Designation: C 366/C 366M – 05

Standard Test Methods for Measurement of Thickness of Sandwich Cores[1]

This standard is issued under the fixed designation C 366/C 366M; 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 Department of Defense.

1. Scope

1.1 These test methods cover plant manufacturing procedures for measuring the thickness of flat sandwich cores. 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 two test methods covered include the following:

1.1.1 *Test Method A*—Roller-Type Thickness Tester.

1.1.2 *Test Method B*—Disk-Type Thickness Tester.

NOTE 1—These test methods are designed for measuring thickness of core as it is produced and are not intended for use in determining dimensions of core specimens for other tests.

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 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.

1.3 *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]

C 274 Terminology of Structural Sandwich Constructions

D 883 Terminology Relating to Plastics

D 3878 Terminology for Composite Materials

D 5229/D 5229M Test Method for Moisture Absorption Properties and Equilibrium Conditioning of Polymer Matrix Composite Materials

E 122 Practice for Calculation of Sample Size to Estimate, Within a Specified Tolerable Error, the Average for Characteristic of a Lot or Process

E 171 Specification for Standard Atmospheres for Conditioning and Testing Flexible Barrier Materials

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E 456 Terminology Relating to Quality and Statistics

E 1309 Guide for Identification of Fiber-Reinforced Polymer-Matrix Composite Materials in Databases

E 1434 Guide for Recording Mechanical Test Data of Fiber-Reinforced Composite Materials in Databases

E 1471 Guide for Identification of Fibers, Fillers, and Core Materials in Computerized Material Property Databases

3. Terminology

3.1 *Definitions*—Terminology D 3878 defines terms relating to high-modulus fibers and their composites. Terminology C 274 defines terms relating to structural sandwich constructions. Terminology D 883 defines terms relating to plastics. Terminology E 456 and Practice E 177 define terms relating to statistics. In the event of a conflict between terms, Terminology D 3878 shall have precedence over the other terminologies.

3.2 *Symbols*:

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

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

X_i = 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 Methods

4.1 These test methods consist of environmentally conditioning a sandwich core specimen, zeroing a thickness tester, placing the core underneath the tester, and measuring the core

[1] These test methods are 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.

thickness by sliding the core underneath the tester. Procedures are provided for thickness measurement using both roller-type and disk-type thickness testers.

5. Significance and Use

5.1 Normally, a close tolerance is desirable for core thickness so that sandwich panels may be manufactured with all the sandwich components fitting properly and without crushing the core.

5.2 These test methods are designed for measuring thickness of core as it is produced and are not intended for use in determining dimensions of core specimens for other tests.

5.3 These test methods provide standard methods of obtaining the core thickness of flat sandwich core materials, and provide a basis for determining average thickness dimensions. The thickness properties derived may be used in design properties, material specifications, research and development applications, and quality assurance.

5.4 Factors that influence core thickness measurement and shall therefore be reported include the following: core material through-thickness rigidity, surface roughness, specimen geometry (including warpage), specimen preparation, methods of dimensional measurement, specimen conditioning, and moisture content during 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/warpage, and surface roughness.

6.2 *Measurement Equipment and Procedures*—Results are affected by the method of thickness measurement, use of pressure to flatten warped core, and the distance along which thickness is measured.

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 thickness.

7. Apparatus

7.1 *Test Method A—Roller-Type Thickness Tester*:

7.1.1 *Roller-Type Thickness Tester*—The tester shall consist of a flat table with a rigid yoke framework attached, as shown in Fig. 1. Two rollers shall be mounted on this yoke, one fixed in position and one movable in the vertical direction. The vertical movement of the upper roller shall be translated to a dial gage, calibrated in 0.01 mm [0.001 in.] increments, that registers the amount of variation above or below a preset nominal dimension. The lower roller shall be fixed in position so that it projects 6 mm [0.25 in.] above the measurement surface. The upper roller shall exert a force of 18 N [4 lbf] on the core material.

FIG. 1 Roller-Type Thickness Tester

7.2 *Method B—Disk-Type Thickness Tester*:

7.2.1 *Disk-Type Thickness Tester*—The tester shall consist of a flat table with a rigid yoke framework attached, as shown in Fig. 2. A 25 mm [1 in.] diameter presser disk movable in a vertical direction shall be mounted on the yoke. The vertical movement of the disk shall be translated to a dial gage, calibrated in 0.01 mm [0.001 in.] increments, that registers the amount of variation above or below a preset nominal dimension. The disk shall exert a force of 24 N [5.5 lbf] on the core material.

