Designation:C480–99 (Reapproved 2005) Designation: C 480/C 480M – 08

Standard Test Method for Flexure Creep of Sandwich Constructions[1]

This standard is issued under the fixed designation C 480/C 480M; 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

1.1This test method covers the determination of the creep characteristics and creep rate of sandwich constructions loaded in flexure, at any desired temperature.

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

1.1 This test method covers the determination of the creep characteristics and creep rate of flat sandwich constructions loaded in flexure, at any desired temperature. 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 either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance 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:* *ASTM Standards:*[2]

C 274 Terminology of Structural Sandwich Constructions

C393Test Method for Flexural Properties of Sandwich Constructions 393/C 393M Test Method for Core Shear Properties of Sandwich Constructions by Beam Flexure

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

D 7249/D 7249M Test Method for Facing Properties of Sandwich Constructions by Long Beam Flexure

E 6 Terminology Relating to Methods of Mechanical Testing

E 122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process

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

3. Significance and Use

3.1The determination of the creep rate provides information on the behavior of sandwich constructions under constant load. Creep is defined as deflection under constant load over a period of time beyond the initial deformation as a result of the application of the load. Deflection data obtained from this test method can be plotted against time, and a creep rate determined. By using standard specimen constructions and constant loading, the test method may also be used to evaluate creep behavior of sandwich panel core-to-facing adhesives.

3.2This test method provides a standard method of obtaining flexure creep of sandwich constructions for quality control,

[1] This specification 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 Mar.Sept. 1, 2005.2008. Published March 2005.October 2008. Originally approved in 1961. Last previous edition approved in 19992005 as C 480 – 99(2005).

[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.

acceptance specification testing, and research and development. 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 6 defines terms relating to mechanical testing. 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 terminology documents.

3.2 *Symbols:*

3.2.1 *A*—distance between pivot point and point of applied force on the specimen

3.2.2 *b*—specimen width

3.2.3 *B*—distance from pivot point to center of gravity of the loading arm

3.2.4 *c*—core thickness

3.2.5 CR_I—creep rate at time, i_i

3.2.6 *d*—sandwich total thickness

3.2.7 *d*—initial static deflection under the same load and at the same temperature

3.2.8 *D*—total deflection at time, *t*

3.2.9 F_f—applied facing stress

3.2.10 F_s—applied core shear stress

3.2.11 *M*—distance between point and weight point

3.2.12 *n*—number of specimens

3.2.13 *p*—mass of loading plate and rod

3.2.14 *P*—applied force

3.2.15 *S*—length of support span

3.2.16 *w*—mass of lever arm

3.2.17 *W*—mass of weight (including tray mass)

4. Summary of Test Method

4.1 This test method consists of subjecting a beam of sandwich construction to a sustained force normal to the plane of the sandwich, using either a 3-point or a 4-point loading fixture. Deflection versus time measurements are recorded.

4.2 For long beam specimens conforming to Test Method D 7249/D 7249M, the only acceptable failure modes for sandwich facesheet strength are those which are internal to one of the facesheets. Failure of the sandwich core or the core-to-facesheet bond preceding failure of one of the facesheets is not an acceptable failure mode for this specimen configuration.

4.3 For short-beam specimens conforming to Test Method C 393/C 393M, the only acceptable failure modes are core shear or core-to-facing bond. Failure of the sandwich facing preceding failure of the core or core-to-facing bond is not an acceptable failure mode for this specimen configuration.

4.4 Careful post-test inspection of the specimen is required as facing failure occurring in proximity to the loading points can be caused by local through-thickness compression or shear failure of the core that precedes failure of the facing.

5. Significance and Use

5.1 The determination of the creep rate provides information on the behavior of sandwich constructions under constant applied force. Creep is defined as deflection under constant force over a period of time beyond the initial deformation as a result of the application of the force. Deflection data obtained from this test method can be plotted against time, and a creep rate determined. By using standard specimen constructions and constant loading, the test method may also be used to evaluate creep behavior of sandwich panel core-to-facing adhesives.

5.2 This test method provides a standard method of obtaining flexure creep of sandwich constructions for quality control, acceptance specification testing, and research and development.

5.3 Factors that influence the sandwich construction creep response and shall therefore be reported include the following: facing material, core material, adhesive material, methods of material fabrication, facing stacking sequence and overall thickness, core geometry (cell size), core density, core thickness, adhesive thickness, specimen geometry, specimen preparation, specimen conditioning, environment of testing, specimen alignment, loading procedure, speed of testing, facing void content, adhesive void content, and facing volume percent reinforcement. Further, facing and core-to-facing strength and creep response may be different between precured/bonded and co-cured facesheets of the same material.

