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Standard Test Method for Density of Sandwich Core Materials[1]

This standard is issued under the fixed designation C271/C271M; 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 density of sandwich construction core materials. 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. ~~Within the text the inch-pound units are shown in brackets.~~ The values stated in each system ~~are~~may not be exact equivalents; therefore, each system ~~must~~shall be used independently of the other. Combining values from the two systems may result in non-conformance 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C274 Terminology of Structural Sandwich Constructions
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
E171 Specification for Atmospheres for Conditioning and Testing Flexible Barrier Materials
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
E456 Terminology Relating to Quality and Statistics
E1309 Guide for Identification of Fiber-Reinforced Polymer-Matrix Composite Materials in Databases
E1434 Guide for Recording Mechanical Test Data of Fiber-Reinforced Composite Materials in Databases
E1471 Guide for Identification of Fibers, Fillers, and Core Materials in Computerized Material Property Databases

3. Terminology

3.1 *Definitions*—Terminology D3878 defines terms relating to high-modulus fibers and their composites. Terminology C274 defines terms relating to structural 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:*

CV~~=*coefficient*~~—coefficient of variation statistic of a sample population for a given property (in percent)
d_{IP}~~=*density*~~—density of a test specimen in inch-pound units
d_{SI}~~=*density*~~—density of a test specimen in SI units
l~~=*length*~~—length of a test specimen
S_{n-1} ~~=*standard*~~—standard deviation statistic of a sample population for a given property

[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.

t=thickness—thickness of a test specimen
x_i=*test*—test result for an individual specimen from the sample population for a given property
$\bar{x}$=*mean*—mean or average (estimate of mean) of a sample population for a given property
w=width—width of a test specimen
W=mass—mass of a test specimen

4. Summary of Test Method

4.1 This test method consists of environmentally conditioning a sandwich core specimen, weighing the specimen, measuring the length, width and thickness of the specimen, and calculating the density.

5. Significance and Use

5.1 Density is a fundamental physical property that can be used in conjunction with other properties to characterize the sandwich core. Most sandwich core structural properties, such as strength and stiffness, are proportional to the density.

5.2 This test method provides a standard method of obtaining sandwich core density data for design properties, material specifications, research and development applications, and quality assurance.

5.3 Factors that influence the density and shall therefore be reported include the following: core material, methods of material fabrication, core geometry (nominal cell size), specimen geometry, specimen preparation, methods of weight and dimensional measurement, specimen conditioning, and moisture content during weight and dimensional measurements.

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. 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 density measurement include uniformity of core cell geometry and core thickness.

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, with different ambient moisture contents, can exhibit significant differences in measured density.

7. Apparatus

7.1 *Oven or Vacuum Drying Chamber*—An air-circulating oven is required that shall be capable of maintaining the required uniform temperatures to within ±3°C [±5°F]. A vacuum drying chamber or a vacuum oven may also be used.

7.2 *Desiccator*—A clean, dry desiccator in which specimens being oven-dried shall be brought to laboratory temperature following removal of the specimens from the oven.

7.3 *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 specimen length, width and thickness. For typical specimen geometries, an instrument with an accuracy of ±25 μm [±0.001 in.] is desirable for length, width, and thickness measurement.

7.4 *Balance or Weighing Scale*—An analytical balance or weighing scale is required that is capable of measuring accurately to ±0.5 %.

7.5 *Gloves*—Clean, non-linting gloves for use when handling specimens.

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, 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 *Geometry*—Test specimens shall have a square or rectangular cross-section. The recommended minimum specimen size is 300 mm [12.0 in.] in length by 300 mm [12.0 in.] in width, with the thickness equal to the sandwich core thickness.

NOTE 1—The specimen's cross-sectional area (length times width) is defined in the facing plane, in regard to the orientation that the core would be placed in a structural sandwich construction. For example, for a honeycomb core the cross-sectional area is defined in the plane of the cells, which is perpendicular to the orientation of the cell walls.

8.3 *Specimen Preparation and Machining*—Prepare the test specimens so that the facing plane surfaces are parallel to each other and perpendicular to the sides of the specimen. Take precautions when cutting specimens from large sheets of core to avoid notches, undercuts, rough or uneven surfaces due to inappropriate machining methods. Obtain final dimensions by lubricated precision sawing, milling, or grinding. The use of diamond tooling has been found to be extremely effective for many material systems. Record and report the specimen cutting preparation method.

8.4 *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.