



STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

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April 26, 2013

NCDOT Guidelines for the Geogrid Evaluation Program
By: Materials and Tests Unit/Operations

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. See terms and abbreviations defined below followed by the source, if applicable.

Approved – Status code assigned to a product that has been evaluated and is approved for use. (NCDOT *Product Evaluation Program Guidelines*)

Approved for Provisional Use – Status code assigned to a product that has been evaluated and is approved for use based on site specific and/or project specific conditions being met. (NCDOT *Product Evaluation Program Guidelines*)

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 of multifilament polyester yarns, joined at the crossover points by a knitting or weaving process, and then encased with a polymer-based, plasticized coating. (*Geosynthetic Design and Construction Guidelines*, FHWA-NHI-07-092)

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*.

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MATERIALS AND TESTS UNIT
1563 MAIL SERVICE CENTER
RALEIGH NC 27699-1563

TELEPHONE: 919-329-4000
Fax: 919-733-8742
connect.ncdot.gov/resources/Materials

LOCATION:
1801 BLUE RIDGE ROAD
RALEIGH NC 27607

The Materials and Tests (M&T) Unit will review geogrids submitted for approval from both prime manufacturers and private label suppliers. After a geogrid is approved, a renewal is required every 3 years or when the geogrid changes or a new or revised National Transportation Product Evaluation Program (NTPEP) report is available for the geogrid. Failure to submit a renewal as required will void the geogrid from M&T's approved product list.

For geogrids that have been evaluated by NTPEP, the following properties are required or optional from the sources listed.

Geogrid Property		Test Method	Required (R) or Optional ¹ (O)		Source (NTPEP, Lab Data ² , AASHTO ³)	
			MD	CD	MD	CD
Wide-Width Tensile Strength	@ Ultimate	ASTM D6637, Method B	R	O	NTPEP	NTPEP or Lab Data
	@ 2% Strain		O	O	Lab Data	Lab Data
	@ 5% Strain		O	O	Lab Data	Lab Data
Reduction Factors		AASHTO PP 66	R	O	NTPEP	NTPEP or Lab Data
Pullout Resistance		ASTM D6706	R	O	NTPEP, Lab Data or AASHTO	NTPEP or Lab Data
Direct Shear		ASTM D5321	R	O	NTPEP, Lab Data or AASHTO	NTPEP or Lab Data
Junction Strength		ASTM D7737	O		Lab Data	
Aperture Stability (Torsional Rigidity)		USACE ⁴ Methodology	O		Lab Data	

¹Geogrid vendor may choose whether or not to provide optional geogrid properties.

²Laboratory testing data from SGI or TRI.

³AASHTO refers to default value of 0.67 from *AASHTO LRFD Bridge Design Specifications*.

⁴US Army Corps of Engineers.

For geogrids that have not been evaluated by NTPEP, the following properties are required or optional from the sources listed.

Geogrid Property		Test Method	Required (R) or Optional ¹ (O)		Source (Lab Data ² , AASHTO ³)	
			MD	CD	MD	CD
Wide-Width Tensile Strength	@ Ultimate	ASTM D6637, Method B	R	R	Lab Data	Lab Data
	@ 2% Strain		R	R	Lab Data	Lab Data
	@ 5% Strain		R	R	Lab Data	Lab Data
Reduction Factors		AASHTO PP 66	O	O	Lab Data	Lab Data
Pullout Resistance		ASTM D6706	R	R	Lab Data or AASHTO	Lab Data or AASHTO
Direct Shear		ASTM D5321	R	R	Lab Data or AASHTO	Lab Data or AASHTO
Junction Strength		ASTM D7737	O		Lab Data	
Aperture Stability (Torsional Rigidity)		USACE ⁴ Methodology	O		Lab Data	

¹Geogrid vendor may choose whether or not to provide optional geogrid properties.
²Laboratory testing data from SGI or TRI.
³AASHTO refers to default value of 0.67 from *AASHTO LRFD Bridge Design Specifications*.
⁴US Army Corps of Engineers.

