Designation: F734 − 17 (Reapproved 2022)

Standard Test Method for Shear Strength of Fusion Bonded Polycarbonate Aerospace Glazing Material[1]

This standard is issued under the fixed designation F734; 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 determines the shear yield strength F_{sy} and shear ultimate strength F_{su} of fusion bonds in polycarbonate by applying torsional shear loads to the fusion-bond line.

1.2 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]
D618 Practice for Conditioning Plastics for Testing

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *fusion bond, n*—the bonding of two pieces of the same material using heat and pressure.

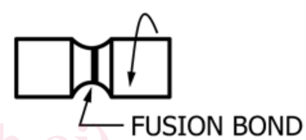
3.1.2 *shear, n*—internal force tangential to the section on which it acts.

3.1.3 *shear strength, n*—the maximum allowable stress in a body resulting from forces which tend to cause two contiguous parts of the body to slide relative to each other in a direction parallel to their plane of contact.

3.1.4 *torsional shear fixture, n*—a device used to apply a shear force in the circular section of the test specimen to produce a peripherally uniform stress distribution.

4. Summary of Test Method

4.1 Test specimens are prepared with a fusion bond at the center of a polycarbonate laminate joined to two metal test blocks. A twisting action is applied to one block and the load required to fracture the fusion bond is transformed into the torsional shear strength of the fusion bond.



5. Significance and Use

5.1 At this writing, aerospace quality extruded transparent polycarbonate material is not available in thicknesses greater than 0.5 in. (12.7 mm). When a requirement exists for sheets thicker than 0.5 in. (12.7 mm), two or more sheets are fusion bonded together to form a single sheet of the desired thickness.

5.2 The structural integrity of the completed transparency depends on the integrity of the fusion bond. This test applies torsional shear loads to measure the structural integrity of the fusion bond. This test method is considered more reliable and more reproducible than shear tests in tension or compression.

6. Apparatus

NOTE 1—A standard torsional test machine is a suitable substitute for the apparatus described in this section. The machine shall have variable angular displacement rates from 8 to 800°/min. (0.14 to 14 rad/min.). If a torsional test machine is used, the calibration and standardization in Section 8 shall be disregarded.

6.1 *Torsional Shear Fixture*—Illustrations of the fixture are shown in Figs. 1 and 2.

6.2 *Calibration Load Arm*—A lever arm with a load pan shall be provided for purposes of calibrating the torsional shear apparatus.

6.3 *Universal Testing Machine*—An autographically recording universal tensile testing machine shall be used to apply a

[1] This test method is under the jurisdiction of ASTM Committee F07 on Aerospace and Aircraft and is the direct responsibility of Subcommittee F07.08 on Transparent Enclosures and Materials.

Current edition approved May 1, 2022. Published June 2022. Originally approved in 1981. Last previous edition approved in 2017 as F734 – 17. DOI: 10.1520/F0734-17R22.

[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.

