
USACE / NAVFAC / AFCEA / NASA UFGS-02374 (September 2004)

Preparing Activity: USACE MasterFormat™ 2004 - 31 05 20
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UML dated 23 June 2005

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09/04

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SECTION 02374

GEOSYNTHETIC DRAINAGE LAYER 09/04

NOTE: This guide specification covers the requirements for geosynthetic drainage layers including both geonets and geocomposites.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

PART 1 GENERAL

1.1 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update

the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 1505	(2003) Density of Plastics by the Density-Gradient Technique
ASTM D 1603	(2001) Carbon Black in Olefin Plastics
ASTM D 4218	(1996; R 2001) Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D 4355	(2002) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D 4491	(1999; R 2004) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(2004) Trapezoid Tearing Strength of Geotextiles
ASTM D 4632	(1991; R 2003) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4716	(2003) Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
ASTM D 4751	(2004) Determining Apparent Opening Size of a Geotextile
ASTM D 4833	(2000e1) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 5035	(1995; R 2003) Breaking Force and Elongation of Textile Fabrics (Strip Method)
ASTM D 5199	(2001) Measuring Nominal Thickness of Geosynthetics
ASTM D 5261	(1992; R 2003) Measuring Mass Per Unit Area of Geotextiles

GEOSYNTHETIC INSTITUTE (GSI)

GSI GRI GC7

(1997) Determination of Adhesion and Bond
Strength of Geocomposites

1.2 MEASUREMENT AND PAYMENT

NOTE: Delete this paragraph when lump sum bidding
is used.

Measurement shall be made of the total surface area in square meters feet covered by geosynthetic drainage layer. Final quantities shall be based on as-built conditions. Allowance will be made for geosynthetic drainage layer in anchor and/or drainage trenches but no allowance will be made for waste, overlap, or materials used for the convenience of the Contractor. Geosynthetic drainage layer accepted by the Contracting Officer will be paid for at the respective contract unit price in the bidding schedule.

1.3 SUBMITTALS

NOTE: Review submittal description (SD) definitions in Section 01330 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G"

designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sampling and Testing

Manufacturer's quality control manual.

Penetrations

Penetration details.

Construction Quality Control Laboratory

Qualifications of Construction Quality Control laboratory.

SD-04 Samples

Geosynthetic Drainage Layer
Seams and Overlaps

One properly identified 610 by 610 mm 24 by 24 inch minimum size geosynthetic drainage layer sample. The fasteners proposed for use and the method of seaming and overlapping shall also be submitted.

SD-06 Test Reports

Sampling and Testing

Construction quality control test results.

Geosynthetic Drainage Layer

Manufacturer's quality control test results.

1.4 CONSTRUCTION QUALITY CONTROL LABORATORY

The construction quality control (QC) laboratory shall have provided QC and/or quality assurance (QA) testing of geosynthetic drainage layers for at least five completed projects having a total minimum area of [186,000] [_____] square meters [2] [_____] million square feet. The QC laboratory shall carry current accreditation via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the QC laboratory will be required to perform.

1.5 DELIVERY, STORAGE AND HANDLING

The QC inspector shall be present during delivery and unloading of the geosynthetic drainage layer. The drainage layer material shall not be damaged during shipping, storage, or handling. Any drainage layer material found to be damaged shall be repaired or replaced. Material shall be delivered only after the required submittals have been approved. Each roll shall be labelled with the manufacturer's name, product identification, lot number, roll number, and roll dimensions. Rolls that have attached geotextiles shall be individually wrapped in plastic. The rolls shall be stored in a level and dry area.

PART 2 PRODUCTS

2.1 GEOSYNTHETIC DRAINAGE LAYER

NOTE: The flow capacity required for the geosynthetic drainage layer should be determined using a procedure such as the one described in GRI Report Number 19 - The Design of Drainage Systems Over Geosynthetically Lined Slopes. Appropriate global safety factors and reduction factors should be applied to transmissivity values reported by manufacturers. A global factor of safety of 2 is typically used. Guidance on reduction factors for intrusion, creep, chemical clogging, and biological clogging are provided in Designing with Geosynthetics by Dr. Robert Koerner and GRI Standard-GC8 Determination of the Allowable Flow Rate of a Drainage Geocomposite.

