INTERNATIONAL

Designation: D7250/D7250M − 20

Standard Practice for
Determining Sandwich Beam Flexural and Shear Stiffness[1]

This standard is issued under the fixed designation D7250/D7250M; 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 practice covers determination of the flexural and transverse shear stiffness properties of flat sandwich constructions subjected to flexure in such a manner that the applied moments produce curvature of the sandwich facing planes. 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). The calculation methods in this practice are limited to sandwich beams exhibiting linear force-deflection response. This practice uses test results obtained from Test Methods C393/C393M or D7249/D7249M, or both.

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.*

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 Test Method for Shear Properties of Sandwich Core Materials
C393/C393M Test Method for Core Shear Properties of Sandwich Constructions by Beam Flexure
D883 Terminology Relating to Plastics
D3878 Terminology for Composite Materials
D7249/D7249M Test Method for Facesheet Properties of Sandwich Constructions by Long Beam Flexure
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:*

b = sandwich width, mm [in.]
c = core thickness, mm [in.]
d = sandwich thickness, mm [in.]
D = flexural stiffness, N-mm^2 [lb-in.^{2}]
Δ = beam mid-span deflection, mm [in.]
G = core shear modulus, MPa [psi]
S = support span length, mm [in.]
L = load span length, mm [in.] (L = 0.0 for 3-point mid-span loading configuration)
n = number of specimens

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

Current edition approved July 1, 2020. Published August 2020. Originally approved in 2006. Last previous edition approved in 2016 as D7250/D7250M – 16. DOI: 10.1520/D7250_D7250M-20.

[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.

P = total applied force, N [lb]
t = facing thickness, mm [in.]
U = transverse shear rigidity, N [lb]

4. Summary of Practice

4.1 This practice consists of calculating the flexural stiffness, transverse (through-thickness) shear rigidity, and core shear modulus of a sandwich beam using deflection or strain data, or both, from two or more flexure tests of different loading configurations conducted under Test Methods C393/C393M or D7249/D7249M, or both. This practice also includes equations for calculating the shear rigidity and core shear modulus of a sandwich beam using deflection data from a single flexure test conducted under Test Method C393/C393M when the facing modulus is known.

5. Significance and Use

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

5.2 This practice provides a standard method of determining sandwich flexural and shear stiffness and core shear modulus using calculations involving measured deflections of sandwich flexure specimens. Tests can be conducted on short specimens and on long specimens (or on one specimen loaded in two ways), and the flexural stiffness, shear rigidity, and core shear modulus can be determined by simultaneous solution of the complete deflection equations for each span or each loading. If the facing modulus values are known, a short span beam can be tested and the calculated bending deflection subtracted from the beam's total deflection. This gives the shear deflection from which the transverse shear modulus can be determined.

NOTE 1—Core shear strength and shear modulus are best determined in accordance with Test Method C273, provided bare core material is available.

NOTE 2—For cores with high shear modulus, the shear deflection will be quite small and ordinary errors in deflection measurements will cause considerable variations in the calculated shear modulus.

NOTE 3—To ensure that simple sandwich beam theory is valid, a good rule of thumb for a four-point bending test is the span length divided by the sandwich thickness should be greater than 20 ($L_1/d > 20$) with the ratio of facing thickness to core thickness less than 0.1 ($t/c < 0.1$).

6. Interferences

6.1 *Material and Specimen Preparation*—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 facing stiffness and thereby the sandwich flexural stiffness include facing thickness, core cell geometry, and facing 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 stiffness. Critical environments must be assessed independently for each specific combination of core material, facing material, and core-to-facing interfacial adhesive (if used) that is tested.

6.4 *Core Material*—For some core materials, the core shear modulus is a function of the direction that the core is oriented relative to the length of the specimen. Another material factor that affects sandwich core stiffness is variability in core density.

7. Sampling and Test Specimens

7.1 *Sampling*—Test at least five specimens per test condition unless valid results can be gained through the use of fewer specimens, as in the case of a designed experiment. For statistically significant data, consult the procedures outlined in Practice E122. Report the method of sampling.

7.2 *Specimen Geometry*—The test specimens shall be rectangular in cross section. The depth of the specimens shall be equal to the thickness of the sandwich construction, and the width shall be not less than twice the total thickness, not less than three times the dimension of a core cell, nor greater than one half the span length. The specimen length shall be equal to the span length plus 50 mm [2 in.] or plus one half the sandwich thickness, whichever is the greater.

7.3 *Loading Configurations, Unknown Facing Modulus*—For cases where the facing modulus is not known, a minimum of two loading configurations must be selected. Refer to Test Methods C393/C393M and D7249/D7249M for the equations used to size the specimen lengths and loading configurations so that facing failure and core shear failures do not occur below the desired maximum applied force level. It is recommended that one loading configuration use a short support span and specimen and the other loading configuration use a long support span and specimen. The purpose of this recommendation is to obtain force-deflection data for one test with relatively high shear deflection and one test with relatively high flexural deformation. If two short configurations or two long configurations are tested, measurement errors may be large relative to the difference in shear and flexural deflections between the two tests and may lead to significant errors in the calculated flexural and shear stiffness values.

7.4 *Loading Configurations, Known Facing Modulus*—For cases where the facing modulus is known for sandwich beams with identical facings, a short support span loading configuration test should be conducted per Test Method C393/C393M.

8. Procedure

8.1 *Unknown Facing Modulus*—Conduct tests on sandwich beam specimens per Test Methods C393/C393M or D7249/D7249M, or both, using two or more different loading configurations; see Fig. 1. It is preferable to conduct each of the loading conditions on each test specimen. This requires that the applied forces for all but the last loading condition to be kept sufficiently low to avoid failure and permanent deformations of the specimen.

8.2 *Known Facing Modulus*—Conduct tests on sandwich beam specimens per Test Method C393/C393M using a single short support span loading configuration.