Designation: D8173 – 23

Standard Guide for Site Preparation, Layout, Installation, and Hydration of Geosynthetic Cementitious Composite Mats[1]

This standard is issued under the fixed designation D8173; 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 guide covers directions for the installation of geosynthetic cementitious composite mat (GCCM) materials under field conditions typically present in erosion control, hydraulic structure armoring and protection, and protection applications. This guide also covers directions for the installation of a special category of GCCMs known as geosynthetic cementitious composite barrier (GCCB) materials, under field conditions typically present in geotechnical or civil engineering applications, with the purpose of reducing or preventing the flow of fluid through the construction.

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

1.3 This guide contains general guidelines. It is not intended to replace project-specific installation requirements. In the event of a conflict between the two, the requirements of the project specifications will supersede the requirements of this guide.

1.4 This is not an all-inclusive guide, and some projects will be beyond the scope of this guide.

1.5 *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.*

1.6 *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]

D4437/D4437M Practice for Nondestructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes

D4439 Terminology for Geosynthetics

D5641/D5641M Practice for Geomembrane Seam Evaluation by Vacuum Chamber

D5820 Practice for Pressurized Air Channel Evaluation of Dual-Seamed Geomembranes

D7177/D7177M Specification for Air Channel Evaluation of Polyvinyl Chloride (PVC) Dual Track Seamed Geomembranes

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

2.2 *American Concrete Institute Standard:*[3]

ACI 306.1 Standard Specification for Cold Weather Concreting

2.3 Further information is available on the various GCCMs from their manufacturers. Individual GCCM manufacturer's recommendations may be more detailed with regards to specific applications or details than the information found in this standard, and should be consulted prior to undertaking any installation.

3. Terminology

3.1 *Definitions:*

3.1.1 *geosynthetic cementitious composite barrier (GCCB), n*—a composite material consisting of a geosynthetic barrier bonded to an integral GCCM protective cover layer. The geosynthetic barrier component of adjacent material must be seamed to reduce or prevent the flow of fluid through the construction.

[1] This guide 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] Available from American Concrete Institute (ACI), 38800 Country Club Dr., Farmington Hills, MI 48331-3439, http://www.concrete.org.

3.1.1.1 *Discussion*—The terms *geosynthetic barrier*, *GCCM*, and *seam* are defined in Terminology D4439.

3.1.2 *hydration, n—in a GCCM installation*, exposure of the GCCM, in this case, to water in prescribed conditions for a prescribed time.

3.1.3 *layer, n—in a GCCM installation*, the distinct material components of which a segment of GCCM material is composed.

3.1.4 *longitudinal layup, n—in a GCCM installation*, a deployed position of the GCCM where the material is deployed in line with the greater length of the structure being lined (that is, along the length of a channel).

3.1.5 *segment, n—in a GCCM installation*, an individual strip or section of GCCM material.

3.1.6 *shingled joint, n—in a GCCM*, a connection method of two separate segments of GCCM where a length of one segment overlaps on top of an adjacent segment.

3.1.7 *transverse layup, n—in a GCCM installation*, a deployed position of the GCCM where the material is deployed transverse to the greater length of the structure being lined (that is, across the width of a channel).

3.1.8 *unjointed edge, n—in a GCCM installation*, an edge of the segment of GCCM that is not secured within an anchor trench or sufficiently fixed to provide immediate contact between the segment and substrate and to minimize ingress. Sometimes referred to as "free ends."

3.1.9 *welding strip, n—in a GCCB installation*, an unprotected edge of the geosynthetic barrier to facilitate thermal fusion weld jointing of GCCB layers. The welding strip may be formed by separating the geosynthetic barrier and GCCM to form an open edge; alternatively, the welding strip may extend beyond the protective GCCM layer.

3.2 For definitions of additional terms used in this standard, refer to Terminology D4439.

4. Significance and Use

4.1 This guide identifies proper layout, installation, and hydration procedures along with equipment for use by GCCM designers, inspectors, and installers.

4.2 *Applications*—Typical GCCM applications may include but are not limited to:

4.2.1 Hydraulic structure armoring or protection, including but not limited to: ditches, swales, canals, flumes, and other similar structures.

