Designation: C 273 – 00$^{\epsilon 1}$

Standard Test Method for Shear Properties of Sandwich Core Materials[1]

This standard is issued under the fixed designation C 273; 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.

ϵ^1 NOTE—In 5.3, the value 6 000 000 lb-in.^{2}/in. was editorially corrected to 600 000 lb-in.^{2}/in. in July 2000.

1. Scope

1.1 This test method covers the determination of shear properties of sandwich construction core materials associated with shear distortion of planes parallel to the facings. It covers the determination of shear strength parallel to the plane of the sandwich, and the shear modulus associated with strains in a plane normal to the facings. The test may be conducted on core materials bonded directly to the loading plates or the sandwich facings bonded to the plates.

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:*

C 393 Test Method for Flexural Properties of Flat Sandwich Constructions[2]

C 394 Test Method for Shear Fatigue of Sandwich Core Materials[2]

E 4 Practices for Force Verification of Testing Machines[3]

3. Significance and Use

3.1 The core shear properties are fundamental properties that are used in the design of sandwich panels. This test method provides information on the load-deflection behavior of sandwich constructions or cores when loaded in shear parallel to the plane of the facings. From a complete load-deflection curve, it is possible to compute core shear stress at any load (such as the shear stress at proportional limit, at yield, or at maximum load) and to compute an effective core shear modulus.

3.2 The test does not produce pure shear, but the specimen length is prescribed so that secondary stresses have a minimum effect. Approximate shear properties can also be obtained from a sandwich flexure test (see Test Method C 393).

3.3 This test method provides a standard method of obtaining sandwich core shear data for quality control, acceptance specification testing, sandwich design, and research and development.

4. Apparatus

4.1 *Test 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 *Deflectometer, compressometer, or extensometer*, capable of measuring the displacement with a precision of at least ±1 %.

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

5. Test Specimens

5.1 The test specimen shall have a thickness equal to the thickness of the sandwich, a width not less than 50 mm (2 in.), and a length not less than twelve times the thickness, except as agreed upon by the purchaser and the seller.

5.2 Measure the thickness to the nearest 0.025 mm (0.001 in.) and the length and width to the nearest 0.25 mm (0.01 in.). Weigh the specimen to the nearest 0.1 g and calculate the specimen density.

5.3 The test specimen shall be rigidly supported by means of steel plates bonded to the facings (Note 1) as shown in Fig. 1. The thickness of the plates may be varied in accordance with the strength of the sandwich, but the plate length shall be such that the line of action of the direct tensile or compressive force shall pass through the diagonally opposite corners of the sandwich as shown in Fig. 1. A correct line of load action may also be obtained by modifying the core length to thickness ratio provided the requirements in 5.1 are fulfulled. It has been

[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 Jan. 10, 2000. Published March 2000. Originally published as C 273 – 51T. Last previous edition C 273 – 94.

[2] *Annual Book of ASTM Standards*, Vol 15.03.

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

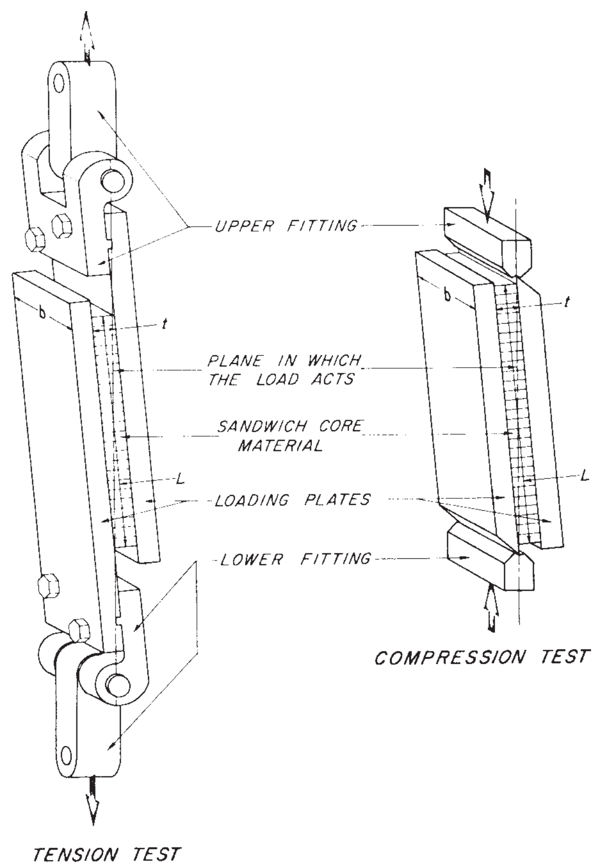


FIG. 1 Plate Shear Specimens, Load Line of Action

found that loading plates having a bending stiffness per unit width, $D = EI/b$, not less than 2.67 MN - mm^2/mm width per millimetre of core thickness (600 000 lb-in.^{2}/in. per inch of core thickness) have performed satisfactorily.

