Designation: D6790/D6790M – 22

Standard Test Method for Determining Poisson's Ratio of Honeycomb Cores[1]

This standard is issued under the fixed designation D6790/D6790M; 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 the determination of the sandwich honeycomb core Poisson's ratio from the anticlastic curvature radii; see Fig. 1.

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]

C271/C271M Test Method for Density of Sandwich Core Materials

D883 Terminology Relating to Plastics

D3878 Terminology for Composite Materials

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

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 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:*

c = chord measurement

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

d = depth measurement

R_a = anticlastic curvature radius

R_c = cylinder radius

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

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

v = Poisson's ratio

4. Summary of Test Method

4.1 This test method determines the Poisson's ratio of sandwich honeycomb core by bending the core around a cylinder and taking measurements of the anticlastic curvature that occurs.

5. Significance and Use

5.1 Certain sandwich panel analyses require the Poisson's ratio of the honeycomb core. It is not possible to measure the honeycomb's Poisson's ratio by conventional methods.

5.2 This test method provides a standard method of determining the Poisson's ratio of honeycomb core materials for design properties, material specifications, research and development applications, and quality assurance.

[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.

Current edition approved May 1, 2022. Published May 2022. Originally approved in 2002. Last previous edition approved in 2016 as D6790/D6790M – 16. DOI: 10.1520/D6790_D6790M-22.

[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.

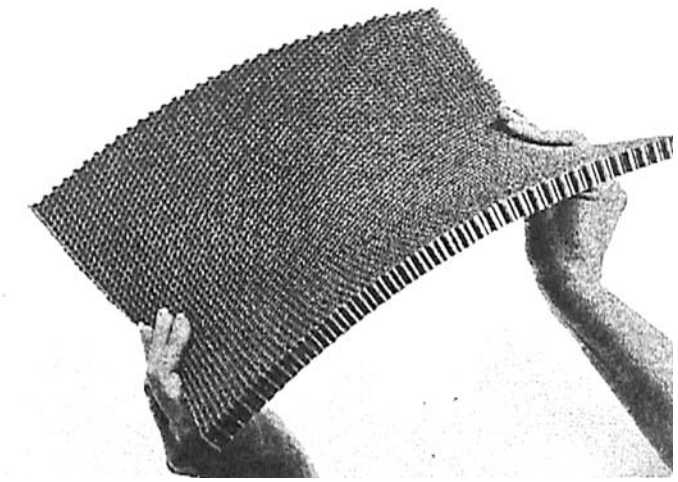

FIG. 1 Anticlastic Curvature

5.3 Factors that influence the Poisson's ratio of honeycomb core materials and shall therefore be reported include the following: core material, methods of material fabrication, core geometry, core thickness, core thickness uniformity, cell wall thickness, specimen geometry, specimen preparation, and specimen conditioning.

6. Interferences

6.1 The test method described here is one means of obtaining the Poisson's ratio of honeycomb core. However, this test method has not been widely used, and it is in its conceptual stage.

6.2 *Material and Specimen Preparation*—Poor material fabrication practices and damage induced by improper specimen machining are known causes of high data scatter for sandwich cores. 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. Non-uniform edge geometry can influence the measurement of the chord distance described in 11.6.

6.3 *Core Geometry*—Core-specific geometric factors that affect Poisson's ratio include core cell size, uniformity of core cell geometry, core cell wall thickness, core cell wall thickness uniformity, core thickness, and core thickness uniformity.

6.4 *Environment*—Results are affected by the environmental conditions under which specimens are conditioned, as well as the conditions under which the core is tested. Specimens tested in various environments can exhibit differences in Poisson's ratio.

6.5 *Specimen-Cylinder Contact*—Results may vary if the specimen is too rigid in bending to permit intimate contact of its surface with the cylinder along the specimen center line without fracturing the core. Use of a larger cylinder radius is recommended if the midpoints of two parallel ends of the core specimen cannot be made to contact the standard cylinder using light hand pressure.

6.6 *Measurement Devices*—Measurements for anticlastic curvature depth described in 11.6 may be affected by the width of the scale described in 7.3 where it contacts the specimen.

7. Apparatus

7.1 *Micrometers and Calipers*—A micrometer having a flat anvil interface, or a caliper of suitable size, shall be used. The accuracy of the instrument(s) shall be suitable for reading to within 0.5 % of the sample length, width and thickness. For typical specimen geometries, an instrument with an accuracy of ±0.025 mm [±0.001 in.] is desirable for thickness measurement, whereas an instrument with an accuracy of ±0.25 mm [±0.01 in.] is desirable for length and width measurement.

7.2 *Cylinders*—A cylinder shall be utilized to bend the core to a defined radius of curvature. Standard tests shall utilize a cylinder of 305 mm [12 in.] radius. This radius is generally acceptable for testing of cores up to 25 mm [1.0 in.] in thickness. A larger cylinder radius shall be used if the midpoints of two parallel ends of the core specimen cannot be made to contact the standard cylinder using light hand pressure without fracturing the core. Tests conducted using non-standard cylinder radii must be designated as such, with the cylinder radius reported with any test results.

7.3 *Scale*—A scale is required that is capable of measuring length with an accuracy of ±1 mm [±0.05 in.].

7.4 *Straight Edge*—A straight edge is required that is capable of measuring length with an accuracy of ±1 mm [± 0.05 in.].