4.2.2 Slope protection.

4.2.3 Berm and bund lining and protection.

4.2.4 Culvert invert lining.

4.2.5 Scour protection at culvert inlets and outlets.

4.2.6 Remediation of existing concrete channels and structures.

4.2.7 Lining of outfalls and spillways.

4.2.8 Mow strips or weed suppression.

4.2.9 Lagoons and secondary containment berms (using GCCBs).

5. Procedure

5.1 *Pre-Construction Meeting and Safety:*

5.1.1 The methods and equipment used for the placement of GCCMs can vary, but the primary objective of the process is to minimize damage and maximize performance. For optimum performance, the GCCM must be installed in a manner that does not negatively impact its physical, mechanical, or hydraulic properties.

5.1.2 All applicable project safety requirements should be observed. Prior to handling any GCCM, the manufacturer's Safety Data Sheet (SDS) should be read and understood.

5.1.3 With most projects, the construction means and methods are the responsibility of the installation contractor. However, pre-construction meetings between the owner or their representative, the contractor, the GCCM manufacturing representative, or other parties should be held prior to installation of the GCCM material.

5.1.4 This meeting shall cover details of (at a minimum):

5.1.4.1 GCCM application purpose and objectives.

5.1.4.2 Review of installation procedures.

5.1.4.3 Provisions for heavy lifting equipment needed for handling and installing GCCM rolls that are too large for manual lifting, based on local requirements for manual labor.

5.1.4.4 Clear understanding of each party's responsibilities and authority.

5.1.4.5 Availability of required ancillaries which can include screws, connectors, ground pegs, and adhesives to be used.

5.1.4.6 Understanding the jointing of the GCCM segments when connecting to appurtenant structures, concrete slabs, curbs, soil surface, etc.

5.1.4.7 Agreed-upon time estimates for installing, then hydrating for each day.

5.1.4.8 Provisions for hydration water source, both required volume and hydration procedure for determining if the GCCM is completely hydrated.

5.1.5 Prior to deployment, the entire fabrication and installation procedures shall be reviewed and accepted by all parties.

5.2 *GCCM Storage at Installation Site:*

5.2.1 GCCMs harden when exposed to water, and therefore should be properly stored to prevent exposure to water and moisture prior to the desired installation.

5.2.2 GCCMs should be stored under cover in dry conditions away from direct sunlight and, if possible, in the manufacturer's sealed packaging.

5.2.3 For some GCCMs, it is not recommended to store in shipping containers in direct sunlight where temperatures may exceed 40 °C (100 °F) for prolonged periods of time.

5.2.4 Once the manufacturer's original sealed packing is opened, the material should be deployed shortly thereafter (that is, within 24 h); if there is leftover material, the leftover material is returned to a sealed package daily or other airtight packaging around the roll.

5.3 *Installation Equipment:*

5.3.1 Several means of handling and deploying the GCCM rolls are possible. Typically, large rolls may be deployed with

proper heavy equipment. Large rolls may be cut into smaller sections or rolls on-site. Roll sizes and widths may vary by manufacturer.

5.3.2 Smaller rolls or precut segments may be handled manually, depending on weight and local lifting regulations.

5.3.3 Larger rolls may be handled and deployed by handling through suspension using a spreader bar or beam of appropriate length and load rating fed through the material core. See example schematic of some proper handling equipment in Fig. 1.

5.3.4 Additional tools and equipment for jointing and fixing GCCMs may include: snap-off blade utility knife, angle grinder or disc cutter, sledgehammer, auto-fed screwdriver, caulking gun, and suitable thermal fusion equipment. Refer to manufacturer's guidelines for additional tooling requirements and suggestions.

5.4 *GCCM Material Selection:*

5.4.1 GCCMs are available in three classification types as described in Specification D8364/D8364M. The GCCM type shall be selected to suit the project requirements.

5.5 *Subgrade Preparation (Soil and Earthen Substrates):*

5.5.1 Subgrade preparation involves the grading and compaction of the soil surface or other subgrade material that will ultimately receive the GCCM segment. Prepare soil surfaces or other subgrades by clearing debris, sharp or protruding rocks, and vegetation, including roots.

5.5.2 Shape and grade the soil to the elevations, slope, and dimensions required for the GCCM placement and according to the performance criteria as per the design specification of the structure. GCCMs shall be in immediate contact with the subgrade to which they are being applied, and shall generally conform to the subgrade. If the grade upon which the GCCM is placed contains ridges, bumps, or valleys, these features may be visible once the GCCM is installed. If the grade is smooth, generally firm, and compacted, the GCCM will lie smooth and flat. Other geotextiles can be used to dampen undulations and provide additional protection to the bottom face of the GCCM.

