



Designation: D4255/D4255M – 20^{ε1}

Standard Test Method for In-Plane Shear Properties of Polymer Matrix Composite Materials by the Rail Shear Method¹

This standard is issued under the fixed designation D4255/D4255M; 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 reappraisal. A superscript epsilon (ε) indicates an editorial change since the last revision or reappraisal.

This standard has been approved for use by agencies of the U.S. Department of Defense.

^{ε1} NOTE—Adjunct stock code was updated editorially to reflect its digital code in February 2023.

1. Scope

1.1 This test method determines the in-plane shear properties of high-modulus fiber-reinforced composite materials by either of two procedures. In Procedure A, laminates clamped between two pairs of loading rails are tested. When loaded in tension, the rails introduce shear forces in the specimen. In Procedure B, laminates clamped on opposite edges with a tensile or compressive force applied to a third pair of rails in the center are tested.

1.2 Application of this test method is limited to continuous-fiber or discontinuous-fiber-reinforced polymer matrix composites in the following material forms:

1.2.1 Laminates composed only of unidirectional fibrous laminae, with the fiber direction oriented either parallel or perpendicular to the fixture rails.

1.2.2 Laminates composed only of woven fabric filamentary laminae with the warp direction oriented either parallel or perpendicular to the fixture rails.

1.2.3 Laminates of balanced and symmetric construction, with the 0° direction oriented either parallel or perpendicular to the fixture rails.

1.2.4 Short-fiber-reinforced composites with a majority of the fibers being randomly distributed.

NOTE 1—Additional test methods for determining in-plane shear properties of polymer matrix composites may be found in Test Methods [D3518/D3518M](#), [D5379/D5379M](#), [D5448/D5448M](#), and [D7078/D7078M](#).

1.3 The reproducibility of this test method can be affected by the presence of shear stress gradients in the gage section and

stress concentrations at the gripping areas. Test Methods [D5379/D5379M](#) and [D7078/D7078M](#) provide superior shear response in comparison to this test method, as their specimen configurations produce a relatively pure and uniform shear stress state in the gage section.

1.4 The technical content of this standard has been stable since 2001 without significant objection from its stakeholders. As there is limited technical support for the maintenance of this standard, changes since that date have been limited to items required to retain consistency with other ASTM D30 Committee standards, including editorial changes and incorporation of updated guidance on micrometers and calipers, strain gage requirements, speed of testing, specimen preconditioning and environmental testing. Future maintenance of the standard will only be in response to specific requests and performed only as technical support allows.

1.5 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.5.1 Within the text the inch-pounds units are shown in brackets.

1.6 *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.*

1.7 *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.*

¹ This test method is under the jurisdiction of ASTM Committee [D30](#) on Composite Materials and is the direct responsibility of Subcommittee [D30.04](#) on Lamina and Laminate Test Methods.

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2. Referenced Documents

2.1 ASTM Standards:²

- D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
 - D883 Terminology Relating to Plastics
 - D2584 Test Method for Ignition Loss of Cured Reinforced Resins
 - D2734 Test Methods for Void Content of Reinforced Plastics
 - D3171 Test Methods for Constituent Content of Composite Materials
 - D3518/D3518M Test Method for In-Plane Shear Response of Polymer Matrix Composite Materials by Tensile Test of a $\pm 45^\circ$ Laminate
 - D3878 Terminology for Composite Materials
 - D5229/D5229M Test Method for Moisture Absorption Properties and Equilibrium Conditioning of Polymer Matrix Composite Materials
 - D5379/D5379M Test Method for Shear Properties of Composite Materials by the V-Notched Beam Method
 - D5448/D5448M Test Method for Inplane Shear Properties of Hoop Wound Polymer Matrix Composite Cylinders
 - D7078/D7078M Test Method for Shear Properties of Composite Materials by V-Notched Rail Shear Method
 - E4 Practices for Force Calibration and Verification of Testing Machines
 - E6 Terminology Relating to Methods of Mechanical Testing
 - E111 Test Method for Young's Modulus, Tangent Modulus, and Chord Modulus
 - E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process
 - E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
 - E251 Test Methods for Performance Characteristics of Metallic Bonded Resistance Strain Gages
 - E456 Terminology Relating to Quality and Statistics
 - E1237 Guide for Installing Bonded Resistance Strain Gages
- ### 2.2 ASTM Adjunct:
- Adjunct No. ADJD4255-E-PDF Rail Shear Fixtures Machining Drawings³

