Designation: D7361 – 07 (Reapproved 2018)

Standard Test Method for Accelerated Compressive Creep of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method[1]

This standard is issued under the fixed designation D7361; 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 accelerated testing for compressive creep properties using the stepped isothermal method (SIM).

1.2 The test method is focused on geosynthetic drainage materials such as HDPE geonet specimens.

1.3 The SIM tests are laterally unconfined tests based on time-temperature superposition procedures.

1.4 Ramp and hold (R+H) tests may be completed in conjunction with SIM tests. They are designed to provide additional estimates of the initial rapid compressive creep strain levels appropriate for the SIM results.

1.5 This method can be used to establish the sustained load compressive creep characteristics of a geosynthetic that demonstrates a relationship between time-dependent behavior and temperature. Results of this method are to be used to augment results of compressive creep tests performed at 20 ± 1 °C and may not be used as the sole basis for determination of long-term compressive creep behavior of geosynthetic material.

1.6 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.7 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1621 Test Method for Compressive Properties of Rigid Cellular Plastics

D2990 Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics

D4439 Terminology for Geosynthetics

D5262 Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics

D6364 Test Method for Determining Short-Term Compression Behavior of Geosynthetics

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions related to geosynthetics, see Terminology D4439.

3.1.2 For definitions related to creep, see Test Methods D2990 and D5262 and Terminology D4439.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *compressive creep*—time-dependent deformation that occurs when a specimen is subjected to a constant compressive load.

3.2.2 *compressive creep modulus*—in SIM analysis, the load divided by the percent compressive strain at any given point in time.

3.2.3 *dwell time*—time during which conditions (particular load) are held constant between temperature steps.

3.2.4 *mean test temperature*—the arithmetic average of all temperature readings of the atmosphere surrounding the test specimen for a particular temperature step, starting at a time not later than established temperature ramp time, and finishing at a time just prior to the subsequent temperature reset.

[1] This test method is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.02 on Endurance Properties.

Current edition approved Feb. 1, 2018. Published February 2018. Originally approved in 2007. Last previous edition approved in 2012 as D7361 – 07 (2012). DOI: 10.1520/D7361-07R18.

[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.

3.2.5 *offset modulus method or pointing*—data analysis method used to normalize any prestrain in the samples by shifting the origin of a stress-versus-strain curve to an axis origin of coordinates, that is, to coordinates (0,0).

3.2.6 *ramp and hold (R+H) test*—a creep test of very short duration, for example, 100 to 1000 s.

3.2.7 *shift factor*—the displacement along the log time axis by which a section of the creep or creep modulus curve is moved to create the master curve at the reference temperature. Shift factors are denoted by the symbol ~ when the displacements are generally to shorter times (attenuation) or the symbol a_T when the displacements are generally to longer times (acceleration).

3.2.8 *stepped isothermal method (SIM)*—a method of exposure that uses temperature steps and dwell times to accelerate creep response of a material being tested under load.

3.2.9 *time-temperature superposition*—the practice of shifting viscoelastic response curves obtained at different temperatures along a horizontal log time axis so as to achieve a master curve covering an extended range of time.

3.2.10 *viscoelastic response*—refers to polymeric creep, strain, stress relaxation, or a combination thereof.

4. Summary of Test Method

4.1 *SIM*—A procedure whereby specified temperature steps and dwell times are used to accelerate viscoelastic creep characteristics during which strain and load are monitored as a function of time.

4.1.1 *Compressive Creep*—Constant compressive load in conjunction with specified temperature steps and dwell times are used to accelerate compressive creep strain response.

4.2 *R+H*—Test specimens are ramp loaded at a predetermined loading rate to a predetermined load and held under constant load (short-term creep test).

5. Significance and Use

5.1 Use of the SIM decreases the time required for creep to occur and the obtaining of the associated data.

5.2 The statements set forth in 1.5 are very important in the context of significance and use, as well as scope of the standard.

5.3 Creep test data are used to calculate the creep modulus of materials as a function of time. These data are then used to predict the long-term creep deformation expected of geosynthetics used in drainage applications.

NOTE 1—Currently, SIM testing has focused mainly on geonets made from high-density polyethylene. Additional testing on other materials is ongoing.

5.4 R+H testing is done to establish the range of creep strains experienced in the brief period of very rapid response following the peak of the load ramp.

6. Apparatus

6.1 *Loading Platens*—Loading platens for SIM and R+H tests should conform to Test Method D6364, Standard Test Method for Determining the Short-Term Compression Behavior of Geosynthetics.

6.2 *Testing Machine*—A universal testing machine or a dead-weight loading system with the following capabilities and accessories shall be used for testing:

6.2.1 Load measurement and control,

6.2.2 Strain measurement,

6.2.3 Time measurement,

6.2.4 Environmental temperature chamber to facilitate control of test conditions,

6.2.4.1 Temperature measurement and control facilities,

6.2.5 Other environmental measurement and control, and

6.2.6 Computer data acquisition and control.

7. Sampling

7.1 The specimens used for R+H and SIM tests should all be taken from the same sample.

7.2 Remove one (1) test specimen from the sample for each SIM test.

7.3 Remove one (1) test specimen from the sample for each R+H test.

8. Test Specimens

8.1 Specimens should be at least 120 by 120 mm (4.7 by 4.7 in.).

8.2 *Number of Tests:*

8.2.1 A single specimen is usually sufficient to define a master creep or relaxation curve using the SIM. However, if only a single SIM test is to be performed, the location of the onset of creep strain or modulus curve should be confirmed using at least two R+H tests.

9. Conditioning

9.1 Compression testing via Test Method D6364 and SIM testing shall be conducted using 20 ± 1 °C as the reference or temperature standard. If the laboratory is not within this range, perform tests in a suitable environmental chamber capable of controlled cooling and heating. The environmental chamber should have a programmable or set-point controller so as to maintain temperature to 20 ± 1 °C. When agreed to, a reference temperature other than 20 °C can be utilized. Also, when agreed to, the results of testing under this standard can be shifted from one reference temperature to another.

9.2 Allow the specimen adequate time to come to temperature equilibrium in the laboratory or environmental chamber. Generally, this can be accomplished within a few hours (see Note 2).

9.3 Record the relative humidity in the laboratory or environmental chamber for all tests.

10. Selection of Test Conditions

10.1 The standard environment for testing is dry, since the effect of elevated temperature is to reduce the humidity of ambient air without special controls.

10.2 The standard reference temperature is 20 °C unless otherwise agreed to. The individual reference temperature for each SIM test is the average achieved temperature of the first dwell time.