



Standard Test Method for Strength Properties of Adhesives in Shear by Tension Loading at Elevated Temperatures (Metal-to-Metal)¹

This standard is issued under the fixed designation D 2295; 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 the determination of the comparative shear strengths of adhesives for bonding metals when tested on a standard specimen and under specified conditions of preparation and testing at elevated temperatures.

1.2 This test method is applicable to the temperature range from 315 to 850°C (600 to 1500°F).

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

1.4 *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 consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

A 167 Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip²

D 638 Test Method for Tensile Properties of Plastics³

D 907 Terminology of Adhesives⁴

D 1002 Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)⁴

2.2 Military Specifications:

MIL-S-25043 Steel Plate, Sheet, and Strip⁵

3. Terminology

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

4. Significance and Use

4.1 Comparative strength of adhesive bonds at elevated

temperatures allows for better selection of adhesives that must perform at temperatures above normal. This test method is useful in supplying such information.

5. Apparatus

5.1 *Testing Machine*, conforming to the requirements of Test Method D 638. Use pin-type grips as shown in Fig. 1 to hold the test specimen.

5.2 *Heating Equipment*, consisting of a radiant heat source, backed by a high-efficiency reflector for the purpose of obtaining the desired heat flux. A suitable lamp arrangement for heating a specimen is shown in Fig. 2.⁶

6. Test Specimens

6.1 Cut test specimens from panels shown in Fig. 3(a). These test specimens' form and dimensions are shown in Fig. 3(b). The specimens are similar to the tension lap shear specimen described in Fig. 1 of Test Method D 1002, except that pin-type grips are used.

6.2 Base the selection of materials on the test temperature range. The following grades of steel are recommended, although use of other types of heat-resistant steel is permitted:

Metal	Designation
Steel, corrosion-resistant (18-8) plate, sheet, and strip	A 167, Type 302
Steel plate, sheet, and strip 17-7PH, TH 1050, corrosion-resistant, precipitation hardened	MIL-S-25043

The nominal thickness⁵ for the sheet 1.270 mm (0.050 in.).

7. Preparation of Test Specimens

7.1 Cut test specimens as shown in Fig. 3(b) to dimensions from the test panel. Measure the width of the specimen and the length of the overlap to the nearest 0.25 mm (0.01 in.).

7.2 Prepare test specimens by bonding individual strips as shown in Fig. 3(b). Machine unbonded individual strips to size and free from burrs or other irregularities.

7.3 Uniformly coat both sides of the dummy and test specimens with carbon black as shown in Fig. 3(b).

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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² *Annual Book of ASTM Standards*, Vol 01.03.

³ *Annual Book of ASTM Standards*, Vol 08.01.

⁴ *Annual Book of ASTM Standards*, Vol 15.06.

⁵ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098

⁶ The General Electric 100 T3/CL tubular quartz lamp has been found suitable for this purpose. A lamp-reflector combination suitable for this purpose may be obtained from Research, Inc., Northfield, MN.