3. Terminology

3.1 Terminology D3878 defines terms relating to high-modulus fibers and their composites. Terminology D883 defines terms relating to plastics. Terminology E6 defines terms relating to mechanical testing. Terminology E456 and Practice E177 define terms relating to statistics. In the event of a conflict between terms, Terminology D3878 shall have precedence over the other terminology standards.

NOTE 2—If the term represents a physical quantity, its analytical dimensions are stated immediately following the term (or letter symbol) in

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 A copy of the detailed drawing for the construction of the fixtures shown in Figs. 1 and 2 is available at a nominal cost from ASTM Headquarters. Request Adjunct No. ADJD4255-E-PDF.

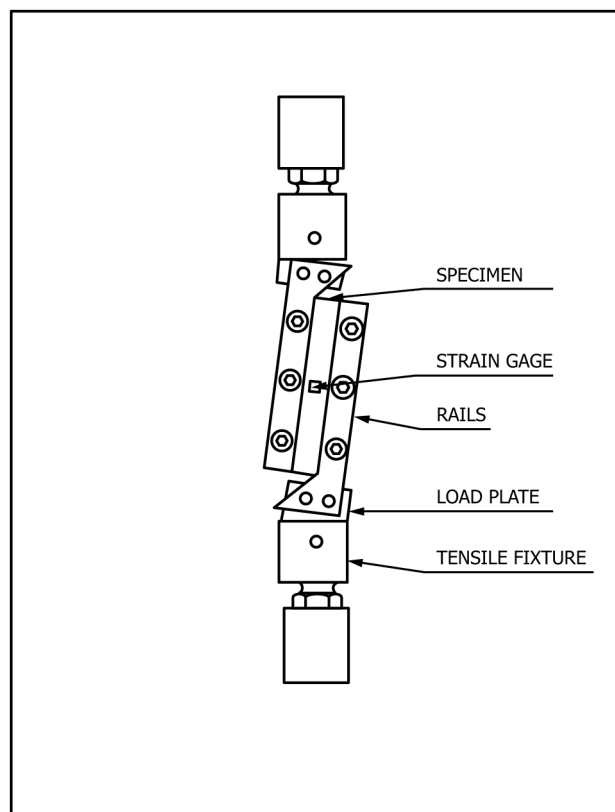


FIG. 1 Procedure A Assembly Rail Shear Apparatus

fundamental dimension form, using the following ASTM standard symbology for fundamental dimensions, shown within square brackets: [M] for mass, [L] for length, [T] for time, [θ] for thermodynamic temperature, and [nd] for nondimensional quantities. Use of these symbols is restricted to analytical dimensions when used with square brackets, as the symbols may have other definitions when used without the brackets.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *in-plane shear*, *n*—shear associated with shear forces applied to the edges of the laminate so that the resulting shear deformations occur in the plane of the laminate rather than through the thickness.

3.2.2 *offset shear stress* [M/(LT²)], *n*—the shear stress associated with an offset of the shear chord modulus of elasticity line along the strain axis (see 13.5).

3.2.3 *shear strength* [M/(LT²)], *n*—the shear stress carried by a material at failure under a pure shear condition.

3.2.4 *transition region*, *n*—a strain region of a stress-strain or strain-strain curve over which a significant change in the slope of the curve occurs within a small strain range.

3.2.4.1 *Discussion*—Many filamentary composite materials exhibit a nonlinear response during loading, such as seen in plots of either longitudinal stress versus longitudinal strain or transverse strain versus longitudinal strain. In certain cases, the nonlinear response may be conveniently approximated by a bilinear fit. There are several physical reasons for the existence of a transition region. Common examples include matrix cracking under tensile loading and ply delamination.

3.2.5 *traveler*, *n*—a small piece of the same material as, and processed similarly to, the test specimen, used for example to