



Designation: F1362 – 18 (Reapproved 2023)

Standard Test Method for Shear Strength and Shear Modulus of Aerospace Glazing Interlayer Materials¹

This standard is issued under the fixed designation F1362; 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 shear strength and shear modulus of interlayer materials that are restrained by relatively high modulus plies in laminated transparencies. This test method can be used with single or multiple plies of the same interlayer materials.

1.2 The values stated in SI units are to be regarded as the standard. The values 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *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](#)

[E4 Practices for Force Calibration and Verification of Testing Machines](#)

[E229 Test Method for Shear Strength and Shear Modulus of Structural Adhesives](#) (Withdrawn 2003)³

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, 2023. Published June 2023. Originally approved in 1991. Last previous edition approved in 2018 as F1362 – 18. DOI: 10.1520/F1362-18R23.

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.

³ The last approved version of this historical standard is referenced on www.astm.org.

[E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method](#)

[F734 Test Method for Shear Strength of Fusion Bonded Polycarbonate Aerospace Glazing Material](#)

3. Terminology

3.1 *Definitions:*

3.1.1 *adherend, n*—relatively higher modulus plies that restrain interlayer materials.

3.1.2 *shear modulus, n*—the ratio of the shear stress to the corresponding shear strain for the initial straight-line portion of the curve.

3.1.3 *shear strength, n*—the maximum shear stress existing in the interlayer prior to failure. Represents the shear strength of the system either as a cohesive or adhesive failure mode.

4. Summary of Test Method

4.1 Torsional shear forces are applied to the interlayer through a circular section that produces a peripherally uniform stress distribution. The maximum stress in the interlayer at failure represents the apparent shear strength of the interlayer. By measuring the interlayer strain as a function of load, a stress-strain curve can be established. The test specimen shall be made from the same materials that are to be used in production, and production processes shall be used when applicable. It is also possible to fabricate specimens from the finished/formed transparency.

5. Significance and Use

5.1 The basic material properties obtained from this test method can be used in the control of the quality of interlayers, in the theoretical equations for designing laminated transparencies, and in the evaluation of new interlayers.

6. Apparatus

6.1 *Testing Machines*—Machines used for shear testing shall conform with the requirements of Practices E4. The loads used in determining shear strength shall be within the loading range of the testing machine as defined in Practices E4.

6.2 *Torsional Shear Apparatus*—The torsional shear jig shall apply a torsional shear load to the specimen without inducing bending, peeling, or transverse shear stresses in the test section. Loading shall be accomplished with torsion-test equipment or by means of a jig used in a universal testing machine. A jig is shown in Fig. 1 (see Practice F734) and Figs. 2 and 3 show the adaptations required for the various specimens. Adequate precautions shall be taken to ensure a minimum of frictional loss of torque (as by careful bearing design) or to provide a direct measurement of the applied torque (as by a load cell), or both, and to prevent the application of axial forces. Also, take up the slack in the system prior to the start of each test.

6.3 *Measurement of Angular Displacement*—Since the shear strains of an interlayer will normally be very large, the angular displacement shall be measured using an angular displacement transducer. This transducer shall be either internal to the torsion-test machine or attached to the jig.

7. Test Specimens

7.1 The specimen shall consist of laminated transparency material machined in such a way as to produce an annular test ring. The laminated transparency material can be either flat or curved, and typical of the materials used in production where applicable. Take adequate precautions to ensure test specimen uniformity.

7.2 Determine the interlayer thickness within an accuracy of 5%. This shall be determined by direct measurement or by subtracting the thickness of the structural plies from the total thickness, except when all plies are not loaded (see Fig. 3, Type II).

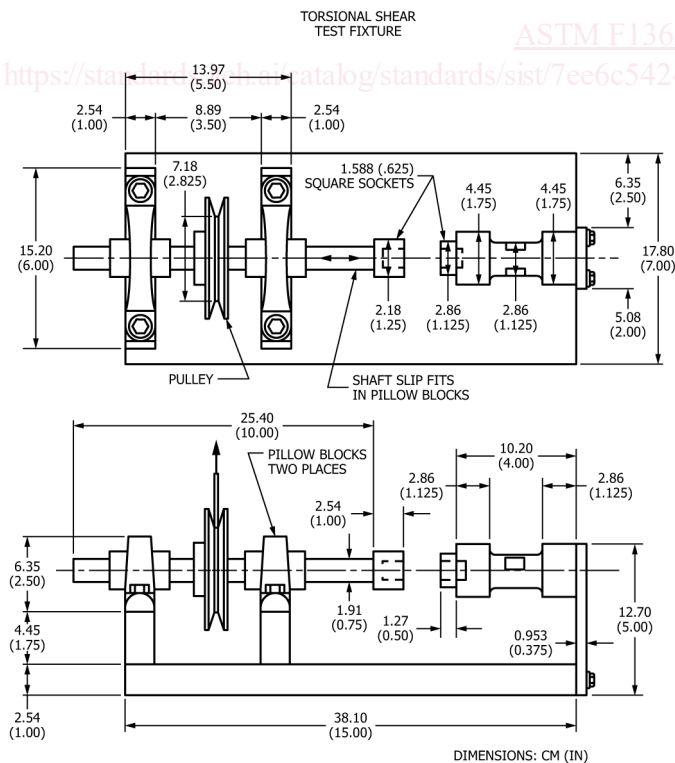


FIG. 1 Torsional Shear Test Fixture (See Fig. 1, Practice F734).

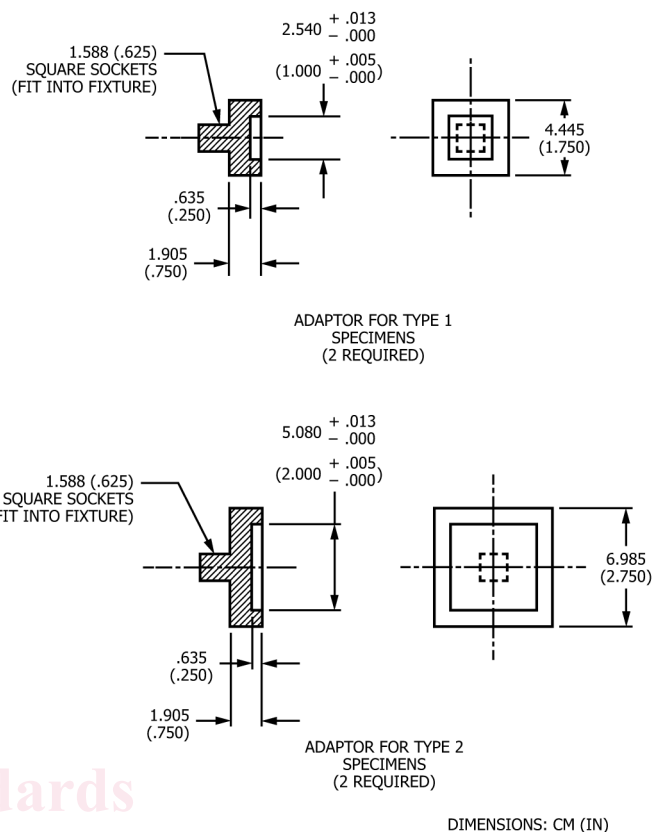


FIG. 2 Adapters Required for Testing Type I and Type II Specimens

7.3 Specimens shall be fabricated using one of the three specimen geometries shown in Figs. 4-6. The test specimen geometry shall be selected to maximize the accuracy of the results within the guidelines. Types 1 and 2 specimens are smaller and are suitable to test curved materials. The type 3 specimens shall be used in the testing of flat material where larger specimen sizes are desirable.

7.4 Other specimens not conforming to 7.3 shall be sized in accordance with the capability of the test machine in order to ensure failure of the specimen; this can be either a load limitation or displacement limitation. Generally, for flat material, the larger the specimen size the greater the consistency and accuracy of the test results. Test specimens removed from a curved sheet shall be sized to limit the effects of curvature. Guidelines are provided in Table 1.

8. Conditioning

8.1 Condition the test specimens at $23\text{ }^\circ\text{C} \pm 2\text{ }^\circ\text{C}$ ($73.4\text{ }^\circ\text{F} \pm 3.6\text{ }^\circ\text{F}$) and $50\% \pm 5\%$ relative humidity for not less than 40 h prior to test in accordance with Procedure A of Practice D618 unless otherwise specified.

9. Procedure

9.1 *Measurement of Specimens*—Measure the loading fixturing and specimens to ensure concentricity and conformance to the dimensional tolerances.

