



Designation: D5849/D5849M – 07 (Reapproved 2020)

Standard Test Method for Evaluating Resistance of Modified Bituminous Roofing Membrane to Cyclic Fatigue (Joint Displacement)¹

This standard is issued under the fixed designation D5849/D5849M; 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 determines the effect of constant cyclic displacement on polymer-modified bituminous membrane specimens. In this test method, a relatively low travel rate of cycling is used and the material is tested for a specified number of cycles under conditions of increased amplitude or lower temperature.

1.2 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.

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

1.4 *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

- D41/D41M Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
- D1079 Terminology Relating to Roofing and Waterproofing
- D5147/D5147M Test Methods for Sampling and Testing Modified Bituminous Sheet Material

¹ This test method is under the jurisdiction of ASTM Committee D08 on Roofing and Waterproofing and is 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.

2.2 *Canadian General Standards Board Method:*³

CGSB 37-GP-56M Standard for Membrane, Modified, Bituminous, Prefabricated, and Reinforced for Roofing

3. Terminology

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

4. Summary of Test Method

4.1 This test method measures the ability of an unaged polymer-modified bituminous membrane material to resist deterioration during 500 cycles (Note 1) at predetermined temperature and cycle amplitude conditions. If the specimen passes the test under the selected conditions, the severity of the test is raised by either lowering the temperature or increasing the amplitude of the cycle, or both (see Table 1). Similarly, heat-aged specimens are subjected to 200 cycles (Note 1) under the same conditions of temperature and cycle amplitude. Test the membrane until failure or until Test Condition No. 5 is achieved.

NOTE 1—Other numbers of cycles may be used depending on the reason for conducting the test, for example, to determine the number of cycles necessary to produce failure.

5. Significance and Use

5.1 This test method provides data on classifying polymer-modified bituminous membranes by their performance related to the fatigue conditions to which they are subjected.

5.2 This test method is applicable to testing specimens consisting of a single ply of the polymer-modified bitumen material or a multiple-ply composite that includes the polymer-modified bitumen material.

5.3 This test method is conducted on both unaged and heat-aged specimens to determine the effect of heat exposure on the membrane material's ability to resist deterioration from cyclic strain. This test method may also be conducted on specimens subjected to other laboratory exposure conditions that are not specified herein.

³ Available from the Canadian General Standards Board (CGSB), Gatineau, Canada, K1A 1G6.

TABLE 1 Test Conditions

Test Condition	Test Temperature	Initial Gap Setting	Cycle Amplitude	Cycles/h
1	23 ± 1 °C [73 ± 2 °F]	1.0 ± 0.05 mm [0.04 ± 0.002 in.]	1.0 mm [0.04 in.]	8
2	0 ± 1 °C [32 ± 2 °F]	1.0 ± 0.05 mm [0.04 ± 0.002 in.]	1.0 mm [0.04 in.]	8
3	0 ± 1 °C [32 ± 2 °F]	2.0 ± 0.05 mm [0.08 ± 0.002 in.]	2.0 mm [0.08 in.]	4
4	-10 ± 1 °C [14 ± 2 °F]	2.0 ± 0.05 mm [0.08 ± 0.002 in.]	2.0 mm [0.08 in.]	4
5	-20 ± 1 °C [-4 ± 2 °F]	2.0 ± 0.05 mm [0.08 ± 0.002 in.]	2.0 mm [0.08 in.]	4

6. Apparatus

6.1 Any fatigue apparatus capable of producing cyclic strain at the selected test temperature is suitable. The apparatus shall be capable of applying sufficient load to the specimens to achieve the specified displacement. The apparatus shall be capable of changing cycle amplitude depending on the selected conditions. It has been found that an apparatus using a cam-driven mechanism is suitable for this purpose. The amplitude of the cycle is altered by changing the lift of the cam.

6.2 The apparatus shall be capable of cycling the specimens at 16 mm/h [0.011 in./min].

6.3 Two concrete slabs (**Note 2**), 150 by 150 by 50 mm [6 by 6 by 2 in.] minimum thickness are attached to the fatigue apparatus such that one moves continuously back and forth in relation to the other. The gap between the slabs forms the joint over which the specimen cycling occurs. Alternatively, two wooden panels 150 by 150 by 38 mm [6 by 6 by 1.5 in.] or steel plates 150 by 150 by 6 mm [6 by 6 by 0.25 in.] minimum may be used. The substrate shall be conditioned at 23 ± 1 °C [73 ± 2 °F] and 50 % relative humidity until the slabs, panels, or plates have reached constant moisture content.

NOTE 2—The concrete slabs are molded, according to usual practice, using a mix design as follows: one part ordinary portland cement; two parts sand, 5 mm [0.2 in.] or less particle size; four parts course aggregate consisting of one third 10 mm [0.4 in.] and two thirds 20 mm [0.8 in.] aggregate size. (The water cement ratio is 0.6.)

