Designation: D7249/D7249M − 20

Standard Test Method for Facesheet Properties of Sandwich Constructions by Long Beam Flexure[1]

This standard is issued under the fixed designation D7249/D7249M; 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 determination of facesheet properties of flat sandwich constructions subjected to flexure in such a manner that the applied moments produce curvature of the sandwich facesheet planes and result in compressive and tensile forces in the facesheets. 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 *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.

1.2.1 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.*

NOTE 1—Alternate procedures for determining the compressive strength of unidirectional polymer matrix composites materials in a sandwich beam configuration may be found in Test Method D5467/D5467M.

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]

C273/C273M Test Method for Shear Properties of Sandwich Core Materials
C393/C393M Test Method for Core Shear Properties of Sandwich Constructions by Beam Flexure
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
D5467/D5467M Test Method for Compressive Properties of Unidirectional Polymer Matrix Composite Materials Using a Sandwich Beam
D7250/D7250M Practice for Determining Sandwich Beam Flexural and Shear Stiffness
E4 Practices for Force 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
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

3. Terminology

3.1 *Definitions*—Terminology D3878 defines terms relating to high-modulus fibers and their composites. 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.

[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 service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.2 *Symbols:*

b	=	specimen width
c	=	core thickness
CV	=	coefficient of variation statistic of a sample population for a given property (in percent)
d	=	sandwich total thickness
$D^{F,nom}$	=	effective sandwich flexural stiffness
E^f	=	effective facesheet chord modulus
ε	=	measuring strain in facesheet
F^u	=	facesheet ultimate strength (tensile or compressive)
F_s	=	core shear allowable strength
F_c	=	core compression allowable strength
k	=	core shear strength factor to ensure facesheet failure
L	=	length of loading span
l_{pad}	=	length of loading pad
n	=	number of specimens
P	=	applied force
P_{max}	=	maximum force carried by test specimen before failure
S	=	length of support span
S_{n-1}	=	standard deviation statistic of a sample population for a given property
σ	=	facesheet stress
t	=	facesheet thickness
x_1	=	test result for an individual specimen from the sample population for a given property
$\bar{x}$	=	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 long beam of sandwich construction to a bending moment normal to the plane of the sandwich, using a 4-point loading fixture. Deflection and strain versus force measurements are recorded.

4.2 The only acceptable failure modes for sandwich facesheet strength are those which are internal to one of the facesheets. Failure of the sandwich core or the core-to-facesheet bond preceding failure of one of the facesheets is not an acceptable failure mode. Careful post-test inspection of the specimen is required as facesheet failure occurring in proximity to the loading points can be caused by local through-thickness compression or shear failure of the core that precedes failure of the facesheet.

5. Significance and Use

5.1 Flexure tests on flat sandwich construction may be conducted to determine the sandwich flexural stiffness, the core shear strength, and shear modulus, or the facesheets' compressive and tensile strengths. Tests to evaluate core shear strength may also be used to evaluate core-to-facesheet bonds.

5.2 This test method is limited to obtaining the strength and stiffness of the sandwich panel facesheets, and to obtaining load-deflection data for use in calculating sandwich beam flexural and shear stiffness using Practice D7250/D7250M. Due to the curvature of the flexural test specimen when loaded, facesheet compression strength from this test may not be equivalent to the facesheet compression strength of sandwich structures subjected to pure edgewise (in-plane) compression.

5.3 Core shear strength and shear modulus are best determined in accordance with Test Method C273/C273M provided bare core material is available. Test Method C393/C393M may also be used to determine core shear strength. Practice D7250/D7250M may be used to calculate the flexural and shear stiffness of sandwich beams.

5.4 This test method can be used to produce facesheet strength data for structural design allowables, material specifications, and research and development applications; it may also be used as a quality control test for bonded sandwich panels.

5.5 Factors that influence the facesheet strength and shall therefore be reported include the following: facesheet material, core material, adhesive material, methods of material fabrication, facesheet stacking sequence and overall thickness, core geometry (cell size), core density, adhesive thickness, specimen geometry, specimen preparation, specimen conditioning, environment of testing, specimen alignment, loading procedure, speed of testing, facesheet void content, adhesive void content, and facesheet volume percent reinforcement. Further, facesheet strength may be different between precured/bonded and co-cured facesheets of the same material.

NOTE 2—Concentrated forces on beams with thin facesheets and low density cores can produce results that are difficult to interpret, especially close to the failure point. Wider loading blocks and rubber pressure pads may assist in distributing the forces.

NOTE 3—To ensure that simple sandwich beam theory is valid, a good rule of thumb for the four-point bending test is the support span length divided by the sandwich thickness should be greater than 20 ($S/d > 20$) with the ratio of facesheet thickness to core thickness less than 0.1 ($t/c < 0.1$).

6. Interferences

6.1 *Material and Specimen Preparation*—Poor material fabrication practices and damage induced by improper specimen machining are known causes of high data scatter in composites and sandwich structures in general. A specific material factor that affects sandwich cores is variability in core density. Important aspects of sandwich core specimen preparation that contribute to data scatter include the existence of joints, voids or other core discontinuities, out-of-plane curvature, and surface roughness.

6.2 *Geometry*—Specific geometric factors that affect sandwich facesheet strength include facesheet thickness, core cell geometry, and facesheet surface flatness (toolside or bagside surface in compression).

6.3 *Environment*—Results are affected by the environmental conditions under which specimens are conditioned, as well as the 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 specific combination of core material, facesheet material, and core-to-facesheet interfacial adhesive (if used) that is tested.

6.4 *Core Material*—If the core material has insufficient shear or compressive strength, it is possible that the core may locally crush at or near the loading points thereby resulting in facesheet failure due to local stresses. In other cases, facesheet