Designation: D1144 – 99 (Reapproved 2016)

Standard Practice for Determining Strength Development of Adhesive Bonds[1]

This standard is issued under the fixed designation D1144; 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 practice covers the determination of the strength development of adhesive bonds when tested on a standard specimen under specified conditions of preparation and testing. It is applicable to adhesives in liquid or paste form that require curing at specified conditions of time and temperature or specific substrate preparation. It is intended primarily to be used with metal-to-metal adherends; however, plastics, woods, glass, or combinations of these may be substituted.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D907 Terminology of Adhesives

D1002 Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)

D1338 Practice for Working Life of Liquid or Paste Adhesives by Consistency and Bond Strength

3. Terminology

3.1 *Definitions*—Several terms in this practice are defined in accordance with Terminology D907.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *activator, or accelerator (surface), n*—an adhesive curing agent that is applied to a bonding surface for the purpose of affecting or speeding, or both, the cure of an adhesive.

3.2.2 *fixture time (set time), n*—the shortest time required by an adhesive to develop handling strength such that test specimens can be removed from fixtures, unclamped, or handled without stressing the bond, thereby affecting bond strength.

3.2.3 *handling strength, n*—a low level of strength initially obtained by an adhesive that allows specimens to be handled, moved, or unclamped without causing disruption of the curing process or affecting bond strength.

4. Significance and Use

4.1 This practice contains suggested provisions for reporting strength values. Any ASTM test method for determining strength properties of adhesive bonds may be used. This practice is not intended to determine the pot or working life of two-component epoxy of similar type adhesives. Refer to Practice D1338. It should be noted that there are adhesives whose testing requires special techniques and whose properties are difficult to reproduce from tester to tester. These variables should be kept in mind when analyzing the data obtained using this practice.

5. Test Specimens

5.1 It is suggested that lap-type shear specimens in accordance with Test Method D1002, be used. Other types of test specimens may be used with agreement between the manufacturer and the purchaser.

6. Preparation of Test Specimens

6.1 Prepare test specimens in accordance with Test Method D1002, or other applicable test method. Prepare the bonding surface by a method mutually agreed upon between the manufacturer and the purchaser. Vapor phase degreasing, grit blasting, hand abrasion, or testing on oiled surfaces are some of the methods that are available. If a surface activator or accelerator is used, apply it in accordance with the instructions of the manufacturer. Use one- or two- surface activation as agreed upon between the manufacturer and the purchaser. Allow assembled specimens to cure at the temperature and period of time prescribed by the manufacturer to develop full strength. This is intended to determine if any post curing of the adhesive occurs that would cause a strength increase and decrease. Bond strength variability could be caused by embrittlement or a further hardening of the adhesive during the cure cycle.

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[1] This practice is under the jurisdiction of ASTM Committee D14 on Adhesives and is the direct responsibility of Subcommittee D14.10 on Working Properties.

Current edition approved May 1, 2016. Published May 2016. Originally approved in 1952. Last previous edition approved in 2011 as D1144 – 99 (2011). DOI: 10.1520/D1144-99R16.

[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.

6.2 In addition, prepare assemblies for curing at the same temperature and time intervals to determine fixture time and 20, 50, and 80 % strength. If the adhesive is cured by heat, heat the specimens at a predetermined rate such that a consistent temperature rise is obtained. Differences in heating rates will naturally occur between different types of test specimens due to different conductivities. Determine the temperature of the adhesive by means of a properly insulated thermocouple or contact pyrometer placed in the geometric center of the bond area. Bring the adhesive layer to the curing temperature as promptly as possible and start the measurement of curing time when the adhesive has reached the curing temperature.

6.3 After the curing treatment, allow the specimens to return to room temperature by natural air convection. Preconditioning of the specimens prior to testing is permissible upon agreement between the purchaser and the manufacturer. Altering the manner in which the cured specimens are to be returned to room temperature also is permissible, provided the method is agreeable to the purchaser and manufacturer. Room temperature-curing adhesives are allowed to cure for specific time intervals at a temperature of 22 ± 3°C (72 ± 6°F). Cure time is measured from the initial assembly and clamping of test specimens. If the test adhesive has an unusual cure mechanism, or does not adapt to conventional assembly and test methods, use a test procedure agreed upon between the manufacturer and the purchaser. Develop this procedure to adhere as closely as possible to those outlined in this practice.

7. Procedure for Determining Fixture Time (Set Time)

7.1 Prepare test specimens as outlined in Section 6. Apply a specified amount of adhesive, as recommended by the manufacturer, to one surface. If a surface activator or accelerator is used, apply this to the other surface, or both, if specifically required by the manufacturer or purchaser. Assemble specimens and clamp as recommended by the manufacturer.

7.2 After a specified time, remove clamps and determine if the bond has developed handling strength. The initial test time is longer than expected to develop handling strength. In subsequent tests, shorten the intervals such that the minimum time to develop handling strength eventually is determined.

7.3 In testing parts for handling strength, load specimens axially, torsionally, or in cleavage, to ensure that the blocking strength of the adhesive is not mistaken for handling strength. Once the minimum time has been determined, repeat the test a minimum of three times to ensure its accuracy. For adhesive types where fixture time is irrelevant or too short to test, exclude this test at the agreement of the manufacturer and purchaser.

7.4 Test the specimens as described in the selected appropriate ASTM test method. Test heat-cured specimens immediately after reaching room temperature. Room temperature-cured specimens are tested immediately after the specified cure time has elapsed.

8. Report

8.1 Report the following:

8.1.1 Complete identification of the adhesive tested, including type, source, manufacturer's code number, lot number, form, and activator,

8.1.2 Complete identification of the adherend used, its type, thickness, method of cleaning, and preparation of surface prior to bonding,

8.1.3 Standard test method used,

8.1.4 Application and bonding conditions used in preparing the specimens,

8.1.5 Cure procedure used for specimens prior to testing,

8.1.6 Fixturing time to the nearest standard unit of time (second, minute, hour),

8.1.7 Fixture time and cure speed data as actual test values, versus test time, to the nearest standard unit of time,

8.1.8 Number of specimens tested, and

8.1.9 Number of joints represented.

9. Keywords

9.1 accelerator; shear strength; tensile loading; working life