Standard Test Method for Pull-Off Strength of Adhered Air and Water Resistive Barriers Using an Adhesion Tester

1. Scope

1.1 This test method provides a method for evaluating the pull-off (adhesion) strength (may also be considered tensile stress) of adhered air and water resistive barriers on rigid substrates. The test determines the greatest perpendicular force (in tension) that the surface area of the material can bear. Failure will occur along the weakest plane within the system comprised of the disc, adhesive, air/water resistive barrier material, and substrate.

1.2 This test method determines tensile stress in contrast to other adhesion test methods (such as shear and peel tests) which measures other stress components and results are not comparable between test methods.

1.3 This test method uses a class of apparatus known as pull-off adhesion testers. They can apply a concentric load and counter load to a single surface so that material can be tested even though only one side is accessible. The maximum measured load is limited by the strength of the bond between the disc and the specimen surface, the cohesive strength of the adhesive, the cohesive strength of the air/water barrier composite, the adhesion between the air/water barrier composite and the adhesive (two-bond) and the adhesive bond between adhesive and substrate.

1.4 This test is destructive and when the test is conducted in the field, the area affected will need to be repaired.

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 document 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 The document shown below is referenced in the text of this document. Unless otherwise stated elsewhere in this document such reference shall be considered to indicate the edition and/or revisions of the document available at the date on which the committee approved this document.

Documents published by the American Society for Testing and Materials (ASTM)
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3. Summary of Test Method

3.1 The pull-off test is performed by securing a disc to the surface of the air/water barrier material with an adhesive. After the adhesive is cured, a testing apparatus is attached to the disc and aligned to apply tension to the test surface. The force applied to the disc is then gradually increased and monitored until failure. Upon failure, the exposed surface represents the plane of limiting strength within the system. The nature of the failure is qualified in accordance with the adhesive and cohesive failures, and the actual interfaces and layers involved. The pull-off strength is determined based on a set size of disc.

3.2 The test can be conducted in a laboratory or in the field. When conducted in the field, a portable adhesion tester shall be used.

4. Significance and Use

4.1 The pull-off strength of a material is an important performance property that has been used in air and water resistive barrier specifications. This test method serves as a means for uniformly preparing and testing materials, and evaluating and reporting the results. This test method is applicable to an apparatus for determining the pull-off strength of a material.

4.2 The results from this test method are only valid for the specific substrate and air/water barrier combination. It is to be expected that results obtained on different substrates with the same air/water barrier material will yield different results.

5. Apparatus

5.1 *Adhesion Tester*, have a central grip for engaging the disc and with a wheel and crank for moving the grip away from the base in a smooth and continuous manner so that a torsion free, co-axial (opposing pull of the grip and push of the base along the same axis) force results between them or utilize hydraulics with a manual or electronically controlled pump. The tester includes a base for uniformly pressing against the material surface around the disc either directly, or by way of an intermediate base.

5.2 *Disc*, metal or plywood material, 60 mm (2.25 inches) in diameter having a flat surface on one side that can be adhered parallel to the material and a means of attachment to the tester on the other side. The thickness of a metal disc shall be 6mm minimum and a plywood disc shall be 15 mm minimum.

5.3 *Timer*, means to determine revolutions per minute.

5.4 *Force Indicator*, digital gauge for determining the actual force delivered to the disc. The gauge shall have an accuracy of 0.5% at full scale. The maximum capacity of the load cell shall be sized for the anticipated maximum load. The force indicator shall be labelled with the date of calibration to an accuracy of 0.5% at full scale. The calibration date shall be within the last 12 months and the calibration shall have been conducted at 23 ± 2 °C (74 ± 5 °F), 50 ± 5 % RH).

5.5 *Cleaning Agent*, means for cleaning the disc surface or material surface. The cleaning agent should not degrade or negatively affect the material's properties. Similarly, surface abrasion may introduce flaws and should generally be avoided or limited to use for removing loose and weakly adhered surface contaminants.

5.6 *Adhesive*, means for bonding the disc to the material that does not affect the material's properties.

Note: Two component epoxies and hot glues have been found to be versatile.

5.7 *Tape*, material used for holding the disc in place while the adhesive cures.

5.8 *Cloth*, material used for removing excess adhesive and defining the adhered area.

5.9 *Utility Knife or Circular Hole Cutter*, device used to cut through the material being tested to the substrate around the disc.

