Designation: D1002 – 10 (Reapproved 2019)

Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)[1]

This standard is issued under the fixed designation D1002; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

INTRODUCTION

The accuracy of the results of strength tests of adhesive bonds will depend on the conditions under which the bonding process is carried out. Unless otherwise agreed upon by the manufacturer and the purchaser, the bonding conditions shall be prescribed by the manufacturer of the adhesive. In order to ensure that complete information is available to the individual conducting the tests, the manufacturer of the adhesive shall furnish numerical values and other specific information for each of the following variables:

(1) Procedure for preparation of surfaces prior to application of the adhesive, the cleaning and drying of metal surfaces, and special surface treatments such as sanding that are not specifically limited by the pertinent test method.

(2) Complete mixing directions for the adhesive.

(3) Conditions for application of the adhesive, including the rate of spread or thickness of film, number of coats to be applied, whether to be applied to one or both surfaces, and the conditions of drying where more than one coat is required.

(4) Assembly conditions before application of pressure, including the room temperature, relative humidity, length of time, and whether open or closed assembly is to be used.

(5) Curing conditions, including the amount of pressure to be applied, the length of time under pressure, method of applying pressure (pressure bag, press platens, etc.), heat-up rate, and the temperature of the assembly when under pressure. It should be stated whether this temperature is that of the bondline or of the atmosphere at which the assembly is to be maintained.

(6) Conditioning procedure before testing, unless a standard procedure is specified, including the length of time, temperature, and relative humidity.

A range may be prescribed for any variable by the manufacturer of the adhesive if it can be assumed by the test operator that any arbitrarily chosen value within such a range, or any combination of such values for several variables will be acceptable to both the manufacturer and the purchaser of the adhesive.

1. Scope

1.1 This test method covers the determination of the apparent shear strengths of adhesives for bonding metals when tested on a standard single-lap-joint specimen and under specified conditions of preparation and test.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered 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*

[1] This test method is under the jurisdiction of ASTM Committee D14 on Adhesives and is the direct responsibility of Subcommittee D14.80 on Metal Bonding Adhesives.

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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]

A109/A109M Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled

A167 Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip (Withdrawn 2014)[3]

B36/B36M Specification for Brass Plate, Sheet, Strip, And Rolled Bar

B152/B152M Specification for Copper Sheet, Strip, Plate, and Rolled Bar

B209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate

B265 Specification for Titanium and Titanium Alloy Strip, Sheet, and Plate

D907 Terminology of Adhesives

D4896 Guide for Use of Adhesive-Bonded Single Lap-Joint Specimen Test Results

E4 Practices for Force Verification of Testing Machines

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 *Definitions*—Many terms in this test method are defined in Terminology D907.

4. Significance and Use

4.1 This test method is primarily comparative. However, it does have application as a discriminator in determining variations in adherend surface preparation parameters and adhesive environmental durability. The test method has found applications in controlling surface preparations, primer, and adhesive systems for determining strength properties of tested systems.

4.2 The misuse of strength values obtained from this test method as design-allowable stress values for structural joints could lead to product failure, property damage, and human injury. The apparent shear strength of an adhesive obtained from a given small single-lap specimen may differ from that obtained from a joint made with different adherends or by a different bonding process. The normal variation of temperature and moisture in the service environment causes the adherends and the adhesive to swell or shrink. The adherends and adhesive are likely to have different thermal and moisture coefficients of expansion.

4.3 Even in small specimens, short-term environmental changes may induce internal stresses or chemical changes in the adhesive that permanently affect the apparent strength and other mechanical properties of the adhesive. The problem of predicting joint behavior in a changing environment is even more difficult if a different type of adherend is used in a larger structural joint than was used in the small specimen.

4.4 The apparent shear strength measured with a single-lap specimen is not suitable for determining design-allowable stresses for designing structural joints that differ in any manner from the joints tested without thorough analysis and understanding of the joint and adhesive behaviors.

4.5 Single-lap tests may be used for comparing and selecting adhesives or bonding processes for susceptibility to fatigue and environmental changes, but such comparisons must be made with great caution since different adhesives may respond differently in different joints. See Guide D4896 for further discussion of the concepts relative to interpretation of adhesive-bonded single-lap-joints.

5. Apparatus

5.1 The testing machine shall conform to the requirements of Practices E4. The testing machine shall be so selected that the breaking load of the specimens falls between 15 and 85 percent of the full-scale capacity. The machine shall be capable of maintaining a rate of loading of 80 to 100 kg/cm^2 (1200 to 1400 psi)/min, or, if the rate is dependent on crosshead motion, the machine should be set to approach this rate of loading, approximately 0.05 in./min. It shall be provided with a suitable pair of self-aligning grips to hold the specimen. It is recommended that the jaws of these grips shall engage the outer 25 mm (1 in.) of each end of the test specimen firmly.

5.2 The grips and attachments shall be so constructed that they will move into alignment with the test specimen as soon as the load is applied, so that the long axis of the test specimen will coincide with the direction of the applied pull through the center line of the grip assembly.

5.3 The length of overlap of the specimen may be varied where necessary. The length of the specimen in the jaws, however, must not be varied. The distance from the end of the lap to the end of the jaws should be 63 mm (2½ in.) in all tests.

