ANSI/SPRI/FM MPO-1 2023

Test Standard for Comparative Pull-Over Strengths of Membrane Fastening Systems and Waterproofing Membrane Materials Used with Low Slope Roofing Systems

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Disclaimer
This standard is for use by roof system manufacturers, roofing component manufacturers, Testing labs, accreditation bodies, certification services, roofing contractors and owners of low slope roofing systems. SPRI, its members and employees do not warrant the applicability of this standard under all conditions.

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1.0 Introduction

1.1 Scope

This standard provides basic requirements and procedures for determining the *maximum failure load* of *waterproofing membrane* materials and *fastening systems* when tested for membrane pull over resistance in both symmetric and asymmetric *stress plate* loading scenarios. See Appendix A—Commentary C1.1 for additional information.

1.2 Reference Document

The Florida Building Code Application Standards TAS 117(B) Test Procedure for Dynamic Pull-Through Performance of Roofing Membranes over *Fastener* Heads or *Fasteners* with Metal Bearing Plates

1.3 Significance and Use

1.3.1 Roof assemblies are tested for wind uplift resistance in accordance with various standards, such as *ANSI*/FM 4474, Florida Building Code TAS 114, UL 1897, or CSA A123.21. Each assembly is made up of various components. The test procedure in this standard is useful in qualifying components or component combinations to reduce the dependence on large scale roof assembly testing. See Appendix A—Commentary C1.3.1 for additional information.

1.3.2 This test procedure is used to determine the *maximum failure load* of *waterproofing membrane* materials when secured with a *fastener* or *fastening system* and exposed to a linear load perpendicular to the plane in which the *stress plate* is installed.

2.0 General Information

2.1 Definitions

All words defined within this section are italicized throughout the standard.

2.1.1 ANSI
American National Standards Institute

2.1.2 Board Stock
A rigid board upon which a *waterproofing membrane* is secured over, ex: insulation board, cover board, thermal barrier, etc.

2.1.3 Fastener
A mechanical component used alone or in conjunction with a *stress plate* to secure roofing components to the roof deck.

2.1.4 Fastening System
An assembly that includes a *fastener* and *stress plate* that is used to secure *waterproofing membranes* and other roofing components to the roof deck.

2.1.5 Maximum Failure Load
The peak load value observed when the test specimen is no longer able to resist the application of additional load.

2.1.6 Standard Laboratory Conditions
The room or enclosure where the materials are conditioned, and test specimens are prepared and tested shall be protected from the elements and maintained at a temperature of 73 ± 2°F (23 ± 1°C) and 50% relative humidity ± 2%.

2.1.7 Stress Plate
A specially designed metal or plastic washer, or plastic sleeve, intended to secure *waterproofing membranes* and resist uplift loads.

2.1.8 Waterproofing Membrane
A flexible rolled sheet product secured to the roof intended to prevent water ingress to the structure. *Waterproofing membrane* materials can be tested for pull over resistance in combination with the *fastener* or *fastening system*.

2.2 Apparatus

2.2.1 A tensile test machine that applies load with a constant rate of speed and can measure the applied load. The equipment shall be calibrated within 12 months of the date of testing, in accordance with a standard that is traceable to a nationally recognized source. The load cell shall be of appropriate load capacity to ensure accurate results. See Appendix A—Commentary C2.2.1 for additional information.

2.2.2 Asymmetric Stress Plate Loading

2.2.2.1 Pinch wheel rollers compatible with the tensile test machine used to attach the free end of the *waterproofing membrane* to the cross head of the tensile testing machine.

2.2.2.2 A suitable test specimen substrate that is a minimum of 6 in.×6 in. (152.4 mm× 152.4 mm) and can be fixed to the tensile test machine, is capable of holding the *fastener* beyond the expected *maximum failure load*, and will prevent *fastener* movement during the test. The *waterproofing membrane* side lap is installed onto the test specimen substrate, through the *board stock* (optional) using the *fastening system*. See Appendix A—Commentary C2.2.2.2 for additional information.

2.2.3 Symmetric Stress Plate Loading

2.2.3.1 Clamping jaws compatible with the tensile test machine used to grip the *fastener* in the *fastening system* being tested.

