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# Standard Test Methods for Sampling and Testing Modified Bituminous Sheet Material[1]

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## 1. Scope

1.1 These test methods cover procedures for sampling and testing prefabricated, reinforced, polymer-modified bituminous sheet materials designed for single- or multiple-ply application in roofing and waterproofing membranes. These products may use various surfacing materials on one side.

1.2 These test methods appear in the following order:

| | Section |
|---|---|
| Sampling | 3 |
| Conditioning | 4 |
| Thickness | 5 |
| Load Strain Properties | 6 |
| Tear Strength | 7 |
| Moisture Content | 8 |
| Water Absorption | 9 |
| Dimensional Stability | 10 |
| Low-Temperature Flexibility | 11 |
| Heat Conditioning | 12 |
| Accelerated Weathering | 13 |
| Granule Embedment | 14 |
| Compound Stability | 15 |
| Coating Thickness | 16 |
| Precision and Bias | 17 |

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *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 95 Test Method for Water in Petroleum Products and Bituminous Materials by Distillation[2]

D 146 Test Method for Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing[3]

D 573 Test Method for Rubber—Deterioration in an Air Oven[4]

D 751 Test Methods for Coated Fabrics[5]

D 1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature[6]

D 4073 Test Method for Tensile-Tear Strength of Bituminous Roofing Membranes[3]

D 4798 Test Method for Accelerated Weathering Test Conditions and Procedures for Bituminous Materials (Xenon-Arc Method)[3]

D 4977 Test Method for Granule Adhesion to Mineral Surfaced Roofing by Abrasion[3]

## 3. Sampling

3.1 From each shipment or fraction thereof, select at random a number of rolls equal to one half the cube root of the total number of rolls in the lot. If the calculated number is fractional, express it as the next highest whole number. For convenience, a table showing the number of rolls to be selected from the lots of various sizes is given in Test Method D 146. When mutually agreed upon by the concerned parties, other sampling frequencies may be used and reported within the framework of these procedures. The minimum sample shall consist of five rolls. The rolls so selected constitute the representative sample used for all subsequent observations and tests pertaining to the lot of material being examined.

## 4. Conditioning

4.1 Unless otherwise specified, condition test specimens for a minimum of 4 h at 23 ± 3°C (73.4 ± 3.6°F) and 50 ± 5 % relative humidity before testing.

## 5. Thickness

5.1 Sheet materials shall be checked at five points across the roll width, to include the weathering surface. Measurements shall taken in accordance with Test Methods D 751, Section 9 except as follows: Lay the sheet out smooth on a horizontal surface and take measurements at two points, each being 150 ± 15 mm (6 ± 0.5 in.) from each edge, and at three points

[1] These test methods are under the jurisdiction of ASTM Committee D08 on Roofing and Waterproofing and are the direct responsibility of Subcommittee D08.04 on Felts and Fabrics.

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[2] *Annual Book of ASTM Standards*, Vol 05.01.

[3] *Annual Book of ASTM Standards*, Vol 04.04.

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

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

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

equally spaced between these two points. Compute the average thickness and the standard deviation of the thicknesses based on the total number of point measurements from all of the rolls taken in accordance with 1.2 of these test methods.

5.2 Using the samples measured in 5.1, take five measurements along the selvage edge, each being 150 ± 15 mm (6 ± 0.5 in.) apart. The presser foot shall be positioned midway between the surfacing and sheet edge or midway between the laying line and sheet edge, in the case of smooth products.

5.3 Report the individual point measurements, average, and estimated standard deviation. Refer to the measurements taken in 5.1 as sheet thickness and the measurements taken in 5.2 as selvage thickness.

## 6. Load Strain Properties

6.1 This test method covers the determination of the load strain (tensile elongation and strain energy) properties of polymer-modified bituminous sheets.

6.1.1 *Specimens*—Prepare five specimens from each sample roll in both the longitudinal and transverse directions for each temperature to be tested. Specimens shall be 25 mm (1.0 in.) wide by a minimum of 150 mm (6.0 in.) long for sheet materials having an ultimate elongation of 75 % or less at −18°C (0°F). Specimens shall be 12.5 mm (0.5 in.) wide by a minimum of 100 mm (4.0 in.) long for materials having an ultimate elongation of greater than 75 % at −18°C (0°F).

