NORTH CAROLINA DEPARTMENT OF TRANSPORTATION SUPPLEMENTAL REQUIREMENTS[i]

Introduction

The North Carolina Department of Transportation (NCDOT) maintains a list of approved mechanically stabilized earth (MSE) wall systems. Wall vendor submittal requirements for requesting approval are stated in NCDOT Policy for Mechanically Stabilized Earth Retaining Walls, that was prepared by the Geotechnical Engineering Unit (GEU) and is available on NCDOT website.

NCDOT accepts IDEA reports as a vendor approval request submittal. Their submittal and approval process does require some additional or variation of the information listed on the IDEA protocols (available at https://www.geoinstitute.org/special-projects/idea). Specifically, NCDOT requires submittal of the information listed below to supplement an IDEA report on a particular MSE wall system.

This listing is based upon the 2020 proposed updates to the NCDOT Policy for Mechanically Stabilized Earth Retaining Walls dated August 23, 2019, that is available at https://connect.ncdot.gov/resources/Geological/Documents/19-08-23_MSE%20Retaining%20Wall%20Policy.pdf. NCDOT should contact the IDEA webmaster and update their report when their policies, etc. change. This supplemental requirements report is readily updateable, and a revision number and date should be noted.

Information that is identical to, and therefore redundant to, IDEA protocol listed items is not listed in this supplemental requirements report. However, items under a topic that the agency requests which are more specific or detailed than the IDEA protocol are listed. The wall system supplier submittal may address this in their supplemental information or, if fully addressed in their IDEA submittal, refer to their IDEA report.

Note that items to provide are listed following the order of the IDEA protocols.

Facing Units

Precast Concrete Panels

1. LRFD calculations and anchor testing for standard size panels and anchors to be used on NCDOT projects.
2. Bearing pad requirements, calculations, and compression testing curves for wall heights of 30 and 40 feet. See NCDOT Policy for Mechanically Stabilized Earth Retaining Walls.

SRW Units

1. Durability requirements for segmental retaining wall (SRW) (a.k.a., concrete modular unit) facing.

Soil Reinforcements

Steel Reinforcement

1. Tensile strength calculations for a 75- and a 100-year design life of standard reinforcement sizes using the three steel corrosion loss rates provided in the following Table 1 (from NCDOT MSE wall provision), and use loss of galvanization rates for nonaggressive backfill in accordance with the AASHTO LRFD specifications.

Table 1. Carbon Steel Corrosion Rates (from NCDOT MSE Retaining Walls provision, dated 1-16-18).

Aggregate Type (in reinforced zone)	Carbon Steel Loss Rate (after coating depletion)
Coarse	0.47 mil/year
Fine (except abutment walls)	0.58 mil/year
Fine (abutment walls)	0.70 mil/year

2. Tensile strength calculations for a 75- and a 100-year design life of standard panel to reinforcement connections using the three corrosion loss rates provided in the NCDOT MSE wall provision (see Table 1, above).
3. Summary tables reinforcement properties as shown in the following Table 2 (from NCDOT Policy for Mechanically Stabilized Earth Retaining Walls). Provide separate tables for coarse and fine aggregates, and for 75-year and 100-year design life.

Table 2. Steel Reinforcement Properties Summary Table (from NCDOT Policy for Mechanically Stabilized Earth Retaining Walls)

Reinforcement (Name & Type, e.g., grid, strip, etc.)	Abutment? (Yes or No for Fine Aggregate, N/A for Coarse Aggregate)	F_y (ksi)	E_n (inches)	b (inches)	S_h (inches)	A_c (square inches)	R_c	F^*_{top}	$F^*_{20\ ft}$	α	Connection (Name & Type)	CR

Where,

F_y = yield strength of steel (ksi),
E_n = nominal thickness of steel reinforcement, strip thickness or wire/bar dia. (inches),
b = unit width of steel reinforcement (inches),
A_c = design cross-sectional area (square 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,
α = scale effect correction factor, and
CR = connection strength reduction factor (CR_u in MSEW program).

Geosynthetic Reinforcement

1. A NTPEP REGEO report and approval of the geosynthetic under a separate NCDOT program are required.
2. Tensile strength calculations for a 75- and a 100-year design life of standard reinforcement sizes.
3. Summary tables of reinforcement properties as shown in the following Table 3 (from NCDOT Policy for Mechanically Stabilized Earth Retaining Walls). Provide separate tables for coarse and fine aggregates, and for 75-year and 100-year design life.