8. Sampling and Test Specimens

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

8.2 *Test Specimens:*

8.2.1 *Core Geometry*—Core test specimens shall be square. The length and width should be great enough to obtain an anticlastic curvature when the specimen is bent over the cylinder. A specimen size of 300 by 300 mm [12 by 12 in.] in planar dimensions is recommended. For honeycomb cores, the planar dimension cross-section is defined to be in the facing plane (in regard to the orientation that the core would be placed in a structural sandwich construction) and is perpendicular to the orientation of the cell walls. Larger specimen sizes may be required if the cylinder radius is larger than 305 mm [12 in.].

8.2.2 *Core Thickness*—Various core thicknesses should be tested. A core thickness of 13 mm [0.50 in.] is recommended as a starting thickness.

8.2.3 *Core Preparation and Machining*—Prepare the core material samples so that the facing plane surfaces are parallel to each other and perpendicular to the sides of the core. Take precautions when cutting specimens from large sheets of core material to avoid notches, undercuts, rough or uneven surfaces due to inappropriate machining methods. Record and report the core material specimen cutting preparation method.

8.2.4 If core material density is to be reported, samples used to determine density shall be obtained from the same sheet of core being tested. Density may be evaluated in accordance with Test Method C271/C271M.

8.3 *Labeling*—Label the test specimens so that they will be distinct from each other and traceable back to the sheet of origin, and will neither influence the test nor be affected by it.

9. Calibration

9.1 The accuracy of all measuring equipment shall have certified calibrations that are current at the time of use of the equipment.

10. Conditioning

10.1 The recommended pre-test condition is effective moisture equilibrium at a specific relative humidity as established by Test Method D5229/D5229M; however, if the test requestor does not explicitly specify a pre-test conditioning environment, no conditioning is required and the test specimens may be tested as prepared.

10.2 The pre-test specimen conditioning process, to include specified environmental exposure levels and resulting moisture content, shall be reported with the test data.

NOTE 1—The term "moisture," as used in Test Method D5229/D5229M, includes not only the vapor of a liquid and its condensate, but the liquid itself in large quantities, as for immersion.

10.3 If no explicit conditioning process is performed, the specimen conditioning process shall be reported as "unconditioned" and the moisture content as "unknown."

11. Procedure

11.1 *Parameters to be Specified Before Test:*

11.1.1 The specimen sampling method, specimen geometry, and conditioning travelers (if required).

11.1.2 The properties and data reporting format desired.

NOTE 2—Determine specific material property, accuracy, and data reporting requirements prior to test for proper selection of apparatus.

11.1.3 The environmental conditioning parameters.

11.2 *General Instructions:*

11.2.1 Report any deviations from this test method, whether intentional or inadvertent.

11.2.2 Following final core material specimen machining, but before conditioning and testing, measure the specimen length and width in the planar dimensions at three places. The thickness of the specimen shall be measured at four locations and recorded as the average of the four measurements. The accuracy of these measurements shall be within 0.5 % of the dimension. Measure the specimen length and width with an accuracy of ± 0.25 mm [± 0.010 in.]. Measure the specimen thickness with an accuracy of ± 0.025 mm [± 0.001 in.]. Record the dimensions to three significant figures in units of millimetres [inches].

11.3 Condition the specimens as required. Store the specimens in the conditioned environment until test time, if the test environment is different from the conditioning environment.

11.4 Following final specimen conditioning, but before testing, re-measure the specimen length, width, and thickness as in 11.2.2. Mark the midpoint along each of the specimen edges with an accuracy of ± 1 mm [± 0.05 in.] (ensuring the marking medium will neither influence the test nor be affected by it).

11.5 Bend the honeycomb core specimen around the cylinder of known radius, making sure the midpoints of two parallel ends of the specimen contact the cylinder. If the ends of the specimen cannot be made to contact the standard cylinder using light hand pressure without fracturing the core, a larger cylinder radius shall be used to determine the Poisson's ratio.

11.6 With the specimen bent around the cylinder, place the straight edge (specified in 7.4) across the midpoints of the two edges of the specimen not in contact with the cylinder (as shown in Fig. 2) and measure the chord distance, c. Using the measured chord distance, locate and mark the midpoint of the straight edge (as shown in Fig. 2) with an accuracy of ± 1 mm [± 0.05 in.]. Position the scale (specified in 7.3) at the midpoint of the straight edge (as shown in Fig. 2) and measure the depth, d. Take care to avoid imparting transverse forces to the specimen when positioning the straight edge and scale, as such loading can affect the chord distance and depth measurements.

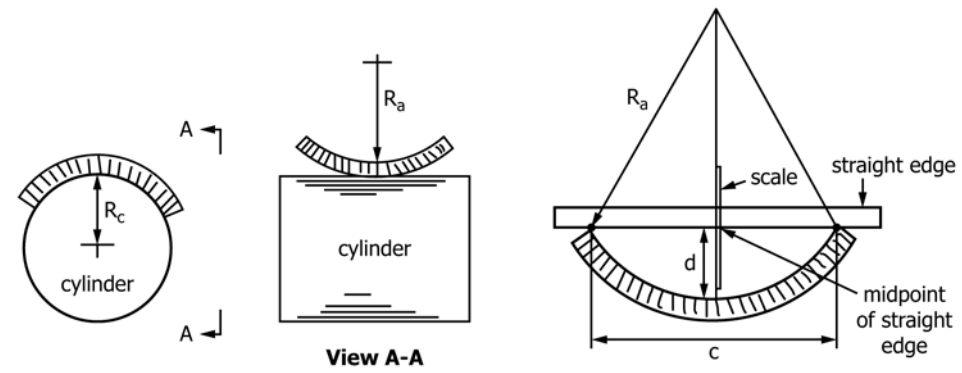

FIG. 2 Measurements