ASTM

Designation: D 5147 – 97

AMERICAN SOCIETY FOR TESTING AND MATERIALS
100 Barr Harbor Dr., West Conshohocken, PA 19428
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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
employ various surfacing materials on one side.

1.2 These test methods appear in the following order:

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1.3 *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 appro-
priate safety and health practices and determine the applica-
bility 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 228 Test Methods for Asphalt Roll Roofing, Cap Sheets,
and Shingles[3]
D 573 Test Method for Rubber—Deterioration in an Air
Oven[4]
D 751 Test Methods for Coated Fabrics[5]
D 1079 Terminology Relating to Roofing, Waterproofing,
and Bituminous Materials[3]

D 1204 Test Method for Linear Dimensional Changes of
Nonrigid Thermoplastic Sheeting at Elevated Tempera-
ture[6]
D 4073 Test Method for Tensile-Tear Strength of Bitumi-
nous Roofing Membranes[3]
D 4798 Test Method for Accelerated Weathering Test Con-
ditions 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 (½) 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 Methods D 228.
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 (5) 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 73.4 ± 3.6°F (23 ± 3°C) and 50 ± 5 %
relative humidity prior to testing.

5. Thickness

5.1 Sheet materials shall be checked at five points across the
roll width, to include the weathering surface. Measurements
shall be made at two points, each being 6 ± 0.5 in. (150 ± 15
mm) 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 Section 3.

5.2 Report the individual point measurements, average, and
estimated standard deviation.

6. Load Strain Properties

6.1 This test method covers the determination of the load-
strain (tensile-elongation, and strain energy) properties of

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[1] These test methods are under the jurisdiction of ASTM Committee D-8 on
Roofing, Waterproofing, and Bituminous materials, and are the direct responsibility
of Subcommittee D08.04 on Fabrics for Bituminous Roofing and Waterproofing.
Current edition approved Feb. 10, 1997. Published April 1997. Originally
published as D 5147 – 91. Last previous edition D 5147 – 95.
[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.

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 1.0 in. (25 mm) wide by a minimum of 6.0 in. (150 mm) long for sheet materials having an ultimate elongation of 75 % or less at 0°F (−18°C). Specimens shall be 0.5 in. (12.5 mm) wide by a minimum of 4.0 in. (100 mm) long for materials having an ultimate elongation of greater than 75 % at 0°F (−18°C).

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 73.4 ± 3.6°F (23 ± 3°C) and 0 ± 3.6°F (−18 ± 3°C).

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 3.0 ± 0.125 in. (75 ± 2 mm) for sheet materials having an ultimate elongation of 75 % or less at 0°F (−18°C), and 2.0 ± 0.125 in. (50 ± 2 mm) for sheet materials having an ultimate elongation greater than 75 % at 0°F (−18°C).

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

6.1.2.5 Record the percent elongation of each specimen at specimen break and also at maximum load using an extensiometer, or calculate the percent elongation at specimen break and also at maximum 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 maximum 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:

$$\text{Percent elongation} = \frac{a-b}{b} \times 100 \text{ at break.}$$

(1)

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

6.1.3.2 Determine the average percent elongation at break in each direction and the standard 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 maximum load obtained from the extensiometer in accordance with the

manufacturer's instructions, or read directly, calculate the strain at maximum load determined from the chart, without an extensiometer, as follows:

$$\text{percent elongation} = \frac{c-d}{b} \times 100 \text{ at maximum load}$$

(2)

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

6.1.3.4 Calculate the average percent elongation at maximum load in each direction and the standard deviation of percent elongation at maximum 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 maximum load in each direction and the standard deviation of the maximum 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 maximum 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*:

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

7. Tear Strength

7.1 This test method determines the tensile-tear strength of

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[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:

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

where 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.

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 this standard.

7.1.2 Test procedure shall be in accordance with Test Method D 4073, except that the rate of jaw separation shall be 2.0 in./min ± 3 % (50 mm/min ± 3 %) for testing at 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 4 by 4 in. (100 by 100 mm) 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 4 by 4 in. (100 by 100 mm) from each sample roll. Seal all cut edges having exposed reinforcement with hot bitumen prior to testing.

9.1.2 Immerse the specimens in a distilled water bath maintained at 122 ± 3.6°F (50 ± 3°C) 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 73.4 ± 3.6°F (23 ± 3°C) 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 below.

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 176 ± 3.6°F (80 ± 3°C) 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 1.00 ± 0.05 in. (25 ± 2 mm) 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 1.0 ± 0.05 in. (25 ± 2 mm) wide by 6.00 ± 0.005 in. (150 ± 2 mm) long.

11.1.4 Begin testing at a temperature where 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 5 ± 2°F (3 ± 1°C) increments.

NOTE 1—If this information is not readily available, make preliminary screening test at 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 5 ± 2°F (3 ± 1°C). If no cracking was evident, decrease the temperature by 5 ± 2°F (3 ± 1°C). Condition ten new specimens at the next test temperature for a minimum of 2 h. If the specimens have been pre-conditioned and the temperature change is no greater than 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 °F (°C) as the lowest temperature at which cracking does not occur.

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 158± 5°F (70 ± 3°C) 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 below.

13.1.1 Use a cycle of 60 min with 51 min arc only and 9 min of arc and water spray 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. High Temperature 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 2.0 ± 0.05 in. (50 ± 2 mm) wide by 3.0 ± 0.05 in. (75 ± 2 mm) long.

15.1.2 *Apparatus*:

15.1.2.1 Bulldog-type clamps with smooth surfaced, clamping faces at least 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 ±5°F (±3°C). Set the forced air oven at 200 ± 2°F (93 ± 1°C) or 10°F (5.5°C) below the expected failure temperature of unknown materials. For screening purposes, one sample can be exposed in 25 ± 5°F (14 ± 3°C) increments.

15.1.3 *Procedure*:

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

15.1.3.2 Suspend the specimen via the clamp in the forced air oven with the 3.0 in. (75 mm) 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 25± 5°F (14 ± 3°C), 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 250°F (121°C).

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 6 in. (150 mm) wide specimen shall be taken by cutting across the width of the roll. The specimen size will be 6 in. (150 mm) 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 2 in. (50 mm) from each edge and make three additional marks equally spaced between the first two points. For products with a selvage edge, place a mark 1 in. (25 mm) from the selvage demarcration and 2 in. (50 mm) 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 mils (mm).

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 mils (mm) as follows:

$$\text{Back Surface Coating Thickness} = T_i - T_f \qquad (3)$$

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.