Designation: D7747/D7747M – 11ε1

# Standard Test Method for Determining Integrity of Seams Produced Using Thermo-Fusion Methods for Reinforced Geomembranes by the Strip Tensile Method[1]

This standard is issued under the fixed designation D7747/D7747M; 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.

ε[1] NOTE—Designation was corrected and editorial changes were made throughout in October 2013.

## 1. Scope

1.1 This test method describes destructive quality control tests used to determine the integrity of thermo-fusion seams made with reinforced geomembranes. Test procedures are described for seam tests for peel and shear properties using strip specimens.

1.2 The types of thermal field and factory seaming techniques used to construct geomembrane seams include the following:

1.2.1 *Hot Air*—This technique introduces high-temperature air between two geomembrane surfaces to facilitate melting. Pressure is applied to the top or bottom geomembrane, forcing together the two surfaces to form a continuous bond.

1.2.2 *Hot Wedge*—This technique melts the two geomembrane surfaces to be seamed by running a hot metal wedge between them. Pressure is applied to the top and bottom geomembrane to form a continuous bond. Some seams of this kind are made with dual tracks separated by a non-bonded gap. These seams are sometimes referred to as dual hot wedge seams or double-track seams.

1.2.3 *Extrusion*—This technique encompasses extruding molten resin between two geomembranes or at the edge of two overlapped geomembranes to effect a continuous bond.

1.2.4 *Radio Frequency (RF) or Dielectric*—High frequency dielectric equipment is used to generate heat and pressure to form an overlap seam in factory fabrication.

1.2.5 *Impulse*—Clamping bars heated by wires or a ribbon melts the sheets clamped between them. A cooling period while still clamped allows the polymer to solidify before being released.

1.3 The types of materials covered by this test method include, but are not limited to, reinforced geomembranes made from the following polymers:

1.3.1 *Very Low Density Polyethylene (VLDPE).*
1.3.2 *Linear Low Density Polyethylene (LLDPE).*
1.3.3 *Flexible Polypropylene (fPP).*
1.3.4 *Polyvinyl Chloride (PVC).*
1.3.5 *Chlorosulfonated polyethylene (CSPE).*
1.3.6 *Ethylene Interpolymer Alloy (EIA).*

1.4 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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:*[2]

D76/D76M Specification for Tensile Testing Machines for Textiles
D7003/D7003M Test Method for Strip Tensile Properties of Reinforced Geomembranes
D7004/D7004M Test Method for Grab Tensile Properties of Reinforced Geomembranes
D4439 Terminology for Geosynthetics
D7749 Test Method for Determining Integrity of Seams Produced Using Thermo-Fusion Methods for Reinforced Geomembranes by the Grab Method

## 3. Terminology

3.1 *Definitions*—Refer to Terminology for Geosynthetics, D4439, for definitions of terms applying to this test method.

[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.

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

## 4. Significance and Use

4.1 The use of reinforced geomembranes as barrier materials has created a need for a standard test method to evaluate the quality of seams produced by thermo-fusion methods. This test method is used for quality control purposes and is intended to provide quality control and quality assurance personnel with data to evaluate seam quality.

4.2 This standard arose from the need for a destructive test method for evaluating seams of reinforced geomembranes. Standards written for destructive testing of nonreinforced geomembranes do not include all Break Codes (Fig. 1) applicable to reinforced geomembranes.

4.3 When reinforcement occurs in directions other than machine and cross machine, scrim are cut at specimen edges, generally lowering results. To partially compensate for this, testing can be performed according to Test Method D7749, or the 2 in. wide strip specimen specified in this method can be utilized. Testing of 1 in. and 2 in. specimens is Method A and Method B respectively.

4.4 The shear test outlined in this method correlates to strength of parent material measured according to Test Method D7003/D7003M only if reinforcement is parallel to TD. For other materials, seam strength and parent material strength can be compared through Test Methods D7749 and D7004/D7004M. Values obtained with the strip methods shall not be compared to values obtained with grab methods.

## 5. Apparatus

5.1 *Tensile Testing Machine*—Constant Rate of Extension (CRE) equipment meeting the requirements of Specification D76/D76M. The load cell shall be accurate to within ±1 % of the applied force. The drive mechanism shall be able to control the rate of extension to within ±1 % of the targeted rate. The maximum allowable error in recorded grip displacement shall be ±1 % of the recorded values. The maximum allowable variation in nominal gage length on repeated return of the clamps to their starting position shall be less than 0.25 mm [0.01 in.].

