



Designation: C297/C297M – 16 (Reapproved 2024)

Standard Test Method for Flatwise Tensile Strength of Sandwich Constructions¹

This standard is issued under the fixed designation C297/C297M; 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.

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

1. Scope

1.1 This test method determines the flatwise tensile strength of the core, the core-to-facing bond, or the facing of an assembled sandwich panel. Permissible core material forms include those with continuous bonding surfaces (such as balsa wood and foams) as well as those with discontinuous bonding surfaces (such as honeycomb).

1.2 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 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.

1.2.1 Within the text the inch-pound units are shown in brackets.

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

D271/C271M Test Method for Density of Sandwich Core Materials

D792 Test Methods for Density and Specific Gravity (Rela-

tive 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

D3039/D3039M Test Method for Tensile Properties of Polymer Matrix Composite Materials

D3171 Test Methods for Constituent Content of Composite Materials

D3878 Terminology for Composite Materials

D5229/D5229M Test Method for Moisture Absorption Properties and Equilibrium Conditioning of Polymer Matrix Composite Materials

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 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

E456 Terminology Relating to Quality and Statistics

3. Terminology

3.1 *Definitions*—Terminology D3878 defines terms relating to high-modulus fibers and their composites, as well as terms relating to sandwich constructions. 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 terminologies.

3.2 *Symbols:*

3.2.1 A —cross-sectional area of a test specimen

3.2.2 CV —coefficient of variation statistic of a sample population for a given property (in percent)

3.2.3 e —edge tolerance between specimen and loading blocks

3.2.4 F_z^{flu} —ultimate flatwise tensile strength

3.2.5 P_{max} —maximum force carried by test specimen before failure

¹ This test method is under the jurisdiction of ASTM Committee D30 on Composite Materials and is the direct responsibility of Subcommittee D30.09 on Sandwich Construction.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.2.6 S_{n-1} —standard deviation statistic of a sample population for a given property

3.2.7 x_i —test result for an individual specimen from the sample population for a given property

3.2.8 $\bar{x}$ —mean or average (estimate of mean) of a sample population for a given property

4. Summary of Test Method

4.1 This test method consists of subjecting a sandwich construction to a uniaxial tensile force normal to the plane of the sandwich. The force is transmitted to the sandwich through thick loading blocks, which are bonded to the sandwich facings or directly to the core.

4.2 The only acceptable failure modes for flatwise tensile strength are those which are internal to the sandwich construction. Failure of the loading block-to-sandwich bond is not an acceptable failure mode.

5. Significance and Use

5.1 In a sandwich panel, core-to-facing bond integrity is necessary to maintain facing stability and permit load transfer between the facings and core. This test method can be used to provide information on the strength and quality of core-to-facing bonds. It can also be used to produce flatwise tensile strength data for the core material. While it is primarily used as a quality control test for bonded sandwich panels, it can also be used to produce flatwise tensile strength data for structural design properties, material specifications, and research and development applications.

5.2 Factors that influence the flatwise tensile strength and shall therefore be reported include the following: facing material, core material, adhesive material, methods of material fabrication, facing stacking sequence and overall thickness, core geometry (cell size, cell wall thickness), core density, adhesive thickness, specimen geometry, specimen preparation, specimen conditioning, environment of testing, specimen alignment, loading procedure, speed of testing, facing void content, adhesive void content, and facing volume percent reinforcement. Properties that may be derived from this test method include flatwise tensile strength.

6. Interferences

6.1 *Material and Specimen Preparation*—Poor material fabrication practices, lack of control of fiber alignment, and damage induced by improper specimen machining are known causes of high data scatter in composites in general. Specific material factors that affect sandwich composites include variability in core density and degree of cure of resin in both facing matrix material and core bonding adhesive. Important aspects of sandwich panel specimen preparation that contribute to data scatter are incomplete or nonuniform core bonding to facings, misalignment of core and facing elements, the existence of joints, voids or other core and facing discontinuities, out-of-plane curvature, facing thickness variation, and surface roughness.

6.2 *System Alignment*—Excessive bending will cause premature failure. Every effort should be made to eliminate excess

bending from the test system. Bending may occur as a result of misaligned grips, poor specimen preparation, or poor alignment of the loading blocks and loading fixture. If there is any doubt as to the alignment inherent in a given test machine, then the alignment should be checked as discussed in Test Method D3039/D3039M.

6.3 *Geometry*—Specific geometric factors that affect sandwich flatwise tensile strength include core cell geometry, core thickness, specimen shape (square or circular), adhesive thickness, facing thickness, and facing per-ply thickness.

6.4 *Environment*—Results are affected by the environmental conditions under which the tests are conducted. Specimens tested in various environments can exhibit significant differences in both strength behavior and failure mode. Critical environments must be assessed independently for each facing, adhesive and core material tested.

6.5 *Conditioning*—As it is inappropriate to bond a moisture-conditioned specimen to the loading blocks, it is necessary to perform the bonding operation prior to such conditioning. The presence of the loading blocks will affect the degree of moisture intake into the specimen, in comparison to a non-bonded sample.

7. Apparatus

7.1 *Micrometers and Calipers*—A micrometer with a 4 mm to 7 mm [0.16 in. to 0.28 in.] nominal diameter ball-interface or a flat anvil interface shall be used to measure the specimen thickness. A ball interface is recommended for thickness measurements when facings are bonded to the core and at least one surface is irregular (for example, the bag-side of a thin facing laminate that is neither smooth nor flat). A micrometer or caliper with a flat anvil interface is recommended for thickness measurements when facings are bonded to the core and both surfaces are smooth (for example, tooled surfaces). A micrometer or caliper with a flat anvil interface shall be used for measuring length and width, as well as the specimen thickness when no facings are present. The use of alternative measurement devices is permitted if specified (or agreed to) by the test requestor and reported by the testing laboratory. The accuracy of the instruments shall be suitable for reading to within 1 % of the sample dimensions. For typical specimen geometries, an instrument with an accuracy of ± 0.025 mm [± 0.001 in.] is adequate for the length, width, and thickness measurements.

7.2 *Loading Fixtures*—The loading fixtures shall be self-aligning and shall not apply eccentric loads. A satisfactory type of apparatus is shown in Fig. 1. A dual-pin connection or universal joint shall be attached to each loading block to minimize any moments imparted to the test specimen. The loading blocks shall be sufficiently stiff to keep the bonded core or facings essentially flat under load. Loading blocks 40 mm to 50 mm [1.5 in. to 2.0 in.] thick have been found to perform satisfactorily. Recommended dimensions and tolerances for the loading blocks are provided in Fig. 2.

7.3 *Testing Machine*—The testing machine shall be in accordance with Practices E4 and shall satisfy the following requirements: