



STATE OF NORTH CAROLINA  
DEPARTMENT OF TRANSPORTATION

BEVERLY EAVES PERDUE  
GOVERNOR

EUGENE A. CONTI, JR.  
SECRETARY

July 19, 2010 (Revised November 21, 2011)

***NCDOT Policy for Mechanically Stabilized Earth Retaining Walls***  
***By: Geotechnical Engineering Unit/Preconstruction***

A mechanically stabilized earth (MSE) retaining wall for permanent applications is defined as a soil-retaining system with steel or geogrid reinforcements in the reinforced zone connected to vertical facing elements consisting of precast concrete panels or segmental retaining wall (SRW) units. This policy does not apply to MSE walls for greenways unless walls are supporting or adjacent to vehicular traffic.

The list of approved MSE wall systems and standard NCDOT Mechanically Stabilized Earth Retaining Walls provision are available from the following website:

[www.ncdot.org/doh/preconstruct/highway/geotech/msewalls](http://www.ncdot.org/doh/preconstruct/highway/geotech/msewalls)

The provision requires the use of an MSE wall system approved by the Geotechnical Engineering Unit (GEU).

MSE wall systems with SRW units or “approved for provisional use” status code may not be used for critical walls or MSE walls connected to critical walls. Define “critical walls” as MSE walls with design heights greater than 35 ft, walls subject to scour or walls that support or are adjacent to railroads, interstate highways or bridges (abutment walls). Define “design height” as the difference between the finished grade and bottom of wall. Define “bottom of wall” as where the grade intersects the front of an MSE wall except when a single faced barrier is placed in front of and against an MSE wall. When this occurs, define bottom of wall as where the grade intersects the front of an MSE wall when the grade is projected through the barrier.

The GEU will review MSE wall systems submitted for approval. For first time approvals, an evaluation is required unless a Highway Innovative Technology Evaluation Center (HITEC) report for the MSE wall system is available. After an MSE wall system is approved, a renewal is required every 3 years or when the system changes in order to remain on the list of approved MSE wall systems.

Evaluation reports are required to include MSE wall system limitations and any proposed deviations from or exceptions to the NCDOT MSE wall provision or *AASHTO LRFD Bridge Design Specifications*. Submit all items listed under the “Submittal Requirements” in this policy to one of the following consultants to perform an evaluation:

**MAILING ADDRESS:**  
NC DEPARTMENT OF TRANSPORTATION  
GEOTECHNICAL ENGINEERING UNIT  
1589 MAIL SERVICE CENTER  
RALEIGH NC 27699-1589

TELEPHONE: 919-707-6850  
Fax: 919-250-4237

[www.ncdot.gov/doh/preconstruct/highway/geotech](http://www.ncdot.gov/doh/preconstruct/highway/geotech)

**LOCATION:**  
CENTURY CENTER COMPLEX  
ENTRANCE B-2  
1020 BIRCH RIDGE DRIVE  
RALEIGH NC 27610

Ryan R. Berg, P.E.  
Ryan Engineering & Design, Inc.  
2190 Leyland Alcove  
Woodbury, MN 55125  
(651) 735-7622  
[RyanBerg@att.net](mailto:RyanBerg@att.net)

James G. Collin, Ph.D., P.E.  
The Collin Group, Ltd.  
7445 Arlington Road  
Bethesda, MD 20814  
(301) 907-9501  
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Barry R. Christopher, Ph.D., P.E.  
210 Boxelder Lane  
Roswell, GA 30076  
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Dov Leshchinsky, Ph.D., P.E.  
Adama Engineering, Inc.  
33 The Horseshoe  
Covered Bridge Farms  
Newark, DE 19711  
(302) 368-3197  
[dov@geoprograms.com](mailto:dov@geoprograms.com)

After receiving a complete submittal and provided no additional information is required during the review, the GEU will approve or approve for provisional use the MSE wall system with or without restrictions or reject the system within 60 days. MSE wall systems will be assigned an “approved for provisional use” status code or rejected if the system has been used on 5 or less state Department of Transportation (DOT) projects in the U.S. with design heights exceeding 20 ft within the last 5 years. After the system has been successfully used on at least 6 DOT projects with design heights greater than 20 ft within the last 5 years, the status of an MSE wall system may be reevaluated.

