



# Standard Test Method for Strength Properties of Adhesively Bonded Plastic Lap-Shear Sandwich Joints in Shear by Tension Loading<sup>1</sup>

This standard is issued under the fixed designation D 3164M; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method is intended to complement Test Method D 1002 and D 3163 and extend its application to single-lap-shear adhesive joints employing plastic adherends. The test method is useful for generating comparative shear strength data for joints made from a number of plastics. It can also provide a means by which several plastics surface treatments can be compared.

1.2 The values stated in SI units are to be regarded as the standard.

NOTE 1—A soft metric (conversion from English) companion to Test Method D 3164M has been developed - D 3164.

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:

D 907 Terminology of Adhesives<sup>2</sup>

D 1002 Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)<sup>2</sup>

D 2093 Practice for Preparation of Surfaces of Plastics Prior to Adhesive Bonding<sup>2</sup>

D 2651 Guide for Preparation of Metal Surfaces for Adhesive Bonding<sup>2</sup>

D 3163 Test Method for Determining Strength of Adhesively Bonded Rigid Plastic Lap-Shear Joints in Shear by Tension Loading<sup>2</sup>

D 3164 Test Method for Strength Properties of Adhesively Bonded Plastic Lap-Shear Sandwich Joints in Shear by Tension Loading<sup>2</sup>

D 4896 Guide for Use of Adhesive-Bonded Single Lap-Joint Specimen Test Results<sup>2</sup>

## 3. Terminology

3.1 *Definitions*—Many terms in this test method are defined in Terminology D 907.

## 4. Significance and Use

4.1 Due to the increased use of adhesively bonded plastics as a result of the inherent advantages afforded by bonded rather than mechanically fastened joints, particularly the alleviation of stress risers and stress cracking, there is a need for standard tests by which joints of various substrates and adhesives can be compared. This test method is intended to meet such a need.

4.2 This test method is limited to test temperatures below the softening point of the subject adherends, and is not intended for use on anisotropic adherends such as reinforced plastic laminates.

4.3 The misuse of strength values obtained from this test method as design stress allowable values for structural joints could lead to product failure, property damage, and human injury.

4.4 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 and shrink. The adherends and adhesive are likely to have different thermal and moisture coefficients of expansion.

4.5 Even in small specimens, short-term environmental changes can 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.

4.6 The apparent shear strength measured with a single-lap specimen is not suitable for determining allowable design 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.

4.7 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

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 15.06.

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differently in different joints. See Guide D 4896 for further discussion of the concepts relative to interpretation of adhesive bonded single lap joints.

**5. Apparatus**

5.1 *Testing Machine*, conforming to the requirements of and having the capabilities of the machine prescribed in Test Method D 1002. Likewise the grips are capable of securely grasping the specimen throughout the test without allowing the specimen to slip. The grips are also self-aligning.

5.2 *Temperature-Controlling Equipment*, capable of maintaining the test temperature to  $\pm 3^{\circ}\text{C}$ . If ambient laboratory conditions are employed the same degree of control is required.

**6. Test Specimen**

6.1 Make specimens that conform to the form and dimensions shown in Fig. 1. It is recommended that the test specimens be cut from the test panel depicted in Fig. 2, but individual specimens may be prepared if preferred. The recommended metal substrate is Alloy 2024-T3 aluminum,  $1.5 \pm 0.1$  mm. A surface treatment such as Method A of Practice D 2651 is recommended for the aluminum. If a metal substrate other than aluminum is employed, then one of the other surface preparations in Practice D 2651 is suggested. The recommended length of overlap is  $12.5 \pm 0.2$  mm. The thickness of

the plastic in the metal/adhesive/plastic/adhesive/metal sandwich configuration may vary depending on the type and manufacturer but thin films of 0.35 mm or less are recommended. An upper limit of  $1.5 \pm 0.1$  mm plastic thickness is suggested.

6.2 The surface preparation used on the adherend depends on the subject plastic adherend. Methods such as those recommended in Practice D 2093 serve as a useful guide.

6.3 Apply the adhesive in accordance with the manufacturer's recommendations. Choose the adhesive such that the cure temperature does not adversely affect the mechanical properties of the adherend.

6.4 Cut test specimens from the bonded panels pictured in Fig. 2. Cutting the specimens must be accomplished without overheating or otherwise physically damaging the adherend or bonded interface. Individual test specimens may also be prepared if desired.

**7. Procedure**

7.1 Condition the test specimens for definite periods of time under specified conditions before testing if desired. After conditioning, it is recommended that all specimens be stabilized in the test environment for 1 h before testing.