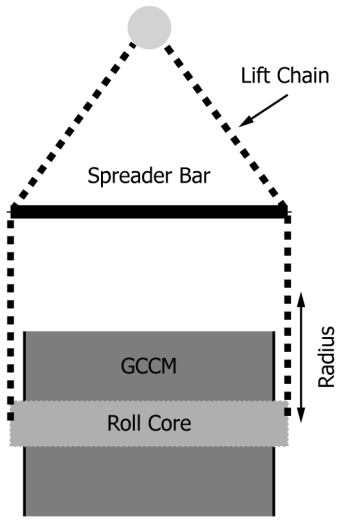

FIG. 1 Details of Typical Large Roll Lifting and Handling Device

5.5.3 All subgrades must be geotechnically stable so that the GCCM is not relied upon to improve the integrity of slopes.

5.5.4 Any voids in the substrate which the GCCM will span across should be filled prior to deployment. This is to prevent cyclical loading in flow conditions and also to support the GCCM when subjected to point loads.

5.6 *Subgrade Preparation (Concrete, Shotcrete, and Asphalt):*

5.6.1 Failing concrete must be stabilized and large cracks and voids (greater than 50 mm (2 in.)) filled. The surface must be structurally sound so that the GCCM is not relied upon to provide additional structural support.

5.6.2 Any exposed, sharp, or protruding reinforcement bars should be cut flush.

5.6.3 The surface should be cleaned and any loose, friable, and spalled concrete removed.

5.7 *Subgrade Preparation (Corrugated Metal Pipe):*

5.7.1 Some GCCMs may be installed over areas of minor corrosion and pitting in the invert of corrugated metal pipe (CMP) culverts.

5.7.2 Areas in the invert should be cleaned and sharp edges removed.

5.7.3 Void areas under penetrated inverts should be infilled with an appropriated material, which may include soil, grout, concrete, asphalt, or gravel, such that the GCCM is supported when installed.

5.8 *Deployment of GCCM Segments:*

5.8.1 If an existing watercourse structure is being lined, divert any flowing water.

5.8.2 In all installations, it is important to orientate and deploy the GCCM such that the hydratable surface layer is exposed for hydration, which in some GCCMs is defined as the top layer.

5.8.3 GCCM rolls should be deployed in a controlled manner, and should not be allowed to freewheel or spin under their own weight.

5.8.4 Depending upon the length of the slope, roll sizes should be considered to avoid horizontal jointing on the slope, if possible. For larger rolls, a staging area may be recommended during construction where larger rolls can be cut into desired lengths to accommodate installation.

5.8.5 Installation of the GCCM in water conveyance channels usually begins at the lowest elevation, with successive segments installed as installation proceeds upstream.

5.9 *Minimizing Ingress:*

5.9.1 It is important in all applications to ensure that liquid media, windblown debris, and wind are unable to ingress around and between GCCM segments. This is to prevent undermining of the substrate or vegetation growth (or both), or to prevent wind capture points, which could cause uplift failure of the GCCM installations.

5.9.2 Minimizing ingress can be achieved by a variety of means depending on the nature of the application, and can include but is not limited to proper jointing and perimeter fastening.

5.10 *Jointing:*

5.10.1 Proper jointing effectively creates a continuous structure from the individual segments, which may aid in securing the GCCM to the substrate. It is important to ensure that the jointed GCCM is fixed sufficiently to ensure intimate contact between the two GCCM segments.

5.10.2 *Jointing of GCCMs:*

5.10.2.1 Layers of GCCM materials shall be shingled to minimize ingress between adjacent layers.

5.10.2.2 Segments shall be placed in a shingled joint either longitudinal or transverse to the direction of the flow, depending on project dimensions. Fig. 2 illustrates an example of proper shingling. Figs. 3 and 4 demonstrate longitudinal and transverse layups of GCCM in a ditching application.

5.10.2.3 All shingled joints should be positioned from upstream to downstream end, and the angle of grading should be such to avoid pooling of water or other liquids at the slightly raised overlap.

5.10.2.4 In many applications, a shingled joint is sufficient to minimize ingress of flow, but segments should be secured together by fastening or thermal fusion to form continuous contact and to reduce the potential for vegetation growth.

