



Designation: D6641/D6641M – 23

Standard Test Method for Compressive Properties of Polymer Matrix Composite Materials Using a Combined Loading Compression (CLC) Test Fixture¹

This standard is issued under the fixed designation D6641/D6641M; 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 compressive strength and stiffness properties of polymer matrix composite materials using a combined loading compression (CLC) (1)² test fixture. This test method is applicable to general composites that are balanced and symmetric. The specimen may be untabbed (Procedure A) or tabbed (Procedure B), as required. One requirement for a successful test is that the specimen ends do not crush during the test. Untabbed specimens are usually suitable for use with materials of low orthotropy, for example, fabrics, chopped fiber composites, and laminates with a maximum of 50 % 0° plies, or equivalent (see 6.4). Materials of higher orthotropy, including unidirectional composites, typically require tabs.

1.2 The compressive force is introduced into the specimen by combined end- and shear-loading. In comparison, Test Method D3410/D3410M is a pure shear-loading compression test method and Test Method D695 is a pure end-loading test method.

1.3 Unidirectional (0° ply orientation) composites as well as multi-directional composite laminates, fabric composites, chopped fiber composites, and similar materials can be tested.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. Within the test the inch-pound units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

NOTE 1—Additional procedures for determining the compressive properties of polymer matrix composites may be found in Test Methods D3410/D3410M, D5467/D5467M, and D695.

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 Boldface numbers in parentheses refer to the list of references at the end of this test method.

1.5 *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.*

1.6 *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:³

- D695 Test Method for Compressive Properties of Rigid Plastics
- D883 Terminology Relating to Plastics
- D3410/D3410M Test Method for Compressive Properties of Polymer Matrix Composite Materials with Unsupported Gage Section by Shear Loading
- 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
- D5467/D5467M Test Method for Compressive Properties of Unidirectional Polymer Matrix Composite Materials Using a Sandwich Beam
- D5687/D5687M Guide for Preparation of Flat Composite Panels with Processing Guidelines for Specimen Preparation
- E4 Practices for Force Calibration and Verification of Testing Machines
- E6 Terminology Relating to Methods of Mechanical Testing
- E122 Practice for Calculating Sample Size to Estimate, With

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.

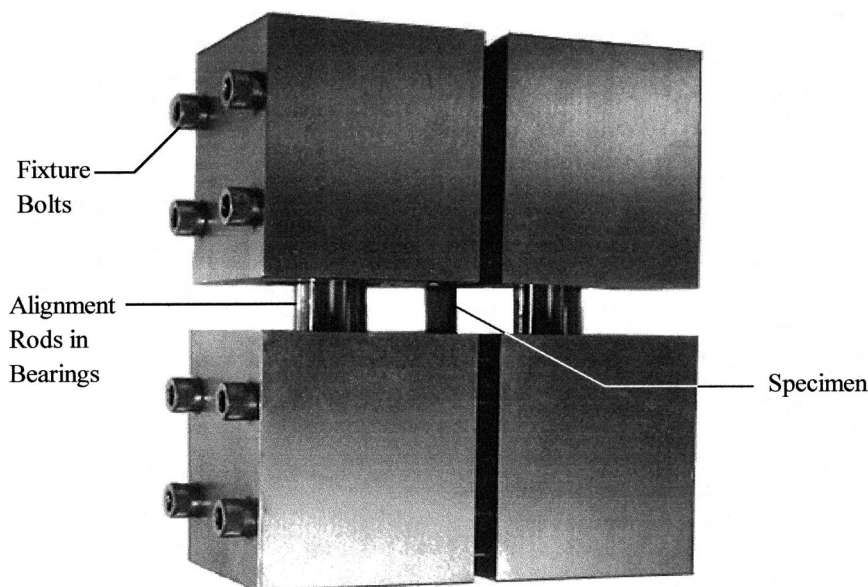


FIG. 1 Photograph of a Typical Combined Loading Compression (CLC) Test Fixture

Specified Precision, the Average for a Characteristic of a Lot or Process

E132 Test Method for Poisson's Ratio at Room Temperature

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E456 Terminology Relating to Quality and Statistics

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

2.2 ASTM Adjunct:

Combined Loading Compression (CLC) Test Fixture, D 6641/D6641M⁴

3. Terminology

3.1 *Definitions*—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.

3.2 *Symbols*: A —cross-sectional area of specimen in gage section

B_y —face-to-face percent bending in specimen

CV —sample coefficient of variation, in percent

E^c —laminate compressive modulus

F^{cu} —laminate ultimate compressive strength

F^{cr} —Euler buckling stress

G_{xz} —through-thickness shear modulus of laminate

h —specimen thickness

I —moment of inertia of specimen cross section

l_g —specimen gage length

n —number of specimens

P —load carried by test specimen

P^f —load carried by test specimen at failure

s —as used in a lay-up code, denotes that the preceding ply description for the laminate is repeated symmetrically about its midplane

s_{n-1} —sample standard deviation

w —specimen gage width

$\bar{x}$ —sample mean (average)

x_i —measured or derived property

ϵ —indicated normal strain from strain transducer

ϵ_x —laminate axial strain

ϵ_y —laminate in-plane transverse strain

ϵ_1, ϵ_2 —strain gage readings

ν_{xy}^c —compressive Poisson's ratio

4. Summary of Test Method

4.1 A test fixture such as that shown in Figs. 1 and 2, or any comparable fixture, can be used to test the untabbed (Procedure A) or tabbed (Procedure B) straight-sided composite specimen of rectangular cross section shown schematically in Fig. 3. A typical specimen is 140 mm [5.5 in.] long and 13 mm [0.5 in.] wide, having an unsupported (gage) length of 13 mm [0.5 in.] when installed in the fixture. A gage length greater or less than 13 mm is acceptable, subject to specimen buckling considerations (see 8.2). The 13-mm [0.5 in.] gage length provides sufficient space to install bonded strain gages when they are required. The fixture, which subjects the specimen to combined end- and shear-loading, is itself loaded in compression between flat platens in a universal testing machine. Load-strain data are collected until failure occurs (or until a specified strain level is achieved if only compressive modulus or Poisson's ratio, or both, are to be determined, and not the complete stress-strain curve to failure).

5. Significance and Use

5.1 This test method is designed to produce compressive property data for material specifications, research and development, quality assurance, and structural design and

⁴ A detailed drawing for the fabrication of the test fixture shown in Figs. 1 and 2 is available from ASTM Headquarters, www.astm.org. Order Adjunct No. ADJD6641-E-PDF.