Designation: D 2095 – 96 (Reapproved 2002)

Standard Test Method for Tensile Strength of Adhesives by Means of Bar and Rod Specimens[1]

This standard is issued under the fixed designation D 2095; 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 relative tensile strength of adhesives by the use of bar- and rod-shaped butt-joined specimens under defined conditions of preparation, conditioning, and testing. This test method is applicable to the testing of adhesives with various adherend materials in either similar or dissimilar combinations.

NOTE 1—An alternative test method for determining the tensile strength of adhesives is Test Method D 897.

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:*

D 897 Test Method for Tensile Properties of Adhesive Bonds[2]

D 907 Terminology of Adhesives[2]

D 2094 Practice for Preparation of Bar and Rod Specimens for Adhesion Tests[2]

E 4 Practices for Force Verification of Testing Machines[3]

E 6 Terminology Relating to Methods of Mechanical Testing[3]

E 104 Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions[4]

3. Terminology

3.1 Many of the terms in this standard are defined in Terminology D 907.

3.2 *Definition of Term Specific to This Standard:*

3.2.1 *tensile strength of an adhesive*—the maximum tensile stress which it is capable of sustaining. Tensile strength is calculated from the maximum load during a tension test carried to rupture and the original cross-sectional area of the specimen (see Terminology E 6).

4. Significance and Use

4.1 Tension tests provide reasonably accurate information with regard to the tensile strength of adhesives. Tensile strength data may be suitable for specification acceptance, service evaluation, manufacturing control, research, and development. Tension tests are not considered significant for applications differing from the test in rate, direction, and type of loading.

5. Apparatus

5.1 *Testing Machine*—A testing machine capable of maintaining a specified rate of loading, with the error for indicated loads that are to be measured not exceeding ±1 % and the load-indicating mechanism essentially free of inertial lag at a specified rate of loading. Verify the accuracy of the testing machine in accordance with Practices E 4. Ensure that the testing machine is provided with the following:

5.1.1 *Fixed Member*—A fixed or essentially stationary member carrying one attachment fixture.

5.1.2 *Movable Member*—A movable member carrying a second attachment fixture.

5.1.3 *Attachment Fixtures*—Self-aligning type fixtures for holding a specimen between the fixed member and the movable member. Ensure that the fixtures are attached to the fixed and movable members in such a way that they will move into alignment as soon as load is applied, so that the long axis of the test specimen will coincide with the direction of the applied load. A design for fixtures that has proven satisfactory is shown in Fig. 1 and Fig. 2.

5.2 *Conditioning Room or Desiccators*—A conditioning room capable of maintaining a relative humidity of 50 ± 2% at 23 ± 1°C (73.4 ± 1.8°F) or desiccators containing a saturated salt solution (Note 2) to give the same relative humidity and temperature.

NOTE 2—A saturated salt solution of calcium nitrate will give approximately 51 % relative humidity at 24.5°C (see Practice E 104).

[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 15.06.

[3] *Annual Book of ASTM Standards*, Vol 03.01.

[4] *Annual Book of ASTM Standards*, Vol 11.03.

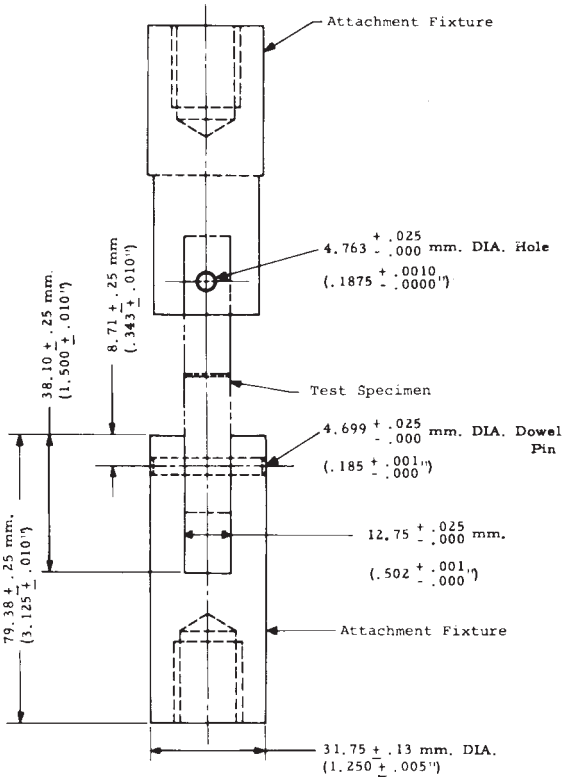

FIG. 1 Test Specimens and Attachment Fixtures

6. Test Specimens

6.1 *Description and Preparation*—Bar- or rod-type specimens. Refer to Practice D 2094 for the design of the specimens and the procedures used in preparing them.

6.2 *Number of Specimens*—Test a minimum of five specimens for each test condition.

7. Conditioning

7.1 Condition all specimens, except those in which both adherends are metals, prior to testing for at least 40 h at 50 ± 1°C (73.4 ± 1.8°F). Metal-to-metal bonds can be tested as soon as the specimen has reached an equilibrium temperature of 23 ± 1°C (73.4 ± 1.8°F) after curing.

7.2 Special conditioning procedures may be used by agreement between the purchaser and the manufacturer when the tensile strength of the adhesive at other conditions is to be determined.

