Designation: D5602/D5602M – 18 (Reapproved 2022)

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

This standard is issued under the fixed designation D5602/D5602M; 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 specimens can withstand without allowing the passage of water.

1.2 This laboratory test is conducted at any desired temperature using sheet membrane specimens 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.

1.3.1 The applicability of this test method to these membrane specimens includes their use in vegetative roof systems.

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 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 nonconformance with the standard.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C578 Specification for Rigid, Cellular Polystyrene Thermal Insulation

D1079 Terminology Relating to Roofing and Waterproofing

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, refer to Terminology D1079.

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 load (that is, force) using a ball bearing having a 10 mm [0.39 in.] diameter.

4.2 The predetermined static puncture load is selected as follows:

4.2.1 In accordance with a performance requirement given in a standard specification in which this test method is cited, or

4.2.2 Through agreement between the party requesting the test and the testing laboratory.

4.3 Puncture of the test specimen is assessed by visual examination and, if necessary, 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.

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

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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.

5.3 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.

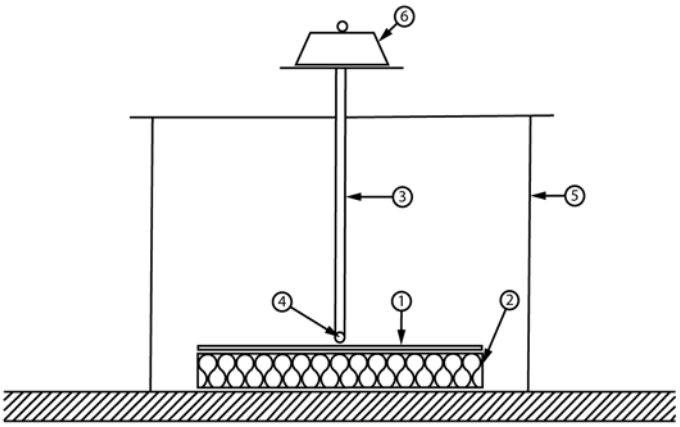
5.7 This test method can be useful for evaluating the static puncture resistance of membranes used in vegetative roof systems.

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 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].



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

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 three 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 substrate shall be expanded polystyrene board conforming to Specification C578, 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 load is selected:

10.1.1 In accordance with a performance requirement given in a standard specification in which this test method is cited, or

10.1.2 Through agreement between the party requesting the test and the testing laboratory.

NOTE 2—The mass of the ball bearing, rod, and platform assembly must be included in the load applied to the specimen.

NOTE 3—If there is interest to conduct the test at the maximum load at which specimen failure (that is, puncture) is expected to occur, this maximum load, if unknown, can be estimated using the screening procedure described in Appendix X1.

10.2 *Static Puncture Testing:*

10.2.1 Place a membrane specimen on an insulation substrate. Position the membrane-insulation 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 Apply the selected 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.

10.2.2.1 If it cannot be determined visually that the specimen has or has not been 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).

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 over the location that was subjected to the puncture test. 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.

10.2.3 *Test Results*—Consider the results as follows:

10.2.3.1 If none of the three specimens punctured at the selected load, report that the specimens passed the test.

10.2.3.2 If one or more of the three specimens punctured at the selected load, report that the specimens failed the test.

11. Report

11.1 Report, as a minimum, 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 Load at which the test was conducted;

11.1.3.1 If the load was selected in accordance with a performance requirement in a standard specification, report the designation of the standard specification.

11.1.4 Temperature of the test;

11.1.5 Description of the watertightness test, if used; and

11.1.6 The test result; that is, whether the specimens passed or failed at the selected load.

12. Precision and Bias

12.1 No information is presented about either the precision or bias of Test Method D5602/D5602M for measuring the static puncture resistance of roof membrane specimens since the test result is non-quantitative.

13. Keywords

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

APPENDIX

(Nonmandatory Information)

X1. SCREENING PROCEDURE FOR ESTIMATING THE MAXIMUM LOAD RESULTING IN SPECIMEN PUNCTURE

X1.1 Introduction

X1.1.1 Test Method D5602/D5602M determines the static puncture resistance of a roofing membrane specimen under a predetermined load. The load is selected by one of two approaches: (*1*) in accordance with a performance requirement given in a standard specification in which this test method is cited, or (*2*) through agreement between the party requesting the test and the testing laboratory. There may be situations wherein it is desired to conduct this static puncture test at a load approximating the maximum load that the test specimen can sustain. For such cases, if the maximum load is not known, this appendix provides a screening procedure for estimating this maximum load (provided that it is not greater than the maximum capacity of the static puncture test apparatus).

X1.2 Screening Procedure

X1.2.1 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.

X1.2.2 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 X1.1—Pretesting specimens under various loads is useful for estimating the initial load to be applied.

NOTE X1.2—The mass of the ball bearing, rod, and platform assembly must be included in the load applied to the specimen.

X1.2.3 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 X1.3—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.

X1.2.4 If it cannot be determined visually that the specimen has or has not been punctured, apply a suitable watertightness