5.2 *Grip Faces*—The clamping force and the clamp surfaces shall hold the specimen firmly without causing damage.

5.2.1 Clamp faces shall be a minimum of 25.4 mm [1.00 in.] in the dimension parallel to direction of test and wide enough to grip the full width of the specimen.

## 6. Sample and Specimen Preparation

6.1 *Seam Samples*—Approximately 1 m [36 in.] length of seam shall be cut out with a minimum of 12.5 cm [5 in.] of material on either side of the seam.

6.2 *Specimen Preparation*—Five specimens each for peel strength and shear strength. The locations from which the specimens are taken shall be spaced evenly along the length of the seam with shear and peel specimens alternating along the sample length (Fig. 2).

6.2.1 *Specimens*—Rectangular test specimens shall be a minimum of 150 mm [6.0 in.] plus the seam width in the direction perpendicular to the seam. For Method A, the specimens shall be 25.4 mm [1.00 in.] in the direction parallel to the seam. For Method B, specimens shall be 50.8 mm [2.00 in.] in the direction parallel to the seam. The seam should be centered in the specimen.

## 7. Conditioning

7.1 *Conditioning*—Specimens may be tested once they have equilibrated at standard laboratory temperature. The time required to reach temperature equilibrium may vary according to the material type and thickness.

7.2 *Test Conditions*—Conduct tests at the standard atmosphere for testing geosynthetics, a temperature of 21 ± 2°C [70 ± 4°F] and a relative humidity between 50 to 70 %, unless otherwise specified.

## 8. Procedure

8.1 *Shear Test*:

8.1.1 Set the grip separation equal to the width of the seam plus 76.2 mm [3.00 in.]. Set the crosshead speed to 305 mm/min [12 in/min].

8.1.2 Place the specimen symmetrically in the clamps so the weld will experience shear force (Fig. 3). Center the seam vertically between the grips.

8.1.3 Elongate the specimen until rupture of reinforcement and coating or until a separation of weld or separation in plane has occurred across the entire weld. (See Fig. 1 for explanation of separation in plane.)

8.1.4 Record the load at peak and Break Code (Fig. 4 and Fig. 1).

8.2 *Peel Test*:

8.2.1 Set the grip separation to 25.4 mm/min [1.00 in.]. Set the crosshead speed to 50.8 mm/min [2.00 in./min].

8.2.2 Place the specimen in the clamps in a "T" configuration (Fig. 4). If there is enough material, center the seam vertically between the grips.

8.2.3 Elongate the specimen until rupture of reinforcement and coating or until a separation of weld or separation in plane has occurred across the entire weld. (See Fig. 1 for explanation of separation in plane.)

8.2.4 If a specimen slips between the clamps, discard the individual result and test another specimen. If reinforcing strands slip through the material held between the grips, discard the individual result and test another specimen. Slipping scrim may require increasing clamping pressure.

8.2.5 Record the load at peak, and Break Code (see Fig. 1 and Fig. 5).

## 9. Calculation

9.1 *Seam Shear Strength*:

9.1.1 Divide the peak load by the width of the specimen to obtain results in N/mm or lbs/in.

9.2 *Seam Peel Strength*:

9.2.1 Divide the peak load by the width of the specimen to obtain results in N/mm or lbs/in.

NOTE 1—Because of the heterogonous nature of a reinforced geomembranes, calculating force per cross-sectional area is not relevant and should not be done.