Connection strength (ASTM D6638), pullout resistance (ASTM D6706) and direct shear (ASTM D5321) testing must be performed by a laboratory accredited by the Geosynthetic Accreditation Institute (GAI) to perform these test methods.

### **Submittal Requirements**

To be considered for approval, send 5 hard copies and a PDF copy of submittal to:

State Geotechnical Engineer  
North Carolina Department of Transportation  
Geotechnical Engineering Unit  
1589 Mail Service Center  
Raleigh, NC 27699-1589

Provide submittals in accordance with the standard NCDOT MSE retaining walls provision. All testing data must be for the exact components submitted and a National Transportation Product Evaluation Program (NTPEP) report is required for geogrid reinforcement. Use values from current NTPEP evaluation reports for geogrids except a default durability reduction factor ( $RF_D$ ) for polyester type (PET) geogrids may be used in accordance with Section 3.5.2.d of the *FHWA Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes* (Publication No. FHWA-NHI-10-024) instead of the  $RF_D$  in NTPEP reports. Submit the following items for first time approvals:

1. HITEC evaluation report with changes to the MSE wall system since the HITEC report or the following:
  - Consultant evaluation report with changes to the MSE wall system since the consultant report;
  - Precast concrete panel dimensions, tolerances, textures, colors and compressive strength, slump and air content requirements;
  - Precast concrete panel LRFD calculations for standard size panels to be used on NCDOT projects;
  - Joint sizes, details and materials (spacers, filter materials, etc.) including bearing pad calculations and testing in accordance with Section 3.6.1.a of the FHWA MSE Wall Manual;
  - Connection strength analysis including connection strength testing data and  $CR_{CR}$  from long-term or short-term testing for geogrids in accordance with Section 4.4.7.i of the FHWA MSE Wall Manual;
  - SRW unit dimensions, tolerances, textures, colors and compressive strength, absorption and durability requirements;
  - Any shear strength between SRW units testing data;
  - Dowels, connectors (e.g., bars, clamps, pins, plates, etc.) and fasteners (e.g., bolts, nuts, washers, etc.);
  - Steel reinforcement type, sizes, tolerances, grades, corrosion protection and design parameters for aggregate;
  - Steel component corrosion calculations for 75 and 100-year design life in accordance with carbon steel corrosion rates (3 corrosion loss rates) in the NCDOT MSE wall provision;
  - Geogrid reinforcement manufacturer, product lines, types, classes, grades, categories and design parameters for aggregate;
  - Geogrid reinforcement splice details and testing data;
  - Any reinforcement pullout resistance and direct shear testing data;
  - Wall drainage system, separation geotextile, leveling pad and coping details including coping attachment methods;
  - Obstruction details and/or calculations including those for foundations in the reinforced zone for MSE wall systems with panels;
  - Any other miscellaneous materials and components such as corner and slip joint elements
  - Quality control (QC) program information;
  - Material suppliers and MSE wall vendor approved or licensed precasters covering North Carolina; and
  - Plan sheets (11" x 17") showing all standard and alternate MSE retaining wall typical details including those for wall elements, connections and construction.
2. Current NTPEP evaluation report for each geogrid product line.
3. Design parameters for reinforcement to be used for NCDOT projects provided in one of the following tables (provide separate tables for coarse and fine aggregate and add rows for more reinforcement types):

- Steel reinforcement (for coarse and fine aggregate),

Reinforcement	$F_y$ (ksi)	$b$ (inches)	$S_h$ (inches)	$A_c$ for 75 and 100-year design life* (sq. inches)	$R_c$	$F^*_{top}$	$F^*_{20 ft}$	$\alpha$
*See NCDOT MSE wall provision for carbon steel corrosion rates.								