6. Test Specimens

6.1 Test specimens shall conform to the form and dimensions shown in Fig. 1. These shall be cut from test panels prepared as prescribed in Section 7. The recommended thickness of the sheets is 1.62 ± 0.125 mm (0.064 ± 0.005 in.). The recommended length of overlap for most metals of 1.62 mm (0.064 in.) in thickness is 12.7 ± 0.25 mm (0.5 ± 0.01 in.).

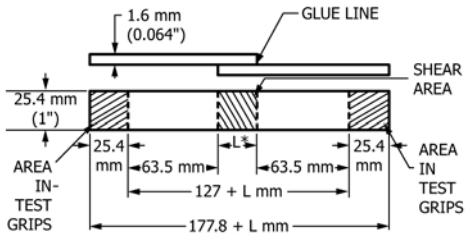

FIG. 1 Form and Dimensions of Test Specimen

[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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

6.2 Since it is undesirable to exceed the yield point of the metal in tension during test, the permissible length of overlap in the specimen will vary with the thickness and type of metal, and on the general level of strength of the adhesive being investigated. The maximum permissible length may be computed from the following relationship:

$$L = Fty\ t/\tau \quad (1)$$

where:

L = length of overlap, in.,
t = thickness of metal, in.,
Fty = yield point of metal (or the stress at proportional limit), psi, and
τ = 50 percent of the estimated average shear strength in adhesive bond, psi.

6.3 A variation in thickness of the metal, and the length of overlap, will likely influence the test values and make direct comparison of data questionable. For this reason, in comparative or specification tests, the thickness should preferably be 1.62 ± 0.125 mm (0.064 ± 0.005 in.) and the length of overlap should preferably be 12.7 ± 0.25 mm (0.5 ± 0.01 in.), or not in excess of the value computed in 6.2. For development tests values could be different, but should then be constant.

6.4 The following grades of metal are recommended for the test specimens:

Metal	ASTM Designation
Brass	B36/B36M, C26800 (Alloy 8)
Copper	B152/B152M, C11000
Aluminum	B209, Alloy 2024, T3 temper
Steel	A109/A109M, Grade 2
Corrosion-resisting steel	A167, Type 302
Titanium	B265

6.5 At least 30 specimens shall be tested, representing at least four different joints. However, if statistical analysis of data and variance is employed, it should be possible to reduce this number.

7. Preparation of Test Joints

7.1 It is recommended that test specimens be made up in multiples of at least five specimens, and then cut into individual test specimens (Note 1), Fig. 2 and Fig. 3. Cut sheets of the metals prescribed in 6.1 and 6.4 to suitable size. All edges of the metal panels and specimens which will be within (or which will bound) the lap joints shall be machined true (without burrs or bevels and at right angles to faces) and smooth (rms 160 max) before the panels are surface-treated and bonded. Clean and dry the sheets carefully, according to the procedure prescribed by the manufacturer of the adhesive, and assemble in pairs. Prepare and apply the adhesive according to the recommendations of the manufacturer of the adhesive. Apply the adhesive to a sufficient length in the area across the end of one or both metal sheets so that the adhesive will

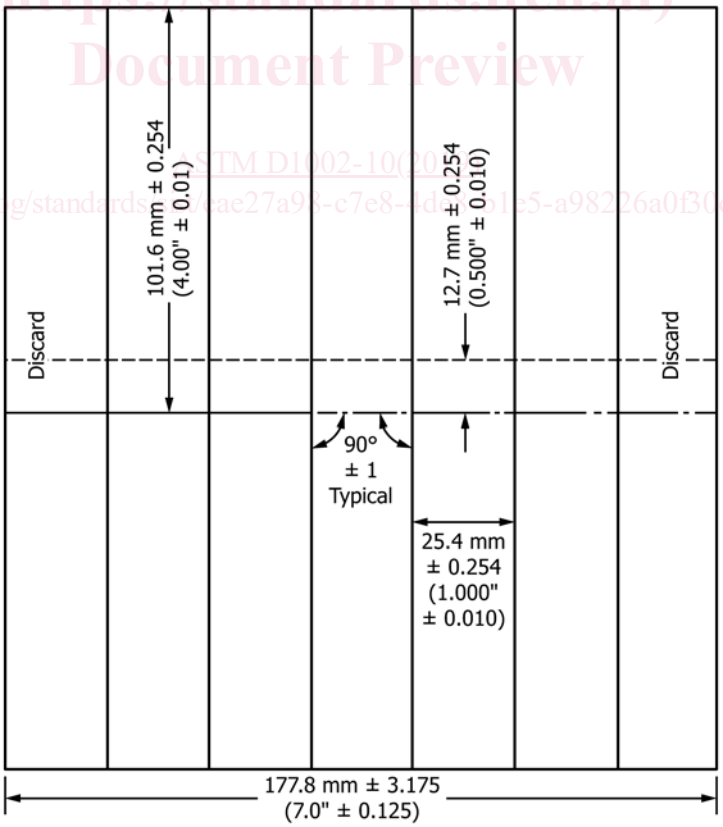

FIG. 2 Standard Test Panel