2.2.3.2 A *waterproofing membrane* holding device which shall have an open area of 12 in.× 12 in. (304.8 mm×304.8 mm) or 18 in.×18 in. (457.2 mm×457.2 mm) and provide sufficient holding capability to prevent the *waterproofing membrane* from slipping out of the holding device during the test. See Appendix A—Commentary C2.2.3.2 for additional information.

2.3 Test Specimen Sourcing

2.3.1 All specimen components shall be provided by the program sponsor or component supplier and tested as received.

2.3.2 All test specimens shall be preconditioned and prepared for testing in *standard laboratory conditions*.

3.0 MPO-1 Procedure

3.1 Personal Protective Equipment
Adequate personal protective equipment shall be available and in use such as eye protection, cut resistant gloves, etc.

3.2 Test Specimen Setup

3.2.1 Asymmetric Stress Plate Loading

3.2.1.1 The *waterproofing membrane* shall be cut to 6 in. (152.4 mm) wide by a minimum of 12 in. (304.8 mm) long strips such that the 6 in. (152.4 mm) width is cut from the factory edge of the *waterproofing membrane* intended to be mechanically fastened (often has printed factory markings for sheet and *fastener* placement).

3.2.1.2 If *board stock* (optional) is being used, cut the *board stock* to a minimum of 6 in.×6 in. (152.4 mm×152.4 mm).

3.2.1.3 The *fastening system* shall be installed in accordance with manufacturer's guidelines through the *board stock* (optional) and *waterproofing membrane* into the test specimen substrate. The *fastening system* shall be centered in the 6 in. (152.4 mm) direction and at the *waterproofing membrane* manufacturer's suggested distance from the factory edge in the minimum of 12 in. (304.8 mm) direction. See Appendix A—Commentary C3.2.1.3 for additional information.

3.2.2 Symmetric Stress Plate Loading

3.2.2.1 The *waterproofing membrane* shall be cut to fit the *waterproofing membrane* holding device being used. The *waterproofing membrane* should be cut from the field of the sheet omitting the factory edges from the test specimen.

3.2.2.2 The *fastening system* shall be installed in accordance with the manufacturer's guidelines at the center of the *waterproofing membrane* test specimen.

3.2.3 The test specimen shall be installed and secured in the tensile test machine in preparation for a load to be applied perpendicular to the plane of the *stress plate*.

3.2.3.1 Asymmetric stress plate loading

Statically secure the test specimen substrate containing the test specimen and move pinch wheel rollers holding the free end of the *waterproofing membrane*. See Appendix A—Commentary C3.2.3.1 for additional information.

3.2.3.2 Symmetric stress plate loading

Statically secure the *waterproofing membrane* holding device and move the *fastener*, or statically secure the *fastener* and move the *waterproofing membrane* holding device. See Appendix A—Commentary C3.2.3.2 for additional information.

3.2.4 Information on test specimen sampling size is provided in Commentary. See Appendix A—Commentary C3.2.4 for additional information.

3.3 Test Method

3.3.1 Testing shall be conducted in *standard laboratory conditions*.

3.3.2 Load is applied perpendicular to the plane of the *stress plate* at a speed of 2.0 in./min (50.8 mm/min).

3.3.3 The *maximum failure load* and mode of failure shall be recorded for each test specimen. See Appendix A—Commentary C3.3.4 for additional information.

4.0 Reporting—Test reports shall include the following:

4.1 Name and address of the manufacturer or supplier of each test specimen component.

4.2 Name or other identification marks of each test specimen component, including any relevant listing and labeling marks.

4.3 Description of each test specimen component.

4.4 Conditioning of the test specimens, environmental data during the test (temperature, RH, etc.).

4.5 Identification of the laboratory technician.

4.6 Identification of the test equipment and instruments used, including open area dimensions of the *waterproofing membrane* holding device.

4.7 Calibration date of the tensile test machine.

4.8 Any deviations from the test method.

4.9 *Maximum failure load* of each test specimen.

4.10 Mode of failure of each test specimen and images representative of each mode of failure.

4.11 Statistics. See Appendix A—Commentary C4.11 for additional information.

5.0 Precision and Bias

There is not enough data available to establish precision and bias.