6.1.2 *Procedure*:

6.1.2.1 Condition each specimen at least 2 h at the selected test temperature. If conditioning is done outside the machine clamps, allow the specimen to equilibrate at the testing temperature for at least 15 min before the testing force is applied.

6.1.2.2 Test specimens at both 23 ± 3°C (73.4 ± 3.6°F) and −18 ± 3°C (0 ± 3.6°F).

6.1.2.3 Use a constant rate of elongation (CRE) tension testing machine, preferably with automatic load and strain recording equipment, and clamps that permit a uniform clamping pressure on the specimen without slipping. The initial clamp separation shall be 75 ± 2 mm (3.0 ± 0.125 in.) for sheet materials having an ultimate elongation of 75 % or less at −18°C (0°F), and 50 ± 2 mm (2.0 ± 0.125 in.) for sheet materials having an ultimate elongation greater than 75 % at −18°C (0°F).

6.1.2.4 Maintain a rate of separation of 50 mm/min ±3 % (2.0 in./min ±3 %) for specimens tested at 23 ± 3°C (73.4 ± 3.6°F) and a rate of separation of 2.0 mm/min ±3 % (0.08 in./min ±3 %) for specimens tested at −18 ± 3°C (0 ± 3.6°F).

6.1.2.5 Record the percent elongation of each specimen at specimen break and also at peak load using an extensiometer, or calculate the percent elongation at specimen break and also at peak load from the chart of the stress versus time knowing the speed of the chart drive and the jaw separation rate.

6.1.2.6 Record the breaking load and peak load of each specimen.

6.1.3 *Calculation*:

6.1.3.1 Determine the percent elongation at break obtained from the extensiometer in accordance with the manufacturer's instructions, or read directly, calculate the percent elongation determined from the chart, without an extensiometer, as follows:

$$\text{Percent elongation} = \frac{a - b}{b} \times 100 \text{ at break} \quad (1)$$

where:

$a$ = jaw separation at specimen break,
= $\dfrac{\text{maximum extension on chart} \times \text{jaw separation rate}}{\text{chart speed}}$
and
$b$ = initial jaw separation.

6.1.3.2 Determine the average percent elongation at break in each direction and the deviation of percent elongation at break in each direction based on the total number of measurements taken.

6.1.3.3 Calculate the percent elongation at peak load obtained from the extensiometer in accordance with the manufacturer's instructions, or read directly, calculate the strain at peak load determined from the chart, without an extensiometer, as follows:

$$\text{percent elongation} = \frac{c - d}{b} \times 100 \text{ at peak load} \quad (2)$$

where:

$c$ = jaw separation at maximum load,
= $\dfrac{\text{maximum extension on chart} \times \text{jaw separation rate}}{\text{chart speed}}$
and
$b$ = initial jaw separation.

6.1.3.4 Calculate the average percent elongation at peak load in each direction and the standard deviation of percent elongation at peak load in each direction based on the total number of measurements taken.

6.1.3.5 Calculate the average breaking load in each direction and the standard deviation of the breaking loads in each direction based on the total number of measurements taken.

6.1.3.6 Calculate the average peak load in each direction and the standard deviation of the peak loads in each direction based on the total number of measurements taken.

6.1.3.7 If the load elongation curve is not available, estimate the strain energy. The strain energy should be reported as either measured or estimated.[7]

6.1.3.8 Calculate the average strain energy at peak load and at break in each direction and the standard deviation of the strain energies in each direction based on the total number of measurements taken.

6.1.4 *Report*:

[7] The estimation technique requires knowledge of the maximum tensile strength and elongation values of the test specimen. This technique can only be used for fibrous glass-reinforced specimens. If the values generated by this technique are in question, verification must be made by analysis of the load-elongation curve. Strain energy for fibrous glass-reinforced specimens is estimated by:

$$se = \frac{[1/2 \times \text{peak load [kN (lbf)]} \times \text{elongation [mm (in.)]}]}{25 \text{ mm (1 in.)} \times \text{gage length [mm (in.)]}}$$

where 25 mm (1 in.) = sample width.
Strain energy represented as the area under the load-elongation curve may also be calculated by direct computer integration or analog techniques such as, the trapezoidal rule, use of planimeter, or gravimetrical analysis.

