



Standard Practice for Elevated Temperature and Moisture Conditioning of Pultruded Fiber Reinforced Polymer (FRP) Composites Used in Structural Designs¹

This standard is issued under the fixed designation D7992/D7992M; 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 In general, it is feasible that the mechanical properties of FRP composites will be affected by environmental conditions such as exposure to moisture at elevated temperatures. In order to make reliable comparisons between different materials under elevated temperature and moisture environmental conditions, it is necessary to standardize the elevated temperature and moisture conditions to which specimens of these materials are subjected prior to and during testing. This practice defines procedures for elevated temperature and moisture conditioning of pultruded FRP composites intended for use in structural design applications. The conditioning medium representing elevated temperature and moisture exposure described in this standard practice is distilled water maintained at $37.8 \pm 1.5^\circ\text{C}$ ($100 \pm 3^\circ\text{F}$) for 1000 hours.

1.2 *Units*—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 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:²

[D618 Practice for Conditioning Plastics for Testing](#)

[D3918 Terminology Relating to Reinforced Plastic Pultruded Products](#)

¹ This test method is under the jurisdiction of ASTM Committee [D20](#) on Plastics and is the direct responsibility of Subcommittee [D20.18](#) on Reinforced Thermosetting Plastics.

Current edition approved Sept. 1, 2015. Published October 2015. DOI: 10.1520/D7992_D7992M-15.

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.

[D6641/D6641M Test Method for Compressive Properties of Polymer Matrix Composite Materials Using a Combined Loading Compression \(CLC\) Test Fixture](#)

[D7290 Practice for Evaluating Material Property Characteristic Values for Polymeric Composites for Civil Engineering Structural Applications](#)

[D7745 Practice for Testing Pultruded Composites](#)

3. Terminology

3.1 Definitions:

3.1.1 *standard laboratory temperature, n*—a temperature of $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$)

3.1.2 *standard laboratory atmosphere, n*—an atmosphere having a temperature of $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) and a relative humidity of $50 \pm 10\%$.

3.1.3 *elevated temperature and moisture resistance, n*—the ability of a thermoset pultruded composite to withstand elevated temperature and moisture exposure at $37.8 \pm 1.5^\circ\text{C}$ ($100 \pm 3^\circ\text{F}$) for 1000 hours. This ability will be quantified in terms of the % retention of the mechanical property of interest as compared to samples held at standard laboratory atmosphere.

3.2 Terminology relating to pultruded composites is found in Terminology [D3918](#).

4. Significance and Use

4.1 The elevated temperature and moisture conditioning procedures prescribed in this practice are designed to provide a standard procedure to be used to evaluate and compare the effect of elevated temperature and moisture conditioning under controlled laboratory conditions on pultruded FRP composites to be used in structural design applications. The conditioning procedures prescribed in this practice are designed to obtain reproducible results to compare and evaluate these materials but are not intended to produce equilibrium conditions or actual service conditions for these materials.

5. Sampling

5.1 Sampling shall be in accordance with the locations from which test specimens shall be taken from the reinforced pultruded composites as defined in Practice [D7745](#).

5.2 Sampling shall be in accordance with the ASTM test methods for the specific mechanical properties to be determined.³

6. Test Specimens

6.1 The numbers and types of test specimens shall be in accordance with the ASTM test methods for the specific mechanical properties to be determined. If Practice **D7290** is to be used to determine characteristic values for a particular mechanical property, at least ten samples are needed for the control and ten samples are needed for the elevated temperature and moisture conditioning for a total of at least 20 samples.

6.2 Test specimens shall be machined or otherwise fabricated to the test coupon geometry specified by the ASTM test method for the property to be determined prior to their exposure to the environmental conditioning.

6.3 The thickness of the test specimens shall be the original product thickness without any machining of the surface. The specimen thickness needs to be compatible with the thickness requirements of the mechanical property test method that will be used to evaluate the samples.

6.4 All test specimens shall be conditioned in the standard laboratory atmosphere in accordance with Practice **D618**, Procedure A prior to initiating the elevated temperature and moisture conditioning procedures described here.