Where,

- $F_y$  = yield strength of steel (ksi),
- $b$  = unit width of reinforcement (inches),
- $A_c$  = design cross-sectional area (sq. inches),
- $S_h$  = center-to-center horizontal spacing (inches),
- $R_c$  = coverage ratio,
- $F^*_{top}$  = pullout resistance factor @ top,  $Z = 0$  ft,
- $F^*_{20 ft}$  = pullout resistance factor @ 20 ft,  $Z = 20$  ft and
- $\alpha$  = scale effect correction factor.

- Geogrid reinforcement (for coarse and fine aggregate),

Reinforcement	$T_{ult}$ (lb/ft)	$RF_{CR}$ for 75 and 100-year design life	$RF_D$	$RF_{ID}$	$T_{al}$ for 75 and 100- year design life (lb/ft)	$F^*$	$\alpha$	$\rho$ (degrees)	$CR_{ult}$	$CR_{cr}$ for 75 and 100-year design life	$T_{ac}$ for 75 and 100- year design life (lb/ft)

Where,

- $T_{ult}$  = ultimate tensile strength of geogrid (lb/ft),
- $RF_{CR}$  = creep reduction factor,
- $RF_D$  = durability (degradation) reduction factor,
- $RF_{ID}$  = installation damage reduction factor,
- $T_{al}$  = long-term geogrid design strength (lb/ft),
- $F^*$  = pullout resistance factor,
- $\alpha$  = scale effect correction factor,
- $\rho$  = soil-geogrid friction angle (degrees),
- $CR_{ult}$  = short-term ultimate connection strength reduction factor,
- $CR_{cr}$  = long-term connection strength reduction factor and
- $T_{ac}$  = long-term connection design strength (lb/ft).

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4. MSEW\* AASHTO LRFD analyses and design calculations sealed by a professional engineer for 4 MSE wall design cases with a 100-year design life in accordance with the following:

<b>Design Case</b>	<b>2:1 (H:V) Back Slope (slope rise <math>\geq</math> 50 ft) or Traffic Surcharge (q = 250 psf)</b>	<b>Coarse or Fine Aggregate in Reinforced Zone</b>
1	Back Slope	Coarse
2	Back Slope	Fine
3	Surcharge (no abutment wall)	Coarse
4	Surcharge (no abutment wall)	Fine

- Seismic not applicable
- H = 30 ft (Design Height) + 2 ft (Embedment) = 32 ft
- Level front slope
- Aggregate parameters:

<b>Aggregate Type*</b>	<b>Unit Weight (<math>\gamma</math>) pcf</b>	<b>Friction Angle (<math>\phi</math>) degrees</b>	<b>Cohesion (c) psf</b>
Coarse	110	38	0
Fine	125	34	0

\*See NCDOT MSE wall provision for coarse and fine aggregate material requirements.

- In-situ material parameters:

<b>Material Type</b>	<b>Unit Weight (<math>\gamma</math>) pcf</b>	<b>Friction Angle (<math>\phi</math>) degrees</b>	<b>Cohesion (c) psf</b>
Backfill and Foundation	120	30	0

5. MSEW\* FHWA traffic barrier impact analyses for Design Cases 3 and 4 in accordance with Section 7.2.1 of the FHWA MSE Wall Manual (see NCDOT MSE wall provision for exception to FHWA for geogrid rupture analysis).
6. MSE wall system construction manual.
7. MSE wall system history including design heights, dates and current contact information for DOT projects within the last 5 years.
8. Reports of any case histories, problems, failures, studies, research or additional testing for the MSE wall system.
9. Any other miscellaneous information requested by the GEU.

\*Computer software MSEW version 3.0 with update 14.2 or later, manufactured by ADAMA Engineering, Inc. is required.

For renewals, submit items from above that have changed since the most recent approval including changes to the MSE wall system since the current HITEC/consultant evaluation report. Revised consultant evaluation reports are not required for renewals. For questions about this policy, contact Scott Hidden, P.E. of the Geotechnical Engineering Unit at (919) 707-6856.