6.1.4.1 For each specimen in each direction, record the temperature of the test, specimen size, and individual measurements of peak load in kN/m (lbf/in.), percent elongation at peak load, breaking load in kN/m (lbf/in.), percent elongation at break, method of determining elongation, strain energy in $kNm/m^2$ (inch-pound/$in.^2$) at peak load, strain energy in $kNm/m^2$ (inch-pound/$in.^2$) at break, and method of determining elongation.

6.1.4.2 Report the average and the standard deviation in each direction based on the total measurements taken of peak load in kN/m (lbf/in.), breaking load in kN/m (lbf/in.), percent elongation at peak load percent elongation at break, strain energy in $kNm/m^2$ (inch-pound/$in.^2$) at peak load and strain energy in $kNm/m^2$ (inch-pound/$in.^2$) at break.

## 7. Tear Strength

7.1 This test method determines the tensile tear strength of polymer-modified bituminous sheets.

7.1.1 Prepare five specimens from each sample roll in each direction in accordance with Test Method D 4073. Condition specimens as set forth in Section 4 of these test methods.

7.1.2 Test procedure shall be in accordance with Test Method D 4073, except that the rate of jaw separation shall be 50 mm/min ±3 % (2.0 in./min ±3 %) for testing at 23 ± 3°C (73.4 ± 3.6°F).

7.1.3 Calculate the average tear strength in each direction and the standard deviation of the tear strength in each direction based on the total number of measurements taken.

7.1.4 Report the individual specimen values, average, and estimated standard deviation of the specimens in each direction.

## 8. Moisture Content

8.1 This test method determines moisture content in polymer-modified bituminous sheets.

8.1.1 Prepare five specimens measuring approximately 100 by 100 mm (4 by 4 in.) from each sample roll.

8.1.2 Determine the mass of each specimen to the nearest 0.1 g. Determine the moisture content in accordance with Test Method D 95. Express water as a percent of dry mass.

8.1.3 Calculate the average moisture content and the standard deviation of the moisture contents based on the total number of measurements taken.

8.1.4 Report the individual specimen values, average, and estimated standard deviation.

## 9. Water Absorption

9.1 This test method determines water absorption of polymer-modified bituminous sheets.

9.1.1 Prepare five specimens measuring approximately 100 by 100 mm (4 by 4 in.) from each sample roll. Seal all cut edges having exposed reinforcement with hot bitumen before testing.

9.1.2 Immerse the specimens in a distilled water bath maintained at 50 ± 3°C (122 ± 3.6°F) for 100 ± 4 h, remove the specimens, blot off surface water with a dry cloth, immerse the specimens in technical grade acetone for 2 ± 1 s, and permit to air dry in laboratory for 15 ± 2 min at 23 ± 3°C (73.4 ± 3.6°F) and 50 ± 5 % RH.

9.1.3 Determine the mass of each specimen to the nearest 0.1 g after immersion. Determine moisture content in accordance with Test Method D 95. Express water as a percent of dry mass.

9.1.4 Determine the total percent of moisture gained by subtracting the moisture content as obtained in Section 8 from the moisture content after immersion as determined in this section.

9.1.5 Calculate the average percent of moisture gain and the standard deviation of percent of moisture gains based on the total number of measurements taken.

9.1.6 Report the individual specimen values, average, and estimated standard deviation.

## 10. Dimensional Stability

10.1 This test method determines a dimensional stability of polymer-modified bituminous sheets in accordance with Test Method D 1204, except as noted in the following.

10.1.1 Prepare five specimens from each sample roll: one specimen from each edge of the sheet and three randomly across the sheet.

10.1.2 Condition the specimens in an oven maintained at 80 ± 3°C (176 ± 3.6°F) for 24 h ± 15 min.

10.1.3 After oven conditioning, cool the specimens and measure as indicated in Test Method D 1204.

10.1.4 Calculate the absolute dimensional change based on the absolute difference between the initial measurements and the measurement after conditioning for each specimen.

10.1.5 Calculate the average absolute dimensional change in each direction and the standard deviation of the absolute dimensional changes in each direction based on the individual results calculated in 10.1.4.

10.1.6 Report the initial measurements of the individual specimens, measurements of individual specimens after conditioning, dimensional change in each direction for each specimen, absolute dimensional change in each direction for each specimen, absolute average, and estimated standard deviation in each direction.