5.4 If the core material shows directional characteristics with respect to shear strength, separate tests shall be made to obtain shear stresses in each of the principal directions.

NOTE 1—To ensure a core shear failure on some honeycomb cores, two plies of adhesive must be used to bond the honeycomb to the steel plates. This provides deeper adhesive fillets on the honeycomb cell walls.

6. Conditioning

6.1 When the physical properties of the component materials are affected by moisture, bring the test specimens to constant weight (±1 %) before testing, preferably in a conditioning room with temperature and humidity control, and make the shear 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.

7. Procedure

7.1 Apply the load to the ends of the rigid plates in compression or tension through a spherical bearing block or a universal joint so as to distribute the load uniformly across the width of the specimen (Fig. 2 and Fig. 3). The tensile shear plates can be attached with bolts or pins to the loading fixture. Apply the load at a constant rate of movement of the testing machine cross-head at such a rate that the maximum load will occur within 3 to 6 min (Note 2).

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

7.2 The failure mode desired is a 100 % shear failure of the core. Specimens that exhibit cohesive failures of the core-to-plate adhesive or adhesion failures to the core or plates should be rejected. The thickness of the adhesive bond to honeycomb core (adhesive-filled depth into the honeycomb core cells) may affect the core shear strength and modulus values depending on the core thickness.

7.3 Data for load-deflection curves may be used to determine the effective shear modulus of the core material. Measure the relative displacement between the steel plates by means of transducers, compressometers or extensometers. The displacement apparatus can be on the specimen side or on the back, and it shall be as close to the center as possible.

8. Calculation

8.1 Calculate the shear stress as follows:

$$\tau = \frac{P}{L\,b} \tag{1}$$

where:
τ = core shear stress, MPa (psi);
P = load on specimen, N (lb);
L = length of specimen, mm (in.); and
b = width of specimen, mm (in.).

8.2 Obtain the ultimate shear strength using Eq 1 when P equals the maximum load and the shear yield strength where P equals the yield load. For core materials that yield more than 2 % strain, use the 2 % offset method for the yield strength.

8.3 Calculate the shear modulus as follows:

$$G = \frac{S\,t}{L\,b} \tag{2}$$

where:
G = core shear modulus, MPa (psi);
S = $\Delta P/\Delta u$, slope of initial portion of load-deflection curve, N/mm (lb/in.);
u = displacement of loading plates; and
t = thickness of core, mm (in.).

