



Standard Test Method for Determination of Ply Adhesion Strength of Reinforced Geomembranes¹

This standard is issued under the fixed designation D 6636; 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 method is used to measure the adhesion strength (180 degree peel) between plies of reinforced geomembranes such as internally-reinforced geomembranes and coated fabrics.

1.2 This method is not intended for determining the strength of geomembrane seams or for determining the ply adhesion strength of geocomposite components (such as nonwoven geotextile bonded to geomembrane, or geotextile bonded to drainage core).

1.3 The values in SI units are the standard. The values provided in inch-pound units are for information only.

1.4 *This standard may involve hazardous materials, operations and equipment. 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 76 Specification for Tensile Testing Machines for Textiles²

D 4354 Sampling of Geosynthetics for Testing³

D 4439 Terminology for Geosynthetics³

3. Terminology

3.1 Definitions:

3.1.1 *atmosphere for testing geosynthetics, n*—air maintained at a relative humidity between 50 to 70 % and a temperature of $21 \pm 2^\circ\text{C}$ ($70 \pm 4^\circ\text{F}$).

3.1.2 *geocomposite, n*—a multi component product at least one of which is a geosynthetic.

3.1.3 *geomembrane, n*—an essentially impermeable geosynthetic composed of one or more synthetic sheets.

3.1.3.1 *Discussion*—In geotechnical engineering, essentially impermeable means that no measurable liquid flows through a geosynthetic when tested in accordance with D 4491.

3.1.4 *ply adhesion, n*—bond between layers of a laminated material.

3.1.5 *ply adhesion strength, n*—force per unit width required to cause separation in peel between layers of a laminated material.

3.1.6 *reinforced geomembrane, n*—a geomembrane internally reinforced with a textile.

3.1.7 *selvage, n*—an edge or edging which differs from the main part of a geosynthetic.

4. Summary of Test Method

4.1 The plies of the reinforced geomembrane are first partially peeled apart by hand for a distance of 25 to 50 mm (1-2 inches) to allow clamping of the specimen in the grips of the tensile machine. The plies are then separated at an angle of 180 degrees at a constant rate of extension and the cross-head movement and force are recorded.

5. Significance and Use

5.1 This method is an index test and measures the force required to separate individual plies of a reinforced geomembrane. The acceptable value of adhesion will vary for different types of products. However for a particular type of product, minimum values of ply adhesion can be determined and agreed to by producer and consumer, and both can monitor to assure compliance with the agreed-upon value.

5.2 *Disputes*—In case of a dispute arising from differences in reported test results when using this test method for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is a statistical difference between their laboratories. Competent statistical assistance is recommended for the investigation of this difference. As a minimum, the two parties should take a group of test specimens which are from the same lot of material as those type in question and which are as homogeneous as possible. 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

¹ This test method is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.10 on Geomembranes.

Current edition approved Feb. 10, 2001. Published April 2001.

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

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

acceptable probability level chosen by the two parties before the testing began. If a difference 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 difference.

6. Apparatus

6.1 *Tensile Testing Machine*—A constant rate of extension (CRE) testing machine complying with D 76 shall be used. The load cell shall be accurate to within $\pm 1\%$ of the applied force. The testing machine shall be capable of maintaining a constant rate of extension of 50 mm/min (2 in/min) over the entire duration of the test.

6.2 The testing machine shall be equipped with either a strip chart recorder or similar auxiliary equipment capable of producing a hardcopy of the force versus displacement graph. Computerized data acquisition systems are acceptable.

6.3 The force applied during the test shall be greater than 15 % and less than 85 % of the load range selected.

6.4 *Grips*—The grip faces shall be a minimum of 25 mm (1 in.) wide and clamp the entire width of the specimen with appropriate clamping force to prevent specimen slippage or damage (crushing). Grips shall be designed to transmit the applied force evenly over the entire width of the specimens.

NOTE 1—Constant pressure pneumatic and wedge type grips have performed satisfactorily for many types of products.

7. Sampling

7.1 *Lot Sample*—For the lot sample, take rolls of geomembrane per the applicable project specification, or as agreed upon between purchaser and supplier. Unless otherwise specified, refer to D 4354 “Sampling of Geosynthetics for Testing”.

7.2 *Laboratory Sample*—For the laboratory sample, take a full-width swatch approximately 1 m (3 ft) long by roll width for each roll in the lot sample. Take a sample that will exclude material from the outer wrap of the roll or the inner wrap around the core. In the case where the sample is taken at the production site, material from the inner and outer wrap may be used.