5.10.3 *Fastened GCCM Joints:*

5.10.3.1 Shingled joints can be fastened using stainless steel screws or screws with a corrosion-resistant coating, or other corrosion-resistant fasteners acceptable to the project engineer, with a typical spacing of 100 to 200 mm (4 to 8 in.), or determined by the project engineer based on project-specific conditions which may include hydraulic loadings, soil heaving, and wind uplift. Consult manufacturer's recommendations on minimum screw spacing and fixing specification.

5.10.3.2 In general, placing screws as designated by the project engineer in accordance with the GCCM manufacturer's recommendations along a shingled joint that has continuous contact between the segments (no gaps or ripples) will create an acceptable joint, but may allow water to pass in the event of hydrostatic pressure buildup beneath or ponding above the GCCM.

5.10.3.3 When water migration is anticipated through the joint, a soil-tight underlayment such as a nonwoven or other geosynthetic material may be used to reduce the loss of fines through the joint as water passes through. This material can be laid directly under the GCCM material to reduce erosion from water at any joint areas as recommended by the design engineer.

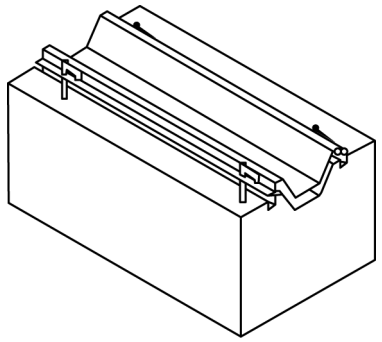

FIG. 3 Longitudinal Deployment of GCCM in Ditching Application

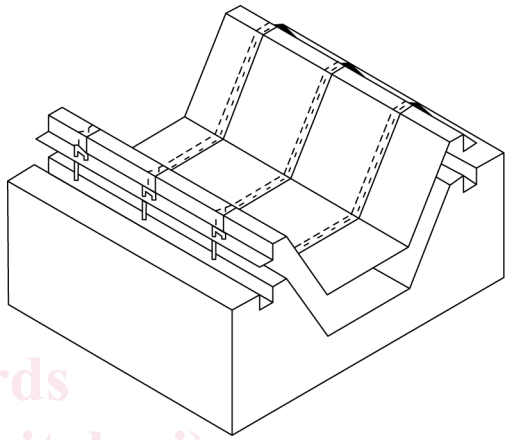

FIG. 4 Transverse Deployment of GCCM in Ditching Application

5.10.3.4 To reduce the permeability of the joint, a continuous bead of adhesive sealant can be used in combination with the fasteners. It is important that the adhesive used is compatible with the GCCM and expressly accepted by the project engineer. Adhesive material should be approved for typical use conditions, which may include requirements such as submersion applications for water conveyance systems.

5.10.4 *Thermal Fusion GCCM Joints:*

5.10.4.1 In some GCCM materials, the top and bottom layers can be thermally fused together. Thermal fusion methods can be used to fasten shingled joints in these compatible GCCMs. Refer to manufacturer's recommendations for these more advanced jointing options.

