**Designation: B 831 – 93 (Reapproved 1998)**

AMERICAN SOCIETY FOR TESTING AND MATERIALS
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# Standard Test Method for Shear Testing of Thin Aluminum Alloy Products[1]

This standard is issued under the fixed designation B 831; 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 single shear testing of thin wrought and cast aluminum alloy products to determine shear ultimate strengths.

1.2 The values stated in inch-pound units are to be regarded as the standard. The SI values given in parentheses are provided 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 The following documents of the issue in effect on the date of material purchase, unless otherwise noted, form a part of this specification to the extent referenced herein:

2.2 *ASTM Standards:*

B 565 Test Method for Shear Testing of Aluminum and Aluminum-Alloy Rivets and Cold-Heading Wire and Rods[2]

B 769 Test Method for Shear Testing of Aluminum Alloys[2]

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

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

## 3. Terminology

3.1 *Definitions*—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 This test method consists of subjecting a full thickness or machined rectangular test specimen to single shear loading to failure in a test fixture using a tension testing machine. The shear strength is calculated from the maximum load required to fracture the specimen.

## 5. Significance and Use

5.1 The intent of this test method is to provide a means of measuring the ultimate shear strength of thin aluminum alloy wrought and cast products. Data obtained by this test method are used to calculate minimum properties that can be utilized in the design of structural members such as found in aircraft. It is recognized that the loading conditions developed by this test method, and by most others, are not ideal in that they do not strictly satisfy the definitions of pure shear. However, rarely do pure shear conditions exist in structures.

NOTE 1—This test method is not interchangeable with that described in Methods B 565 and B 769. Shear strengths obtained by this test method have been shown to vary from those developed by the other methods.[4]

## 6. Apparatus

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

6.2 *Loading Device*:

6.2.1 The loading device shall be of the type shown in Fig. 1 and shall be made of a hardened steel.

## 7. Test Specimens

7.1 The specimen size shall be 1½ in. (38.1 mm) wide by 4½ in. (114 mm) long. The specimen thickness shall be full thickness 0.250 in. under (6.4 mm). The minimum specimen thickness will be dictated by the material's ability to resist buckling around the pin hole area during testing. The specimen is shown in Fig. 2.

7.2 The test area to be sheared shall be centered within ± 0.001 in. (0.025 mm) of the loadline of the specimen.

7.3 Measurement of the thickness and length of the area to be sheared shall be made as follows:

7.3.1 Measurement of the specimen thickness shall be made at a location between the two slots machined into the specimen. Measurement of the length of the shear area shall be between the ends of the slots machined into the specimen, Fig. 2. For dimensions 0.200 in. (5.1 mm) and over, measure to the nearest 0.001 in. (0.025 mm). For dimensions less than 0.200 in. (5.1 mm) and not less than 0.100 in. (2.5 mm), measure to the nearest 0.0005 in. (0.013 mm). For dimensions less than 0.100 in. (2.5 mm), measure to the nearest 0.0001 in. (0.0025 mm).

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[1] This test method is under the jurisdiction of ASTM B-7 on Light Metals and Alloys and is the direct responsibility of Subcommittee B07.05 on Testing.
Current edition approved Jan. 15, 1993. Published March 1993.

[2] *Annual Book of ASTM Standards*, Vol 02.02.

