Designation: D4562 – 01 (Reapproved 2013)

Standard Test Method for Shear Strength of Adhesives Using Pin-and-Collar Specimen[1]

This standard is issued under the fixed designation D4562; 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.

1. Scope

1.1 This test method covers the determination of the shear strength of curing liquid adhesives used for retaining cylindrical assemblies or for locking and sealing threaded fasteners.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A108 Specification for Steel Bar, Carbon and Alloy, Cold-Finished

D907 Terminology of Adhesives

D2651 Guide for Preparation of Metal Surfaces for Adhesive Bonding

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 of the terms in this standard are defined in Terminology D907.

4. Summary of Test Method

4.1 This test method consists of bonding a metal pin inside a metal collar and determining the force required to shear the adhesive joint.

5. Significance and Use

5.1 This test method provides reasonably accurate information with regard to the ability of an adhesive to withstand shearing forces. It may also be used to determine degree of cure and the effect of environment on shear strength.

6. Apparatus

6.1 *Universal Test Machine,* or equivalent, for applying force to the specimen. Details of the test specimen (pin-and-collar) are given in Fig. 1.

6.2 *Specimen Curing Rack,* as shown in Fig. 2, or equivalent.

7. Preparation of Test Specimens

7.1 Assemble five specimens for each test as described in the following paragraphs:

7.1.1 Each specimen is comprised of a pin 0.498 to 0.499 in. (12.65 to 12.675 mm) in diameter and a slip collar 0.500 to 0.501 in. (12.7 to 12.725 mm) inside diameter by 0.435 to 0.439 in. (11.05 to 11.15 mm) wide, both components finished to 32 to 64 µin (0.8 to 1.6 µm) with 0.001 to 0.003 in. (0.025 to 0.075 mm) diametrical clearance between the pin and collar (see Fig. 1). The pin and collar, by agreement, may be made of any material (see Appendix X1), but the most common material is steel, as specified in Specification A108.

7.1.2 Degrease all pins and collars (refer to Guide D2651), store in an atmosphere of low humidity (20 % relative humidity), and keep them clean. Use degreased specimens within four days or discard. (Oxidation affects the test results after this time. Prior to vapor degreasing, it is permissible to soak or wash hard-greased or waxed parts in solvent.) Do not prime or activate unless specified for the material to be tested.

7.1.3 To apply the adhesive, assemble the parts to be sure that there are no nicks that will cause them to stick or drag. Disassemble the parts. Apply sufficient adhesive to the circumference of the pin, beginning at one end, to completely cover an

[1] This test method is under the jurisdiction of ASTM Committee D14 on Adhesives and is the direct responsibility of Subcommittee D14.60 on Adhesive Material Classification System.

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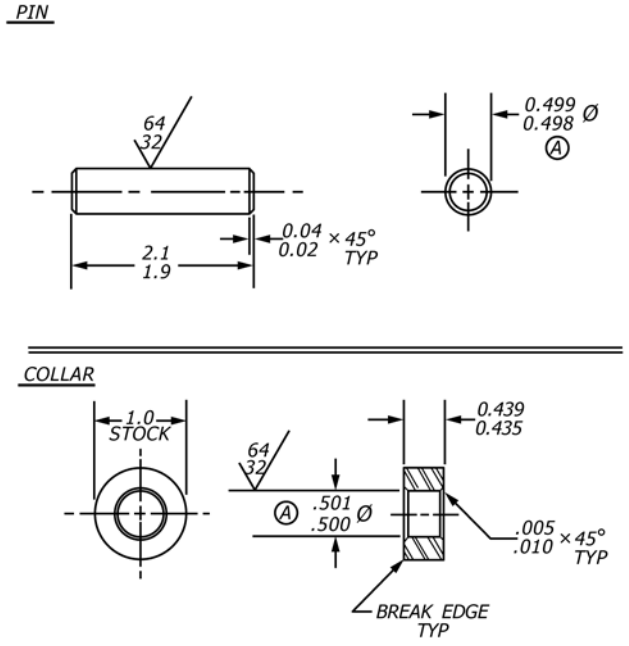
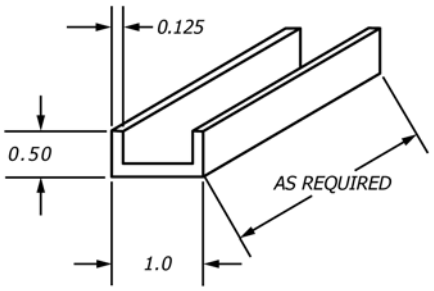
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.