6. Interferences

6.1 The interferences listed in Test Methods C 393/C 393M and D 7249/D 7249M are also applicable to this test method.

7. Apparatus

4.1The apparatus for loading the specimen shall conform to Test Method C393 except that a constant load shall be applied by means of weights and a lever system.

7.1 *Micrometers and Calipers*—A micrometer having a flat anvil interface, or a caliper of suitable size, shall be used. The instruments(s) shall have an accuracy of ±25 μm [±0.001 in.] for thickness measurement, and an accuracy of ±250 μm [±0.010 in.] for length and width measurements.

NOTE 1—The accuracies given above are based on achieving measurements that are within 1 % of the sample length, width and thickness.

7.2 *Loading Fixtures*— The fixture for loading the specimen shall be a 3-point loading configuration that conforms to either Test Method D 7249/D 7249M (for a long beam test) or to Test Method C 393/C 393M (for a short beam test) except that a constant force shall be applied by means of weights and a lever system. Fig. 1 shows a lever and weight-loading apparatus that has been found satisfactory.

~~4.2*Micrometer, gage, or caliper* , capable of measuring accurately to 0.025 mm (0.001 in.).~~

~~**5.Test Specimens**~~

~~5.1The test specimen shall be of sandwich construction of a size and proportions conforming to the flexure test specimen described in Test Method C393.~~

~~5.2The 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 three specimens shall be tested.~~

~~**6.**~~

7.3 *Deflectometer (LVDT)*—The deflection of the specimen shall be measured in the center of the support span by a properly calibrated device having an accuracy of ±0.025 mm [±0.001 in.] or better.

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 (a minimum of once daily checks are recommended).

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 gage section of the 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 E 122. Report the method of sampling.

8.2 *Geometry, Facing, Core*:

8.2.1 *Core or Core-to-Facing Failure Mode Desired*—The test specimen configuration shall be a sandwich construction of a size and proportions conforming to the flexure test specimen described in Test Method C 393/C 393M. The standard specimen configuration should be used whenever the specimen design equations in Section 8.2.3 of C 393/C 393M indicate that a core of core-to-facing bond failure mode is expected. In cases where the standard C 393/C 393M specimen configuration will not produce a desired failure, a non-standard specimen shall be designed to produce a core or bond failure mode.

8.2.2 *Facesheet Failure Mode Desired*— The test specimen configuration shall be a sandwich construction of a size and proportions conforming to the flexure test specimen described in Test Method D 7249/D 7249M. A non-standard 3-point loading specimen configuration shall be designed per Section 8.2.3 of D 7249/D 7249M to achieve a facing failure mode. The standard 4-point loading D 7249/D 7249M specimen configuration may be used if a suitable creep loading apparatus is used.

8.3 *Compression Side Facing*—Unless otherwise specified by the test requestor, the bag-side facing of a co-cured composite sandwich panel shall be placed as the upper, compression-loaded facing during test, as facing compression strength is more sensitive to imperfections typical of bag-side surfaces (for example, intra-cell dimpling) than is facing tension strength. Creep response is expected to follow the same trends as static strength.

8.4 *Specimen Preparation and Machining* —Specimen preparation is extremely important for this test method. Take precautions when cutting specimens from large panels to avoid notches, undercuts, rough or uneven surfaces, or delaminations due to

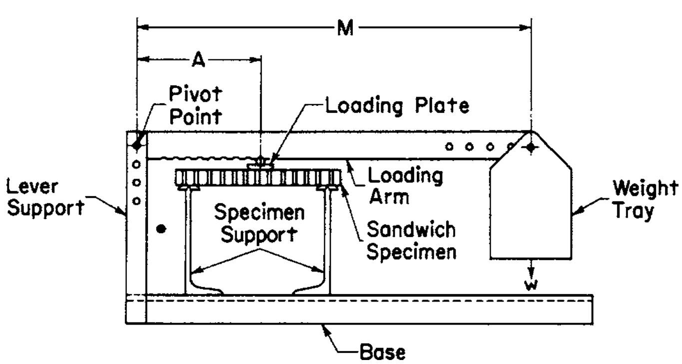

FIG. 1 Creep Test Apparatus and Loading System