



STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

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NCDOT Guidelines for the Geosynthetic Reinforcement Evaluation Program
By: Geotechnical Engineering Unit/Technical Services

This program applies to geosynthetic reinforcement which includes both geogrids and geostrips used to reinforce soil or aggregate for retaining walls, soil slopes and embankments. A *geogrid*, as defined by the American Society for Testing and Materials (ASTM) *Standard Terminology for Geosynthetics* (D4439), is a geosynthetic formed by a regular network of integrally connected elements with apertures greater than ¼" to allow interlocking with surrounding soil, rock, earth and other surrounding materials to function primarily as reinforcement. ASTM D4439 also defines a *geostrip* as a polymeric material in the form of a strip of width not more than 8", used in contact with soil or other materials in geotechnical and civil engineering applications, or both. See terms and abbreviations defined below followed by the source, if applicable.

Borrow – Material that meets Section 1018 of the NCDOT *Standard Specifications for Roads and Structures* or Class I select material in accordance with Section 1016 of the *Standard Specifications*.

Coarse Aggregate – Aggregate that meets standard size No. 57, 57M, 67 or 78M in accordance with Table 1005-1 of the NCDOT *Standard Specifications for Roads and Structures*.

Cross-Machine Direction (CD) – The direction in the plane of the fabric perpendicular to the direction of manufacture. (*Standard Terminology for Geosynthetics*, ASTM D4439)

Fine Aggregate – Aggregate that meets standard size No. 1S, 2S, 2MS or 4S in accordance with Table 1005-2 of the NCDOT *Standard Specifications for Roads and Structures* or Class II or III select material in accordance with Section 1016 of the *Standard Specifications*.

High Density Polyethylene (HDPE) or Polypropylene (PP) Geogrid – Geogrid manufactured by extruding and orienting sheets of polyolefins. (*Geosynthetic Design and Construction Guidelines*, FHWA-NHI-07-092)

Long-Term Design Strength (LTDS) – Nominal long-term reinforcement tensile strength in accordance with 11.10.6.4.3b of the *AASHTO LRFD Bridge Design Specifications*.

Machine Direction (MD) – The direction in the plane of the fabric parallel to the direction of manufacture. (*Standard Terminology for Geosynthetics*, ASTM D4439)

Polyester Type (PET) Geogrid – Geogrid manufactured from multifilament polyester yarns, joined at the crossover points by a knitting or weaving process and encased with a polymer-based, plasticized coating. (*Geosynthetic Design and Construction Guidelines*, FHWA-NHI-07-092)

PET Geostrip – Geostrip manufactured from high tenacity polyester yarns in a planar strip configuration and encased in a polyethylene sheath.

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Reduction Factors – Strength reduction factors to account for potential long-term degradation due to installation damage, creep and chemical and biological degradation in accordance with 11.10.6.4.3b of the *AASHTO LRFD Bridge Design Specifications*.

The Geotechnical Engineering Unit (GEU) will review geosynthetic reinforcement submitted for approval from both geosynthetic manufacturers and private labelers. After a geosynthetic is approved, a renewal is required every 5 years or when the geosynthetic changes or a new National Transportation Product Evaluation Program (NTPEP) Qualification Evaluation is available. Failure to submit a renewal as required will void the geosynthetic reinforcement from the GEU’s qualified product list.

For evaluating geosynthetic reinforcement, provide the following properties from the sources listed below.

Geosynthetic Property	Test Method	Source (NTPEP, Lab Data¹, AASHTO²)
Tensile Strength @ Ultimate	ASTM D6637 per AASHTO R 69	NTPEP
Reduction Factors	AASHTO R 69	NTPEP
Pullout Resistance	ASTM D6706	NTPEP, Lab Data or AASHTO
Direct Shear	ASTM D5321	NTPEP, Lab Data or AASHTO

¹Laboratory testing data from SGI or TRI.

²AASHTO refers to default value of 0.67 from *AASHTO LRFD Bridge Design Specifications*.

After receiving a complete submittal and provided no additional information is required during the review, the geosynthetic reinforcement will be approved or rejected within 30 days. Geosynthetic reinforcement from a geosynthetic manufacturer or private labeler with a current NTPEP evaluation report will be assigned an “approved” status code based on laboratory testing data submitted, if applicable. Laboratory testing must be performed by SGI Testing Services in Atlanta, GA or TRI/Environmental in Austin, TX. Laboratory data should not be more than 9 years old but older data may be accepted depending on the data quality and provided the geosynthetic has not changed since tested.

Submittal Requirements:

Do not include NTPEP reports in submittals. Email submittals to the State Geotechnical Engineer at jpilipchuk@ncdot.gov and carbon copy shidden@ncdot.gov. For first time approvals, submit the following for each geosynthetic:

1. Any laboratory testing data separate from NTPEP reports including gradation and angle of internal friction (ϕ) from materials tested for C_i and C_{ds} ; and
2. Required information as shown above provided in the following table (add rows to table for more geosynthetics):

Geogrid and Direction (MD, CD)/ Geostrip	Polymer (PET, HDPE, PP)	Geogrid Aperture Size/ Geostrip Width (inches)			T_{ult}^A , lb/ft (geogrid) or lb (geostrip)			RF _{CR}			RF _D
								3-yr	75-yr	100-yr	
Geogrid and Direction (MD, CD)/ Geostrip	Borrow ($\phi = 30^\circ$)										
	RF _{ID}	RF			T_{al} , lb/ft (geogrid) or lb (geostrip)			C_i	F*	C_{ds}	ρ (deg)
		3-yr	75-yr	100-yr	3-yr	75-yr	100-yr				
Geogrid and Direction (MD, CD)/ Geostrip	Fine Aggregate ($\phi = 34^\circ$)										
	RF _{ID}	RF			T_{al} , lb/ft (geogrid) or lb (geostrip)			C_i	F*	C_{ds}	ρ (deg)
		3-yr	75-yr	100-yr	3-yr	75-yr	100-yr				
Geogrid and Direction (MD, CD)/ Geostrip	Coarse Aggregate ($\phi = 38^\circ$)										
	RF _{ID}	RF			T_{al} , lb/ft (geogrid) or lb (geostrip)			C_i	F*	C_{ds}	ρ (deg)
		3-yr	75-yr	100-yr	3-yr	75-yr	100-yr				

^A“Minimum Average Roll Values” (MARV) in accordance with ASTM D4439.

Where,

- T_{ult} = ultimate tensile strength, lb/ft (geogrid) or lb (geostrip),
- RF_{CR} = creep reduction factor for 3, 75 and 100-yr design life,
- RF_D = durability (degradation) reduction factor,
- RF_{ID} = installation damage reduction factor,
- RF = ($RF_{CR} \times RF_{ID}$) for 3-yr design life or ($RF_{CR} \times RF_D \times RF_{ID}$) for 75 and 100-yr design life,
- T_{al} = short-term design strength for 3-yr design life or LTDS for 75 and 100-yr design life, lb/ft (geogrid) or lb (geostrip) = T_{ult} / RF ,
- C_i = coefficient of interaction,
- F* = pullout resistance factor = $C_i \times \tan \phi$,
- C_{ds} = coefficient of direct sliding and
- $\tan \rho$ = soil-geosynthetic friction angle (deg) = $C_{ds} \times \tan \phi$.

For renewals, submit items from above that have changed since the most recent approval. For questions about this program, contact Scott Hidden of the Geotechnical Engineering Unit at (919) 707-6856.