If high long term normal stresses are anticipated (e.g. 192 kPa (4000 psf) or greater), requirements for maximum allowable creep strain should be included in Table 1. Creep strain requirements for geosynthetic drainage layers are determined using test method GRI GS 4 - Time Dependent (Creep) Deformation Under Normal Pressure. Typically, a normal stress of 2 to 3 times the design stress for a period of at least 10000 hours is used for creep strain testing.

Delete paragraphs and sentences which describe geotextile material and construction requirements if geotextiles will not be attached to the geonet.

The polymer used to manufacture the geonet component of the geosynthetic drainage layer shall be polyethylene which is clean and free of any foreign contaminants. Regrind material which consists of edge trimmings and other scraps may be used to manufacture the geonet; however, post-consumer recycled materials shall not be used. The geosynthetic drainage layer shall conform to the property requirements listed in Table 1. Component criteria for the geonet alone and geotextile alone are also listed in Table 1. The geonet shall be covered on [one] [both] sides with nonwoven geotextile. Geocomposite shall be created by heat bonding geotextile to the geonet. The geotextile shall not be bonded to the drainage net within 150 mm 6 inches of the edges of the rolls. Where applicable, Table 1 property values represent minimum average roll values (MARV). The value for AOS represents the maximum average roll value (MaxARV).

TABLE 1 - GEOSYNTHETIC DRAINAGE LAYER PROPERTIES

PROPERTY	TEST METHOD	TEST VALUE	MINIMUM MQC TESTING FREQUENCY
GEONET COMPONENT			

TABLE 1 - GEOSYNTHETIC DRAINAGE LAYER PROPERTIES

PROPERTY	TEST METHOD	TEST VALUE	MINIMUM MQC TESTING FREQUENCY
Thickness, minimum avg, Note 1	ASTM D 5199	5 mm	9,300 sq m
Polymer Density, minimum avg	ASTM D 1505	0.940 g/cc	9,300 sq m
Carbon Black Content	ASTM D 1603 ASTM D 4218	1-3 percent	9,300 sq m
Tensile Strength, minimum avg, Note 2	ASTM D 5035	7884 N/m	9,300 sq m
GEOTEXTILE COMPONENT			
Mass/Unit Area, MARV	ASTM D 5261	0.2 kg/sq m	9,300 sq m
Grab Strength, MARV	ASTM D 4632	698 N	9,300 sq m
Grab Elongation, MARV	ASTM D 4632	50 percent	9,300 sq m
Tear Strength, MARV	ASTM D 4533	245 N	9,300 sq m
Puncture Strength, MARV	ASTM D 4833	245 N	9,300 sq m
Permittivity, MARV	ASTM D 4491	.2/sec	46,500 sq m
AOS(O95), MaxARV	ASTM D 4751	.25 mm	46,500 sq m
UV Stability, percent retained (500 hrs)	ASTM D 4355	50 percent	Note 3
GEOCOMPOSITE			
Transmissivity, min, including attached geotextiles Note 4	ASTM D 4716	[_____] gal/ min-foot	18,600 sq m
Geonet/Geotextile Adhesion, minimum avg, Note 5	GSI GRI GC7	0.5 lbs/inch	9,300 sq m

Note 1: The diameter of the presser foot shall be 56 mm and the pressure shall be 20 kPa. For other thickness options, see manufacturer's literature.

Note 2: This is the average peak value for five equally spaced machine direction tests across the roll width.

Note 3: Manufacturer's historical data.

Note 4: Manufacturing quality control transmissivity tests shall be measured using a gradient of [0.1] [_____] under a normal pressure of [10] [100] [_____] kPa. A minimum seating period of 15 minutes shall be used. The test shall be performed between rigid end platens.

Note 5: Average of five tests across the roll width. Discounting the outer

TABLE 1 - GEOSYNTHETIC DRAINAGE LAYER PROPERTIES

PROPERTY	TEST METHOD	TEST VALUE	MINIMUM MQC TESTING FREQUENCY
305 mm of each side of the roll, samples shall be collected at the 10, 30, 50, 70, and 90 percent positions across the roll width. Both sides shall be tested for double sided geocomposites.			