8. Procedure

8.1 Place the specimen in the testing machine (see Fig. 2), using steel dowel pins and fixtures such as those described in 5.1.3 and start the loading. Conduct tests at other than room temperature with a suitable temperature-controlled test chamber enclosing the fixtures and test specimen while assembled in the testing machine.

8.2 *Speed of Testing*—Apply the load to the specimen at the rate of 17 to 20 MPa/cm^2 (2400 to 2800 psi) of bond area per min, or, if rate of loading is measured as crosshead motion, set the testing machine to obtain the foregoing rate of loading.

8.3 *Record*—Record the maximum load carried by the specimen at failure. Estimate the percentage cohesion failure, adhesion failure, contact failure, and adherend failure on the basis of bond area by visual inspection and record. If dissimilar adherends are used, estimate and record the percentage adhesion failure for each material. Discard specimens that break at some obvious flaw and retest, unless such flaws constitute a variable the effect of which it is desired to study.

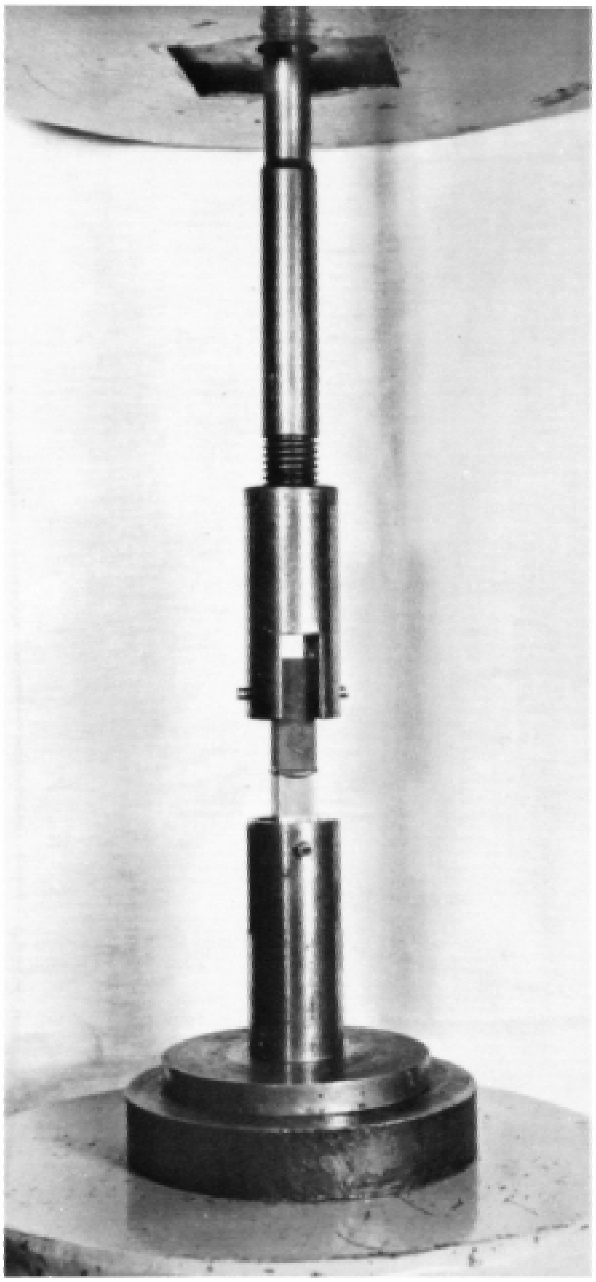

FIG. 2 Test Specimen with Attachment Fixtures Assembled in Tension Testing Machine

9. Calculation

9.1 Calculate the tensile strength by dividing the breaking load by the area of the bonded surface. Express this result in megapascals per square centimetre (pounds per square inch) and, if possible, report to three significant figures.

9.2 For each series of tests, calculate the arithmetic mean of

all values obtained and report this value as the average tensile strength.

9.3 If it is desired to determine the standard deviation and coefficient of variation, calculate these values as follows and report to two significant figures:

$$s = \sqrt{(\Sigma X^2 - n\bar{X}^2)/(n-1)}$$

$$v = 100 s / \bar{X}$$

where:

s = estimated standard deviation,
X = value of a single observation,
n = number of observations,
$\bar{X}$ = arithmetic mean of the set of observations, and
v = estimated coefficient of variation.

10. Report

10.1 Report the following information:

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

10.1.2 Identification of materials used as adherends and method of surface preparation used,

10.1.3 Type of specimen (rod or bar) used and dimensions of inserted sheet material, if any,

10.1.4 Method of application of adhesive and drying, precure, and cure conditions used,

10.1.5 Average thickness of adhesive layer after formation of the joint, within 0.025 mm (0.001 in.). Describe the method of obtaining the thickness of the adhesive layer including procedure, location of measurements, and range of measurements,

10.1.6 Whether or not flash was removed and method employed, if any,

10.1.7 Conditioning procedure used,

10.1.8 Test room conditions and temperature of specimens at time of test,

10.1.9 Number of specimens tested,

10.1.10 Speed of testing, and

10.1.11 An average value of the tensile strength. Also, an average value of the percentage of each type of failure, that is, adhesion, cohesion, contact, or adherend failure.

11. Precision and Bias

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