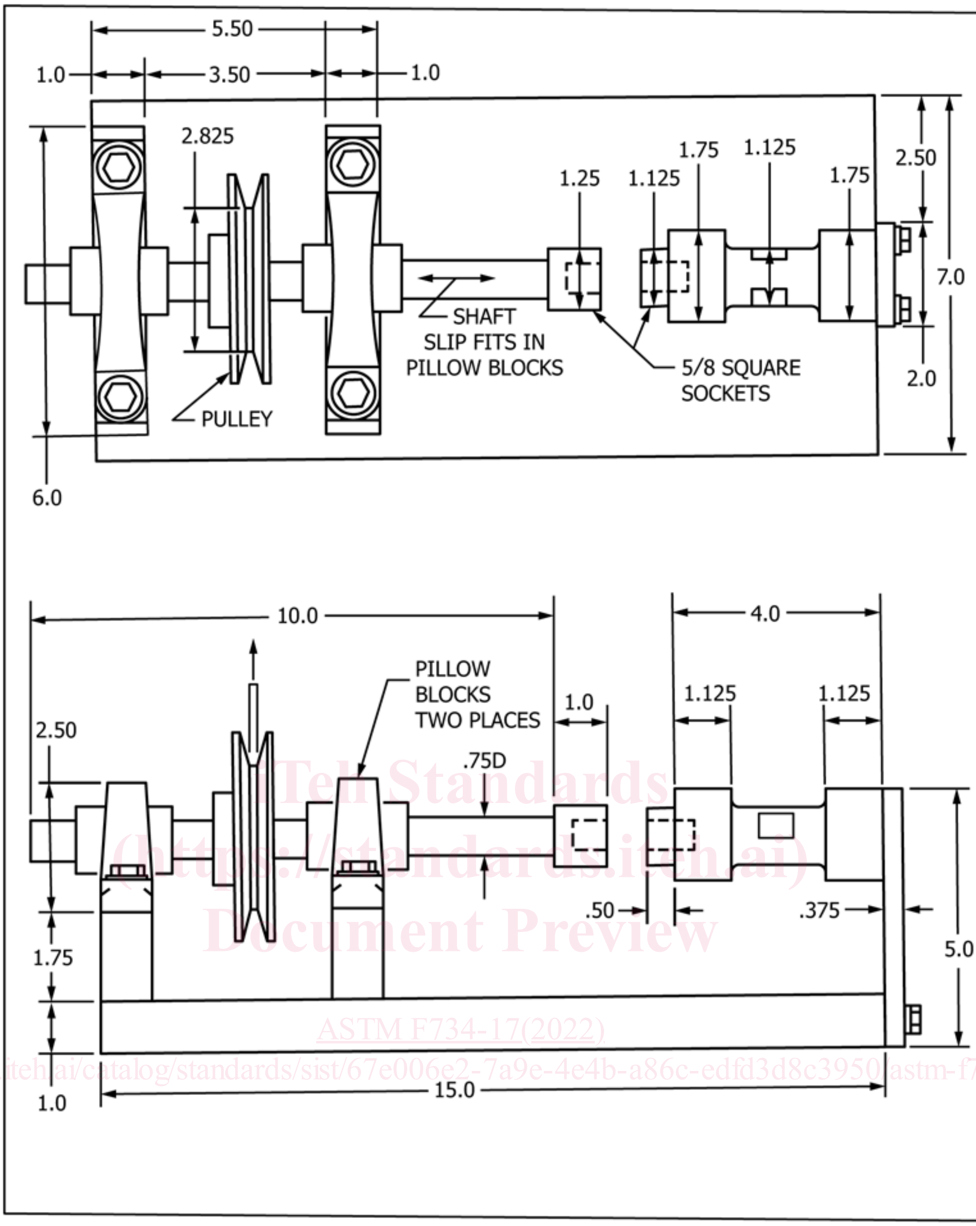


FIG. 1 Torsional Shear Test Fixture (All Dimensions in Inches)

constant rate of rotation to the torsional shear fixture by means of the loading cable. The machine shall have variable cross-head rates (from 0.2 in./min [5.08 mm/min] to 20 in./min [508 mm/min.]), and a calibrated load measurement mechanism usable in a range from 0 to 200 lb (0 to 90 kg) in tension.

6.4 *Calibrated Spring Scales,* 0 to 10 lb (4.54 kg) ± 1 %, are required for calibration purposes.

7. Test Specimens and Sample

7.1 Machine test specimens to the geometry shown in Fig. 3. Machine specimens at less than 1-m (3.28-ft)/s surface velocity to avoid heat buildup during machining. Position the groove such that the fusion bond lies at the minimum diameter of the groove. The groove shall have a 125-µin. (3-µm) finish.

7.2 Test a minimum of five specimens from each fusion bonded sheet. Sheets with multiple fusion bonds shall have five test specimens tested for each fusion bond interface.

8. Calibration and Standardization

8.1 Attach the torsional shear fixture securely to the base of the test machine.

8.2 Attach the calibration load arm to the rotatable shaft and tighten screw to preclude slippage. See Fig. 4.

8.3 Determine the equivalent weight of the calibrating arm at the load pan with no torsional resistance in the apparatus and with the load arm level. This load is L_0.

