



Designation: C 297 – 94 (Reapproved 1999)

Standard Test Method for Flatwise Tensile Strength of Sandwich Constructions¹

This standard is issued under the fixed designation C 297; 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 core flatwise tension strength or the bond between core and facings of an assembled sandwich panel. The test consists of subjecting a sandwich construction to a tensile load normal to the plane of the sandwich, such load being transmitted to the sandwich through thick loading blocks bonded to the sandwich facings or directly to the core.

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 Machines²

3. Significance and Use

3.1 For a sandwich panel to function properly, the facings must have a sufficient bond to the core.

3.2 This test method provides information on how well the facings are bonded to the core or the flatwise tensile strength of the core. It is mainly used as a quality control test for bonded sandwich panels.

4. Apparatus

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

4.2 *Loading fixtures*, the loading fixtures shall be self-aligning and shall not apply eccentric loads. A satisfactory type

of apparatus is shown in Fig. 1. The loading blocks shall be sufficiently stiff to keep the bonded facings essentially flat under load. Loading blocks 40 to 50 mm (1.5 to 2.0 in.) thick have been found to perform satisfactorily.

4.3 *Micrometer, gage, or caliper*, capable of measuring accurately to 0.025 mm (0.001 in.).

5. Test Specimens

5.1 Test specimens shall be square or round and equal in thickness to the sandwich panel thickness. All dimensions shall be measured to the nearest 0.25 mm (0.01 in.). Minimum areas for various types of core materials are given below:

5.1.1 For continuous cores, such as balsa wood and foams, the minimum facing area of the specimen shall be 625 mm² (1 in.²).

5.1.2 For open-celled cores, such as honeycomb, having cells less than 6 mm (0.5 in.), the minimum area shall be 2600 mm² (4 in.²), and for cells 6 mm (0.5 in.) or greater, the minimum area shall be 5800 mm² (9 in.²).

5.2 The loading blocks shall be bonded to the facings of the test specimen using a suitable adhesive. Ideally, the bonding temperature and pressure shall not appreciably affect the existing bond between facing and core. The bonding pressure shall not be greater than the original facing to core bonding pressure. If possible, the assembly temperature shall be room temperature or at least 28°C (50°F) lower than that at which the sandwich was originally bonded.

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, at least five specimens shall be tested.

6. Conditioning

6.1 When the physical properties of the component materials are affected by moisture, bring the test specimens to constant weight ($\pm 1\%$) before testing, preferably in a conditioning room with temperature and humidity control, and make the tests, preferably, in a room under the same conditions. A temperature of $23 \pm 3^\circ\text{C}$ ($73 \pm 5^\circ\text{F}$) and a relative humidity of $50 \pm 5\%$ are recommended.

¹ This test method is under the jurisdiction of ASTM Committee D-30 on Composite Materials and is the direct responsibility of Subcommittee D30.09 on Sandwich Construction.

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



FIG. 1 Flatwise Tension Test Setup

7. Procedure

7.1 Determine the plan dimensions of the specimens in millimetres (inches) to a precision of $\pm 0.5\%$.

7.2 Measure the thickness of the specimens in millimetres (inches) to the nearest 0.025 mm (0.001 in.).

7.3 Apply a tensile load at a constant rate of movement of the testing machine cross-head at such a rate that the maximum load will occur between 3 and 6 min (Note 1). One acceptable test setup is shown in Fig. 1.

7.4 An adhesion failure of the bond to the loading blocks is not considered a valid failure. A retest shall be performed.

NOTE 1—A suggested rate of cross-head movement is 0.50 mm/min (0.020 in./min).

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8. Calculation

8.1 Calculate the flatwise tensile strength as follows:

$$\sigma = \frac{P}{A} \quad (1)$$

where:

σ = flatwise tensile strength, MPa (psi);

P = ultimate load, N (lb); and

A = cross-sectional area, mm² (in.²).

9. Report

9.1 The report shall include the following:

9.1.1 Description of test specimens; core material, facings, core-to-facing adhesive,

9.1.2 Dimensions of test specimens,

9.1.3 Method of bonding specimen to blocks; 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 Flatwise tensile strength; individual values and average, and

9.1.8 Description of failure mode; percentage of failure area of core, adhesive (cohesion or adhesion), or facing (Note 2).

NOTE 2—Failure definitions:

core failure—tensile failure of the sandwich core. Pieces of the core are in the adhesive that bonds the core to the block or facing.

cohesive failure of adhesive—failure in the adhesive layer used to bond the facing to the core or the block to the core. The adhesive is on the core and the facing or block.

adhesion failure of adhesive—failure by disbonding of the adhesive to the core or to the facing or block. No adhesive on the core or on the facing or block.

facing failure—tensile failure of the facing. Usually by delamination of composite plies in the case of a fiber-reinforced composite facing.

10. Precision and Bias

10.1 *Precision*—The precision of the procedure in Test Method C 297 for measuring sandwich construction flatwise tensile strengths will be determined in the future.

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 flatwise tension; sandwich; sandwich construction; tensile strength