Appendix A

Commentary

This Commentary is not a part of this standard. It consists of explanatory and supplementary material designed to assist users in complying with the requirements. It is intended to create an understanding of the requirements through brief explanations of the reasoning employed in arriving at these requirements or to provide other clarifications. It therefore has not been processed in accordance with *ANSI* Essential Requirements and may contain material that has not been subjected to public review or a consensus process. Thus, it does not contain requirements necessary for conformance with the standard.

The sections of the Commentary are numbered to correspond to the sections of the standard to which they refer. Since it is not necessary to have supplementary material for every section in the standard itself, there may be gaps in the numbering in the Commentary.

C1.1 Scope

This standard provides basic requirements and procedures for testing *waterproofing membrane* pull over resistance. *Stress plates* may be exposed to symmetrical or asymmetrical loading schemes depending on the application and proposed roofing system. An asymmetrically loaded *stress plate* would be found in a traditional inseam or lap fastened system with a one sided weld. A symmetrically loaded plate would be found in systems where the *waterproofing membrane* is field fastened or where a double sided weld is used with an inseam or lap fastened system. This test procedure can be used for induction welded system membrane and plate disengagement as well as base sheet rupture evaluations.

C1.3.1 Significance and Use

This standard is intended to be a basis of practical comparative testing for roof system components that are within the scope of this standard. Acceptable applications include, but aren't limited to:

1. **Determination of the comparative performance of component combinations:**
   Prior to full scale roof assembly testing, it is reasonable to perform small scale testing in accordance with this standard to determine the most critical or lowest performing component combination(s). Using the most critical component combination(s) in full-scale roof assembly testing would allow the inclusion of the component combination(s) tested in accordance with this standard to be included in the full-scale assembly listings or approvals.
2. **Inclusion of alternate components into existing roof assembly listings or approvals:**
   Should a manufacturer desire to change a component, or include an alternate component, it is reasonable to perform comparative small-scale testing in accordance with this standard to determine if the proposed components perform as well or better than the existing components.

When comparing one data set to another to determine the most critical components, it is important to be sure those data sets were generated using the same testing conditions, apparatus, and test specimen setup.

C2.2.1 Load Cell

Ensure the load cell is appropriate for the expected or discovered loads. In some cases, load cells have a recommended load range that differs from the stated maximum load capacity due to non-linearity near zero or near maximum load.

C2.2.2.2 Test Specimen Substrate can be cut larger to hold more than one sample as long as the substrate can still be fixed to the tensile testing machine, each sample can be tested independently of one and other, and the testing of one will not interfere with the testing or results of another. When paired with the *fastener* used for the test, the chosen substrate should provide adequate pull out resistance to prevent *fastener* pull out from being the failure mode. The substrate should also prevent lateral movement of the *fastener* so that the angle of pull remains constant during the test.

C2.2.3.2 Waterproofing Membrane Holding Device

FM Approvals uses a 12 in.×12 in. (304.8 mm×304.8 mm) open area holding device, while TAS 117(b) requires the use of an 18 in.×18 in. (457.2 mm×457.2 mm) open area holding device. It is the responsibility of the program sponsor to determine their needs to meet the requirements of the authority having jurisdiction. Data from one test specimen should only be compared to data from another test specimen if the two data points were generated using the same sized *waterproofing membrane* holding **device.**

C3.2.1.3 Fastening System Installation—Asymmetric Loading

Different *waterproofing membranes* and *fastening systems* require different installation locations for the *stress plate* in relation to the waterproofing membrane's factory edge. Care should be taken to install the *fastening system* correctly for each sample of the same test specimen set noting that the locations may change membrane to membrane or *stress plate* to *stress plate*.