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

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

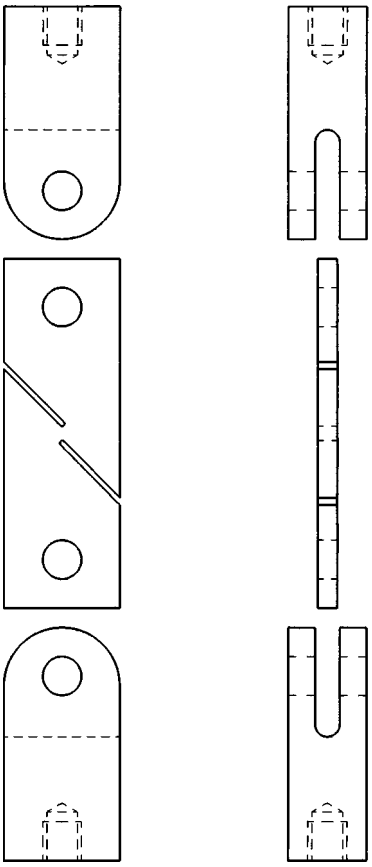

**FIG. 1 Slotted Single Shear Test Fixture**

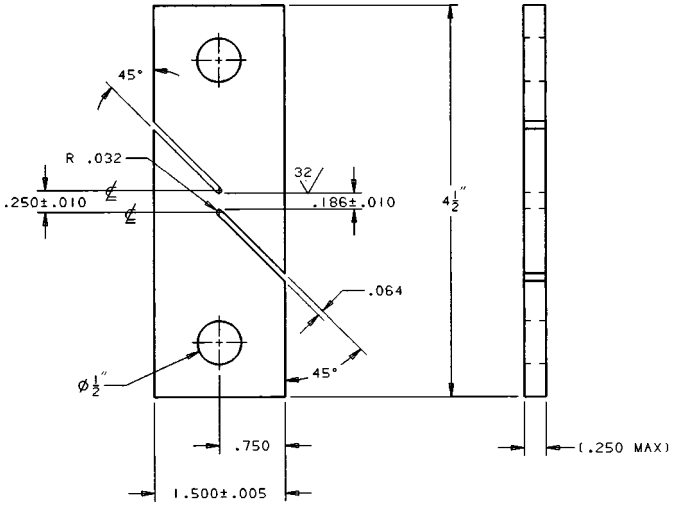


**FIG. 2 Slotted Single Shear Test Specimen**

NOTE 2—**Caution:** Measurements of dimensions presume smooth surface finishes for the specimens. Rough surfaces due to the manufacturing process such as hot rolling, metallic coating, etc., may lead to inaccuracy of the computed areas greater than the measured dimensions would indicate. Therefore, cross sectional dimensions of shear test specimens with rough surfaces due to processing may be measured and recorded to the nearest 0.001 in. (0.025 mm).

7.4 All machined surfaces in the test area shall have a surface finish of 32 in. (AA) or better.

## 8. Precision Orientation and Direction

8.1 The shear strength of wrought aluminum materials usually depends on the specimen orientation and the direction in which the load is applied relative to the grain flow in the specimen.[4] The specimen orientation and the loading direction should be identified by the following systems.

8.1.1 The reference directions for rectangular shapes are indicated in Fig. 3. These are suitable for sheet, plate, extrusions, forgings, and other shapes of nonsymmetrical grain flow.

8.2 The three letter code is used in Fig. 3 to describe the specimen orientations and loading directions. The first two letters designate the grain orientations making up the shear plane, the third letter designates the direction of loading. The most commonly used specimen orientations and loading directions are LS-L and TS-T for thin products.

NOTE 3—Typically, cast aluminum products do not exhibit the directionality of wrought products; therefore, the orientation codes are not applicable to castings.

## 9. Procedure

9.1 *Measurement of Specimens*—Measure the applicable dimensions designated in 7.3 and calculate the cross-sectional area by multiplying the two dimensions.

9.2 *Testing*—Mount the specimen in the test fixture as shown in Fig. 1. The specimen should not be restrained by clamping of the load pin area during the test.

9.2.1 When assembling the loading train (clevises and their attachments to the testing machine), take care to minimize eccentricity of loading due to misalignments external to the clevises. To obtain satisfactory alignment, keep the centerline of the upper and lower loading rods coincident within 0.03 in. (0.76 mm) during the test.

9.2.2 The cross head speed of the testing machine shall not exceed 0.75 in./min (19.1 mm/min) and the loading rate shall not exceed 100 ksi/min (689 MPa/min) on the cross-section. The loading rate to failure should be uniform.

9.2.3 Determine the maximum load to fracture the specimen.

## 10. Calculation

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

$$S = P_{max}/A \quad (1)$$

where:

$S$ = shear strength, psi (MPa),
$P_{max}$ = maximum load, lbf (N), and
$A$ = cross-sectional area (thickness times length), in.$^2$ ( mm$^2$).

## 11. Report

11.1 Report the following information:

11.1.1 ASTM method of shear test,

NOTE 4—Since the test method significantly influences the test results, it is essential that the ASTM method be referenced.

11.1.2 Material and sample identification,

11.1.3 Specimen dimensions, in inches (millimetres),

11.1.4 Specimen orientation and loading direction,

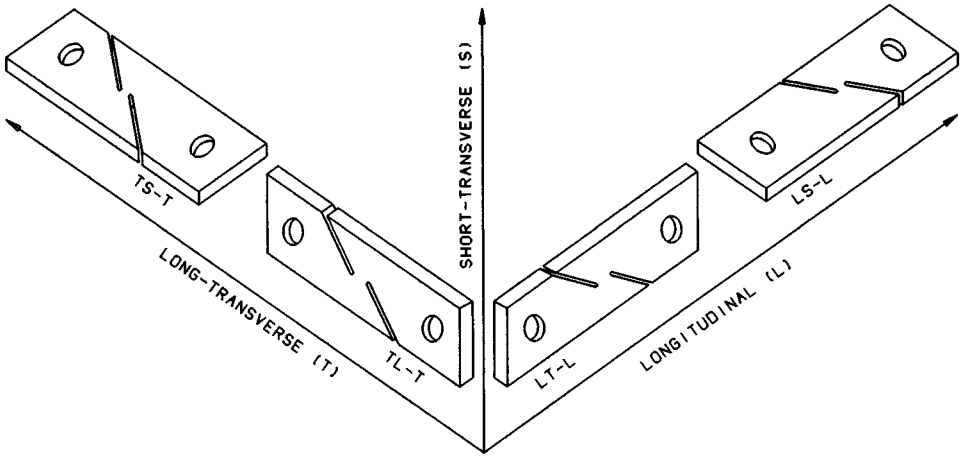


**FIG. 3 Grain Orientations and Loading Directions for Slotted Single Shear Specimens from Rectangular Shapes**

11.1.5 Maximum load, in pounds force (newtons),

11.1.6 Shear strength, in pounds per square inch (or megapascals), and

11.1.7 Test temperature, if other than room temperature, in degrees Fahrenheit (Celcius).

## 12. Precision and Bias

12.1 The precision and bias of this test method needs to be established. Subcommittee B7.05 is developing the precision and bias statements for this test method.

## 13. Keywords

13.1 aluminum; mechanical test; shear; strength