Designation: D5147/D5147M – 11a

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

This standard is issued under the fixed designation D5147/D5147M; 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 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.

1.4 *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]

D95 Test Method for Water in Petroleum Products and Bituminous Materials by Distillation

D146 Test Methods for Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing

D1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature

D4073 Test Method for Tensile-Tear Strength of Bituminous Roofing Membranes

D4798 Practice for Accelerated Weathering Test Conditions and Procedures for Bituminous Materials (Xenon-Arc Method)

D4977 Test Method for Granule Adhesion to Mineral Surfaced Roofing by Abrasion

D5636 Test Method for Low Temperature Unrolling of Felt or Sheet Roofing and Waterproofing Materials

D5869 Practice for Dark Oven Heat Exposure of Roofing and Waterproofing Materials

D6162 Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements

D6163 Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fiber Reinforcements

D6164 Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements

D6222 Specification for Atactic Polypropylene (APP) Modified Bituminous Sheet Materials Using Polyester Reinforcements

D6223 Specification for Atactic Polypropylene (APP) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements

[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, Fabrics and Bituminous Sheet Materials.

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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.

D6298 Specification for Fiberglass Reinforced Styrene-Butadiene-Styrene (SBS) Modified Bituminous Sheets with a Factory Applied Metal Surface
D6509 Specification for Atactic Polypropylene (APP) Modified Bituminous Base Sheet Materials Using Glass Fiber Reinforcement
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Significance and Use

3.1 These test methods are used for sampling and testing modified bitumen sheet materials. Property requirements, determined by these test methods, are found in the following product standards: Specifications D6162, D6163, D6164, D6222, D6223, D6298, and D6509.

4. Sampling

4.1 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 D146. 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.

5. Conditioning

5.1 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.

6. Thickness

6.1 The thickness measuring device shall be a micrometer of the dial or digital-electronic type capable of measuring dimensions to an accuracy of 0.1 mm [0.004 in.]. The micrometer shall be equipped with a flat, circular presser foot with a diameter greater or equal to 9.5 mm [0.375 in.] and less than 32 mm [1.25 in.]. During operation, contact between the presser foot and the specimen shall be maintained either by a spring inside the micrometer or by the weight of the presser foot and attached parts.

6.2 One specimen shall be obtained from each of the rolls selected in accordance with the Sampling section of these test methods. Each specimen shall be at least 700 mm [27½ in.] in length by the manufactured width of the roll. Five measurements of sheet thickness and five measurements of selvage thickness shall be taken on each specimen. All measurements shall be taken in a manner that requires the presser foot to contact the side of the sheet that is intended to be exposed when applied in accordance with the manufacturer's instructions.

NOTE 1—When measuring products with particulate surfaces, wiping particles from the presser foot between measurements is recommended to prevent buildup of particles that may result in inaccurate measurements.

6.2.1 Take five measurements of the sheet thickness along a line parallel to cross-machine direction. Two of the five measurements shall be taken 150 ±15 mm [6 ± 0.5 in.] from each edge of the specimen. The remaining three measurements shall be taken at three points approximately equally spaced (±15 mm [0.5 in.]) between these two points. Refer to Fig. 1 for an illustration of the sheet thickness measurement locations.

6.2.2 Take five measurements of the selvage thickness along a line parallel to machine direction. The measurements are to be taken midway between the surfacing edge and the sheet edge or, in the case of smooth products, midway between the laying line and the sheet edge, and spaced 150 ± 15 mm [6 ± 0.5 in.] apart. Refer to Fig. 1 for an illustration of the selvage thickness measurement locations.

6.3 For each specimen, report the individual point measurements, mean, and standard deviation for both the sheet thickness and selvage thickness measurements.

6.4 Calculate the mean of the specimen sheet thickness means and report this value as sample sheet thickness. Calculate the mean of the specimen selvage thickness means and report this value as sample selvage thickness. Unless otherwise required by the standard product specification that references these test methods, sample sheet thickness and sample selvage thickness are the values used for comparison with the product specification requirements.

6.5 *Precision and Bias:*

6.5.1 *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 sample sheet thickness and sample selvage thickness in each of eleven laboratories. Each laboratory tested two sets of five specimens of each material. Practice E691 was followed for the experimental design and analysis of the data. Details of the experiment are available in ASTM Research Reports RR:D08-1010 and RR:D08-1011.[3,4]

6.5.2 *Test Result*—The precision information given below for sheet thickness and selvage thickness in the units of measurement (millimetres) is for the comparison of two test results, each of which is the average of five test determinations.

[3] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D08-1010.
[4] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D08-1011.