9. Report

9.1 The report shall include the following:

9.1.1 Mode of testing; tension or compression,

9.1.2 Description of test specimens; core material, facings if used,

9.1.3 Dimensions of the test specimens, core orientation,

9.1.4 Method of bonding specimen to plates; adhesive, cure cycle, and pressure,

9.1.5 Specimens conditioning, if any,

9.1.6 Test temperature and specimens time at temperature,

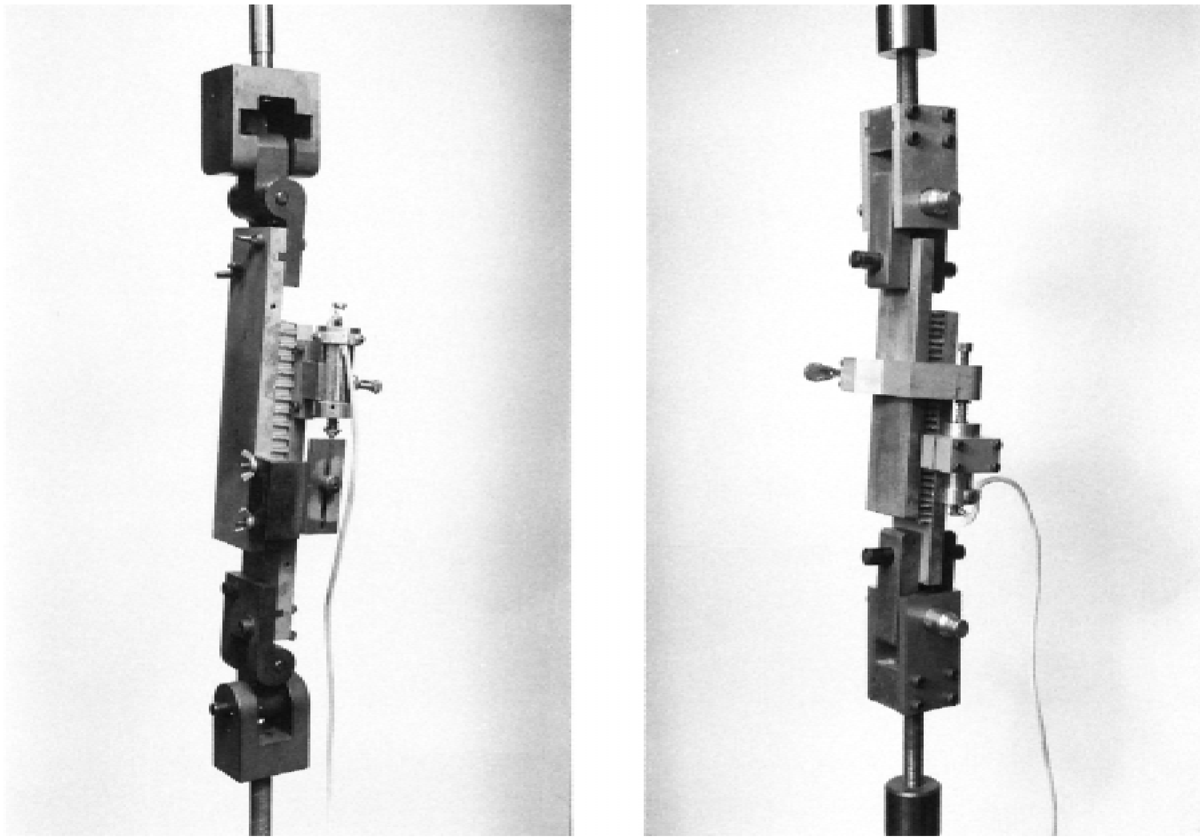
9.1.7 Test machine cross-head loading rate,

9.1.8 Shear strength; individual values and average,

9.1.9 Shear modulus; individual values and average,

9.1.10 Load-deflection curves, if required, and

9.1.11 Description of failure mode; whether core, adhesive, or bond failure occurred.



(a) Bolted Specimen (b) Pinned Specimen

FIG. 2 Tensile Plate Shear Tests

10. Precision and Bias

10.1 *Precision*—The precision of the procedure in Test Method C 273 for measuring sandwich core material shear properties is not available.

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

11. Keywords

11.1 sandwich core; shear; shear modulus; shear strength

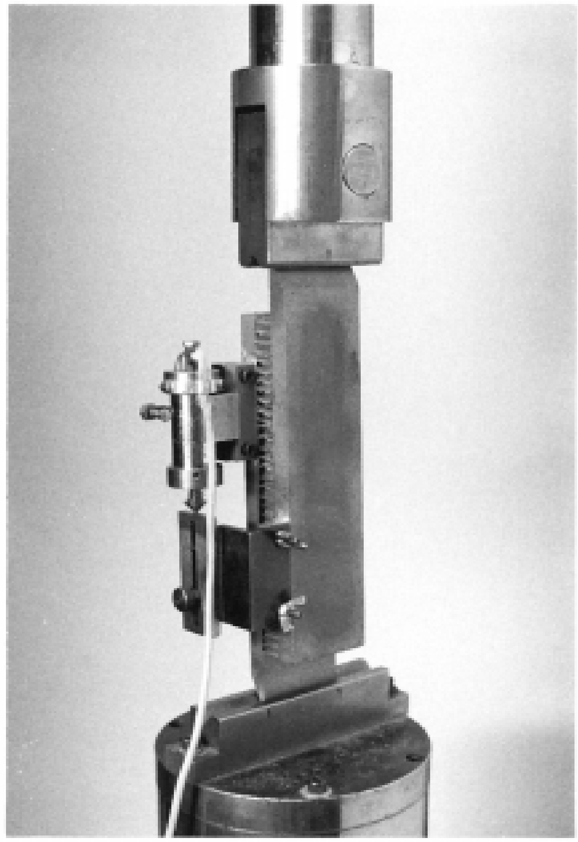


FIG. 3 Compressive Plate Shear Test