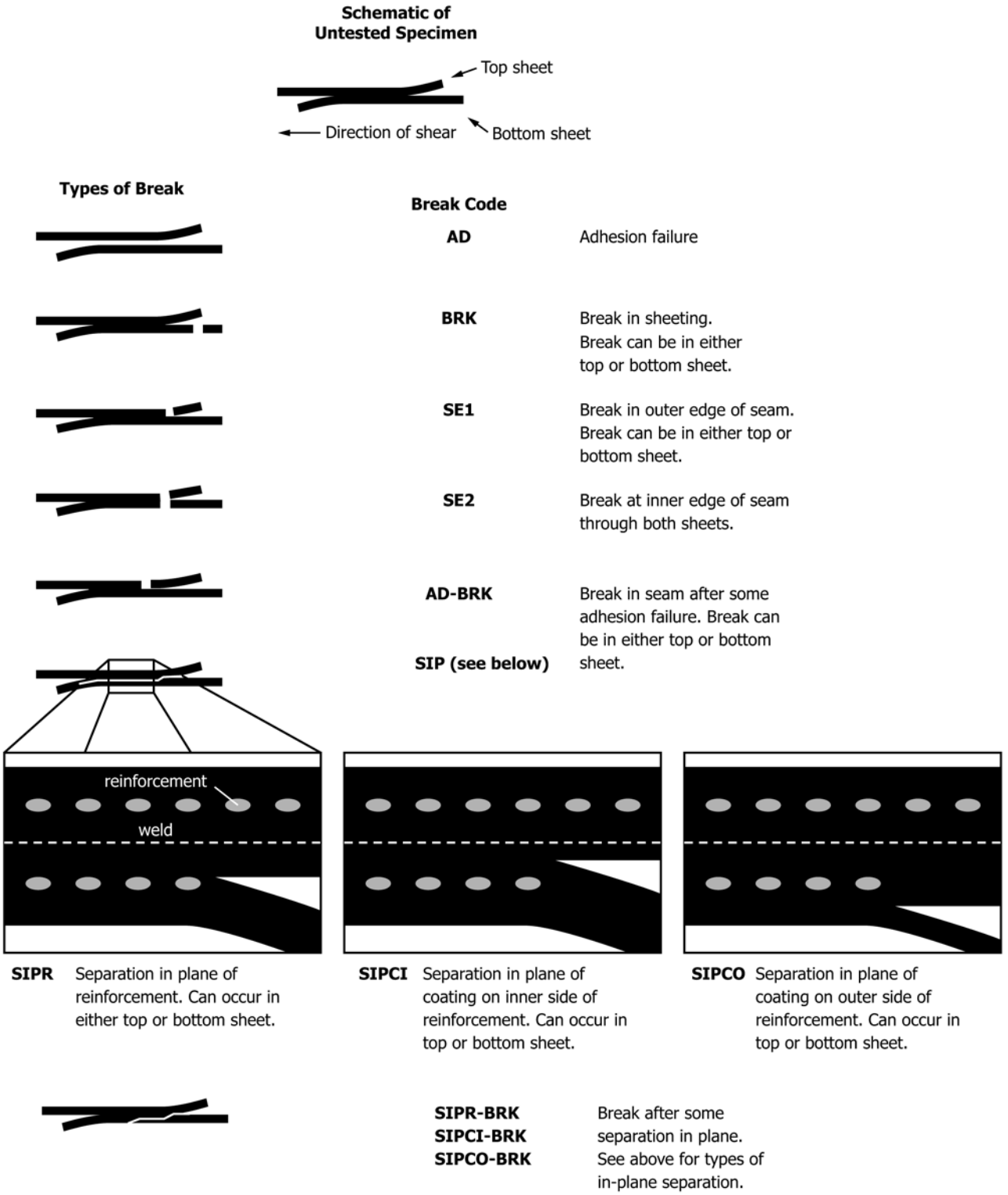



**FIG. 1 Break Codes for Dual Hot Wedge and Hot Air Seams of Reinforced Geomembranes Tested for Seam Strength in Shear and Peel Modes**

