Designation: B 565 – 04

Standard Test Method for Shear Testing of Aluminum and Aluminum-Alloy Rivets and Cold-Heading Wire and Rods[1]

This standard is issued under the fixed designation B 565; 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 Department of Defense.

1. Scope*

1.1 This test method covers the double shear testing of aluminum and aluminum alloy rivets with round, solid shanks and cold-heading wire and rod.[2]

NOTE 1—Exceptions to this test method may be necessary in individual specifications or methods for tests for a particular material.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parenthesis are mathematical conversions to SI units which 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 The latest issues of the following documents form a part of this standard to the extent referenced herein:

2.2 *ASTM Standards:* [3]

B 316/B 316M Specification for Aluminum and Aluminum-Alloy Rivet and Cold-Heading Wire and Rods

B 769 Test Method for Shear Testing of Aluminum Alloys

B 831 Test Method for Shear Testing of Thin Aluminum Alloy Products

E 4 Practices for Force Verification of Testing Machines

E 6 Terminology Relating to Methods of Mechanical Testing

3. Terminology

3.1 *General*—The definitions of terms relating to shear testing in Terminology E 6 are applicable to the terms used in this test method.

4. Summary of Test Method

4.1 The test consists of subjecting a length of wire or rod or a rivet in full cross section, or a machined length of rod or rivet, to double-shear loading, with a suitable test device in a tension testing machine, and determining the shear stress required to fracture the specimen (that is, the shear strength).

5. Significance and Use

5.1 This test method is intended solely for the shear testing of rivets and cold-heading wire and rod, and is not generally recommended for the determination of the shear strength of other products. For rivets, this method is limited to rivets having a shank length equal to or greater than 2*d*.

NOTE 2—The results of shear tests of specimens machined from products other than wire, rod, and rivets may be greatly dependent upon the orientation of the specimen within the original test material, and the direction in which the force is applied relative to the grain flow in the specimen.[4] It is recommended that shear strengths of other products be determined by Test Method B 769 for products greater than 0.250 in. (6.4 mm) and Test Method B 831 for products less than 0.250 in. (6.4 mm). Shear strengths developed by this test method have been shown to vary from those developed by other methods.[4] If Test Method B 565 is used for shear testing of other products, variables such as those described in Test Method B 769 should be identified and controlled.

5.2 The results of shear tests are dependent upon the relative and absolute lengths of specimen which are sheared out, and those which are supported.[4] The results of tests made in accordance with this method should not be directly compared with those determined in other types of tests in which the methods of loading and supporting the specimen are different.

[1] This test method is under the jurisdiction of ASTM Committee B07 on Light Metals and Alloys , and is under the jurisdiction of Subcommittee B07.05 on Testing.

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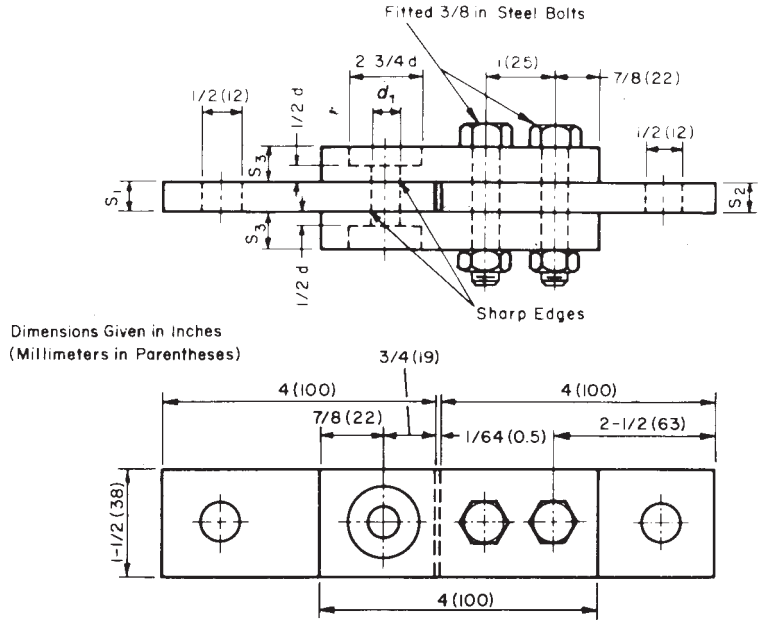
[2] This product is covered by Specification B 316/B 316M.

[3] 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.

[4] Kaufman, J. G., and Davies, R. E. "Effects of Test Method and Specimen Orientation on Shear Strengths of Aluminum Alloys," *ASTM Proceedings,* ASTEA, Am. Soc. Testing Mats., Vol 64, 1964.

***A Summary of Changes section appears at the end of this standard.**



d = nominal diameter of specimen (rivet, wire, or machined specimen),
d_1 = actual diameter of hole (see Note), and
d_2 = actual diameter of specimen
Clearance ($d_1 - d_2$), maximum = 0.02 d + 0.005 in. (0.12 mm)
Note—The tolerance applicable to the diameter of the specimen being shear tested must be recognized in drilling the hole in the device. It is recommended that the drilled hole size be equal to 1.02 d plus 0.005 in. (0.12 mm) less the minus tolerance applicable to the specimen.

$S_1 = d$
$S_2 = S_1$ + 0.001 in. (0.025 mm)
S_3 = ¼ in. (6 mm) for d = 1⁄16 in. (1.5 mm) to 5⁄32 in. (4 mm)
= ½ in. (12 mm) for d = 3⁄16 in. (5 mm) to ⅜ in. (10 mm)

FIG. 1 Shear Test Device

5.3 The presence of a lubricant on the surfaces of the specimen and device may result in shear strengths up to 3 % lower than those determined in the absence of lubrication.

