Designation: D 4437 – 99

Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes[1]

This standard is issued under the fixed designation D 4437; 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 practice is intended for use as a summary of destructive and nondestructive quality control test methods for determining the integrity of field seams used in the joining of flexible sheet materials in a geotechnical application. This practice outlines the test procedures available for determining the quality of bonded seams. Any one or combination of the test methods outlined in this practice can be incorporated into a project specification for quality control. These test methods are applicable to manufactured flexible polymeric membrane linings that are scrim reinforced or nonreinforced.

1.2 The types of field seams covered by this practice include the following:

1.2.1 *Thermally Bonded Seams*:

1.2.1.1 *Hot Air*—A seam produced by applying high-temperature air or gas between two polymeric sheet surfaces, thus melting the surfaces, at which time pressure is applied to form a homogeneous bond between the two membrane surfaces.

1.2.1.2 *Hot Wedge (or Knife)*—A seam produced by melting the two intimate surfaces by running a hot metal wedge between the surfaces followed immediately by pressure to form a homogeneous bond.

1.2.1.3 *Extrusion*—A bonded seam produced by extruding molten parent material between or at the edge of two overlapped polymer sheet materials to effect a homogeneous melt between the two sheets to be joined.

1.2.2 *Solvent Bonded Seams*—A solvent is used to soften the surfaces to be bonded, followed by pressure to form a homogeneous bond.

1.2.3 *Bodied Solvent Bonded Seams*—The parent lining polymer material is dissolved in a solvent that is then applied in the same manner as a straight solvent, thus effecting a homogeneous bond.

1.2.4 *Adhesive Bonded or Cemented Seams*— An adhesive system is used to bond two polymeric surfaces together. This system forms an adhesive bond between the sheet materials.

1.2.5 *Taped Seams*—An adhesive-based tape is placed between two polymer sheet materials forming a surface bond.

1.2.6 *Waterproofed Sewn Seams*—Seam fabricated by mechanical sewing of the overlapped sheet materials and sealed with an appropriate sealant as recommended by the sheet manufacturer.

1.3 The values stated in inch-pound units are to be regarded as the standard.

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 413 Test Methods for Rubber Property—Adhesion to Flexible Substrate[2]

D 618 Practice for Conditioning Plastics for Testing[3]

D 816 Methods of Testing Rubber Cements[2]

3. Significance and Use

3.1 The increased use of geomembranes as barrier materials to restrict liquid migration from one location to another in soil and rock, and the large number of seam methods and types used in joining these geomembrane sheets, has created a need for standard tests by which the various seams can be compared and the quality of the seam systems can be evaluated. This practice is intended to meet such a need.

4. Materials and Manufacture

4.1 The geomembrane sheet material shall be formulated from the appropriate polymers and compounding ingredients to form a plastic or elastomer sheet material that meets all specified requirements for the end use of the product. The sheet material (reinforced or nonreinforced) shall be capable of being bonded to itself by one of the methods described in 1.2 in accordance with the sheet manufacturer's recommendations and instructions.

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[1] This practice is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.10 on Geomembranes.

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[2] *Annual Book of ASTM Standards*, Vol 09.01.

[3] *Annual Book of ASTM Standards*, Vol 08.01.

5. Sampling for Destructive Test Methods

5.1 *Field Fabricated Startup Seam*— The installation contractor shall provide a representative seam fabricated from the same sheet material and using the same seaming methods as those recommended by the geomembrane sheet manufacturer. The startup seam shall be no less than 10 ft (3 m) in length and shall be provided at the start of each day's or shift's seaming. Cut random samples for shear and peel testing from the startup seam. Allow the seam to cure or age properly before testing in accordance with manufacturer's directions.

5.2 *Field Cutout*—For a minimum of one sample per seaming crew per day, cut a 2-ft (0.61-m) long section of the fabricated seam from the installed lining. The cutout section shall be wide enough to accommodate peel and shear testing as in 6.2 and 6.3. Cut random specimens for peel and shear testing from the sample. The frequency of cutouts can be determined by the size of the geomembrane installation and may require only one or two cutouts. Patch the resulting hole with an oval-shaped piece of sheet material and seam in accordance with the manufacturer's instructions. Before testing, allow the cutout seam to cure or age properly in accordance with manufacturer's directions.

6. Destructive Test Methods

6.1 These test methods are applicable only at sites where access to a testing laboratory is readily available, where project scheduling will allow offsite testing, or where a portable test laboratory is available.

6.2 *Peel Testing*—Follow Test Methods D 413, Method A, or Methods D 816, Method C, using a minimum of five l-in. (25.4-mm) wide specimens, a gage length of 1 in. (25.4 mm) (grips positioned ½ in. (13.0 mm) on either side of the start of seam bond), and a constant machine crosshead speed of 2 in./min (51 mm/min). The seam overlap length shall be as fabricated in the field. Fully support the test specimen within the grips across the width of the specimen.

