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

This standard is issued under the fixed designation D 5147; 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 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:

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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:* [2]

D 95 Test Method for Water in Petroleum Products and Bituminous Materials by Distillation

D 146 Test Methods for Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing

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

D 751 Test Methods for Coated Fabrics

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

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

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

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

D 5636 Test Method for Low Temperature Unrolling of Felt or Sheet Roofing and Waterproofing Materials

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

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 ± 2°C (73.4 ± 3.6°F) and 50 ± 5 % relative humidity before testing.

[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] 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.

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 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 ± 2°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 ± 0.1 in.) for sheet materials having an ultimate elongation of 75 % or less at −18°C (0°F), and 50 ± 2 mm (2.0 ± 0.1 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 ± 2°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 extensometer, 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 extensometer in accordance with the manufacturer's instructions, or read directly, calculate the percent elongation determined from the chart, without an extensometer, 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 extensometer in accordance with the manufacturer's instructions, or read directly, calculate the strain at peak load determined from the chart, without an extensometer, as follows:

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

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.

NOTE 1—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.

6.1.3.8 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 *Ultimate Elongation*—Determine the ultimate elongation using data obtained from tests conducted in accordance with 6.1.2. Ultimate elongation is defined as the elongation measured on the load-elongation curve at which point the load has dropped to 5 % of its maximum value, after the peak load has been reached.

6.1.5 *Report*:

6.1.5.1 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.

6.1.5.2 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 ± 2°C (73.4 ± 3.6°F), and the moisture content test required in Test Method D 4073 shall not be conducted.

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.

7.2 *Precision and Bias*:

7.2.1 *Interlaboratory Test Program*— Interlaboratory studies were run in which randomly drawn test specimens of three materials (sand-surfaced SBS-modified base sheet, fiberglass-reinforced SBS-modified cap sheet, and polyester-reinforced APP-modified cap sheet) were tested for machine-direction (MD) tear strength and cross-machine-direction (CD) tear strength in each of nine laboratories. Each laboratory tested two sets of five specimens of each material. Practice E 691 was followed for the experimental design and analysis of the data.

7.2.2 *Test Result*—The precision information given below for machine-direction tear strength and cross-machine-direction tear strength in the units of measurement (newtons) is for the comparison of two test results, each of which is the average of five test determinations.

7.2.3 *Precision*:

	Machine Direction Tear Strength	Cross-Machine-Direction Tear Strength
Test Range	514 to 642 N	388 to 534 N
r, 95 % repeatability limit (within a laboratory)	30.4 N (23.0 to 44.2 N)	34.2 N (33.0 to 36.2 N)
R, 95 % reproducibility limit (between laboratories)	86.1 N (78.7 to 96.4 N)	69.4 N (63.4 to 73.8 N)

The above terms (repeatability limit and reproducibility limit) are used as specified in Practice E 177. The respective standard deviations among test results may be obtained by dividing the above limit values by 2.8.

7.2.4 *Bias*—Since there is no accepted reference material suitable for determining the bias for the procedure in this test method for measuring machine-direction tear strength and cross-machine-direction tear strength, no statement on bias is being made.

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 ± 2°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.