7.3 *Measurement Surface*—A flat, rigid surface shall be positioned such that the specimen can be supported underneath the thickness tester without bending or warping.

8. Sampling and Test Specimens

8.1 *Sampling*—Test at least five specimens per test condition, or take five readings from alternative locations on a single large specimen, 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 E 122. Report the method of sampling.

8.2 *Geometry*—Test specimens shall be flat but otherwise may be any length, width, and thickness consistent with the limits of the measuring apparatus.

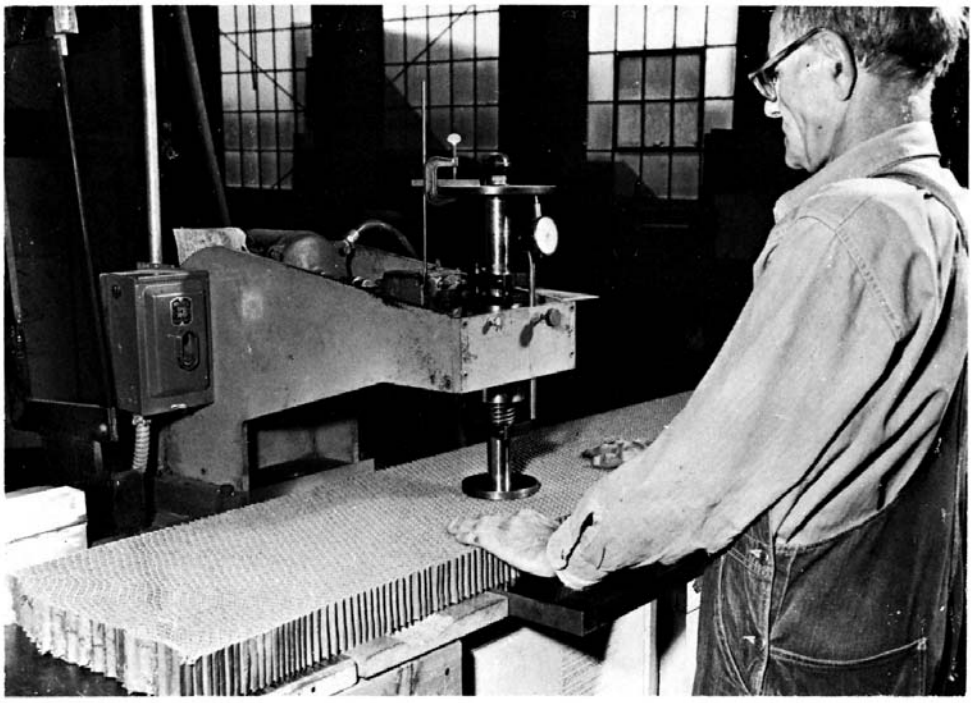

FIG. 2 Disk-Type Thickness Tester

8.3 *Specimen Preparation and Machining*—Ensure the test specimens are flat, and that the facing plane surfaces are parallel to each other. Take precautions when cutting specimens to avoid notches, undercuts, and rough or uneven surfaces which can affect the measured thickness due to inappropriate machining methods. 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.

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 As the physical dimensions of the core materials are affected by moisture, subject the test specimens to standard ASTM atmospheric conditions (Specification E 171) of 23 ± 3°C [73 ± 5°F] and 50 ± 5 % relative humidity, in accordance with Procedure C of Test Method D 5229/D 5229M.

NOTE 2—If a conditioning chamber is not available, record the actual temperature and humidity at the time of measurement.

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

11.1.3 The environmental conditioning test parameters.

11.1.4 The method of thickness measurement (Method A or B) and accuracy of thickness tester.

11.2 *General Instructions*:

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

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

11.3 *Method A—Roller-Type Thickness Tester*:

11.3.1 Place a spacer bar of a thickness equal to the desired nominal core thickness between the rollers on the measurement surface, and zero the dial gage.

