Designation: C364/C364M – 07 (Reapproved 2012) C364/C364M – 16

Standard Test Method for Edgewise Compressive Strength of Sandwich Constructions[1]

This standard is issued under the fixed designation C364/C364M; 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 compressive properties of structural sandwich construction in a direction parallel to the sandwich facing plane. 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 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:*

C274 Terminology of Structural Sandwich Constructions (Withdrawn 2016)[2]
D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
D883 Terminology Relating to Plastics
D2584 Test Method for Ignition Loss of Cured Reinforced Resins
D2734 Test Methods for Void Content of Reinforced Plastics
D3039/D3039M Test Method for Tensile Properties of Polymer Matrix Composite Materials
D3171 Test Methods for Constituent Content of Composite Materials
D3878 Terminology for Composite Materials
D5229/D5229M Test Method for Moisture Absorption Properties and Equilibrium Conditioning of Polymer Matrix Composite Materials
D5687/D5687M Guide for Preparation of Flat Composite Panels with Processing Guidelines for Specimen Preparation
E4 Practices for Force Verification of Testing Machines
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
E1012 Practice for Verification of Testing Frame and Specimen Alignment Under Tensile and Compressive Axial Force Application
E1309 Guide for Identification of Fiber-Reinforced Polymer-Matrix Composite Materials in Databases (Withdrawn 2015)[2]
E1434 Guide for Recording Mechanical Test Data of Fiber-Reinforced Composite Materials in Databases (Withdrawn 2015)[2]
E1471 Guide for Identification of Fibers, Fillers, and Core Materials in Computerized Material Property Databases (Withdrawn 2015)[2]

[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 Aug. 1, 2012April 1, 2016. Published December 2012April 2016. Originally approved in 1955. Last previous edition approved in 20072012 as C364/C364M– 07. – 07(2012). DOI: 10.1520/C0364_C0364M-07R12.10.1520/C0364_C0364M-16.

3. Terminology

3.1 *Definitions*—Terminology D3878 defines terms relating to high-modulus fibers and their ~~composites. Terminology~~composites, as ~~C274 defines~~well as terms relating to ~~structural~~ sandwich constructions. Terminology D883 defines terms relating to plastics. Terminology E6 defines terms relating to mechanical testing. Terminolgoy 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 = width of specimen

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

L = length of specimen

P = force on specimen

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

t_c = core thickness

t_{fs} = nominal facesheet thickness

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

σ = facesheet compressive stress

4. Summary of Test Method

4.1 This test method consists of subjecting a sandwich panel to monotonically increasing compressive force parallel to the plane of its faces. The force is transmitted to the panel through either clamped or bonded end supports. Stress and strength are reported in terms of the nominal cross-sectional area of the two facesheets, rather than total sandwich panel thickness, although alternate stress calculations may be optionally specified.

4.2 The only acceptable failure modes for edgewise compressive strength of sandwich constructions are those occurring away from the supported ends. The sandwich column, no matter how short, usually is subjected to a buckling type of failure unless the facings are so thick that they themselves are in the short column class. The failure of the facings manifests itself by wrinkling of the facing, in which the core deforms to the wavy shape of the facings; by dimpling of the facings into the honeycomb cells; by bending of the sandwich, resulting in crimping near the ends as a result of shear failure of the core; or by failure in the facing-to-core bond and associated facesheet buckling.

5. Significance and Use

5.1 The edgewise compressive strength of short sandwich construction specimens provides a basis for judging the load-carrying capacity of the construction in terms of developed facing stress.

5.2 This test method provides a standard method of obtaining sandwich edgewise compressive strengths for panel design properties, material specifications, research and development applications, and quality assurance.

5.3 The reporting section requires items that tend to influence edgewise compressive strength to be reported; these include materials, fabrication method, facesheet lay-up orientation (if composite), core orientation, results of any nondestructive inspections, specimen preparation, test equipment details, specimen dimensions and associated measurement accuracy, environmental conditions, speed of testing, failure mode, and failure location.

6. Interferences

6.1 *Material and Specimen Preparation*—Poor material fabrication practices, lack of control of fiber alignment, and damage induced by improper specimen machining are known causes of high data scatter in composites in general. Specific material factors that affect sandwich composites include variability in core density and degree of cure of resin in both facing matrix material and core bonding adhesive. Important aspects of sandwich panel specimen preparation that contribute to data scatter are incomplete or nonuniform core bonding to facings, misalignment of core and facing elements, the existence of joints, voids or other core and facing discontinuities, out-of-plane curvature, facing thickness variation, and surface roughness.

