Designation: D 4545 – 86 (Reapproved 1999)

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

This standard is issued under the fixed designation D 4545; 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 as a summary of destructive and nondestructive quality control test methods for determining the integrity of factory fabricated seams used in the joining of flexible sheet materials. This practice outlines the test procedures available for determining the quality of bonded seams. Tests chosen to be performed shall be selected from the nondestructive and destructive tests for their specificity to the liner system and the design application. These test methods are applicable to the seaming methods commonly used on manufactured flexible sheet geomembranes that are scrim-reinforced or nonreinforced.

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

1.2.1 *Thermally Bonded Seams*:

1.2.1.1 *Dielectric*—A dielectric seam is produced by clamping two lapped sheets of polymeric membrane between two conductive bars and applying an electric current to the bars, thus producing a field that generates friction heat at the interface between the two sheets to melt the surfaces. The pressure of the clamping bars creates a homogeneous bond which is allowed to cool by cutting off the electric current, while still under pressure.

1.2.1.2 *Hot Air*—A hot air seam is 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.

1.2.1.3 *Hot Wedge (or Knife)*—A hot wedge seam is 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.

1.2.1.4 *Extrusion*—A bond seam is 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. Hot air is sometimes applied between the two sheets to bring their temperature close to the melt point. The extrudate heat then melts the two preheated surfaces to effect the homogeneous bond.

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 *Cured or Vulcanized Seams*—These are thermally bonded seams that are produced prior to vulcanization of a cured ribbon sheet. A homogeneous bond is obtained by curing the seam along with the parent material blanket.

1.2.5 *Adhesive Bonded or Cemented Seams, Taped Seams, and Waterproofed Sewn Seams*—These seams are rarely made at the factory during the fabrication process and are generally limited to field installation seams. Adhesive bonded and taped seams provide a means, although nonhomogeneous, of joining cured sheets. Waterproofed sewn seams are used with geotextiles, which may be laminated to a geomembrane film.

1.3 The types of factory seams covered by this practice include the following seam constructions:

1.3.1 *Lap Seams*—One sheet overlaps the other by a recommended minimum amount, with the bonded area between or at the edge of the two sheets.

1.3.2 *Cap-Stripped Seams*—A separate strip of the parent sheet material is bonded to both sheets covering the lap seam.

1.3.3 *Butt Seams, Envelope Seams, and Standing Seams*—These seams are not commonly used in factory seam fabrication.

1.4 The values stated in SI units are to be regarded as 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:*

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

D 618 Methods of Conditioning Plastics and Electrical Insulating Materials for Testing[3]

[1] This practice is under the jurisdiction of ASTM Committee D-35 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 10.01.

D 751 Methods of Testing Coated Fabrics[4]
D 816 Methods of Testing Rubber Cements[3]

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 manufactured 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.

5. Sampling for Destructive Test Methods

5.1 A starting seam from each seamer will be tested by the fabricator following each machine shut-down period; that is, at the start of shift, following lunch, and after any time the seamer has been turned off and allowed to cool.

5.2 Cut random samples from actual fabricated seams for testing in peel or shear, or both, in accordance with the manufacturer's recommendations or agreed-upon specifications. Patch the resulting hole with an oval shaped piece of the parent sheet material and seam in accordance with the manufacturer's instructions.

6. Destructive Test Methods

6.1 These methods are used during the factory seam fabrication and testing and should be performed as soon as possible after the seam has been made, unless a specified cure time is stated.

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

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

7. Nondestructive Test Methods

7.1 For all 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 geomembrane materials.

7.1.1 *Air Lance Test*—Inspect all factory 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 345 kPa (50 psi) (gage) air supply directed through a 4.8-mm (3⁄16-in.) (typical) nozzle, held not more than 51 mm (2 in.) from the seam edge and directed at the seam edge.

7.1.2 *Vacuum Box Testing*—Inspect all factory 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.[5] Thoroughly soap a section of the seam and place the inspection box over the soaped seam section and seal the gasket to the liner. Apply a vacuum between 122 and 244 mm (4 and 8 in.) of mercury (Hg) to the box by use of a gasoline or electric-driven power vacuum pump and then mark the unbonded areas for repair.

7.1.3 *Ultrasonic (High Frequency) Pulse Echo Testing*—Test all nonreinforced factory 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 1.5 to 2.1 m/min (5 to 7 ft/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. The test head shall be assured good contact with the lining surface by providing a continuous contact medium (water) at the interface between the test head and the lining. The ultrasonic signal shall be capable of being viewed on a monitor as well as triggering an audible alarm when a discontinuity is detected. Discontinuities shall be marked after detection.

7.1.4 *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 factory 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.

[4] *Annual Book of ASTM Standards*, Vol 09.02.

[5] A vacuum box similar to the Series A100 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. 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 seaming system used, including material, method, temperatures, seam width, cure time, and date of fabrication of seams,

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

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

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 dimension, and grip pressure,

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

8.1.8 Average, maximum, and minimum peel and shear load values in kilograms per millimetre (pounds per inch) 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 the number of apparent failures and repairs per 30.5 m (100 ft) of seam.

9. Precision and Bias

9.1 No statement is made about either the precision or the 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.