## 11. Low-Temperature Flexibility

11.1 This test method determines the low-temperature flexibility of polymer-modified bituminous sheets.

11.1.1 Low-temperature flexibility is defined as the lowest temperature recorded at which no visual signs of cracking in the membrane are observed after bending 180 ± 5° at the desired temperature around a 25 ± 2 mm (1.00 ± 0.05 in.) diameter mandrel in approximately 2 ± 1 s.

11.1.2 Cracking is defined as a fracture of the polymer-modified bitumen coating that visibly exposes the reinforcement of the sheet. The condition of cracking shall be visible to the naked eye and shall not include separation of granules or other surfacing material that does not extend through the modified bitumen coating surface to the reinforcement.

11.1.3 Prepare five specimens from each sample roll in both the longitudinal and transverse direction for each temperature to be tested. Specimens shall be 25 ± 2 mm (1.00 ± 0.05 in.) wide by 150 ± 2 mm (6.00 ± 0.005 in.) long.

11.1.4 Begin testing at a temperature at which the sheet is known to pass, allowing the refrigerated unit, mandrel, and

specimens to equilibrate for a minimum of 2 h and decrease or increase temperature in 3 ± 1°C (5 ± 2°F) increments.

NOTE 1—If this information is not readily available, make preliminary screening tests at −12 ± 1°C (10 ± 2°F) intervals.

11.1.5 After the specimens have been conditioned, position the center of the specimen firmly on the mandrel, weathering side away from the mandrel, and bend the projecting ends without exerting any stress other than that required to keep the specimen in contact with the mandrel. Complete the entire procedure inside the refrigerated unit.

11.1.5.1 Bend the specimen until the projecting ends of the specimen are parallel to each other keeping the bottom surface in contact with the mandrel through an arc of 180 ± 5°.

11.1.5.2 Visually examine the specimen immediately keeping the sample in the flexed position, on the mandrel, at the test temperature, for any signs of cracking.

11.1.5.3 Repeat the above for any remaining specimens.

11.1.5.4 If any cracking is observed, increase the temperature in the refrigerated unit by 3 ± 1°C (5 ± 2°F). If no cracking was evident, decrease the temperature by 3 ± 1°C (5 ± 2°F). Condition ten new specimens at the next test temperature for a minimum of 2 h. If the specimens have been preconditioned and the temperature change is no greater than 3°C (5°F), the specimens may be reconditioned for 30 ± 5 min after the chamber reaches equilibrium.

11.1.6 Repeat 11.1.5 until the lowest temperature at which none of the specimens show cracking is achieved.

11.1.7 Report the low-temperature flexibility in °C (°F) as the lowest temperature at which cracking does not occur.

11.1.8 *Precision*—The following data should be used for judging the acceptability of results on samples from the same lot from the same supplier:

11.1.8.1 *Repeatability*—Duplicate results by the same operator should not be considered suspect unless they differ by more than 3°C (5°F).

11.1.8.2 *Reproducibility*—The results submitted by each of two laboratories should not be considered suspect unless they differ by more than 6°C (10°F).

## 12. Heat Conditioning

12.1 This test method determines the effects of heat conditioning on polymer-modified bituminous sheets.

12.1.1 Prepare five specimens from each sample roll in the longitudinal and transverse directions of necessary sizes for tensile, elongation, and low-temperature flexibility testing before and after conditioning. Sufficient number of specimens should be conditioned to accommodate subsequent testing.

12.1.2 Condition specimens in a forced air oven at 70 ± 3°C (158 ± 5°F) for 90 ± 0.25 days in accordance with Test Method D 573. Evaluate physical properties before and after conditioning.

12.1.3 Report the individual specimen values, average, and estimated standard deviation for tensile, elongation, strain energy, and low-temperature flexibility, as set forth in the test methods for determination of these properties, before and after heat conditioning.

## 13. Accelerated Weathering

13.1 This test method determines the effects of accelerated weathering on polymer-modified bituminous sheets in accordance with Section 7 of Test Method D 4798 except as noted in the following.

13.1.1 Use a cycle of 60 min with 51-min arc only and 9 min of arc and waterspray per cycle.

13.1.2 Expose the specimens for 83 ± 0.35 days (2000 ± 8 cycles).

13.1.3 Orient the intended weathering surface toward the light source.

13.1.4 Expose a sufficient quantity of specimens from each sample roll for tensile, elongation, and low-temperature flexibility testing after accelerated weathering. Specimens shall be cut to size and quantity after weathering.