7.2 Place the test specimens in the grips of the testing machine so that the applied load coincides with the long axis of

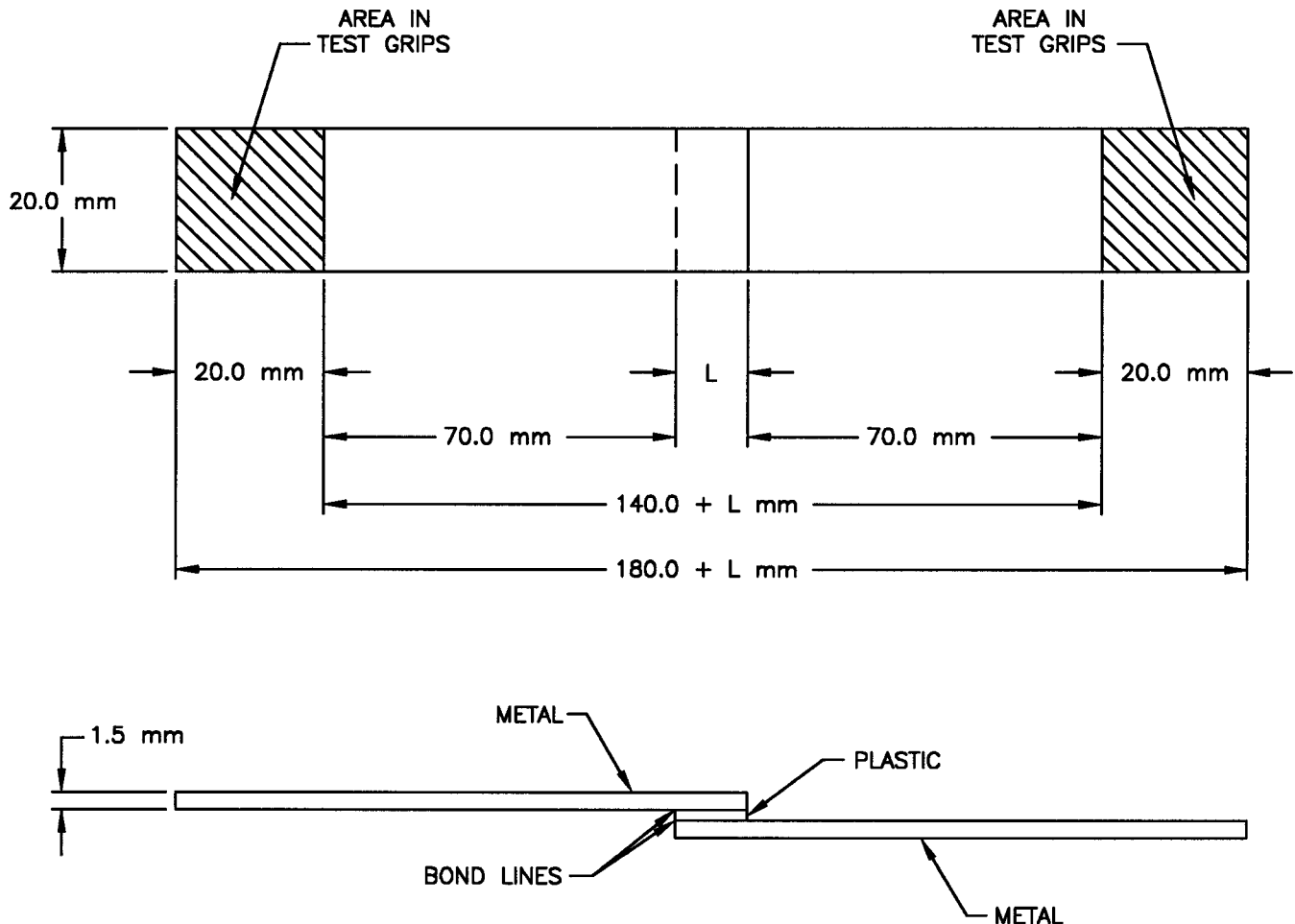


FIG. 1 Form A—Dimensions of Test Specimen

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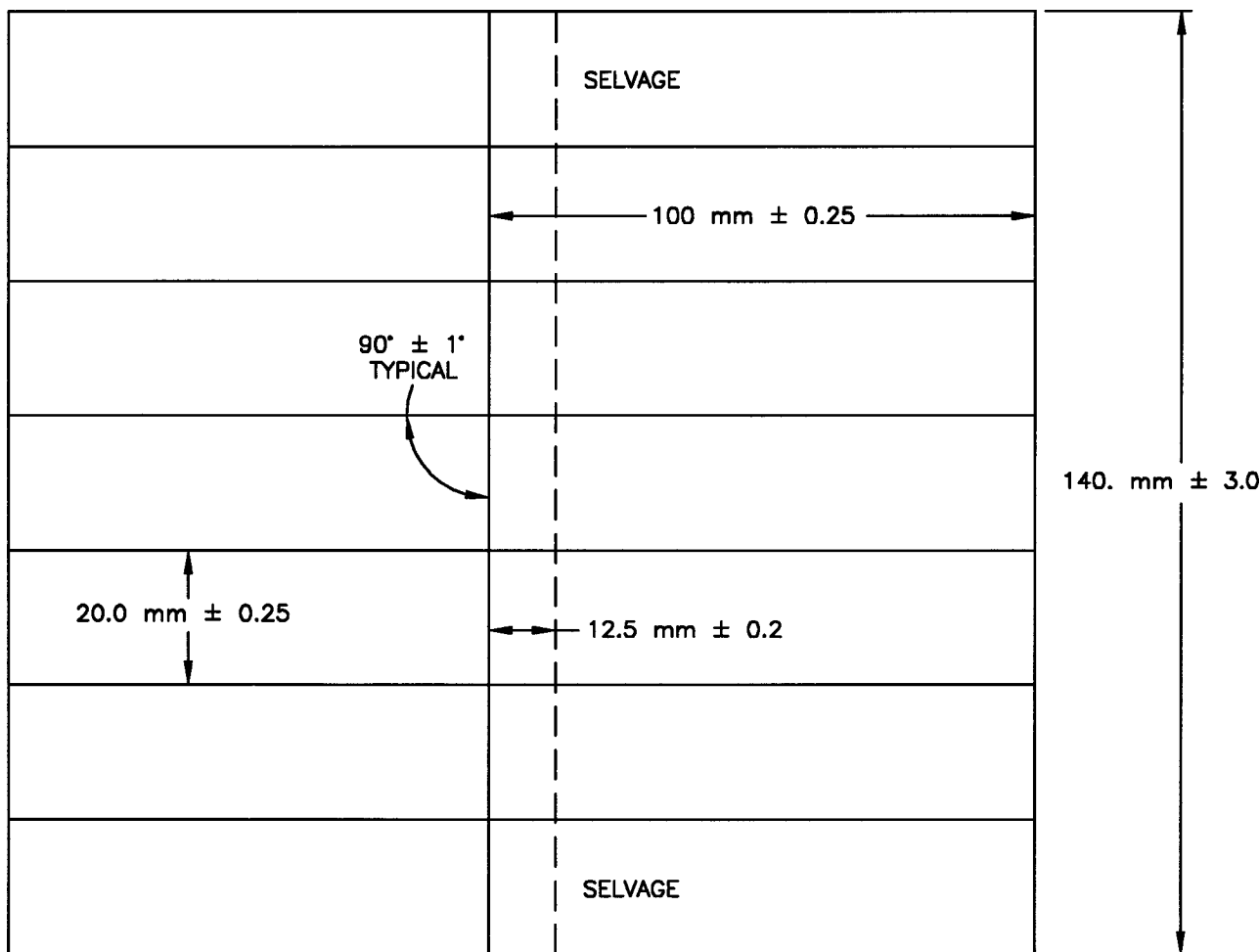


FIG. 2 Standard Test Panel

the specimen. Load the specimen to failure at a rate of 80 to 100 kg/cm<sup>2</sup> of shear area per minute.

NOTE 2—The thickness of the plastic insert used will influence the joint strengths obtained in this test due to the added offset. Thermal stresses introduced in the joint by elevated temperatures bonding dissimilar materials will also offset ultimate joint strength. Direct comparison of results is possible only for the same thickness and composition of insert so as to minimize differences resulting from offset or thermal stress.

**8. Calculations**

8.1 Calculate the bond area to the nearest 0.05 cm<sup>2</sup>. Record both load at failure and type of failure (percentage cohesive and apparent failure in adhesion). Calculate failing stress as megapascals of shear area.

**9. Report**

9.1 Report the following:

9.1.1 Complete identification of the adhesive tested, including type, source, date manufactured, manufacturer's code number, form, etc.

9.1.2 Complete identification of the metal used, its thickness, and method of cleaning and preparing its surface prior to bonding.

9.1.3 Complete identification of the plastic used, its thickness, and the method of cleaning and preparing its surface prior to bonding.

9.1.4 Method of adhesive application (brush, spray, roller coat, tape, etc.).

9.1.5 Ambient conditions at time of bonding (temperature, humidity, etc.).

9.1.6 Length of overlap used.

9.1.7 Conditioning of joint prior to testing.

9.1.8 Maximum, minimum, and average values of the failing load.

9.1.9 Number of specimens tested.

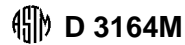
9.1.10 Type of failure. This should include estimated percentages of cohesive failure in the adhesive unbonded area, apparent failure in adhesion, and failure in the adherend.

9.1.11 Test temperature employed.

9.1.12 The average thickness of adhesive layer after formation of the joint shall be reported within 0.01 mm. The method of obtaining the thickness of the adhesive layer shall be described including procedure, location of measurements and range of measurements.

**10. Precision and Bias**

10.1 A precision and bias statement does not exist for this test method because resources necessary for round robin testing have not been forthcoming.



## **11. Keywords**

11.1 adhesive bond; lap-shear; sandwich joint; shear; tension

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