Designation: D 5602 – 98

AMERICAN SOCIETY FOR TESTING AND MATERIALS
100 Barr Harbor Dr., West Conshohocken, PA 19428
Reprinted from the Annual Book of ASTM Standards. Copyright ASTM

Standard Test Method for Static Puncture Resistance of Roofing Membrane Specimens[1]

This standard is issued under the fixed designation D 5602; 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 test method covers evaluation of the maximum static puncture load that roofing membrane samples can withstand without allowing the passage of water.

1.2 This laboratory test is conducted at any desired temperature using sheet membrane samples manufactured in a factory or prepared in a laboratory.

1.3 Roof membrane specimens to which the test method is applicable include bituminous built up, polymer-modified bitumens, vulcanized rubbers, non-vulcanized polymeric, and thermoplastic materials.

1.4 This test method is not applicable to aggregate-surfaced membrane specimens, but it is applicable to specimens having factory-applied granules.

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

1.6 *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:*

C 578 Specification for Preformed Cellular Polystyrene Thermal Insulation[2]

D 1079 Terminology Relating to Roofing, Waterproofing, and Bituminous Materials[3]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, refer to Terminology D 1079.

4. Summary of Test Method

4.1 Set on a thermal insulation substrate, the roofing membrane test specimen is subjected for 24 h to a predetermined static puncture force using a ball bearing having a 10-mm (0.39-in.) diameter.

4.2 The loads are increased in 10-N (2.2-lbf) increments until puncture of the membrane specimen occurs or the maximum load of the test apparatus which is at least 250 N (56 lbf) is reached.

4.3 Puncture of the test specimen is assessed by visual examination and verified by conducting a watertightness test.

5. Significance and Use

5.1 An important factor affecting the performance of many membrane roofing systems is their ability to resist static puncture loads. This test method provides a means for assessing static puncture resistance.

5.2 This test method can be used to compare the puncture resistance of a single type of membrane as a function of a variety of insulation substrates or, conversely, to compare the resistance of a number of membrane specimens set on a single type of insulation.

5.3 The effect of temperature on puncture resistance can be studied by conducting the test under controlled conditions using such equipment as an environmental chamber, oven, or freezer.

5.4 This test method can be useful for developing performance criteria for membrane roofing systems.

5.5 This test method can be useful for developing classifications of the static puncture resistance of membrane roofing systems.

5.6 While it is considered that the results obtained by this laboratory test can afford a measure of the static puncture resistance of membrane roofing systems in the field provided that service loads and temperature conditions are known, no direct correlation has yet been established.

6. Apparatus

6.1 *Static Puncture Device*—An apparatus consisting primarily of a movable rod to which a 10-mm (0.39-in.) diameter ball bearing is attached at one end and a means for loading the specimen is attached to the other (Fig. 1). The rod shall be sufficiently rigid so that it will not flex or rotate when used under the maximum test load.

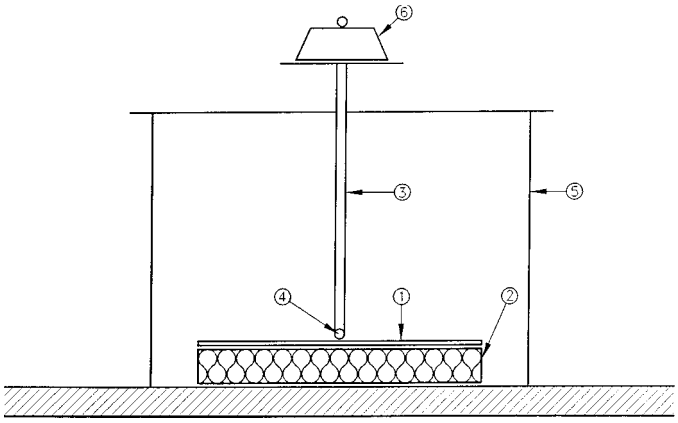
NOTE 1—One means for loading the specimen is to attach a platform, on which deadweights are placed, to the rod. Another method is to use pneumatic loading whereby the ball bearing is attached to the piston rod

[1] This test method is under the jurisdiction of ASTM Committee D-8 on Roofing, Waterproofing, and Bituminous Materials and is the direct responsibility of Subcommittee D08.20 on Roofing Membrane Systems.

Current edition approved Jan. 10, 1998. Published September 1998. Originally published as D 5602–94. Last previous edition D 5602–94.

[2] *Annual Book of ASTM Standards*, Vol 04.06.

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



NOTE 1—membrane test specimen; 2—insulation substrate; 3—movable rod; 4—ball bearing; 5—framework supporting the moveable rod and load; and 6—load.

FIG. 1 Schematic of the Static Puncture Device

and the load is measured by an air pressure gage that has been calibrated against a load cell.

6.1.1 The length of the rod above the specimen shall be sufficient to provide adequate space for placing the specimen properly on the insulation substrate. A framework, having a minimum width of 250 mm (9.8 in.), supports the rod perpendicular to the surface of the test specimen. Free vertical movement of the rod shall not be hindered by the framework. The rod and framework shall be capable of supporting puncture loads up to at least 250 N (56 lbf).

7. Sampling and Sample Preparation

7.1 *Single-Ply Samples*—Cut the test specimens directly from the sheet membrane material using the directions provided in 8.1.

7.2 *Multi-Ply Samples Prepared in the Laboratory*:

7.2.1 Condition all components at 23 ± 2°C (74 ± 3°F) and 50 ± 5 % relative humidity for 24 ± 0.25 h prior to constructing the membrane sample.