After receiving a complete submittal and provided no additional information is required during the review, M&T will approve, approve for provisional use or reject geogrids within 30 days. Geogrids from a prime manufacturer or private label supplier with a NTPEP evaluation report will be assigned an “approved” status code. A NTPEP report for a prime manufacturer may not be used for a private label supplier. Geogrids that have not been evaluated by NTPEP will be assigned an “approved for provisional use” or “unapproved” status code based on laboratory testing data submitted. 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 3 years old but older data may be accepted provided the geogrid has not changed since tested.

Submittal Requirements

To be considered for approval, send 3 hard copies and a PDF copy of submittal to:

State Materials Engineer
 NCDOT Materials and Tests Unit
 1801 Blue Ridge Road
 Raleigh, NC 27607

For first time approvals, submit the following for each geogrid:

1. Labeled product sample (at least 4" x 7");
2. Quality Control Plan (QC Plan) information in accordance with Appendix A;
3. Any laboratory testing data including gradation and angle of internal friction (ϕ) from materials tested for RF_{ID} , C_i and C_{ds} ; and
4. Required and optional information as shown above provided in the following table (add rows to table for more geogrids):

Geogrid and Direction (MD, CD)	Polymer (PET, HDPE, PP)	Aperture Size (inches)	T_{ult}^A (lb/ft)	$T_{2\%}^A$ (lb/ft)	$T_{5\%}^A$ (lb/ft)	X_{jave}^A (lb/ft)	J^A (m-N/deg)	RF_{CR}			RF_D
								3-yr	75-yr	100-yr	
Borrow ($\phi = 30^\circ$)											
Geogrid and Direction (MD, CD)	RF_{ID}	RF			T_{al} (lb/ft)			C_i	F*	C_{ds}	ρ (deg)
		3-yr	75-yr	100-yr	3-yr	75-yr	100-yr				
Fine Aggregate ($\phi = 34^\circ$)											
Geogrid and Direction (MD, CD)	RF_{ID}	RF			T_{al} (lb/ft)			C_i	F*	C_{ds}	ρ (deg)
		3-yr	75-yr	100-yr	3-yr	75-yr	100-yr				
Coarse Aggregate ($\phi = 38^\circ$)											
Geogrid and Direction (MD, CD)	RF_{ID}	RF			T_{al} (lb/ft)			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),
- $T_{2\%}$ = tensile strength @ 2% strain (lb/ft),
- $T_{5\%}$ = tensile strength @ 5% strain (lb/ft),
- X_{jave} = average junction strength (lb/ft),
- J = aperture stability modulus (m-N/deg),
- 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) = 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-geogrid friction angle (deg) = $C_{ds} \times \tan \phi$.

For renewals, submit items from above that have changed since the most recent approval including updated samples and NTPEP reports, if applicable. For questions about this program, contact Scott Hidden, P.E. of the Geotechnical Engineering Unit at (919) 707-6856 or C. K. Su of the Materials and Tests Unit at (919) 329-4150.

APPENDIX A
Quality Control Plan Information Requirements
North Carolina Department of Transportation (NCDOT)

A Quality Control Plan (QC Plan) documents the processes for recording test data and sampling, testing, handling and storing geogrids for use by NCDOT. A QC plan is required for each facility (plant or warehouse) manufacturing or supplying geogrid products for NCDOT. The plan may be generic but should be site specific. Provide details in the QC Plan that describe how the manufacturer controls equipment, materials and production methods to ensure geogrids meet specified requirements. List personnel responsible for production and quality control at each facility including contact information for each person. Submit the following information in the QC Plan:

- Facility locations, production or supply capacities and geogrid products provided;
- Raw material sources and standards or procedures and processes to maintain traceability of geogrids back to prime manufacturer;
- Lot and sample identification methods during production, testing, storing and shipping;
- Sampling frequency and testing methods and tolerances;
- Laboratory information, association, affiliations and certifications;
- Processes for identifying and disposition of geogrids that do not meet specified requirements; and
- Packaging and shipping procedures.

If geogrids are approved, NCDOT reserves the right to conduct on-site inspections. Random inspections may be conducted at any time to verify compliance with the QC Plan. Revised or updated QC Plans should be submitted to M&T as needed. Falsifying test data, documentation or records, adjusting processes, discarding samples or test results or any other deliberate misrepresentation of geogrid products will result in revocation of product approvals.