Designation: C 365 – 00

Standard Test Method for Flatwise Compressive Properties of Sandwich Cores[1]

This standard is issued under the fixed designation C 365; 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 This test method covers the determination of the compressive strength and modulus of sandwich cores. These properties are usually determined for design purposes in a direction normal to the plane of facings as the core would be placed in a structural sandwich construction. The test procedures pertain to compression in this direction in particular, but also can be applied with possible minor variations to determining compressive properties in other directions.

1.2 The values stated in SI units are to be regarded as the standard. The inch-pound units given may be approximate.

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:*

E 4 Practices for Force Verification of Testing Machines[2]

3. Significance and Use

3.1 The flatwise compressive strength and modulus are fundamental mechanical properties of sandwich cores that are used in designing sandwich panels. Deformation data can be obtained, and from a complete load-deformation curve it is possible to compute the compressive stress at any load (such as compressive stress at proportional limit load or compressive strength at maximum load) and to compute the effective modulus of the core.

3.2 This test method provides a standard method of obtaining the flatwise compressive strength and modulus for sandwich panel design and research and development.

4. Apparatus

4.1 *Testing Machine*, capable of maintaining a controlled loading rate and indicating the load with an accuracy of ±1 % of the indicated value. The accuracy of the test machine shall be verified in accordance with Practices E 4.

4.2 *Spherical Bearing Block*, preferably of the suspended, self-aligning type.

4.3 *Deflectometer or Compressometer*, capable of measuring the displacement with a precision of at least ±1 %. Bonded resistance strain gages are not usually considered satisfactory because of their stiffness. The reinforcing effect of bonding these gages to some cores leads to large errors in measurement of strains. Also, using the test machines cross-head travel reading is not satisfactory as large modulus errors can result. A transducer and rod setup as shown in Fig. 1 and Fig. 2 have been found to work satisfactorily. Here a small hole is drilled in the center of the specimen and in the bottom loading platen, and a transducer rod is inserted that contacts the upper loading platen.

4.4 *Micrometer, Gage, or Caliper*, capable of measuring accurately to 0.025 mm (0.001 in.).

5. Test Specimens

5.1 Test specimens shall be of core or of sandwich construction and shall be of square or circular cross section having areas not exceeding 400 mm^2 (16 $in.^2$), but not less than the following minimum areas for various types of cores:

5.1.1 For continuous cores, such as balsa wood and foams, the minimum cross-sectional area shall be 625 mm^2 (1 $in.^2$).

5.1.2 For open-celled cores, such as honeycomb, having cells less than 6 mm (½ in.) the minimum cross-sectional area shall be 2580 mm^2 (4 $in.^2$) and for cells 6 mm (½ in.) or greater the minimum cross-sectional area shall be 5800 mm^2 (9 $in.^2$).

5.2 The height of the specimen shall be as agreed upon by the purchaser and the seller.

5.3 The number of test specimens and the method of their selection depend on the purpose of the particular test under consideration, and no general rule can be given to cover all cases. However, when specimens are to be used for acceptance tests, not less than five specimens of a type shall be tested.

5.4 Prepare the test specimens so that the loaded ends will be parallel to each other and perpendicular to the sides of the specimen. To avoid local crushing at the ends of some honeycomb cores, it is desirable to reinforce the ends with a suitable material. The ends may be dipped in a thin layer of resin or thin facings bonded to the core. When either of these methods are used the test is called a stabilized compression test. When the honeycomb cell edges are not stabilized, the test

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[2] *Annual Book of ASTM Standards*, Vol 03.01.