NOTE 1 — ALL DIMENSIONS ARE IN INCHES
NOTE 2 — MATERIAL : AISI 12L14 OR UNSG 12144
NOTE 3 — DIMENSIONS MARKED "A" TO HAVE A CLEARANCE OF .001 TO .003

FIG. 1 Pin-and-Collar Assembly



NOTE 1 — MATERIAL: EXTRUDED SHARP CORNER ALUM. CHANNEL
NOTE 2 — BREAK SHARP EDGES
NOTE 3 — ALL DIMENSIONS ARE IN INCHES
NOTE 4 — CAN BE PURCHASED AS SHARP CORNER STANDARD CHANNEL

FIG. 2 Specimen Rack

area the width of the collar in its final position. Also apply sufficient adhesive to completely cover the interior of the collar 360°. Slip the collar over the coated end of the pin with at least 180° of rotation as the collar travels over the adhesive. Repeat a back-and-forth rotation three times, or until the collar exhibits a smooth, consistent resistance to rotation.

7.1.4 Rack the assembly with the fillet up so that the collar does not slip out of the bond area. Take care that the rack is at the required temperature and do not place onto a hot or cold surface. There should be excess material on the leading edge of the collar; if not, apply sufficient adhesive to create a fillet.

7.1.5 Cure the specimens in accordance with the manufacturer's instructions.

7.1.5.1 For primed or activated surfaces, when specified or recommended, use the manufacturer's primer. Apply the

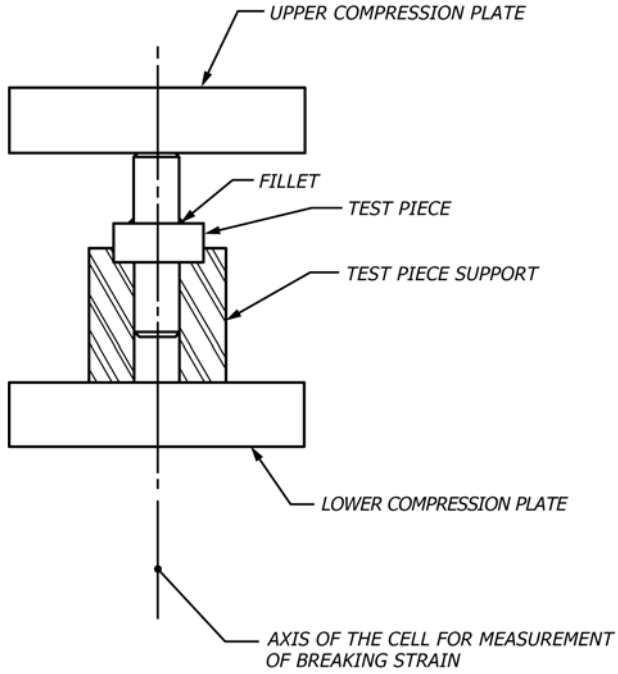


FIG. 3 Test Device

primer and adhesive according to the manufacturer's instructions. Assemble and cure the specimens for a time and temperature in accordance with the manufacturer's recommendation.