C3.2.3.1 Asymmetric Stress Plate Loading Test Specimen Securement Schematics

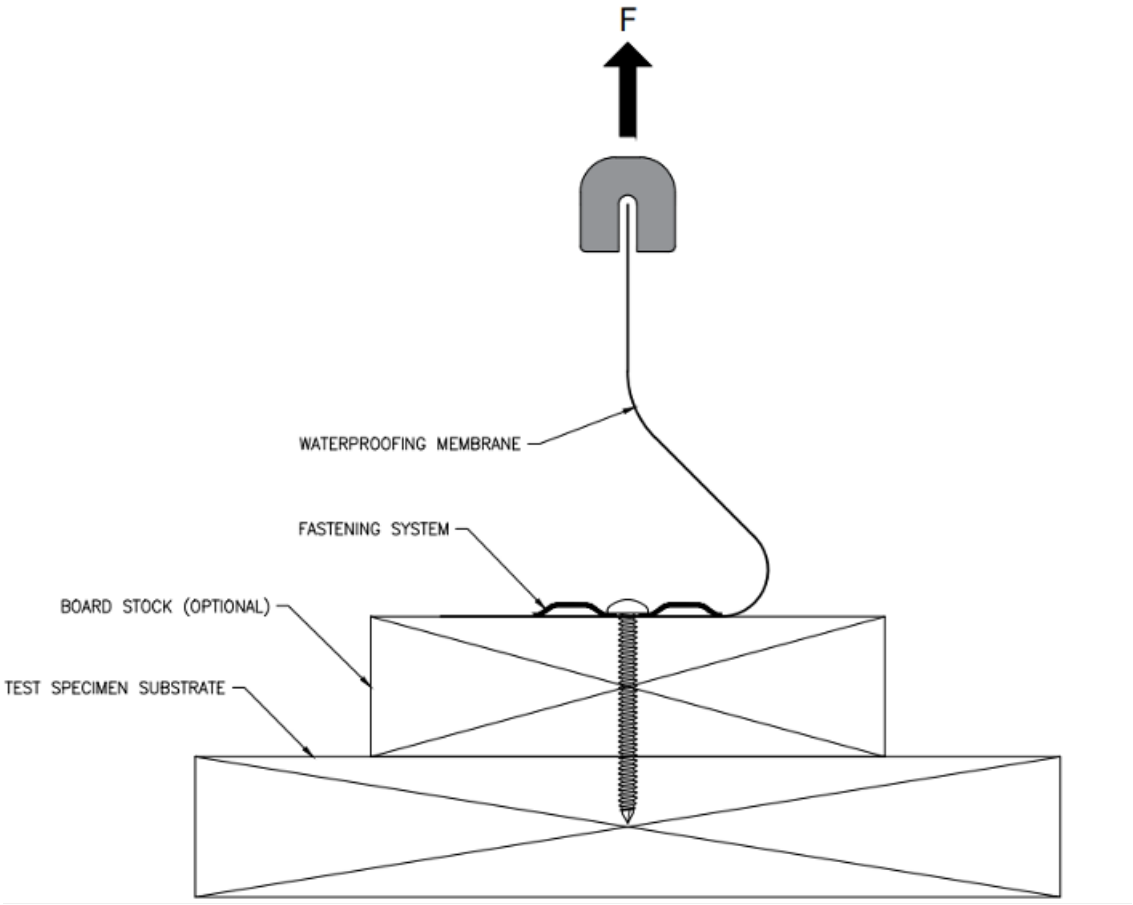

Figure C3.2.3.1

Cross-sectional view of a test apparatus setup whereby the test specimen substrate containing the test specimen is statically secured and the pinch wheel rollers holding the free end of the waterproofing membrane are free to move when a load is applied.