TABLE 1 - GEOSYNTHETIC DRAINAGE LAYER PROPERTIES

PROPERTY	TEST METHOD	TEST VALUE	MINIMUM MQC TESTING FREQUENCY
GEONET			
Thickness, minimum avg, Note 1	ASTM D 5199	200 mil	100,000 SF
Polymer Density, minimum avg	ASTM D 1505	0.940 g/cc	100,000 SF
Carbon Black Content	ASTM D 1603 ASTM D 4218	1-3 percent	100,000 SF
Tensile Strength, minimum avg, Note 2	ASTM D 5035	45 lbs/in	100,000 SF
GEOTEXTILE			
Mass/Unit Area, MARV	ASTM D 5261	6.0 oz/SY	100,000 SF
Grab Strength, MARV	ASTM D 4632	157 lbs	100,000 SF
Grab Elongation, MARV	ASTM D 4632	50 percent	100,000 SF
Tear Strength, MARV	ASTM D 4533	55 lbs	100,000 SF
Puncture Strength, MARV	ASTM D 4833	55 lbs	100,000 SF
Permittivity, MARV	ASTM D 4491	.2/sec	500,000 SF
AOS(O95), MaxARV	ASTM D 4751	.25 mm	500,000 SF
UV Stability, percent retained (500 hrs)	ASTM D 4355	50 percent	Note 3
GEOCOMPOSITE			
Transmissivity, min, including attached geotextiles Note 4	ASTM D 4716	[_____] gal/ min-foot	200,000 SF
Geonet/Geotextile Adhesion, minimum avg, Note 5	GSI GRI GC7	0.5 lbs/inch	100,000 SF

Note 1: The diameter of the presser foot shall be 2.22 inches and the

TABLE 1 - GEOSYNTHETIC DRAINAGE LAYER PROPERTIES

PROPERTY	TEST METHOD	TEST VALUE	MINIMUM MQC TESTING FREQUENCY
pressure shall be 2.9 psi. For other thickness options, see manufacturer's literature.			

Note 2: This is the average peak value for five equally spaced machine direction tests across the roll width.

Note 3: Manufacturer's historical data.

Note 4: Manufacturing quality control transmissivity tests shall be measured using a gradient of [0.1] [_____] under a normal pressure of [1.45] [14.5] [_____] psi. A minimum seating period of 15 minutes shall be used. The test shall be performed between rigid end platens.

Note 5: Average of five tests across the roll width. Discounting the outer 305 mm of each side of the roll, samples shall be collected at the 10, 30, 50, 70, and 90 percent positions across the roll width. Both sides shall be tested for double sided geocomposites.

2.2 SAMPLING AND TESTING

2.2.1 Manufacturing Quality Control Testing

Manufacturing quality control test methods and frequencies shall be in accordance with Table 1 unless otherwise approved.

2.2.2 Construction Quality Control Testing

NOTE: One or more additional performance type transmissivity tests are often required to be performed by the Contractor's quality control laboratory. These tests should be performed at gradients and normal stresses that model site conditions. The type of material in contact with the geosynthetic drainage layer affects the flow properties of the drainage layer. Performance tests should use site specific soils and geosynthetics when such materials are known.

Typically, normal loads for CQC transmissivity tests are seated on the geosynthetic drainage layer for 100 hours prior to testing to account for long-term intrusion and creep. A reduction factor for intrusion should be used if a seating period of less than 100 hours is used.

The transmissivity requirement for the construction quality control transmissivity tests will generally be lower than the value shown in Table 1 for the manufacturing quality control tests.

A minimum of [one] [_____] construction quality control transmissivity test

shall be performed in accordance with the requirements of this paragraph. Transmissivity shall be measured using a gradient of [_____] under a normal pressure of [_____] kPa psf. Geotextile shall be attached to the geonet in the same configuration as will be used in the field. The drainage layer shall be sandwiched between [_____] on the bottom and [_____] on the top. A minimum seating period of [100][_____] hours shall be used. The construction quality control test results must achieve a minimum transmissivity of [_____].

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Surface Preparation

Prior to placement of the geosynthetic drainage layer, the subgrade shall be smooth and free of all materials which could damage the drainage layer.

