



Designation: D7234 – 22

Standard Test Method for Pull-Off Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers¹

This standard is issued under the fixed designation D7234; 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 procedures for evaluating the pull-off strength of a coating on concrete. Pull-Off strength of coatings for other rigid substrates is described in Test Method [D4541](#). The test determines the greatest perpendicular force (in tension) that a surface area can bear before a plug of material is detached. Failure will occur along the weakest plane within the system comprised of the loading fixture, glue, coating system, and substrate, and will be exposed by the fracture surface.

1.2 This test method uses a class of apparatus known as portable pull-off adhesion testers.² They are capable of applying a concentric load and counter load to a single surface so that coatings can be tested even though only one side is accessible. Measurements are limited by the strength of adhesion bonds between the loading fixture, coating system and the substrate or the cohesive strengths of the glue, coating layers, and substrate.

1.3 This test method is suitable for both laboratory and field testing.

1.4 Pull-off strength measurements depend upon both material and instrumental parameters. There are different instruments used that comply with this test method. The specific instrument used should be identified when reporting results. This test is destructive and spot repairs may be necessary.

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

¹ This test method is under the jurisdiction of ASTM Committee [D01](#) on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee [D01.46](#) on Industrial Protective Coatings.

Current edition approved Dec. 1, 2022. Published December 2022. Originally approved in 2005. Last previous edition approved in 2021 as D7234 – 21. DOI: 10.1520/D7234-22.

² The term adhesion tester may be somewhat of a misnomer, but its adoption by two manufacturers and at least two patents indicates continued usage.

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:³

[C1583](#) Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)

[D16](#) Terminology for Paint, Related Coatings, Materials, and Applications

[D2651](#) Guide for Preparation of Metal Surfaces for Adhesive Bonding

[D3933](#) Guide for Preparation of Aluminum Surfaces for Structural Adhesives Bonding (Phosphoric Acid Anodizing)

[D4541](#) Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

[E177](#) Practice for Use of the Terms Precision and Bias in ASTM Test Methods

[E178](#) Practice for Dealing With Outlying Observations

[E691](#) Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 The terms and definitions in Terminology [D16](#) apply to this test method.

3.2 Definitions:

3.2.1 *concrete, n*—with respect to this test method, refers to all forms of concrete including masonry units.

3.2.2 *glue, n*—with respect to this test method, glue refers to the material that bonds the bottom of the loading fixture to the top surface of the coating to be tested.

³ 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.

3.2.3 *loading fixture, n*—(also referred to as dollies or studs) a metal structure that is flat on one end for bonding to the coating surface and shaped on the other end for attachment to the adhesion tester and is used to determine the pull-off strength of coatings.

3.2.4 *portable pull-off adhesion testers, n*—instruments that are capable of applying a concentric load and counter load to a single surface so that coatings can be tested even though only one side is accessible.

4. Summary of Test Method

4.1 The general pull-off test is performed by scoring through the coating down to the surface of the concrete substrate at a diameter equal to the diameter of the loading fixture (dolly, stud), and securing the loading fixture normal (perpendicular) to the surface of the coating with a glue. After the glue is cured, a testing apparatus is attached to the loading fixture and aligned to apply tension normal to the test surface. The force applied to the loading fixture is then uniformly increased and monitored until a plug of material is detached. When a plug of material is detached, the exposed surface represents the plane of limiting strength within the system. The nature of the failure is qualified in accordance with the percent of adhesive and cohesive failures, and the actual interfaces and layers involved. The pull-off strength is computed based on the maximum indicated load, the instrument calibration data, and the surface area stressed. Pull-off strength results obtained using different devices may be different because the results depend on instrumental parameters.

5. Significance and Use

5.1 The pull-off strength and mode of failure of a coating from a concrete substrate are important performance properties that are used in specifications. This test method serves as a means for uniformly preparing and testing coated surfaces, and evaluating and reporting the results.

5.2 Variations in strength results obtained using different instruments, different substrates, or different loading fixtures with the same coating are possible. Therefore, it is recommended that the specific test instrument and loading fixture be mutually agreed upon between the interested parties.

5.3 It is recommended that the coating be sufficiently cured to ensure cohesive strength and adhesion. This required minimum cure time before testing should be provided by the coating manufacturer, and may require an extension due to atmospheric conditions on site (for example, low temperature, and low or high humidity).

5.4 This test method may be adapted to determine surface strength of uncoated concrete (see X2.1). Test Method C1583 is also suitable for that determination.

5.5 The objective of this method is to determine the adhesion of a coating to concrete (or adapted for surface strength as stated in 5.4) and will result in failure in the coating or near the substrate surface. If evaluating the cohesive strength of the substrate or cementitious surfacers is the purpose of the testing, or if the substrate or cementitious surfacers have low strength, then Test Method C1583 may be more suitable.

6. Apparatus

6.1 *Adhesion Tester*, including the components and accessories described in 6.1.1 – 6.1.5.

6.1.1 *Loading Fixtures*, having a flat surface on one end that can be adhered to the coating and a means of attachment to the tester on the other end. The bonding surface may be round, square or rectangular. The round loading fixtures are usually 50 mm (2.0 in.) in diameter but may range from 20 mm (0.75 in.) to 75 mm (3.0 in.) in diameter.

6.1.2 *Detaching Assembly*, having a central grip for engaging the loading fixture.

6.1.3 *Base*, on the detaching assembly, for uniformly pressing against the coating surface around the fixture either directly, or by way of an intermediate bearing ring. A means of aligning the base is needed so that the resultant force is normal to the surface.

6.1.4 *Force Applicator*, means of moving the grip away from the base in as smooth and continuous a manner as possible 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.

6.1.5 *Force Indicator and Calibration Information*, for determining the actual force delivered to the loading fixture. The force indicator shall be verified to be within $\pm 5\%$ of the force measured by a calibrated testing machine at a frequency determined by the user, typically once a year.

6.2 *Timer*, or means of limiting the rate of stress to less than or equal to 0.2 MPa/s (30 psi/s) so that the maximum stress (failure) is obtained in about 5 to 30 s.

6.3 *Solvent*, or other means for cleaning the loading fixture surface.

6.4 *Fine Sandpaper*, or other means of cleaning or preparing the coating that will not alter its integrity.

6.5 *Glue*, for securing the fixture to the coating that does not affect the coating properties. Two-component epoxies and acrylics⁴ have been found to be the most versatile.

6.6 *Mechanical Clamps*, if needed, for holding the fixture in place while the glue cures.

6.7 *Cotton Swabs*, or other means for removing excess glue.

6.8 *Core Bit with Drill Press or Hand Drill*, and means to ensure that the scoring is normal to the coating for the procedures that use a round loading fixture. The core bit inside diameter should equal the diameter of the loading fixture. If a core bit with an inside diameter equal to the diameter of the loading fixture is not available, the closest size available should be used. The diameter of the scored area should be measured and recorded for performing the calculations. The core bit or saw blades should be diamond tipped and, when required to minimize heat and suppress dust, supplemented with water

⁴ The sole source of supply of the acrylics known to the committee at this time is Versilac 201 and 204 with accelerator, available from Lord Corp., Industrial Adhesive Div., 2000 W. Grandview Blvd., P.O. Box 10038, Erie, PA 16514. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,¹ which you may attend.