C3.2.3.2 Symmetric Stress Plate Loading Test Specimen Securement Schematics

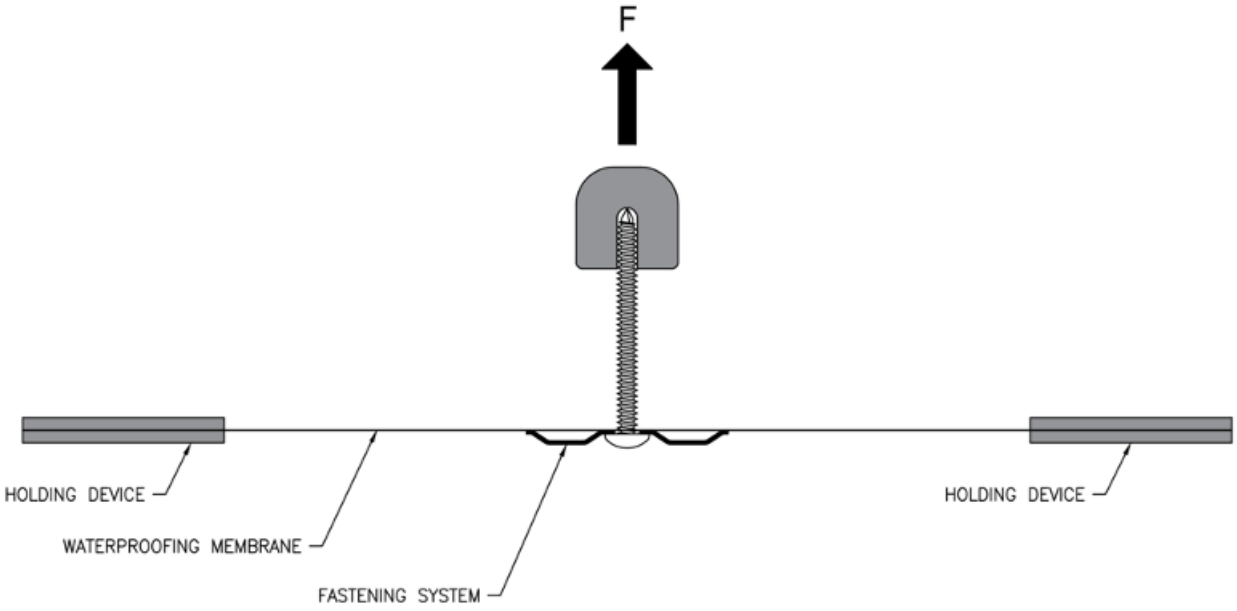

Figure C3.2.3.2A

Cross-sectional view of a test apparatus setup whereby the waterproofing membrane holding device is statically secured and the fastener is free to move when a load is applied.

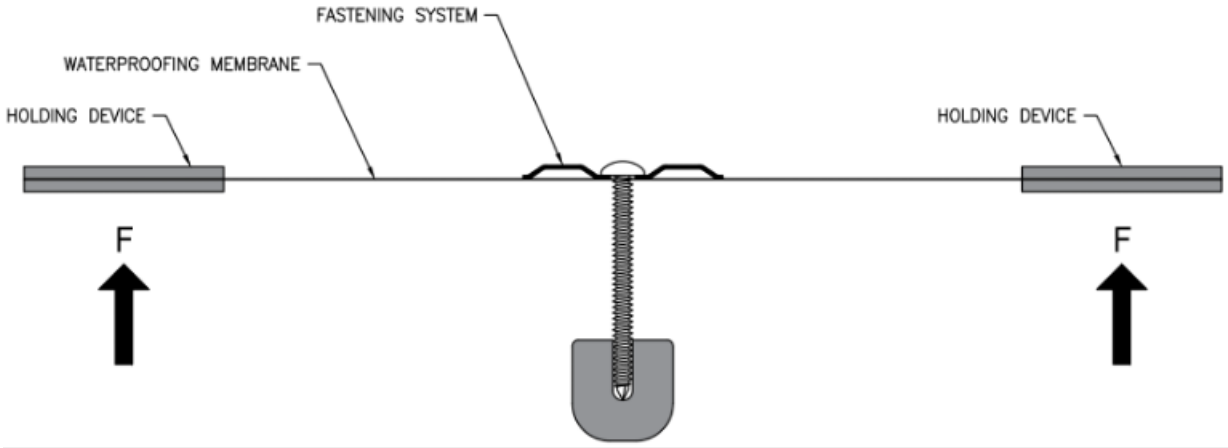

Figure C3.2.3.2B

Cross-sectional view of a test apparatus setup whereby the fastener is statically secured and the waterproofing membrane holding device is free to move when a load is applied.

C3.2.4 Test Specimen Sampling Size

This standard does not provide requirements for test specimen sampling size. FM Approvals requires a sampling size of three (n=3) for their purposes and The Florida Building Code Application Standards TAS 117(B) requires a sampling size of fourteen (n=14) for their purposes, but other jurisdictions may have different requirements. It is the responsibility of the program sponsor to determine their needs to meet the requirements of the authority having jurisdiction.

C3.3.4 Mode of Failure

The test procedure described in this standard is used to evaluate and compare the interface of *waterproofing membranes* and *fastening systems*. Should the failure of a test be the *fastening system* pulling out from the test specimen substrate, a more suitable test specimen substrate should be selected and the test sample with *fastener* pull out should be omitted from the data set when comparing one *waterproofing membrane* and *fastening system* to another.

C4.11 Statistics

Statistical information required for approvals or listings may vary depending on the jurisdictional requirements. It is the responsibility of the program sponsors to determine the appropriate statistics to report.