6.2 *System Alignment*—Unintended loading eccentricities will cause premature failure. Every effort should be made to eliminate undesirable eccentricities from the test system. Such eccentricities may occur as a result of misaligned grips, poor specimen preparation, or poor alignment of the loading fixture. If there is any doubt as to the alignment inherent in a given test machine, then the alignment should be checked as discussed in Test Method D3039/D3039M.

6.3 *Geometry*—Specific geometric factors that affect edgewise compressive strength of sandwich panels include facesheet fiber waviness, core cell geometry (shape, density, orientation), core thickness, specimen shape (L/W ratio), and adhesive thickness.

6.4 *Environment*—Results are affected by the environmental conditions under which the tests are conducted. Specimens tested in various environments can exhibit significant differences in both static strength and failure mode. Critical environments must be assessed independently for each sandwich construction tested.

7. Apparatus

7.1 *Micrometers*—The micrometer(s) shall use a 4- to 6-mm [0.16- to 0.25-in.] nominal diameter ball-interface on irregular surfaces such as the bag-side of a facing laminate, and a flat anvil interface on machined edges or very smooth-tooled surfaces. The accuracy of the instrument(s) shall be suitable for reading to within 1 % of the sample length, width and thickness. For typical specimen geometries, an instrument with an accuracy of ±25 µm [±0.001 in.] is desirable for thickness, length and width measurement. .

7.2 *Test Fixtures:*

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

7.2.2 *Lateral End Supports*—Via (*1*) clamps made of rectangular steel bars fastened together so as to clamp the specimen lightly between them (the cross-sectional dimensions of each of these bars shall be not less than 6 mm [0.25 in.], such as that shown in Fig. 1; (*2*) fitting the specimen snugly into a lengthwise slot in a round steel bar, where such bars shall have a diameter not less than the thickness of the sandwich plus 6 mm [0.25 in.], and are suitably retained on the spherical bearing block surfaces; or (*3*) casting the ends of the specimens in resin or other suitable molding material. The cast ends of the specimen should be ground flat and parallel, meeting or exceeding the specimen end tolerances shown in Fig. 2 and Fig. 3.

7.3 *Testing Machine*—The testing machine shall be in accordance with Practices E4 and shall satisfy the following requirements:

7.3.1 *Testing Machine Configuration*—The testing machine shall have both an essentially stationary head and a movable head.

7.3.2 *Drive Mechanism*—The testing machine drive mechanism shall be capable of imparting to the movable head a controlled velocity with respect to the stationary head. The velocity of the movable head shall be capable of being regulated in accordance with 11.6.

7.3.3 *Force Indicator*—The testing machine force-sensing device shall be capable of indicating the total force being carried by the test specimen. This device shall be essentially free from inertia lag at the specified rate of testing and shall indicate the force with an accuracy over the force range(s) of interest of within ±1 % of the indicated value.

7.3.4 *Strain Gage*—Capable of measuring strain to at least 0.0001 mm/mm [0.0001 in./in.] and having a gage length not greater than two thirds of the unsupported length of the specimens to be tested, nor less than three unit cells if the facesheet is a composite fabric material form.