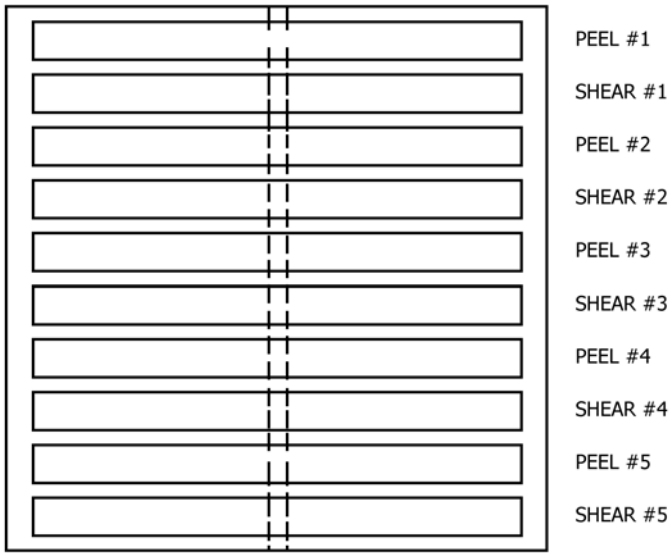



**FIG. 2 Specimen Configuration of Seam Sample**

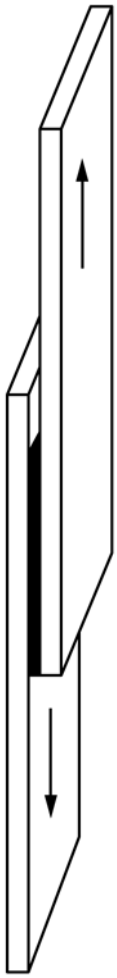


**FIG. 3 Example of Shear Test**

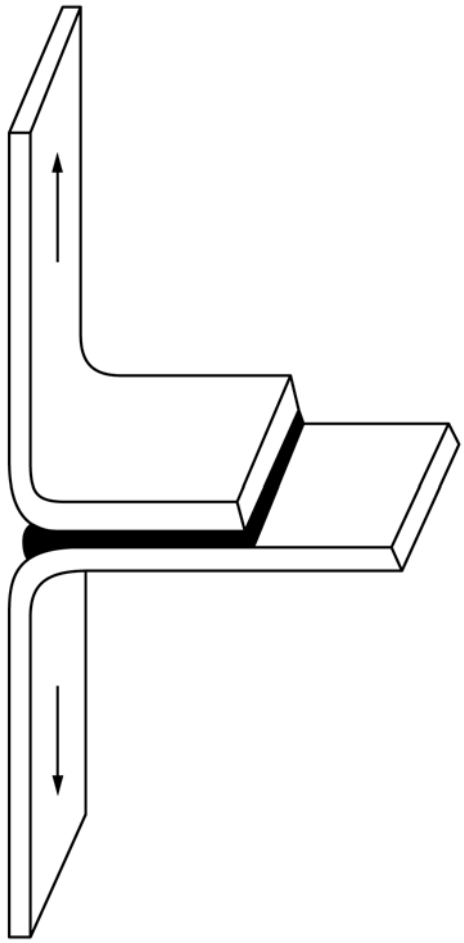


**FIG. 4 Example of Peel Test**

## 10. Report

10.1 The report shall include the following information:

10.1.1 Type of test: shear or peel.

10.1.2 Method A (1 in. specimen), or Method B (2 in. specimen).

10.1.3 Individual location of break code for each specimen.

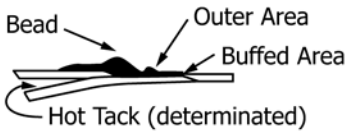
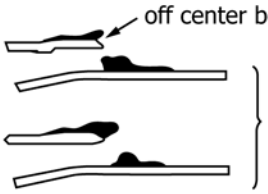
| Schematic of Untested Specimen | Location of Break Code | Description |
|---|---|---|
|  | | |
|  | **AD1** | Failure in adhesion. Specimens may also delaminate under the bead and break through the thin extruded material in the outer area. |
|  | **AD2** | Failure in adhesion. |
|  | **AD-WLD** | Break through the fillet. |
|  | **SE1** | Break at seam edge in the bottom sheet (applicable to shear only) |
|  | **SE2** | Break at the seam edge in the top sheet (applicable to peel only) |
|  | **SE3** | Break at the seam edge in the bottom sheet (applicable to peel only) |
|  | **BRK1** | Break in the bottom sheet. A "B" in parentheses following the code means the specimen broke in the buffed area. |
|  | **BRK2** | Break in the top sheet. A "B" in parentheses following the code means the specimen broke in the buffed area. |
|  | **AD-BRK** | Break in the bottom sheeting after some adhesion failure between the fillet and the bottom sheet. |
|  | **HT** | Break at the edge of the hot tack for specimens which could not be delaminated in the hot tack. |
|  | **SIPR, SIPIC, SIPOC** | Separation in plane of the sheet. See figure 4. |

**FIG. 5 Break Codes for Fillet Extrusion Weld Seams in Reinforced Geomembranes Tested for Seam Strength in Peel and Shear Modes**

10.1.4 *Shear tests:* Individual seam shear strength for each specimen and average seam shear strength for allspecimens in units of N/mm or lbs/in.

10.1.5 *Peel tests:* Individual seam peel strength for each specimen and average seam peel strength for all specimens in units of N/mm or lbs/in., rate of extension.

NOTE 2—"Locus-of-Failure" (Fig. 1 and Fig. 5) include only some of the typically found seam configurations found in the industry. When this test method is applied to seams bonded in configurations other than those identified in Fig. 1 or Fig. 5, the users of this test method must agree on applicable descriptions for modes of specimen rupture.

10.1.6 If the specimen does not rupture, report this and the maximum extension achieved during the test.

## 11. Precision and Bias

11.1 No statement can be made at this time concerning precision or bias.