7. Apparatus

7.1 *Conditioning Chamber*—A temperature controlled water bath is to be used for immersion purposes. This bath is to be capable of maintaining a constant water temperature of $37.8 \pm 1.5^{\circ}\text{C}$ ($100 \pm 3^{\circ}\text{F}$) and is to be equipped with a device or mechanism for separating test specimens from each other such that the faces of the gage sections of the specimens do not rest against one another. If necessary due to space available in the conditioning chamber, it is acceptable to stack samples in a lattice type arrangement such that the samples lie on each other at the grip area. The chamber dimensions need to be such that the depth of the water necessary to immerse the samples is no more than 0.5 m (19.7 in.). The temperature of the water bath is to be monitored at least daily, and the water bath must possess a cover in order to minimize loss of water to the air through evaporation.

7.2 *Water Pump*—In order to reduce or minimize ‘dead zones’ in the water bath of the conditioning chamber, a small water pump (or similar device) shall be placed in the water bath. It is acceptable to utilize an air pump for this purpose; if such an air pump is used, the information shall be reported.

³ To evaluate the effect of elevated temperature and moisture conditioning on the matrix and fiber/matrix interface of a pultruded composite material, the use of Test Method **D6641/D6641M** for mechanical property determination is suggested. To evaluate the effect of freeze/thaw cycling on the matrix and fiber/matrix interface of a pultruded composite material, the use of Test Method **D6641/D6641M** for mechanical property determination is suggested. If other property effects are to be examined, appropriate test methods for the desired property should be selected.

8. Procedure

8.1 Distilled water shall be used for all conditioning. Distilled water is to be used to serve as a standard medium for the conditioning procedure; however, distilled water is not intended to mimic field conditions.

8.2 The presence of any residue in the water bath during the exposure time shall be noted in the report as the presence of residue indicates a material loss of the test specimens.

8.3 Samples shall be immersed in distilled water in the conditioning chamber for 1000 ± 8 hours, with the ± 8 hour time period to be utilized for the mechanical property testing of the samples.

8.3.1 The conditioning chamber is required to be thoroughly cleaned with distilled water and wiped clean of debris prior to use. The temperature sensor must be placed in such a way that its sensor does not come in contact with the walls of the conditioning chamber.

8.3.2 Prepare the conditioning chamber by filling it with distilled water and control its temperature until it is steady at the temperature required for conditioning the samples. Allow the conditioning chamber to stabilize at $37.8 \pm 1.5^{\circ}\text{C}$ prior to the immersion of the samples.

8.3.3 Daily monitoring of the temperature of the conditioning chamber and water level is recommended until 1000 ± 8 hours of immersion conditioning are reached.

8.4 Perform tests for desired mechanical properties on the unconditioned samples held at standard laboratory atmosphere to establish the baseline properties of the material prior to the elevated temperature and moisture conditioning testing.

8.5 Perform tests for the desired mechanical properties on the elevated temperature and moisture conditioning specimens after 1000 ± 8 hours of conditioning according to the applicable ASTM mechanical property test method.

8.5.1 When conducting mechanical property tests on specimens removed from the water immersion, wipe the specimens with a dry cloth and test them at standard laboratory temperature.

8.5.2 Do not remove specimens from the water until the mechanical property tests are ready to be conducted.

8.5.3 Record the testing time period in the report.

9. Precision and Bias

9.1 No statements of precision and bias are applicable to this practice; these are dependent upon the ASTM test methods for the specific properties to be determined.

10. Report

10.1 The report of any test referencing this practice shall state:

10.1.1 The specific identification of the pultruded composite.

10.1.2 The location on the pultruded composite from which the specimens were machined.

10.1.3 The geometry of the test specimens used and the mechanical testing procedure for which they were prepared.

10.1.4 Any deviation from the specified conditioning procedures.



10.1.5 The time period of testing of each specimen.

10.1.6 Any visual observations made during the conditioning or subsequent testing.

10.1.7 The % retention of the mechanical property of interest after elevated temperature and moisture conditioned

samples as compared to the same mechanical property for samples exposed to standard laboratory atmosphere.

11. Keywords

11.1 elevated temperature; moisture immersion; pultrusion

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org). Permission rights to photocopy the standard may also be secured from the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, Tel: (978) 646-2600; <http://www.copyright.com/>