
P_{avg} = average force from 10.1, and
w = original width of test specimen, 50 mm (2 in.).

10.3 Calculate a percent strength retained as follows:

$$T_{ret} = (T_{avg}/T_{unexposed}) \times 100 \quad (2)$$

where:

T_{ret} = percent strength retained,
T_{avg} = strength of exposed specimens from 10.2, and
$T_{unexposed}$ = strength of unexposed specimens from 10.2.

10.4 Calculate the average elongation at break.

10.5 Calculate the average strain at failure as follows:

$$S_{avg} = (L_{avg} - L_{orig})/L_{orig} \quad (3)$$

where:

S_{avg} = average strain at failure,
L_{avg} = average elongation at failure from 10.4,
L_{orig} = original gage length, that is, 75 mm (3 in.).

10.6 Calculate a percent strain retained at failure by comparison of the average strain at failure for exposed specimens to the average strain at failure for the unexposed specimens as follows:

$$S_{ret} = (S_{avg}/S_{unex}) \times 100 \quad (4)$$

where:

S_{ret} = percent strain at failure retained,
S_{avg} = average strain at failure from 10.4, and
S_{unex} = average strain at failure for unexposed (control) specimens.

10.7 From the results of 10.2, determine the standard deviation and the coefficient of variation for each exposure time, and each direction tested.

10.8 Plot graphs of percent strength retained, percent strain at failure, or modulus versus exposure time, or all of these.

10.8.1 Plot graphs of percent strength retained, percent strain at failure, or modulus versus total ultraviolet radiation, if measured, or all of these, for each exposure time.

11. Report

11.1 Report the following information:

11.1.1 The test was performed according to this test method,

11.1.2 Any variations from this test method,

11.1.3 A listing of the test results from Section 10,

11.1.3.1 If requested the following results may be reported: individual specimen results, standard deviations and coefficient of variations for each exposure time and,

11.1.4 The plots developed in 10.8,

11.1.5 A summary of mean and average temperatures, rainfall, and cloud cover versus sunlight, if obtained from weather stations, for each exposure period,

11.1.6 The inclusive dates of exposure for each set of test results, and

11.1.7 The orientation of the exposure based on the azimuth of the exposed face.

12. Precision and Bias

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

12.2 *Bias*—The bias of this test method, if any, is being determined.

13. Keywords

13.1 degradation; geotextile; outdoor exposure; strength retained; ultraviolet degradation