5.10.4.2 Figs. 5-7 illustrate several types of common fastened and thermal fusion GCCM joints, but are not intended to

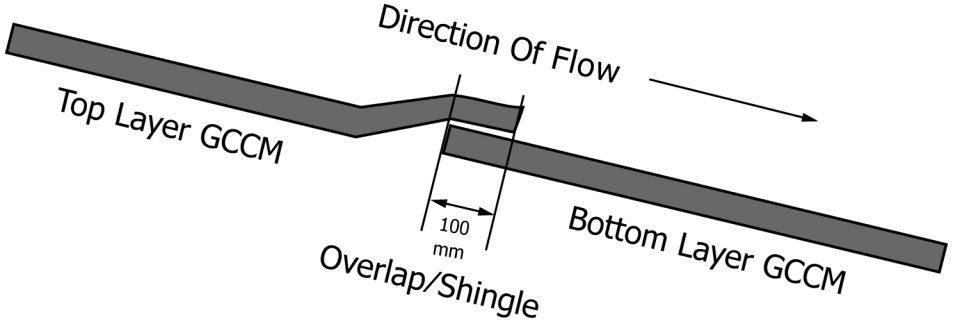

FIG. 2 Proper Shingled Joint of GCCM with Respect to Water Flow

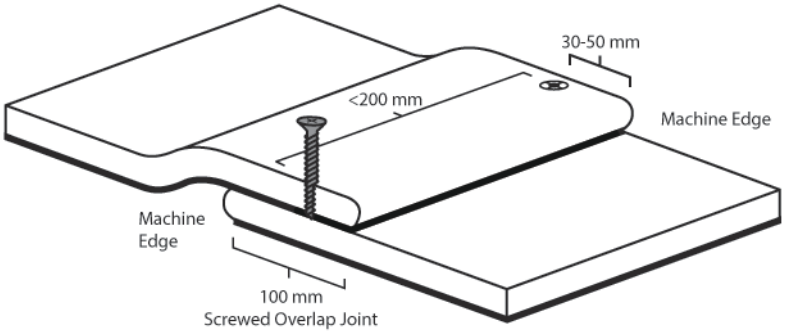

FIG. 5 Typical Shingled Joint with Screw

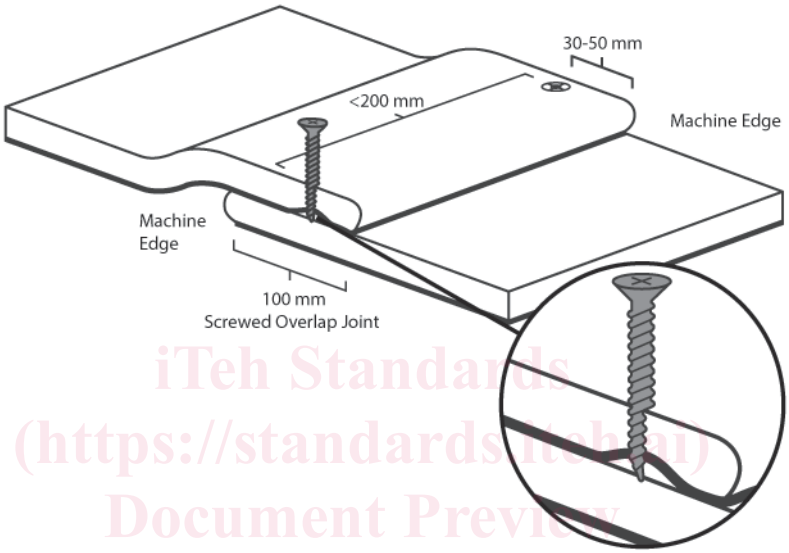

FIG. 6 Shingled Joint with Screw and Adhesive

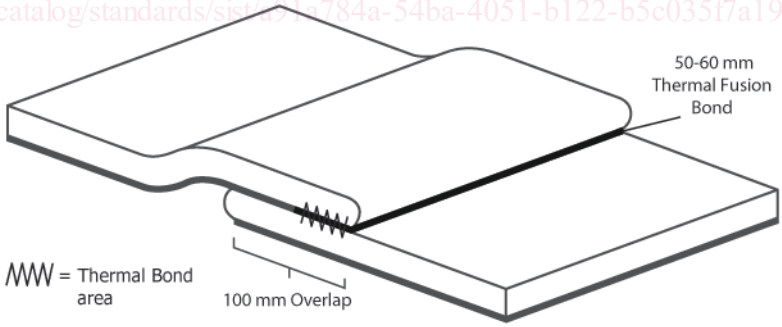

FIG. 7 Shingled Joint with Thermal Fusion Bond

be limiting of the type of joints that are possible. Typical screw, adhesive sealant, and shingled overlap dimensions are detailed in these figures.

5.10.5 *Jointing of GCCBs:*

5.10.5.1 The geosynthetic barrier component of GCCBs must be jointed to reduce or prevent the flow of fluid through the material. For GCCBs with a polymeric geosynthetic barrier, thermal fusion welding is typically used. Typically, GCCB materials have a geosynthetic barrier welding strip to enable thermal fusion welding. Some thermal fusion welding methods may facilitate field seam testing as outlined in Practice D5641/D5641M, D4437/D4437M, or D5820, Specification D7177/D7177M, or similar.

5.10.5.2 Welding strips should be placed such that the GCCM cover layer is configured to be shingled. See Figs. 8 and 9.

5.10.6 Additional joint techniques may be developed and recommended by specific manufacturers for use with their