11.3.2 Remove the spacer bar and insert the core material to be measured.

11.3.3 Move the core through the rollers back and forth and observe the dial gage readings. Record the maximum variation in readings on the dial gage to three significant figures in units of millimetres [inches] (with an accuracy of ±25 mm [±0.001 in.]), plus and minus, along with the distance traversed under the rollers. Take care not to exert hand pressure on the core near the rollers, as this will affect the dial gage readings.

11.4 *Method B—Disk-Type Thickness Tester*:

11.4.1 Place a spacer bar of a thickness equal to the desired nominal core thickness on the measurement surface beneath the disk and zero the dial gage.

11.4.2 Remove the spacer bar and insert the core material to be measured.

11.4.3 With the disk automatically reciprocating vertically, move the core in a saw tooth pattern along the length of the specimen and observe the dial gage readings. Record the maximum variation in readings on the dial gage to three

significant figures in units of millimetres [inches] (with an accuracy of ±25 mm [±0.001 in.]), plus and minus, along with the distance traversed under the disk.

11.4.4 If the specimen is excessively warped and the weight of the presser disk is not sufficient to straighten it, use an additional adjustable pressure ring concentric with the 25 mm [1 in.] diameter disk presser foot to force the specimen to lie flat on the measurement surface. The outside diameter of this ring shall be 115 mm [4.5 in.].

12. Validation

12.1 Property values shall not be calculated for any specimen that contains some obvious flaw described in 6.1, unless such flaw constitutes a variable being studied. Retests shall be performed for any specimen on which values are not calculated.

13. Calculation

13.1 *Statistics*—For each series of tests calculate the average value, standard deviation, and coefficient of variation (in percent) for the maximum variation in dial gage readings, both plus and minus:

$$\bar{x} = (\sum_{i=1}^{n} x_i)/n \quad (1)$$

$$S_{n-1} = \sqrt{(\sum_{i=1}^{n} x_i^2 - n\,\bar{x}^2)/(n-1)} \quad (2)$$

$$CV = 100 \times S_{n-1}/\bar{x} \quad (3)$$

where:

$\bar{x}$ = sample mean (average),
S_{n-1} = sample standard deviation,
CV = sample coefficient of variation, %,
n = number of specimens, and
x_i = measured or derived property.

14. Report

14.1 Report the following information, or references pointing to other documentation containing this information, to the maximum extent applicable (reporting of items beyond the control of a given testing laboratory, such as might occur with material details or panel fabrication parameters, shall be the responsibility of the requestor):

NOTE 4—Guides E 1309, E 1434 and E 1471 contain data reporting recommendations for composite materials and composite materials testing.

14.1.1 The revision level or date of issue of this test method.

14.1.2 The name(s) of the test operator(s).

14.1.3 Any variations to this test method, anomalies noticed during testing, or equipment problems occurring during testing.

14.1.4 Identification of all the materials constituent to the sandwich core specimen tested, including for each: material specification, material type, manufacturer's material designation, manufacturer's batch or lot number, source (if not from manufacturer), date of certification, and expiration of certification.

14.1.5 Description of the fabrication steps used to prepare the sandwich core including: fabrication start date, fabrication end date, process specification, and a description of the equipment used.

14.1.6 Method of preparing the test specimen, including specimen labeling scheme and method, specimen geometry, sampling method, and specimen cutting method.

14.1.7 Results of any nondestructive evaluation tests.

14.1.8 Calibration dates and methods for all measurements and test equipment.

14.1.9 Type of thickness tester and method used (Method A or B).

14.1.10 Conditioning parameters and results.

14.1.11 Relative humidity and temperature of the testing laboratory.

14.1.12 Number of specimens (or measurements taken from a single large specimen) tested.

14.1.13 Nominal core thickness.

14.1.14 Prescribed or recommended thickness tolerance, plus or minus.

14.1.15 Distance over which thickness measurements are observed and recorded.

14.1.16 Individual maximum positive (plus) variation of dial gage reading from zero, along with average value, standard deviation, and coefficient of variation (in percent) for the population.

14.1.17 Individual maximum negative (minus) variation of dial gage reading from zero, along with average value, standard deviation, and coefficient of variation (in percent) for the population.

15. Precision and Bias

15.1 *Precision*—The data required for the development of a precision statement is not available for this test method.

15.2 *Bias*—Bias cannot be determined for this method as no acceptable reference standards exist.

16. Keywords

16.1 core; core thickness; sandwich