6.3 *Shear Testing*—Follow Methods D 816, Method B, using a minimum of five 1-in. (25.4-mm) wide specimens for unreinforced sheet materials. For reinforced sheet materials, the following procedure shall be used: Prepare a minimum of five 2-in. (51-mm) wide specimens for reinforced sheet materials with the field seam at the center of the test specimen and perpendicular to the centerline. Grip separation shall be 2 in. (51 mm) plus the width of the seam with the seam centered between the grips. Crosshead speed shall be 2 in./min (51 mm/min). The seam overlap shall be as fabricated in the field. Fully support the test specimen within the grips across the width of the specimen.

7. Nondestructive Test Methods

7.1 For all test methods listed below, any and all flaws in seam construction that are detected under a given test procedure shall be repaired. All nondestructive test methods listed are not necessarily applicable to all polymeric geomembrane materials.

7.2 *Air Lance Test*—Inspect all field seams for unbonded areas using an air nozzle directed on the upper seam edge and surface to detect loose edges, riffles indicating unbonded areas within the seam, or other undesirable seam conditions. Check all bonded seams using a minimum 50 psi (345 kPa) (gage) air supply directed through a 3⁄16 in. (4.8 mm) (typical) nozzle, held not more than 2 in. (51 mm) from the seam edge and directed at the seam edge.

7.3 *Vacuum Box Testing*—Inspect all field seams for unbonded areas by applying a vacuum to a soaped section of seam. The vacuum shall be applied by a vacuum box equipped with a vacuum gage, a clear glass view panel in the top, and a soft rubber gasket on the periphery of the open bottom[4]. Thoroughly soap a section of the seam and place the inspection box over the soaped seam section and the gasket sealed to the liner. Apply a vacuum between 4 and 8 in. (122 and 244 mm) of mercury (Hg) to the box by use of a gasoline or electric-driven power vacuum pump apparatus. The applied vacuum will show bubbles over unbonded areas; the unbonded areas can then be marked for repair.

7.4 *Ultrasonic (High Frequency) Pulse Echo Testing*—Test all nonreinforced field seams by passing a high frequency sound wave through the seam overlap to detect discontinuities in the bonded seam. A commercially available frequency generator capable of producing frequencies in the range of 5 to 15 MHz shall be used. The contact send/receive transducer head shall be the width of the bonded seam width and shall be capable of being moved at the rate of 5 to 7 ft/min (1.5 to 2.1 m/min) along the surface length of the seam area. The transducer head shall be so designed as to give continuous surface to surface thickness measurements once calibrated. Assure good contact of the test head with the lining surface by providing a continuous contact medium (water) at the interface between test head and lining. The ultrasonic signal shall be capable of being viewed on a monitor and capable of triggering an audible alarm when a discontinuity is detected. Discontinuities shall be marked after detection.

7.5 *Mechanical Point Stressing*—This test method shall be used as a qualitative measure of edge bonding. A blunt instrument (for example, a screwdriver) shall be run along the edge of the field seam to find obvious unbonded areas. The procedure shall not puncture or otherwise damage the sheet material. Perform point stressing only after the seam has had sufficient time to cure in accordance with manufacturer's directions. This test method is not applicable to all materials, especially those that are easily punctured.

8. Report

8.1 The report shall include the following:

8.1.1 Complete identification of geomembrane system, including type of polymer, source, thickness, reinforced or nonreinforced sheeting,

8.1.2 Complete identification of field seaming system used, including material, method, temperatures, seam width, cure time, and date of fabrication of field seams,

8.1.3 Quality control test or tests used as outlined in this practice,

8.1.4 Complete description of field sampling procedure, number of test specimens, and size of test specimens,

[4] A vacuum box similar to the Series A 100 Straight Seam Tester as supplied by the American Parts and Service Company, 2201 West Commonwealth Avenue, P.O. Box 702, Alhambra, CA 91802 has been found satisfactory.

8.1.5 Conditioning procedure prior to destructive seam testing,

8.1.6 Type of tensile machine used, grip separation, crosshead speed, grip surface texture, grip dimensions, and grip pressure,

8.1.7 Method of recording loading and determining average load for destructive test methods,

8.1.8 Average, maximum, and minimum peel and shear load values in pounds per inch (kilograms per millimetre) of width for individual specimens,

8.1.9 Type of failure in the peel and shear tests, that is, within the adhesive system, within the sheet material, clamp edge, or seam edge, for each individual specimen, and

8.1.10 For nondestructive testing, the type of nondestructive test and number of apparent failures and repairs per 100 ft (30.5 m) of seam.

9. Precision and Bias

9.1 No statement is made about either the precision or bias of this practice since it merely refers to available destructive and nondestructive methods which could be used in determining the quality of bonded seams.