7.3 *Test Specimen*—The standard test specimens shall be 25 ± 0.5 mm (1.00 ± 0.02 in.) wide and at least 200 mm (8 in.) long to permit ply separation over a length of at least 100 mm (4 in.). The test specimens shall be cut parallel to the scrim. No test specimen shall be taken closer than 100 mm (4 in.) from the selvage.

7.4 *Number of Test Specimens*—Prepare five test specimens, in the longitudinal (machine) direction only.

8. Preparation of Test Specimens

8.1 *Standard Method - Separation Sheet*—During manufacture, specimens can be easily obtained by deliberately placing separation sheets between the plies.

8.2 *Alternate Method*—Separate the plies of the reinforced geomembrane by hand for a distance of 25 to 50 mm (1 to 2 in.) to allow clamping of the specimen in the grips of the tensile machine. A sharp knife or scalpel may prove useful to initiate ply separation.

9. Conditioning

9.1 Prior to testing, condition the specimens for a minimum

of 24 h at the standard atmosphere for testing geosynthetics.

10. Procedure

10.1 Fix the separated ends of the test specimen in the grips of the testing machine and adjust so that the tension is distributed uniformly, that no twisting of the test specimen occurs during the test, and that the angle of separation is approximately 180 degrees. The portion of the test specimen not fixed in the grips is left unrestrained.

10.2 *Speed of Testing*—The speed of testing is 50 mm/min (2 in/min). The speed of testing is to be uniform throughout the test.

10.3 *Test Atmosphere*—The test atmosphere shall be the standard atmosphere for testing geosynthetics, $21 \pm 2^\circ\text{C}$ ($70 \pm 4^\circ\text{F}$) and 50 to 70 % relative humidity.

10.4 Begin the test. Measure and record the force necessary for ply separation over a length of at least 100 mm (4 in.).

10.5 *Tearing*—If during the test, either ply begins to tear instead of separating at the bonded interface, cut the ply being torn with a knife up to the surface of contact between the two plies and start the test again. In case of repeated tearing, either reject the specimen and prepare additional specimens, or accept the test and record the highest load at which tearing occurs (see section 11.1).

11. Interpretation of Results

11.1 The true ply adhesion strength is not determined if the specimens repeatedly tear. However, tearing indicates that the ply adhesion strength exceeds the tear strength of the individual plies. In cases of tearing, the results should be so designated in the report per section 13.1.7.

11.2 The ply adhesion strength may differ between different plies of the same article and also at different points along the same ply. Therefore, the ply adhesion strength should be measured over a reasonable separation distance. When possible, the separation distance shall be at least 100 mm (4 in.).

12. Calculations

12.1 *Ply Adhesion Strength*—Calculate the ply adhesion strength for each of the individual specimens; that is, calculate the force per unit width required to cause the plies to separate:

$$S_{PA} = F/W \quad (1)$$

where:

S_{PA} = Ply Adhesion Strength, N/m (lbf/in.),

F = Force, N (lbf), and

W = Width, m (in.).

12.2 The force required to cause ply separation for an individual specimen is maximum load recorded during the test. For specimens that repeatedly tear, the true value may be higher than the recorded maximum load.

12.3 The final reported value shall be the average of the results from the five test specimens.

13. Report

13.1 The report shall include the following:

13.1.1 A statement that the specimens were tested in accordance with this standard, listing any variations.

13.1.2 Date of test.

- 13.1.3 Test temperature and relative humidity.
- 13.1.4 Identification of the material tested, including date of manufacture (if known).
- 13.1.5 Method of test specimen preparation per Section 8.
- 13.1.6 Test equipment, including size and type of grip faces.
- 13.1.7 A report of the individual specimen results which are the maximum loads recorded during each test, reported as force per unit width. For specimens that tear, the highest force recorded during that test should be reported. Identify primary failure mode for each specimen as either “ply separation” or “tear”.
- 13.1.8 A report of the average results for the five (5) specimens tested in units of N/m (lbf/in.).

13.1.9 Observations and recorded data on which the results are based.

14. Precision and Bias

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

14.2 *Bias*—The true value of ply adhesion of reinforced geomembranes can be defined only in terms of a test method. Since there is no referee test method, the procedures within this test method have no bias.

15. Keywords

- 15.1 geomembrane; ply adhesion; reinforced

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