8.4 Measure the lever arm, *D*, in inches to ±1 % accuracy between the shaft center and the load pan pivot point.

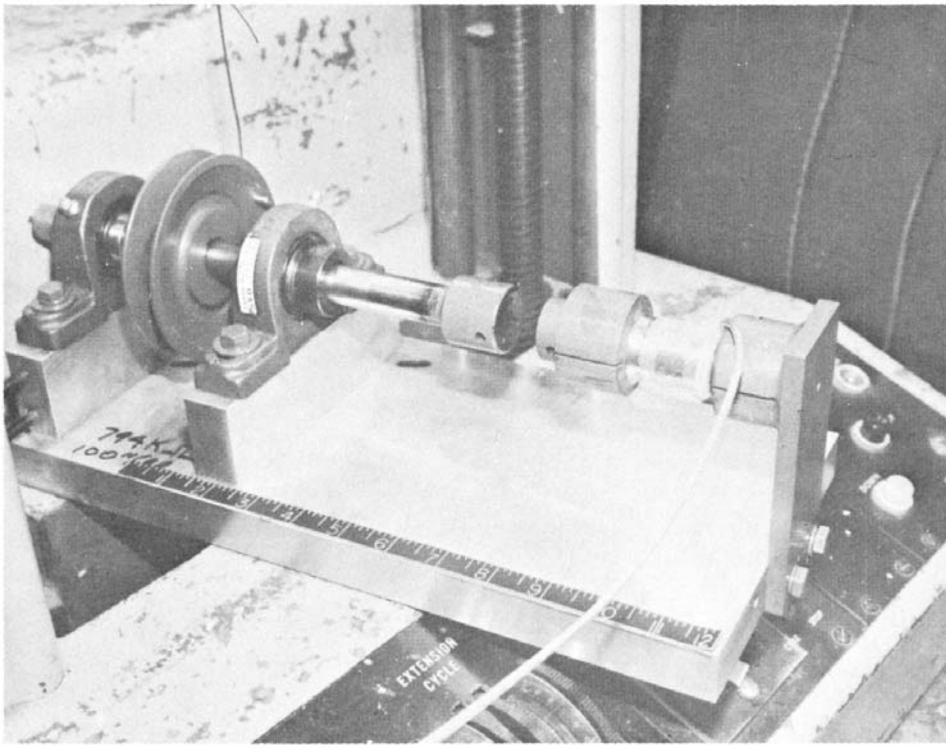


FIG. 2 Torsional Shear Test Fixture

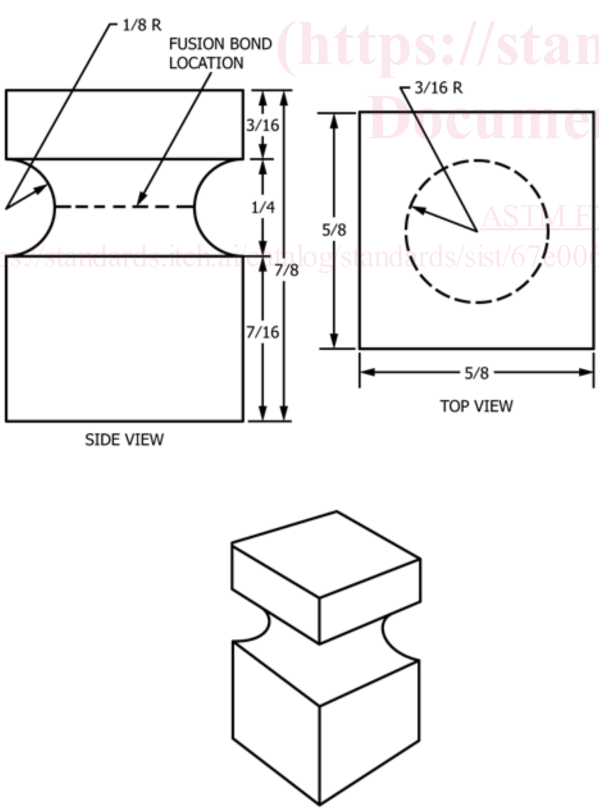


FIG. 3 Torsional Shear Test Specimen

8.5 Calculate $L_1 = (200/D) - L_0$.

8.6 Attach the loading cable to the testing machine load-weighing mechanism.

8.7 Place a weight equal to L_1 in the calibrating arm load pan and note reading L_2 on the testing machine weighing mechanism; L_2 is equivalent to 200 in. lb (22.6 N-m) of torque. Calculate a conversion factor K, $K = (200/L_2)$.

8.8 Remove calibration load arm from the torsional shear test fixture.

9. Conditioning

9.1 Unless otherwise specified, condition the test specimens in accordance with Procedure A of Practice D618.

10. Procedure

10.1 Measure the diameter (d) of each specimen at the groove root to ±1 % accuracy.

10.2 Insert the test specimen into the test specimen grips.

10.3 Set crosshead separation to cause 360° (6.283 radians) rotation in the apparatus within 60 ± 10 s.

10.4 Record load at specimen yield, L_3, and load at specimen ultimate, L_4, and autographically determine load rate $\Delta L/\Delta t$ and angular strain rate, ω, in the straight line portion of the autographic curve. Calculate the torsional loads $T_3 = KL_3$ and $T_4 = KL_4$.

NOTE 2—If a torsional test machine is used, record the yield torque, T_3, and the ultimate torque, T_4, and autographically determine torque rate, $\Delta T/\Delta t$, and angular strain rate, ω, in the straight line portion of the autographic curve.

11. Calculation

11.1 The shear yield stress F_{sy}, and shear ultimate stress F_{su} in pounds per square inch, are calculated by the formula: