Designation: E2399 – 05

Standard Test Method for Maximum Media Density for Dead Load Analysis of Green Roof Systems[1]

This standard is issued under the fixed designation E2399; 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 a procedure for determining the maximum media density for purposes of estimating the maximum dead load for green roof assemblies. The method also provides a measure of the moisture content and the water permeability measured at the maximum media density.

1.2 This procedure is suitable for green roof media that contain no more than 30 % organic material as measured using the loss on ignition procedure Test Methods F1647, Method A.

1.3 The maximum media density and associated moisture content measured in this procedure applies to drained conditions near the saturation point.

1.4 The test method is intended to emulate vertical percolation rates for water in green roofs.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.6 *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 to determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3(600 kN-m/m^3))

D2325 Test Method for Capillary-Moisture Relationships for Coarse- and Medium-Textured Soils by Porous-Plate Apparatus[3]

E631 Terminology of Building Constructions

E2114 Terminology for Sustainability Relative to the Performance of Buildings

F1647 Test Methods for Organic Matter Content of Putting Green and Sports Turf Root Zone Mixes

3. Terminology

3.1 *Definitions:*

3.1.1 For terms related to building construction, refer to Terminology E631.

3.1.2 For terms related to sustainability relative to the performance of buildings, refer to Terminology E2114.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *maximum media density*—the density of a mixed media material determined after it has been subjected to a specific amount of compaction and hydrated by immersion to simulate prolonged exposure to both foot traffic and rainfall.

3.2.1.1 *Discussion*—The maximum media density applies to drained conditions.

3.2.2 *maximum media water retention*—the quantity of water held in a media at the maximum media density.

3.2.2.1 *Discussion*—This is useful measure of the capacity of a media to hold water under drained conditions.

3.2.3 *saturation point*—the moisture content at which the soil tension in the mixed media is zero, but a free water surface has not developed.

3.2.3.1 *Discussion*—The saturation point represents the theoretical maximum moisture content that a material can contain in a drained state.

3.2.4 *water permeability*—the coefficient, which when multiplied by the hydraulic gradient will yield the apparent velocity with which water, at 68°F (20°C) will move through a cross-section of media.

3.2.4.1 *Discussion*—The conditions created in this method apply to freely-drained media where the free water surface is level with the upper surface of the media layer (such as, impending accumulation of water above the surface of the media).

4. Summary of Test Method

4.1 This test method involves compressing a moist sample of a media into a perforated mold using specified compaction developed using a Proctor hammer. The sample is subsequently

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[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] Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

immersed in a water bath for 24 hours to promote full hydration of the material. After allowing the sample to drain briefly, its density and moisture content are determined using standard gravimetric procedures. This procedure also includes a method for estimating the water permeability using a pseudo-constant head procedure.

4.2 This test method involves measuring the density of the media after the sample has been allowed to drain for 2 h. This measurement is the maximum media density. The 2-h measurement is valuable to the green roof designer, since it is directly comparable to media densities determined using the most common international procedures for establishing green roof dead load values.

5. Significance and Use

5.1 This test method describes simple laboratory methods that provide reproduceable measurements of critical media properties, and permit direct comparisons to be made between different media materials.

5.2 The density of mixed media materials will vary depending on the degree to which they are subjected to compaction and the length of time that the material is allowed to hydrate and subsequently drain. Most green roof media materials have a large capacity to absorb and retain moisture. Furthermore, moisture will drain gradually from the media following a hydration cycle. The maximum media density measured in this procedure approaches the density at the theoretical saturation point.

5.3 Existing methods for measuring the capillary-moisture relationship for soils (Test Method D2325) rely on sample preparation procedures (Test Methods D698) that are not consistent with the conditions associated with the placement of green roof media materials. This procedure is intended to provide a reproducible laboratory procedure for predicting the maximum media density, moisture content, and water permeability under conditions that more closely replicate field conditions on green roofs.

5.4 The value of this test method to the green roof designer is that it provides an objective measure of maximum probable media density (under drained conditions) for estimating structural loads. It also provides a method for estimating the lower limit for the water permeability of the in-place media. This latter value is important when considering drainage conditions in green roofs. Finally, the maximum media water retention has been shown to be a useful indicator of the moisture retention properties of green roof media.

6. Apparatus

6.1 *Apparatus*—contains the following:

6.1.1 Cylindrical stainless steel container: inside dimensions 6.5 in. (16.5 cm) high with a 6-in. (15.2 cm) inside diameter and 125 3⁄16-in. (4.75-mm) perforations in the bottom,

6.1.2 U.S. #30 (0.6 mm) sieve disc, 5.8-in. (14.7-cm) diameter,

6.1.3 Steel disk plate, 5.8-in. (14.7-cm) diameter,

6.1.4 Proctor hammer: 10 lb (4.54 kg), with fall height of 18 in. (45.7 cm),

6.1.5 Scale, accurate to 0.005 oz (0.14 kg),

6.1.6 Drying dish,

6.1.7 Plastic water immersion bath with minimum immersion depth of 8 in. (20.3 cm),

6.1.8 Drain stand,

6.1.9 Filter fabric disk, 5.8-in. (14.7-cm) diameter, for covering the upper surface of the sample within the test cylinder,

6.1.10 4-in. (10-cm) concrete cubes (for use as weights),

6.1.11 Measuring scale, supported by a circular wire stand, with marks at 1.5 and 2.0 in. (3.8 and 5.0 cm), and

6.1.12 Thermometer.

7. Conditioning

7.1 The procedure requires a damp sample. If the sample is received in a dry condition, it must be moistened. Add water and incorporate by gently mixing. After moistening, allow the sample to stand in an airtight container for 3 hours before continuing the procedure.

8. Procedure

8.1 *General*:

8.1.1 Establish the weight of the cylinder together with the bottom sieve. Cover the perforations with the sieve disc, and fill the cylinder with the sample material to a height of 4.75 to 5.5 in. (12 to 14 cm). The quantity of material added should be sufficient to produce a sample height of approximately 4 in. (10 cm) after being compressed.

8.1.2 Cover the contained material with the steel plate and compress with 6 blows of the Proctor hammer. Remove the steel plate. Determine the sample height, H_i, in the compressed condition, by measuring the depth from the top of the upper cylinder edge to the upper surface of the sample. Subtract this measurement and the thickness of the steel plate from the inside cylinder height. Compute the initial sample volume, V_i.

8.1.3 Determine the weight of the container together with the contained sample. Compute the initial sample weight, W_i, by subtracting the combined weight of the container and bottom sieve (see above).

8.2 The sample volume and the sample weight must be established initially, before the sample is immersed. Any change in sample volume during subsequent immersion should be reported with the test results. A determination of the sample density in the dry condition is undertaken after determination of the maximum media density capacity

8.3 Cover the upper surface of the sample with the filter fabric disc. Cover the fabric with the sieve disc and place the stone weights on top in order to minimize swelling of the sample during immersion.

8.4 Place the cylinder in the immersion bath and slowly fill with water to a depth of 0.5 in. (1.25 cm) over the top of the sample. As required, fill to maintain the water level. Maintain the temperature of the bath at 68°F ± 5°F (20 ± 2.75°C).

8.5 Remove the cylinder after 24 hours of immersion. Place on the drain stand and allow to drain for 120 min. Wipe the outside of the container dry and remove the blocks and upper sieve disc. Do not remove the fabric. Weigh the cylinder with the contained sample.

8.6 Compute the sample weight, W_{120}, by subtracting the combined weight of the container and bottom sieve disc. Check the final sample height, H, and record changes from the initial