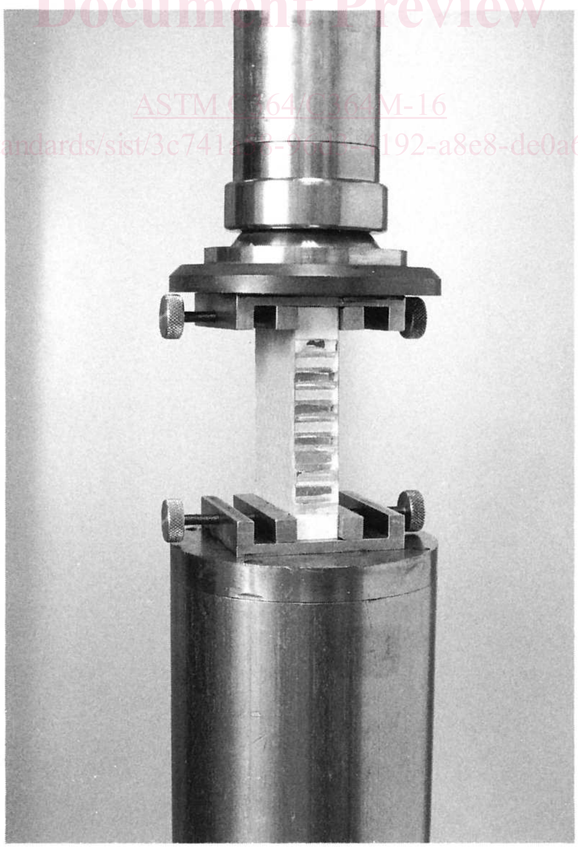
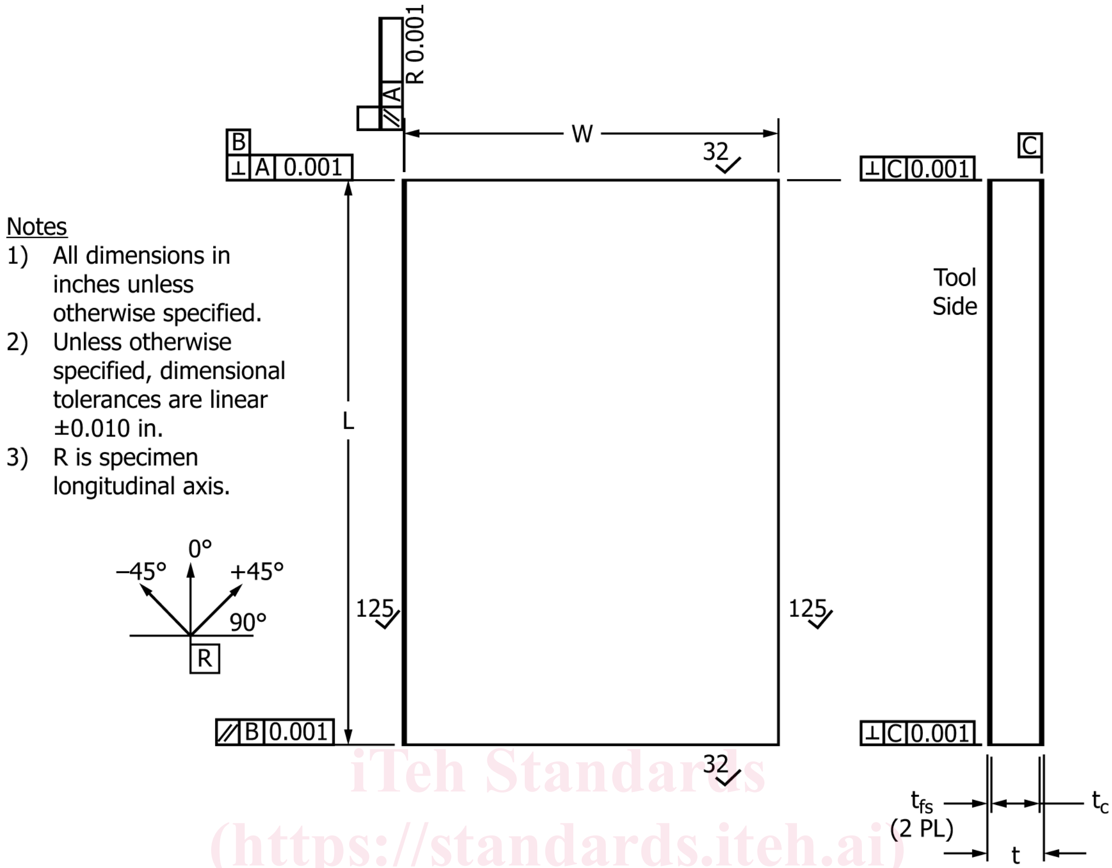


FIG. 1 Edgewise Compression Test Setup



Dimension	Recommended Range
Length, L (in.)	L ≤ 8 × *t*
Width, W (in.)	2.00 ≤ W ≤ L; W ≥ 2 × *t*; W ≥ 4 × cell widths (honeycomb only)
t, total panel thickness (in.)	As required, in order to be representative of intended use
Facesheet thickness, t_{fs}(in.)	As required, in order to be representative of intended use
Core thickness, t_c(in.)	As required, in order to be representative of intended use

FIG. 2 Test Specimen Dimension (inch-pound version)

7.4 *Conditioning Chamber*—When conditioning materials at non-laboratory environments, a temperature/vapor-level controlled environmental conditioning chamber is required that shall be capable of maintaining the required temperature to within ±3°C [±5°F] and the required relative humidity level to within ±3 %. Chamber conditions shall be monitored either on an automated continuous basis or on a manual basis at regular intervals.

7.5 *Environmental Test Chamber*—An environmental test chamber is required for test environments other than ambient testing laboratory conditions. This chamber shall be capable of maintaining the entire test specimen at the required test environment during the mechanical test.

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*—The test specimens shall be as shown in Fig. 2 (inch-pound units) and Fig. 3 [SI units].

8.3 *Specimen Preparation and Machining*—Guide D5687/D5687M provides recommended specimen preparation practices and should be followed where practical. Of particular note in this end-loaded compression test is the machining quality and dimensional accuracy of the loaded ends, and the overall flatness and parallelism of the sandwich panel, as denoted in Fig. 2 and Fig. 3.

8.3.1 *Labeling*—Label the test specimens so that they will be distinct from each other and traceable back to the panel 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.