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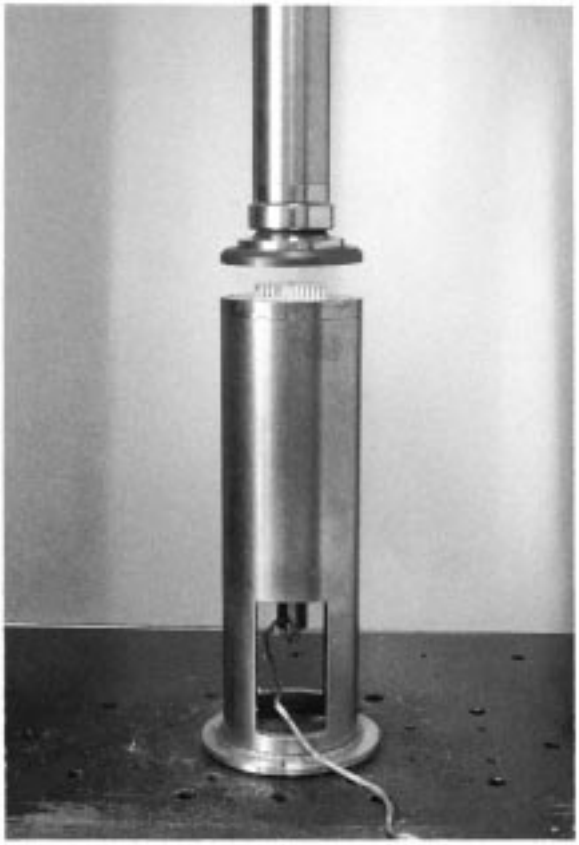

FIG. 1 Transducer and Rod Setup

FIG. 2 Close-up of Specimen

is called a bare compression test.

6. Conditioning

6.1 When the physical properties of the core material are affected by moisture, bring the specimens to constant weight (±1 %) before testing, preferably in a conditioning room having temperature and humidity control, and make the tests, preferably, in a room under the same conditions. A temperature of 23 ± 3°C (73 ± 5°F) and a relative humidity of 50 ± 5 % are recommended for standard control conditions.

7. Procedure

7.1 The length and width dimensions of the specimen shall be measured to the nearest 0.25 mm (0.01 in.) and the thickness dimension to the nearest 0.025 mm (0.001 in.). Weigh the specimen to the nearest 0.1 g and calculate the specimen density.

7.2 Apply the load to the specimen through a spherical loading block, preferably of the suspended, self-aligning type, in such a manner that the block distributes the load as uniformly as possible over the entire loading surface of the specimen (Note 1). Apply the load at a constant rate of movement of the cross-head of the testing machine (Note 2) and at such a rate that the maximum load (Note 3) will occur between 3 and 6 min.

7.3 Load-deflection curves may be taken to determine the modulus of elasticity, proportional limit, and maximum load as defined by the load at 2 % strain (see Note 3).

NOTE 1—Great care must be taken to load the specimen ends uniformly and parallel to the load surfaces. At failure, the result of nonuniform loading can usually be seen as a failure that is confined to one corner or one edge of the specimen.

NOTE 2—A suggested rate of cross-head movement is 0.50 mm/min (0.020 in./min).

NOTE 3—For cores that continue to compress and have no definite maximum load, the maximum load shall be the load at 2 % strain.

8. Calculation

8.1 Calculate the flatwise compressive strength as follows:

$$\sigma = \frac{P}{A} \tag{1}$$

where:

σ = core compressive strength, MPa (psi);
P = ultimate load, N (lb); and
A = cross-sectional area, mm^2($in.^2$).

8.2 Calculate the flatwise compressive modulus as follows:

$$E = \frac{St}{A} \tag{2}$$

where:

E = core compressive modulus, MPa (psi);
S = ($\Delta P/\Delta u$) slope of initial linear portion of load-deflection curve, N/mm (lb/in.);
u = displacement of the loading block; and
t = core thickness, mm (in.).

9. Report

9.1 The report shall include the following:

9.1.1 Description of test specimens; core materials, facings if used,

9.1.2 Dimensions and densities of the test specimens,

9.1.3 Method of bonding facings to specimens; adhesive, cure cycle, and pressure,

9.1.4 Specimens conditioning, if any,

9.1.5 Test temperature and specimens time at temperature,

9.1.6 Test machine cross-head loading rate,

9.1.7 Compressive strength; individual values and average,

9.1.8 Compressive modulus; individual values and average, if required,

9.1.9 Load-deflection curves, if required, and

9.1.10 Description of failure mode.

10. Precision and Bias

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

10.2 *Bias*—Since there is no accepted reference material suitable for determining the bias for the procedure in this test method, bias has not been determined.

11. Keywords

11.1 compressive modulus; compressive strength; flatwise; sandwich core

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