Note: Significant friction may be developed between circular hole cutters and air barrier material, resulting in torsion applied to the bond interface and significant heat. A circular hole cutter with a kerf at the cutting edge may be used to minimize this problem. In other words, there is a small region at the cutting edge that has a smaller inside diameter and larger outside diameter than the remainder of the barrel. This is an important consideration to see less variability in testing results for some air barrier material which are thick.

6. Test Preparation

6.1 Select a surface area which is 1 m x 1 m (39 inch x 39 inch). The surface may have any orientation regarding gravitational pull. Three (3) pulls shall be conducted to determine a representative characterization of the adhesion of the material in the area selected. These three (3) pulls shall be considered a single test.

6.2 The selected test area shall be flat and be rigid enough to support the counter force.

6.3 Select three (3) representative pull areas within the test site which are the size of the test apparatus base.

6.4 Where the material is not parallel to the substrate, shave off some of the material to have the surface where the dish will be installed parallel to the substrate.

6.5 Clean the surfaces of the pull areas in a manner that will not affect integrity of the material or leave a residue.

6.6 Separate each pull area by a distance greater than the base of the apparatus.

6.7 Clean the disc surface to avoid a failure at the disc/adhesive interface and/or abrade the disk to promote adhesion.

6.8 Prepare the adhesive in accordance with the adhesive manufacturer’s recommendations. Apply the adhesive to the disc and/ or the surface to be tested using a procedure recommended by the adhesive manufacturer. Apply the adhesive in a manner so that the adhesive coats 100% of the surface area.

6.9 Apply the disc on the surface of fully cured air/water restive barrier material, based on the air/water resistive barrier manufacturer’s recommendations and the environmental conditions experienced. The disc shall be parallel to the rigid substrate. Apply pressure to the disc when placing it on the material to ensure full contact between material, adhesive, and disc. Temporarily secure disc in place while adhesive cures to ensure full bonding and prevent movement of disc. Allow time for the adhesive to fully cure before performing the test, based on the adhesive manufacturer’s recommendations and the anticipated environmental conditions.

Note: High tack tapes can work well for temporarily securing the disk to the substrate. The use of masking tape should be avoided.

6.10 After the adhesive has completely cured, cut through the air/water restive barrier material around the disc, at the edge of the disk completely through the material down to the substrate to isolate the test specimen.

7. Test Procedure

7.1 Position the adhesion tester over the disc that has been adhered to the substrate. Place it concentrically around the disc on the material surface. Place shims, if required, between the base and the material surface to position the adhesion tested perpendicular to the material surface.

7.2 Connect the central grip of the adhesion tester to the disc without bumping, bending, or otherwise pre-stressing the specimen. Support the adhesion tester, when used on non-horizontal surfaces, so that the weight of the adhesion tester does not contribute to the force exerted on the specimen.

7.3 Take up any slack in the connection to the disk so that the apparatus is just starting to pull on the disk.

7.4 Set the force indicator to zero.

7.5 If using a crank, increase the load to the disc, in a smooth and continuous a manner, at a maximum rate of ½ revolution per five (5) seconds until failure occurs. If using hydraulics with a manual or electronically controlled pump, increase the load to the disk using a loading rate to 110 kPa/m (58 psi/m) until failure occurs.

7.6 Record the force attained at failure.

8. Report

8.1 Produce a test report which includes, as a minimum, the following information:

8.2 Date of test,

8.3 Name of entity conducting the test, testing location, name of the person conducting the test,

8.4 Brief description of the general nature of the test, such as, field or laboratory testing,

8.5 Identification of material tested including manufacturer name, material name, material type, and manufacturer production code and tested thickness,

8.6 Temperature and relative humidity of the environmental during the test period,

8.7 Description of the apparatus used, including: apparatus manufacturer and model number,

8.8 Description of the substrate where the material has been installed including thickness, type, surface temperature, moisture content and rigidity,

8.9 Adhesive type, brand name and manufacturer,

8.10 Identify the specimen system as substrate (A), material (B), adhesive (C), and disk (D).

8.11 Indicate failures by the interfaces at which they occur, such as A/A, A/B, B/B, B/C, C/C, and C/D.

8.12 Test results including the result of each of the individual three pull tests and the average of the three tests,

8.13 Disregard results other than substrate / material (A/B) interface failures or material cohesive (B/B) failures.

8.14 A statement that the test method has not been modified.