6.3.1 The surface of the slabs to which the specimen is applied shall be that taken from the bottom of the mold.

6.3.2 Braces (metal battens) shall be attached to the sides of the slabs, panels, or plates to hold them rigid and to set the joint between the slabs during placement of the test specimens on them, and for placing the slabs in the fatigue apparatus.

7. Sampling

7.1 When sampling entire lots of material, follow the procedure outlined in Test Methods **D5147/D5147M**, Section 3.

8. Test Specimens

8.1 Test specimens may be either a single ply of the membrane material or multiple-ply composites prepared in accordance with the normal procedure used to install the membrane in practice, for example, hot asphalt, cold adhesive, or torch.

8.2 The dimensions of the test specimens shall be 300 by 50 mm [12 by 2 in.] and oriented such that the weakest tensile direction is tested, either in the machine direction or cross-machine direction. The weakest orientation may be determined by a constant rate tension apparatus.

8.3 The test specimens shall be new (unexposed) and heat conditioned in accordance with Test Methods **D5147/D5147M** (Section 12). In addition, other exposure conditions may be used, and if so, they shall be described in the test report.

9. Cycle Conditions and Specimen Conditioning

9.1 *Temperature and Amplitude Conditions*—Select the temperature, initial gap, cycle rate, and cycle amplitude conditions according to those given in **Table 1**. See **4.1**.

10. Test Procedure

10.1 Remove the slabs, panels, or plates from the cycling apparatus and coat with an asphalt primer which conforms to Specification **D41/D41M**, and allow the primer to dry.

10.2 Using a metal shim, set the initial gap between the slabs, panels, or plates at either 1 or 2 ± 0.05 mm [0.04 or 0.08 ± 0.002 in.], depending on the selected test condition in **Table 1**. Attach side braces to maintain the initial gap.

10.3 Remove the metal shim and fill the gap with sand to prevent asphalt from entering it during specimen adhesion.

10.4 Adhere two test specimens, with their long dimensions oriented perpendicular to the gap. The method of adhesion shall be that normally used in practice to install the specimen on the substrate, for example, hot asphalt, cold adhesive, or torch. Alternatively, in the research of membrane performance, specimens may be adhered to the wooden panels or steel plates using epoxy adhesive which will not disbond at the specified aging and test conditions.

10.5 After the specimens have cooled to ambient laboratory temperature, remove the sand from the gap between the concrete slabs.

10.6 Reattach the slabs to the cycling apparatus and remove the side braces from the slabs.

10.7 Condition the adhered test specimens at the selected test temperature (see **Table 1**) for a 4-h minimum before the start of cycling.

10.8 Test new (unexposed) specimens for 500 cycles; test exposed specimens for 200 cycles.

11. Interpretation of Results

11.1 After cycling is stopped, examine the specimens for visual evidence of damage experienced during testing. Such evidence includes cracking, splitting, or tearing of the specimen over the joint, or loss of adhesion of the specimen to the slabs or panels or between plies of the test specimen. If such evidence is seen on either of the two specimens, the specimens are considered to have failed the test. Partial delamination of the specimens to the slabs, panels, or plates occurring within 25 mm [1 in.] of the joint is allowable, but shall be noted in the report. Buckling of the membrane specimen over the joint

without cracking, splitting, or tearing damage is also not considered to have failed, but shall be noted in the report.

11.2 If evidence of damage to the specimens is not seen, they are considered to have passed the test (**Note 3**).

NOTE 3—In disputed cases, a water column test may be used to determine the watertight integrity of the system. The test described in CGSB 37-GP-56M is a viable method. If this or another water column test method is used, it shall be noted in the report.

12. Report

12.1 Report the following information:

12.1.1 Dates of test initiation and termination;

12.1.2 The test specimen description, including the number and type of plies, and whether it was new or exposed;

12.1.3 Method of interply adhesion for multiple-ply composites;

12.1.4 Type of substrate used;

12.1.5 Method of adhering the specimens to the substrate;

12.1.6 Selected test conditions (temperature and amplitude);

12.1.7 Description of the cycling apparatus used;

12.1.8 Number of cycles;

12.1.9 Observations made on the tested specimens; and,

12.1.10 How many of the specimens passed or failed the test.

12.2 A permanent record of the report shall be made.

13. Retesting

13.1 If the specimens failed under Conditions 2 through 5 in **Table 1**, they shall be retested at a set of conditions less severe than those originally selected. Retest conditions shall be noted in the report.

14. Precision and Bias

14.1 The precision and bias of this test method has yet to be determined.

15. Keywords

15.1 cyclic displacement; fatigue; polymer-modified bituminous membrane

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