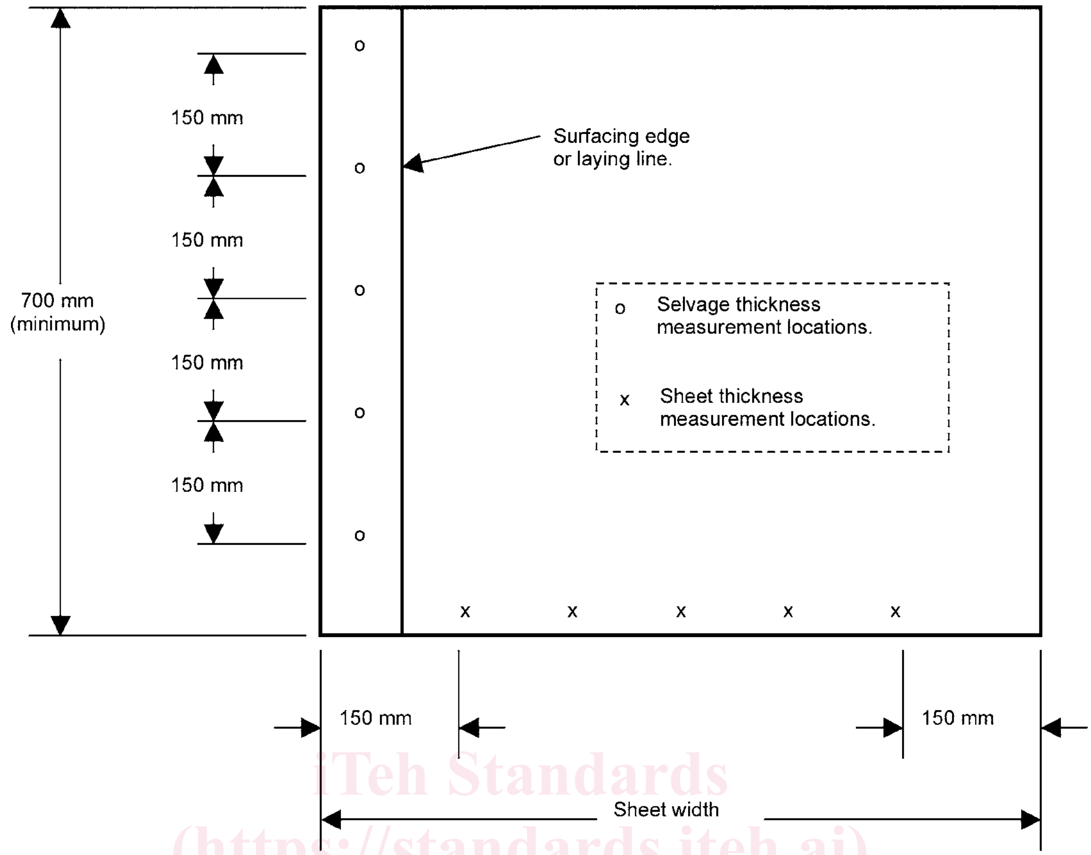

FIG. 1 Location of Thickness Measurements

6.5.3 *Precision:*

	Selvage Thickness	Sheet Thickness
Test range	1.952 to 2.706 mm	1.959 to 3.824 mm
r, 95 % repeatability limit (within a laboratory)	0.088 mm (0.040 to 0.157 mm)	0.048 mm (0.039 to 0.054 mm)
R, 95 % reproducibility limit (between laboratories)	0.281 mm (0.148 to 0.366 mm)	0.252 mm (0.239 to 0.277 mm)

The above terms (repeatability limit and reproducibility limit) are used as specified in Practice E177. The respective standard deviations among test results may be obtained by dividing the above limit values by 2.8.

6.5.4 *Bias*—Since there is no accepted reference material suitable for determining the bias for the procedure in this test method for measuring sheet thickness and selvage thickness, no statement on bias is being made.

7. Load Strain Properties

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

7.1.1 *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].

7.1.2 *Procedure:*

7.1.2.1 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.

7.1.2.2 Test specimens at both 23 ± 2°C [73.4 ± 3.6°F] and −18 ± 3°C [0 ± 3.6°F].

7.1.2.3 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].

7.1.2.4 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].

7.1.2.5 An alternative clamping method can be used for high tensile materials that slip in conventional jaws. Clamp the specimen in the jaws so that the length or width is aligned with the axis of the jaws.

7.1.2.6 Use a cylindrical stop in each jaw such as shown in Fig. 2 for membranes difficult to clamp.

7.1.2.7 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.

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

7.1.3 *Calculation:*

7.1.3.1 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.

7.1.3.2 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.

7.1.3.3 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.

7.1.3.4 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.

7.1.3.5 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.

7.1.3.6 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.

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

NOTE 2—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:

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

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.

7.1.3.8 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.

7.1.4 *Ultimate Elongation*—Determine the ultimate elongation using data obtained from tests conducted in accordance with 7.1.2. 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.

7.1.5 *Report:*

7.1.5.1 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 [$inch\text{-}pound/in.^2$] at peak load, strain energy in kNm/m^2 [$inch\text{-}pound/in.^2$] at break, and method of determining elongation.

7.1.5.2 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 [$inch\text{-}pound/in.^2$] at peak load and strain energy in kNm/m^2 [$inch\text{-}pound/in.^2$] at break.

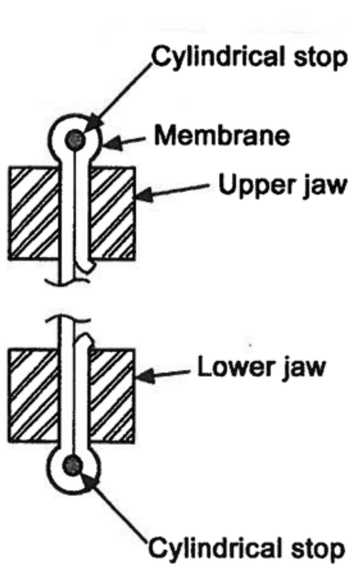

FIG. 2 Alternative Clamping Method