3.1.2 Placement

The geosynthetic drainage layer shall not be damaged during placement. The drainage layer shall be unrolled in the direction of maximum slope, keeping the net flat against the subgrade to minimize wrinkles and folds. The drainage layer shall not be dragged across textured geomembrane if a geotextile is attached to the surface facing the geomembrane. Adequate ballast (e.g. sandbags) shall be placed to prevent uplift by wind prior to covering.

3.1.3 Seams and Overlaps

3.1.3.1 Geonet Side Seams

Geonet side seams shall be overlapped a minimum of 100 mm 4 inches. Side seam fastener spacing shall be a maximum of 1.5 m 5 feet. In anchor trenches, fastener spacing shall be a maximum of 305 mm 1 foot.

3.1.3.2 Geonet End Seams

NOTE: Flow capacity of the geosynthetic drainage layer must be adequate to ensure all flow remains in the drainage layer and head does not build up in the cover soils above the drainage layer. For this reason, consideration must be given to flow capacity of end seams on slopes. If end seam flow capacity is a concern, end seams can be prohibited on side slopes or they can be configured such that water can flow from one geonet to another without passing through any geotextile layers.

Geonet end seams shall be overlapped a minimum of 305 mm 1 foot. End seam fastener spacing shall be a maximum of 305 mm 1 foot. The overlaps shall be in the direction of flow.

3.1.3.3 Geonet Fasteners

Geonet rolls shall be tied together with plastic fasteners. The fasteners shall be a contrasting color from the geonet and attached geotextiles.

Metallic fasteners will not be allowed.

3.1.3.4 Geotextile Seams

The geotextile component of the geocomposite shall be [overlapped in the direction of flow] [thermally bonded using approved methods] [sewn using approved methods].

3.1.3.5 Geotextile Cap Strips

Geotextile cap strips shall be placed over any exposed edges of geocomposite. Cap strips shall be a minimum of 610 mm 2 feet in width and shall be thermally bonded to the geotextile component of the geocomposite.

3.1.4 Stacked Geosynthetic Drainage Layers

When geosynthetic drainage layers are to be stacked, roll ends and edges shall be staggered so that joints do not lie above one another.

3.1.5 Corners

In the corners of landfill liner side slopes, an extra layer of drainage layer material shall be installed from the top to the bottom of the slope.

3.1.6 Penetrations

A geotextile apron shall be mechanically attached to pipes and other appurtenances penetrating through the drainage layer so that soil is prevented from getting into the drainage layer. The apron of the attached geotextile shall extend out from the pipe or appurtenance a minimum of 610 mm 2 feet. The apron geotextile shall be thermally bonded to the geotextile [component of the geocomposite.] [overlying the geonet.]

3.2 REPAIRS

3.2.1 Geonet Damage

Repairs shall be made by placing a patch of the geosynthetic drainage layer over the damaged area. The patch shall extend a minimum of 610 mm 2 feet beyond the edge of the damage. Approved fasteners, spaced every 150 mm 6 inches around the patch, shall be used to hold the patch in place. If more than 25 percent of the roll width is damaged, approval must be obtained to repair or replace the damaged roll.

3.2.2 Geotextile Damage

Damaged geotextile shall be repaired by placing a patch of geotextile over the damaged area with a minimum of 305 mm 12 inches of overlap in all directions. The geotextile patch shall be thermally bonded in place.

3.3 PROTECTION AND BACKFILLING

The geosynthetic drainage layer shall be covered with the specified materials within [14] [_____] days of acceptance. Cover soil shall be placed from the bottom of the slope upward and shall not be dropped directly onto the drainage layer from a height greater than 915 mm 3 feet. The cover soil shall be pushed out over the geosynthetic drainage layer in an upward tumbling motion so that wrinkles in the drainage layer do not fold over. No equipment shall be operated on the top surface of the

geosynthetic drainage layer without permission from the Contracting Officer. The initial loose soil lift thickness shall be 305 mm 12 inches. Equipment with ground pressures no greater than 50 kPa 7 psi shall be used to place the first lift of soil. A minimum of [460] [610] [915] [_____] mm [18] [24] [36] [_____] inches of soil shall be maintained between construction equipment with a ground pressure greater than 50 kPa 7 psi and the drainage layer. Cover soil compaction and testing requirements are described in Section [_____].

-- End of Section --