Designation: D 3163 – 01

Standard Test Method for Determining Strength of Adhesively Bonded Rigid Plastic Lap-Shear Joints in Shear by Tension Loading[1]

This standard is issued under the fixed designation D 3163; 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 is intended to complement Test Method D 1002 and extend its application to single-lap shear adhesive joints of rigid 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 plastic surface treatments can be compared.

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

D 907 Terminology of Adhesives[2]

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

D 2093 Practice for Preparation of Surfaces of Plastics Prior to Adhesive Bonding[2]

D 4896 Guide for Use of Adhesive-Bonded Single Lap-Joint Specimen Test Results[2]

3. Terminology

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

4. Significance and Use

4.1 Due to the increased use of adhesive-bonded plastics as a result of the inherent advantages afforded by bonded rather than mechanically fastened joints, particularly the alleviation of stress raisers and stress cracking, there is a need for standard tests by which joints of various plastic 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 allowable design-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 and shrink. The adherends and adhesive are likely to have different thermal and moisture coefficients of expansion. 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.

4.3.1 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.

4.3.2 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 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. The grips are self-aligning and capable of securely grasping the specimen throughout the test, without allowing the specimen to slip.

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[1] This test method is under the jurisdiction of ASTM Committee D14 on Adhesives and is the direct responsibility of Subcommittee D14.40 on Adhesives for Plastics.

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[2] *Annual Book of ASTM Standards,* Vol 15.06.

5.2 *Temperature-Controlling Equipment*, capable of maintaining the test temperature to ±3°C (±5°F). 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 set forth in Test Method D 1002 where possible. However, due to the low yield points in plastics compared with those of metals, it may not always be feasible to limit test specimen geometry to that called for in Test Method D 1002. Therefore adherend thicknesses and joint overlaps must be chosen so that failure occurs preferentially in the joint and not in the substrate. Thicker adherends allow the stress on the bonded area to be increased, before either tensile failure or yield occurs in the adherend. Recognize, however, that depending on the surface treatment and adhesive used, the bond strength may often be greater than the tensile yield strength of the adherend. Use data collected by this test method only for comparative purposes when the investigator is certain that the specimen configurations and joint geometries of the specimens being compared are identical.

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

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

6.4 Cut test specimens from the bonded panels pictured in Fig. 1. Cut the specimens without overheating or otherwise physically damaging the adherend or bonded interface. Individual specimens may also be prepared if desired.

7. Procedure

7.1 Place the specimens in the grips of the testing machine so that the applied load coincides with the long axis of the test specimen. Load the specimen to failure at a rate of 8.3 to 9.7 MPa (1200 to 1400 psi) of shear area per minute (approximately 0.05 in./min cross head speed).

7.2 Condition 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.

8. Calculation

8.1 Calculate the bond area to the nearest 0.06/cm^2 (0.01 in.^{2}). Record both load at failure and type of failure (percent cohesive and apparent adhesive). Calculate failing stress as megapascals (pounds force per square inch) of shear area.

9. Report

9.1 Report the following information:

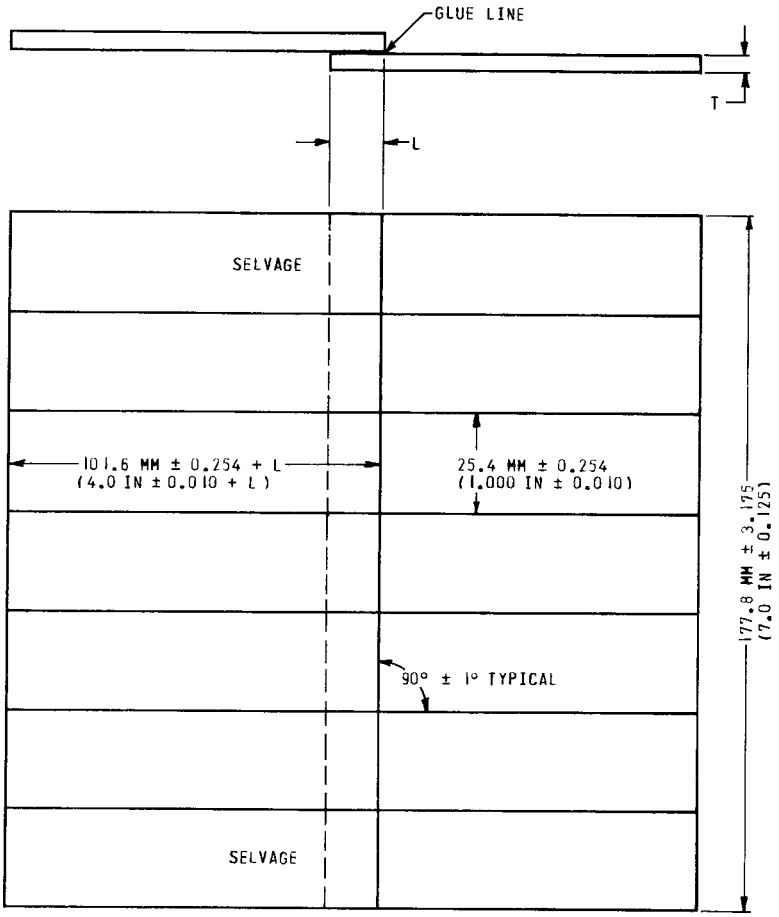

FIG. 1 Standard Test Panel and Specimen Configuration

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

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

9.1.4 Conditions present at time of bonding (temperature, etc.).

9.1.5 Length of overlap used.

9.1.6 Conditioning of joint prior to testing.

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

9.1.8 Number of test specimens tested.

9.1.9 Type of failure. Include estimated percent cohesion failure, unbonded area, apparent failure in adhesion, and failure in the adherend.

9.1.10 Test temperature employed.

9.1.11 Average thickness of adhesive layer after formation of the joint, within 0.0127 mm (0.0005 in.). Describe the method of obtaining the thickness of the adhesive layer including procedure, location of measurements, and range of measurements.

NOTE 1—The length of overlap, *L*, may be varied where necessary. The length of the test specimen in the jaws, however, must not be varied. The distance from the end of the overlap to the end of the jaws should be 63 mm (2½ in.) in all tests.

NOTE 2—The thickness of the adherend, *t*, may be varied to strengthen the adherend relative to the strength of the bonded area. A maximum thickness of 4.76 mm (3⁄16in.) is recommended, however, to minimize the effects of offset.

10. Precision and Bias

10.1 The precision and bias statement for this test method has not yet been determined. Archival and round-robin information is being reviewed, and the results are expected by September 2004.

11. Keywords

11.1 adhesive bonds; plastic; shear strength; tension