NOTE 3—In order to be able to test rivets having shanks as short as 2d, the supported lengths of the specimen are ½ d (Fig. 1), although it is recognized that higher values of shear strength would be obtained if the supporting lengths were longer.

5.4 Investigations have determined that the shear strength decreases slightly as the clearance between the specimen diameter and the diameter of the test hole in the device increases, and that the effect of the clearance decreases with increasing specimen diameter. This test method (refer to Fig. 1) permits clearances for production testing which should affect shear strengths by no more than 2 %. For referee testing, the maximum clearance shall be 0.001 in. (0.03 mm).[5]

6. Apparatus

6.1 *Testing Machines*—The testing machine shall conform to the requirements as defined in Practices E 4. The forces used to determine the shear strength shall be within the range of the testing machine as defined as Practices E 4.

6.2 *Shear Test Device*—A shear device of the type shown in Fig. 1 shall be used. It shall be made of hardened steel having a hardness of not less than 52 HRC and the shearing edges of the holes shall have a radius of no more than 0.0005 in. (0.013 mm). To minimize the possible effect of distortion of the device under force, fitted machined steel bolts shall be used to hold the components together. The mating surfaces between the tongue and clevises shall be polished and shall have a finish of 16 µin. Ra or better.

7. Test Specimens

7.1 Specimens shall consist of round, solid rivets or short lengths of wire, either in full cross section or machined to a smaller diameter. The minimum length of the specimen shall be twice its diameter. The maximum length is not specified as it has no effect on the results of the test.

7.2 For diameters up to and including 0.372 in. (9.45 mm), the specimens shall be the full cross section of the rivet shank or wire, except that the rivet shank or wire may be reduced up to 30 % in area by machining to accommodate the device size. In the case of wire, rod, or rivets over 0.372-in. (9.45-mm)

[5] Fenn, R. W., Jr. and Clapper, R. B. "Evaluation of Test Variables in the Determination of Shear Strength," *ASTM Proceedings*, ASTEA, Am. Soc. Testing Mats., Vol 56, 1956.

diameter, it is permissible to turn down to 0.372-in. (9.45-mm) diameter for testing. The machined finish shall be 32 µin. Ra or better.

7.3 The maximum clearance between the specimen diameter and the diameter of the test hole in the device shall not exceed that allowed in Fig. 1.

8. Test Specimen Measurement

8.1 Measure the diameter of the specimen to the nearest 0.001 in. (0.03 mm) for test specimens equal to or greater than 0.1 in. (2.5 mm) in diameter, and to the nearest 0.0005 in. (0.013 mm) for test specimens less than 0.1 in. (2.5 mm) in diameter.

9. Procedure

9.1 The mating surfaces of the shear fixture should be visually inspected before use for aluminum buildup around the test holes. Removal of the aluminum buildup can be accomplished with crocus cloth or soaking the test device in a caustic soda solution followed by a water rinse and drying. Before referee testing, the test device should be cleaned in the above manner followed by procedures in 9.2.

9.2 Since lubrication may have an effect on results (see 5.3), clean the specimens and test device before referee testing (for example, clean ultrasonically in a suitable solvent) and take care to avoid touching the specimen and test-hole area of the shear device with the hands after cleaning.

9.3 Place the specimen in the shear test device, assemble as in Fig. 1, and apply force at a uniform rate until complete failure occurs.

9.4 The cross-head speed during the test shall not exceed ¾ in. (19.1 mm)/min and the loading rate shall not exceed 100 ksi (689 MPa)/min on the double-shear test cross section.

9.5 Determine the maximum force to fracture the specimen.

10. Calculations of Shear Strength

10.1 Calculate the shear strength from the maximum force as follows:

$$S = \tfrac{1}{2}P_{max}/A = \tfrac{1}{2}P_{max}/(\pi D^2/4) = 2P_{max}/\pi D^2 \quad (1)$$

where:

S = the shear strength, psi (or MPa),
P_{max} = the maximum force in the test, lbf (or N), and
D = the measured diameter of the specimen, in. (or mm).

11. Report

11.1 The report shall include the following for each specimen tested:

11.1.1 The ASTM shear test method.

NOTE 4—In view of the influence of test methods on shear test results as indicated in 5.2, it is important to reference the ASTM test method in reporting results.

11.1.2 Material and sample identification.
11.1.3 Specimen diameter, in. (or mm).
11.1.4 Maximum force, lbf (or N).
11.1.5 Shear strength, ksi (or MPa).
11.1.6 Test temperature, °F (°C).

NOTE 5—For metric equivalents:

1 in = 25.4 mm
1lbf = 4.448 N
1 ksi = 6.89 MN/m^2 (MPa)

12. Precision and Bias

12.1 The precision and bias of this test method needs to be established. Subcommittee B07.05 is developing the precision and bias statements for this test method.

13. Keywords

13.1 double shear loading; shear test device; shear aluminum rivet

SUMMARY OF CHANGES

Committee B07 has identified the locations of selected changes to this standard since the last issue (B 565 – 94 (2000)) that may impact its use.

(*1*) Created 1.2 for the values statement.
(*2*) Replaced the designation “AA” with “Ra” (Roughness average) in 6.2 and 7.2.
(*3*) Reordered the procedural steps in Section 9
(*4*) Added Section 12 on Precision and Bias.
(*5*) Replaced the word “load” with “force” throughout the standard.
(*6*) Replaced the words “jig,” “grips,” and “fixture” with “device” throughout the standard.