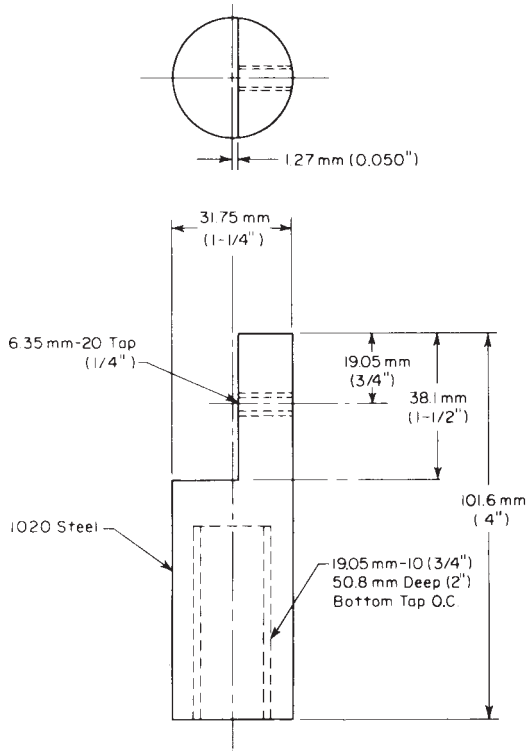


FIG. 1 Specimen Holder

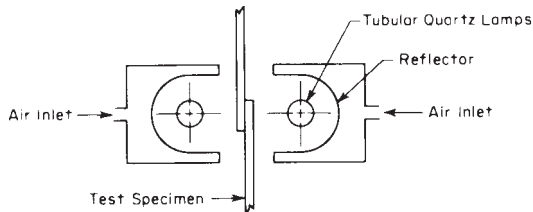


FIG. 2 Heat Lamp Arrangement

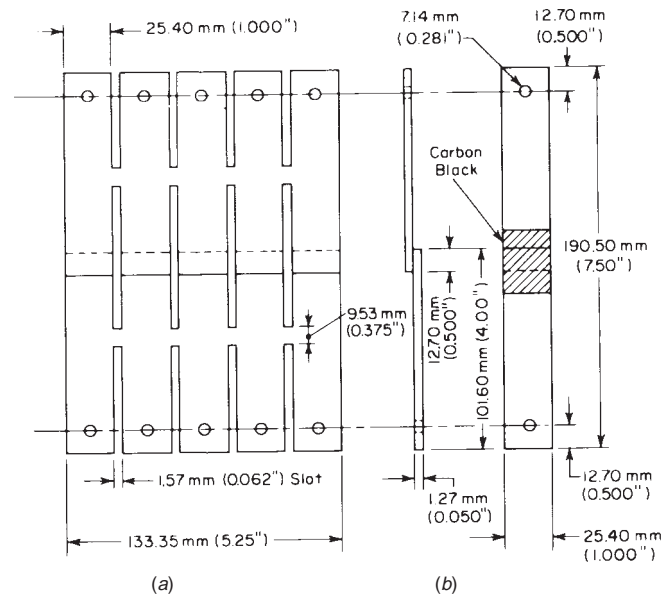


FIG. 3 Form and Dimension of Bonded Panel and Test Specimen

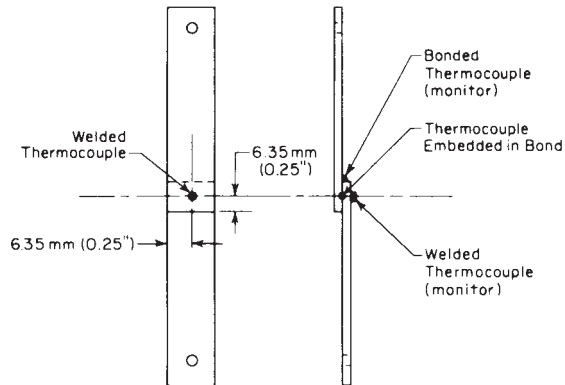


FIG. 4 Thermocouple Location

8. Procedure

8.1 Place the specimens in the pin-type grips of the testing machine so that the long axis of the test specimen coincides with the direction of applied pull through the center line of the grip assembly.

8.2 Heat the specimen uniformly in the bond area using a radiant source. Ensure that the required bondline temperature is reached within a prescribed period of time.

8.3 Perform a temperature calibration on a dummy specimen prior to test. Calibrate the bond temperature using two thermocouples positioned in the geometric center of the bond. Embed one thermocouple in the center of the bond and superimpose and bond or spot weld the other to the outer surface (Fig. 4). If spot welding is employed, do this in such a way as not to cause damage to the bond. Bring the bond to temperature using the embedded thermocouple as the monitor and simultaneously recording the external temperature.

8.4 Test the specimen as follows:

8.4.1 Allow no slack in the test fixture just prior to applying load. If a preload is used, do not exceed 345 kPa (50 psi) at ambient temperature.

8.4.2 Control the temperature by the external thermocouple which has been calibrated in accordance with 6.3.

8.4.3 Establish the heating rate and time at steady state for bondline temperature.

8.4.4 The test temperature tolerance is $\pm 1\%$.

8.4.5 Unless otherwise specified, load the test specimen to failure at a rate of 8.3 to 9.7 MPa (1200 to 1400 psi)/min.

8.5 Record the load at failure and the nature and amount of this failure (cohesion in adhesive or metal, or adhesion) for each specimen. Express all failing loads in megapascals (or pounds-force per square inch) and if possible, report to three significant figures.

9. Report

9.1 Report the following information:

9.1.1 Complete identification of the adhesive tested, including type, source, manufacturers' code numbers, form, and so forth,

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

9.1.3 Application and bonding conditions used in preparing the specimens,

9.1.4 Length of overlap used,

- 9.1.5 Conditioning procedure used for specimens prior to testing,
- 9.1.6 Test temperature,
- 9.1.7 Number of specimens tested,
- 9.1.8 Number of joints represented,
- 9.1.9 Maximum, minimum, and average values for the load at failure,
- 9.1.10 Nature of the failure, including the average estimated percent of failure in the cohesion of the adhesive, contact failure, and adhesion to the metal, and
- 9.1.11 Average thickness of adhesive layer after formation

of the joint, within 0.025 mm (0.001 in.). 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 elevated-temperature; metal; shear; tension

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