8. Procedure

8.1 After allowing for cure and any planned environmental conditioning, determine the static shear strength as follows:

8.1.1 Place the pin and collar assembly on the universal test machine as shown in Fig. 3. Load the specimen smoothly at about 500 lb/s (2200 N/s) using a free crosshead speed of 0.05 in./min (1.3 mm/min). Record the maximum load in pounds (Newtons). Calculate the static shear strength by dividing the breakaway load by the bond area as follows:

$$\text{Shear Strength} = \text{Maximum Load/Diameter} \times 3.14 \times \text{Width}$$

9. Report

9.1 Report the following information:

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

9.1.2 Complete identification of the metal used 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 Conditioning procedure used for specimens prior to testing.

9.1.5 Number of specimens tested.

9.1.6 Maximum, minimum, and average values for failing load, and shear strength.

10. Precision and Bias

10.1 *Precision*—An interlaboratory study of the shear strength of anaerobic adhesives was run in 1989. Each of six

laboratories tested ten test specimens from each of six adhesives ranging in viscosity from 125 to 2000 cP. Relative humidity was controlled between 48 and 62 % at 72 to 76°F, and all samples were cured for 24 h. All shear strengths were obtained by dividing maximum loads by a nominal bond area of 0.69 in^2. Practice E691 was followed for the design and analysis of the data. The following repeatability and reproducibility limits were obtained for each of the six materials as a result of the interlaboratory study:

Adhesive	Shear Strength, psi	95 % limit, psi	
		Repeatability	Reproducibility
E	2742	703	977
F	3320	778	1008
C	3377	930	1022
A	3630	862	1005
D	3717	1341	2134
B	4006	778	1126

The above terms repeatability limit and reproducibility limit are used as specified in Practice E177. The respective standard deviations among test results may be obtained by dividing columns 3 and 4 by 2.8.

10.2 *Bias*—Since there is no accepted reference material, method, or laboratory suitable for determining the bias for the procedure in this test method for measuring shear strength of adhesives, no statement on bias is being made.

11. Keywords

11.1 pin and collar; shear strength

APPENDIX

(Nonmandatory Information)

X1. SPECIMEN MATERIALS

X1.1 Specimens may be made of other materials or with finishes other than steel. Mixing of materials is not recommended unless the results of differential thermal expansion are specifically desired. Some material and finish standards are as follows:

X1.1.1 *ASTM Standard:* B633 Specification for Electrodeposited Coatings of Zinc on Iron and Steel[2]

X1.1.2 *Federal Specifications:*[3]QQ-A-250/4 Aluminum Alloy 2024, Plate and Sheet

QQ-B-613 Brass, Leaded and Nonleaded: Flat Products (Plate, Bar, Sheet, and Strip)

QQ-P416 Plating, Cadmium (Electrodeposited)

QQ-A-200/4 Aluminum Alloy 5083, Bar, Rod, Shapes, Tube and Wire, Extruded

QQ-A-200/5 Aluminum Alloy 5006, Bar, Rod, Shapes, Tube and Wire, Extruded

QQ-A-200/6 Aluminum Alloy 5454, Bar, Rod, Shapes, Tube and Wire, Extruded

QQ-A-200/7 Aluminum Alloy 5456, Bar, Rod, Shapes, Tube and Wire, Extruded

QQ-A-200/8 Aluminum Alloy 6061, Bar, Rod, Shapes, Tube and Wire, Extruded

QQ-A-200/15 Aluminum Alloy, Bar, Rod, and Shapes, Extruded. 7075-76 (Improved Exfoliation Resistant)

QQ-S-763 Steel Bars, Wire Shapes, and Forgings, Corrosion-Resisting

TT-C-490 Cleaning Method and Pretreatment of Ferrous Surfaces for Organic Coatings

X1.1.3 *Military Specification:*[3]MIL-A-8625—Anodic Coatings for Aluminum and Aluminum Alloys

X1.1.4 *Society of Automotive Engineers (SAE) Aeronautical Materials Specification:*[4]AMS 4935 Titanium Alloy Extrusions and Flash Welded Rings, 6A1–4V Annealed, Beta Processed

[3] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://www.dodssp.daps.mil.

[4] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.