13.1.5 Report the individual specimen values, average, and estimated standard deviation for tensile, elongation, strain energy, and low-temperature flexibility as set forth in the test methods for determination of these properties before and after weathering.

## 14. Granule Embedment

14.1 Test in accordance with Test Method D 4977 and report the average granule loss for each sample roll.

## 15. Compound Stability

15.1 This test method determines high-temperature stability of polymer-modified bituminous sheets.

15.1.1 *Specimens*—From each sample roll, prepare five specimens in both the longitudinal and transverse directions for each test temperature. Specimens shall be 50 ± 2 mm (2.0 ± 0.05 in.) wide by 75 ± 2 mm (3.0 ± 0.05 in.) long.

15.1.2 *Apparatus*:

15.1.2.1 Bulldog-type clamps with smooth surfaced, clamping faces at least 50 mm (2 in.) wide are used to suspend the specimens in a forced air oven.

15.1.2.2 The forced air oven shall be capable of maintaining the preset test temperature to a tolerance of ±3°C (±5°F). Set the forced air oven at 93 ± 1°C (200 ± 2°F) or 5.5°C (10°F) below the expected failure temperature of unknown materials. For screening purposes, one sample can be exposed in 14 ± 3°C (25 ± 5°F) increments.

15.1.3 *Procedure*:

15.1.3.1 Clamp each specimen on the 50-mm (2.0-in.) edge with a bulldog-type clamp.

15.1.3.2 Suspend the specimen via the clamp in the forced air oven with the 75-mm (3.0-in.) edge of the specimen set vertically.

15.1.3.3 After the specimens have been conditioned for 2 h, 15 ± 5 min at the specified temperature, observe each specimen for signs of flowing, dripping, or drop formation on the lower edge of the specimen.

15.1.3.4 If flowing, dripping, or drop formation is not observed on any of the five specimens, increase the oven temperature by 14 ± 3°C (25 ± 5°F), allow the oven to equilibrate and repeat 15.1.3.

15.1.4 Report the highest temperature at which no flowing, dripping, or drop formation was observed. Maximum test temperature need not exceed 121°C (250°F).

## 16. Coating Thickness

16.1 This test method covers the determination of back surface coating thickness of polymer-modified bituminous sheet materials.

16.1.1 *Specimens*—Sample the rolls in accordance with Section 3. One 150-mm (6-in.) wide specimen shall be taken by cutting across the width of the roll. The specimen size will be 150 mm (6 in.) times the manufactured width of the roll. (This specimen may be taken from the sample used to determine thickness in Section 5.)

16.1.2 *Procedure*:

16.1.2.1 On the back surface of the specimen, mark or indicate five distinct locations for measurements. Place a mark 50 mm (2 in.) from each edge and make three additional marks equally spaced between the first two points. For products with a selvage edge, place a mark 25 mm (1 in.) from the selvage demarcration and 50 mm (2 in.) from the opposite edge, then make three additional marks equally spaced between the first two points.

16.1.2.2 Measure the thickness at the center of each marked area and reported in accordance with Section 5, in millimetres (mils).

16.1.2.3 Carefully heat the back surface coating of the specimen in the indicated area by waving a flame (or heat gun) so the flame just touches the surface of the coating. Remove the back surface coating down to the reinforcement by placing the edge of a heated flat spatula at an angle and scrape off the coating with slow steady force. Clean the spatula and repeat the process being careful not to damage the reinforcing layer. After removing the back surface coating, allow the specimen to cool to the conditions established in Section 4. Upon cooling, the back surface may be dusted with very fine talc to prevent sticking of the thickness gage during measurement.

16.1.2.4 Again, measure the thickness in the five specified locations of the specimen and report according to Section 5.

16.1.3 *Calculation*—Determine the back surface coating thickness in millimetres (mils) as follows:

$$\text{Back surface coating thickness} = T_i - T_f \quad (3)$$

where:

$T_i$ = initial thickness measurement and

$T_f$ = thickness of measurement after the removal of the back coating.

16.1.4 *Report*—Report the individual measurements in mils (mm), average, and standard deviation.

## 17. Precision and Bias

17.1 The precision and bias of these test methods as related to polymer-modified bituminous sheets have not been established. Round robin test will be conducted to establish these values.

## 18. Keywords

18.1 bituminous sheet material; roofing membranes; sampling; testing; waterproofing membranes