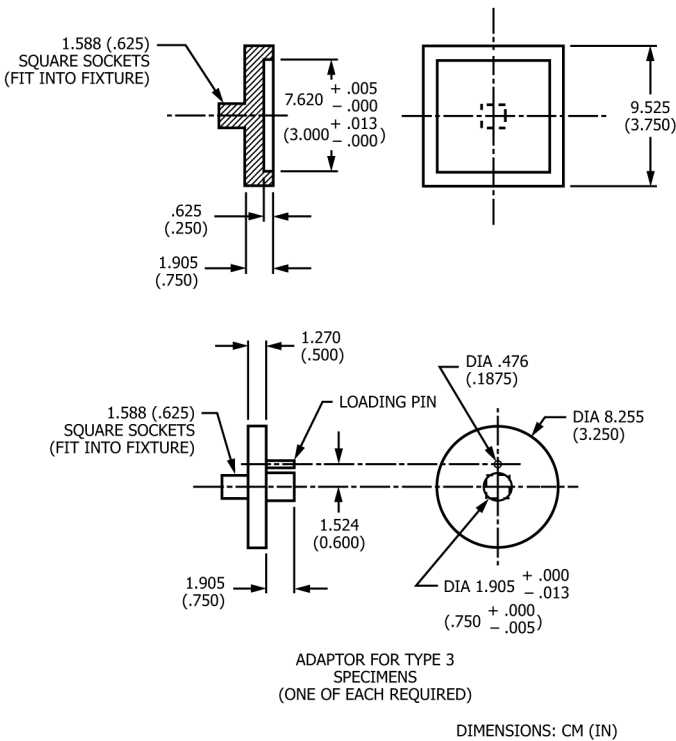


FIG. 3 Adapter Required for Testing the Type III Specimen

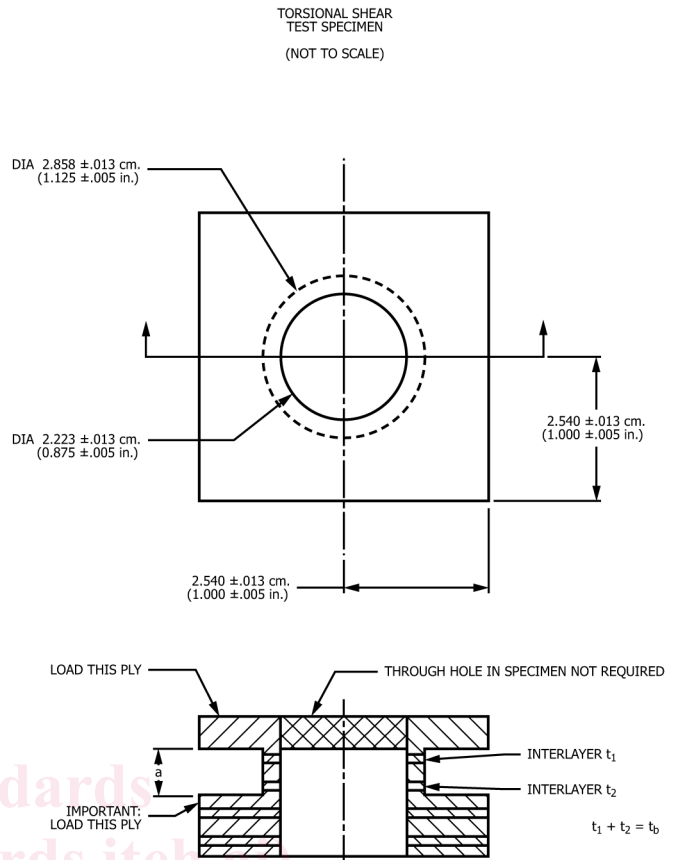
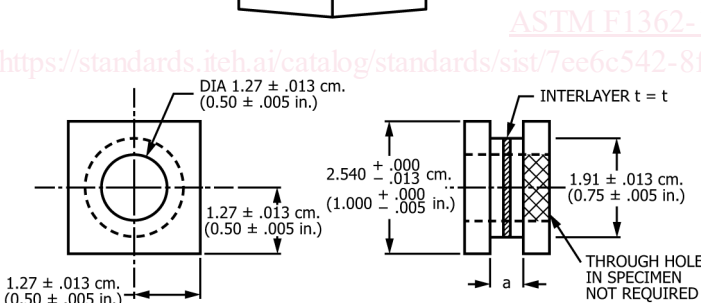


FIG. 5 Torsional Shear Test Specimen, Type II



NOTE 1—Dimension a can be varied to test singular or multiple interlayer material depending on requirements.

FIG. 4 Torsional Shear Test Specimen, Type I

9.2 *Load and Deflection*—Make simultaneous measurements of load (torque) and deflection and record the data. Take care to correct for jig deflections if any occur.

9.3 *Speed of Testing*—Load the specimen so as to produce failure in 2 min to 5 min for static properties. This test method is valid for high strain rate testing conducted using a constant displacement rate.

9.4 *Test Conditions*—Conduct tests in the standard laboratory atmosphere of $23\text{ °C} \pm 2\text{ °C}$ ($73.4\text{ °F} \pm 3.6\text{ °F}$) and 50 % \pm 5 % relative humidity unless otherwise specified.

10. Calculation (Test Method E229)

10.1 *Shear Strength*—Calculate the shear strength (τ_{\max}) as follows (see Table 1):

$$\tau_{\max} = Tr/I_p \quad (1)$$

where:

- I_p = $\pi(r_o^4 - r_1^4)/2$, polar moment of inertia, m^4 (in.^4),
- T = applied torque at failure, N-m (lbf-in.),
- r = radius to midpoint of interlayer ring as measured, m (in.),
- r_o = radius to outside of interlayer ring as measured, m (in.),
- r_1 = radius to inside of interlayer ring, m (in.), and
- τ_{\max} = maximum shear stress or shear strength of the interlayer, Pa (psi).

10.2 *Interlayer Circumferential Displacement*—Calculate the interlayer deformation (Δ_b) as follows: