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Standard Test Method for Determining the Tensile Strength of GCCM Materials¹

This standard is issued under the fixed designation D8480; 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 The purpose of the proposed test method is to determine the tensile strength of cured/hydrated GCCM materials to include reporting the initial tensile strength (first crack in the cementitious layer) and final tensile strength for GCCMs as supplied and in a weathered state with the geosynthetic top layer(s) removed.

1.2 As a performance test, this method will be used relatively infrequently and to test large lots of material. This test is not intended for routine quality control testing of GCCMs.

1.3 The values in SI units are to be regarded as the standard. Values in inch-pound units are in parentheses for information.

1.4 *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.*

1.5 *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

D76/D76M Specification for Tensile Testing Machines for Textiles

D4354 Practice for Sampling of Geosynthetics and Rolled Erosion Control Products (RECPs) for Testing

D4439 Terminology for Geosynthetics

D8030/D8030M Practice for Sample Preparation for GCCM

D8364/D8364M Specification for Geosynthetic Cementitious Composite Mat (GCCM) Materials

¹ This test method is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.05 on Geosynthetic Erosion Control.

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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. Terminology

3.1 For definitions of common technical terms used in this standard, refer to Terminology D4439.

3.2 Definitions:

3.2.1 *cured, adj*—a description of the state of a GCCM after hydration for a specified period of time and quantity of water (when known) under specified conditions, followed by a period of time where the GCCM is kept under a specified environmental condition during which the cementitious material continues to cure and develop compressive strength.

3.2.2 *final tensile strength, n*—the tensile strength, expressed in kilonewtons per meter (pound force per inch), is calculated from the maximum breaking load of a GCCM specimen and dividing by the specimen width. The final tensile strength is oriented in either the machine or cross-machine direction.

3.2.3 *initial tensile strength, n*—the tensile strength, expressed in kilonewtons per meter (pound force per inch), is calculated from the initial breaking load of a GCCM specimen (when the cementitious material first cracks, observed as the first reduction in load on a load/extension graph) and dividing by the specimen width. The initial tensile strength is oriented in either the machine or cross-machine direction.

3.2.4 *top layer, n*—the upper layer of the GCCM in contact with the cementitious material that would face away from the subgrade (upwards) in a normal installation. Without this layer, the loose cementitious fill will no longer be constrained.

3.2.5 *uncured, adj*—a description of the state of a GCCM before it has been exposed to a hydration source and typically describes the “as received” dry product after conditioning in a prescribed manner.

4. Significance and Use

4.1 This test method is applicable for testing GCCMs in the cured state. This determines the initial and final breaking load to determine the initial and final tensile strength of the GCCM. It is used with a constant rate of extension type tensile testing machine.

4.2 GCCMs are composites, and the cured cementitious material typically has a lower tensile strength to the geosynthetic layer(s). When testing the tensile strength of a cured GCCM, multiple cracks will typically form in the cementitious

material, transferring loads to the reinforcing fibers (or linking elements) before the ultimate tensile strength of the GCCM is reached. In certain applications, engineers need to know the initial tensile strength of the GCCM, which is when the cementitious material first breaks and the material's rigidity is reduced, not just the final tensile strength (ultimate strength), which is governed primarily by the geosynthetic layer(s).

4.3 In service, the top layer of geosynthetic in a GCCM is particularly exposed to degradation from UV exposure and abrasion, especially in erosion control applications such as for channel lining with high levels of sedimentation in water flow. It is important that reported values take account of the effects of environmental degradation where this has a significant effect on in-service performance. It is therefore also necessary to test the initial and final tensile strength of the GCCM when the top layer has been removed to provide an indication of long-term GCCM tensile performance.

5. Summary of Test Method

5.1 This method applies to testing GCCM tensile strength in the cured state only. The initial breaking load (first crack), the load-versus-displacement behavior, and the final breaking load (maximum load) are all a part of this specification. Uncured GCCM tensile strength testing methodology is described in Specification [D8364/D8364M](#).

5.2 Finally, a specimen with the geosynthetic top layer removed/abraded before testing commences allows a better understanding of the long-term in-service strength of these materials.

6. Apparatus

6.1 *Tensile Testing Machine*—A testing machine of the constant rate of extension type as described in Specification [D76/D76M](#) shall be used. The machine shall be equipped with a device for recording the tensile force and the amount of separation of the grips. Both of these measuring systems shall be accurate to $\pm 2\%$ and, preferably, shall be external to the testing machine. The rate of separation shall be uniform and capable of adjustment within the range of the test.

6.2 *Rotary Tile Saw*, with diamond-tipped blades capable of dry cutting samples. Used for cutting cured sample to predetermined dimension using pattern marked on cured specimen with template and markers.

6.3 *Miscellaneous, Knives, Templates, Markers, Rulers, Saw*, as required for marking, measuring, and cutting specimens to fixed dimensions before measurement of weight. A knife with a “snap off” type blade is recommended for cutting GCCMs, which can dull blade tips rapidly.

6.4 *Clamps*—A gripping system that minimizes (with the goal of eliminating) slippage, damage to the specimen (such as premature cracking of the cementitious material), and uneven stress distribution. The gripping system shall extend to or beyond the outer edge of the specimen to be tested. Manual or pneumatic grips can be used. Pyramid serrated jaws should be used to prevent the GCCM from slipping during the test.

7. Sampling, Test Specimens, and Test Units

7.1 *Lot Sample*—For the lot sample, refer to Practice [D4354](#) for discussion of recommended practice for breaking up shipments of GCCM into lots for testing.

7.2 *Laboratory Samples*—Cut a full-width sample from the lot sample that must be large enough to enable the required number of test specimens for both the machine and cross-machine directions to be cut from it. The laboratory sample must be cut at least 300 mm (1 ft) from the ends of the lot sample. It is essential that the cementitious material is not damaged and has not fallen out of the GCCM. In cases of dispute, take a laboratory sample that will exclude material from the outer wrap of the roll or the inner wrap around the core, of at least 900 mm (3 ft) from the interior end of the roll (wrapped around the core) or exterior end of the material roll, measured from the edge of the cementitious portion of the material.

7.3 *Test Specimens*—Take a total of 20 test specimens from the laboratory sample, with ten test specimens for Method A tests (five in the machine direction and five in the cross-machine direction) and ten test specimens for Method B tests (five in the machine direction and five in the cross-machine direction). Take specimens at random but equally spaced from the laboratory sample, with those for the measurement of the machine direction tensile properties from different positions across the sample width, and the specimens for the measurement of the cross-machine direction tensile properties from different positions along the length of the laboratory sample. Test specimens must be taken a minimum of 100 mm (4 in.) from the edge of the laboratory sample, measured from the edge of the cementitious portion of the material.

7.4 Test Specimen Preparation:

7.4.1 *Method A*—To determine the tensile properties for cured GCCMs with the geosynthetic top layer still present (if no geosynthetic top layer is present in the cured GCCM, use Method B).

7.4.1.1 GCCM samples shall be prepared in accordance with Practice [D8030/D8030M](#) with a sufficient number of cured specimens prepared for testing.

7.4.1.2 Prepare each cured test specimen a minimum of 200 ± 1.6 mm ($8.0 \pm \frac{1}{16}$ in.) wide by at least 300 ± 1.6 mm ($12 \pm \frac{1}{16}$ in.) long, with the length precisely aligned with the direction in which the specimen is to be tested. The specimens must be long enough to extend completely through both clamps of the testing machine.

7.4.1.3 Cured specimens are to be tested at 28 days from initial hydration (24 h of immersion to Practice [D8030/D8030M](#) and then 27 days of curing in controlled conditions also described in Practice [D8030/D8030M](#)).

7.4.1.4 Mark an arrow on the underside of the test specimen pointing in the machine direction for ease of identification.

7.4.1.5 To reduce the ratio of test specimens failing due to breaks within 5 mm (0.2 in.) of the clamps, 5 mm (0.2 in.) notches shall be cut in the middle of each side of the test specimen to ensure failure in that region. See [Figs. 2 and 3](#).

7.4.2 *Method B*—To determine the tensile properties for cured GCCMs with the geosynthetic top layer removed.