7.2.2 Prepare multi-ply membrane samples at least 0.90 by 1.20 m (3 by 4 ft), in accordance with the membrane manufacturer's instructions, or using other preparation methods at the discretion of the test laboratory. The method of preparation shall be described in the test report. The quantity of material in each layer of the membrane sample shall be within 10 % of that specified, and the entire sample shall be within 5 %. Cut the test specimens directly from this larger membrane sample using the directions provided in 8.1.

8. Test Specimens

8.1 *Dimensions*—The dimensions of the membrane test specimens and insulation substrates are 200 by 200 mm (7.9 by 7.9 in.) ±5 %. Cut the test specimens and substrates to size using a metal template having these dimensions.

8.2 *Number of Specimens*—A minimum of four test specimens is necessary to conduct the test.

8.3 *Type of Membrane Specimen Substrate*—The use of any roof insulation as a membrane specimen substrate is allowable. Unless otherwise specified, the membrane sub-strate shall be expanded polystyrene board conforming to Specification C 578, Type IX, and having a thickness of 38 mm (1.5 in.) ±15 %. The sections used as the specimen substrate throughout the test shall be taken from the same manufactured lot whatever insulation is used.

9. Conditioning

9.1 Condition the apparatus and all specimens at the selected test temperature for a minimum of 8 h prior to testing. The selected temperature shall be maintained at ±2°C (±3°F) throughout the test.

10. Procedure

10.1 *Loads*—The load applied during testing shall be within ±1 % of that selected. The maximum load at which the test is conducted is the failure point (that is, puncture) of the specimen, except whereby highly puncture-resistant specimens do not fail within the capacity of the test apparatus.

10.2 *Screening Procedure*:

10.2.1 Place a membrane specimen on an insulation substrate. Position the assembly within the framework of the puncture device such that the ball bearing is set on the center of the surface of the specimen (Fig. 1). Ensure that the rod is aligned perpendicular to the specimen surface.

10.2.2 Select a load, in an integral increment of 10 N (2.2 lbf), somewhat below that at which the specimen may be expected to fail.

NOTE 2—Pretesting specimens under various loads is useful for estimating the initial load to be applied.

NOTE 3—The mass of the ball bearing, rod, and platform assembly must be included in the load applied to the specimen.

10.2.3 Apply the load to the specimen for 24 ± 0.25 h, and then remove the specimen from the puncture device and examine it visually to determine whether puncture has occurred.

NOTE 4—Some specimens, particularly single-ply synthetic materials, may not remain flat on the insulation substrate when loaded. This condition is allowable, and provisions do not need to be taken to hold the specimen flat on the substrate.

10.2.4 If it cannot be determined visually that the specimen has or has not punctured, apply a suitable watertightness test. One example of a suitable test is the use of water pressure of 5000 Pa (0.73 lbf/in.^{2}) applied for 15 min to the surface of the membrane specimen that was subjected to the ball-bearing force (Note 5). Another example is a dielectric test (Note 6). If the test specimen is not watertight, repeat the procedure in 10.2.3 and 10.2.4 on another test specimen using a lesser load.

NOTE 5—One type of watertightness test that has been used to examine whether membrane specimens have been punctured incorporates a water column sealed to the top of the membrane specimen. A water height of 500 mm (20 in.) provides a pressure of 5000 Pa (0.73 lbf/in.^{2}). A similar type of watertightness test uses a chamber in which the membrane specimen is sealed and into which water is forced at the specified pressure.

NOTE 6—One dielectric test for examining whether membrane specimens have been punctured uses a 15 kV dielectric tester with a pointed electrode. The test specimen is placed on a metal plate (second electrode), such that contact exists between the impacted area of the specimen and the metal plate. The size of the metal plate is at least that of the specimen. A 15 kV charge is applied across the specimen at the location of the applied

puncture force by passing the pointed electrode over the impacted area while in contact with the specimen surface. If sparks are observed, puncture has occurred.

10.2.5 Increase the load by 10 N (2.2 lbf) on the same specimen; maintain it for 24 ± 0.25 h, after which the specimen is examined again visually for puncture. If necessary, conduct the watertightness test (10.2.4) to ascertain whether puncture occurred.

10.2.6 Repeat the steps given in 10.2.5 until puncture occurs or the maximum load of the test apparatus is reached.

10.3 *Static Puncture Resistance Determination*—Conduct the test on three additional membrane specimens and new insulation substrates in accordance with 10.2.1 using a load that is 10 N (2.2 lbf) less than that which caused puncture in the screening procedure, or at the maximum load of the test apparatus. Consider the results as follows:

10.3.1 If none of the three specimens is punctured at this selected load, repeat the test, using three new specimens at incrementally higher loads, the number of times necessary until at least one of the set of three specimens fails or the maximum load of the test apparatus is reached. Report the highest load at which a set of three specimens showed no failures as the puncture resistance.

10.3.2 If puncture of any one of the original set of three specimens occurs, repeat the test, as necessary, using three new specimens at loads reduced incrementally by 10 N (2.2 lbf). Report the puncture resistance for the greatest load that did not produce puncture of any specimens in the set of three.

10.3.3 Use a watertightness test on the three test specimens (10.2.4) for which the puncture resistance is reported to verify that puncture did not occur.

11. Report

11.1 Report the following information;

11.1.1 Complete identification of the roof membrane sample, including type, source, manufacturer, and method of preparation, if made in the laboratory;

11.1.2 Complete identification of the insulation substrate, including type, source, manufacturer, density, and thickness;

11.1.3 Temperature of the test;

11.1.4 Description of the watertightness test used; and

11.1.5 Static puncture resistance of the specimen as the load that three specimens can support for 24 h without allowing the passage of water.

12. Precision and Bias

12.1 There is no basis for statements concerning the precision and bias of test results obtained from either within-laboratory or between-laboratory testing at the present time.

13. Keywords

13.1 insulation substrate; membranes; puncture; roofing; static; test method