Table 3. Geosynthetic Reinforcement Properties Summary Table (from NCDOT Policy for Mechanically Stabilized Earth Retaining Walls)

Reinforcement (Product Label & Type, e.g., grid, strip, etc.)	T_{ult} (lb/ft)	RF_{CR}	RF_D	RF_{ID}	T_{al} (lb/ft)	F*	α	ρ (degrees)	CR_u	CR_{cr}	T_{ac} (lb/ft)

Where,

T_{ult} = ultimate tensile strength of geogrid/geostrip (lb/ft),
RF_{CR} = creep reduction factor,
RF_D = durability (degradation) reduction factor,
RF_{ID} = installation damage reduction factor,
T_{al} = long-term geosynthetic design strength (lb/ft),
F* = pullout resistance factor,
α = scale effect correction factor,
ρ = soil-geosynthetic reinforcement friction angle (degrees),
CR_u = short-term ultimate connection strength reduction factor (CR_{ult} in MSEW),
CR_{cr} = long-term connection strength reduction factor, and
T_{ac} = long-term connection design strength (lb/ft).

4. Splice details, testing data, and tensile strength calculations for a 75- and a 100-year design life of standard reinforcement sizes. Note if splicing is not applicable to the system.

Other Components

1. Details for standard corner facing elements.
2. Obstruction details including those for a 4-foot square drainage box in the reinforced zone located 2 feet behind the facing, for abutment walls.

ERS Design

1. Four example wall design calculations as described below, in Figure 1, and in Tables 4, 5, and 6 (from NCDOT Policy for Mechanically Stabilized Earth Retaining Walls).
   AASHTO LRFD analyses using the Simplified design method and the MSEW software (version 3.0 with 14.98 update, or later, by ADAMA Engineering, Inc. is required), and design calculations for each steel reinforcement type (e.g., grid, strip, etc.) and geosynthetic reinforcement product line sealed by a Professional Engineer for 4 MSE wall design cases with a 100-year design life in accordance with the following (see Figure 1 for descriptions of design height, wall height, wall embedment, reinforced zone and backfill and foundation material):
   - Design cases, see Table 4
   - Seismic not applicable
   - Design Height (H) = 30 ft (Wall Height) + 2 ft (Wall Embedment) = 32 ft
   - Level front slope
   - Reinforced zone aggregate parameters, see Table 5
   - In situ assumed material parameters, see Table 6

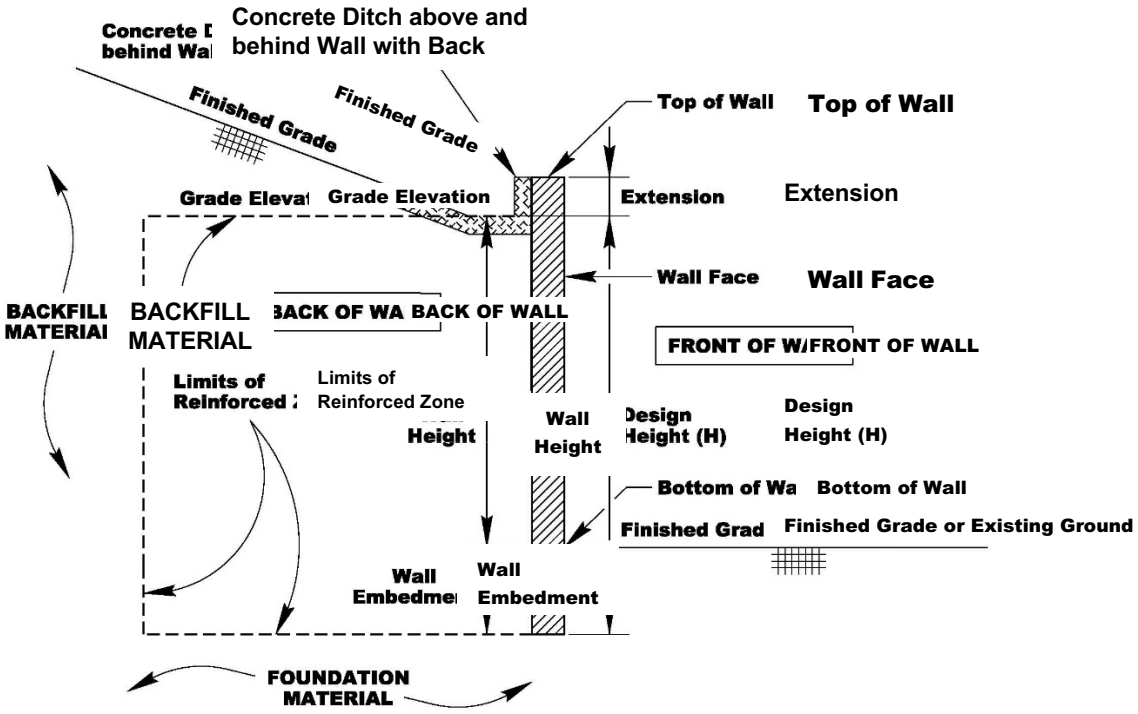

Figure 1. Typical MSE wall section.

Table 4. Design Cases for Example Problems

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

Table 5. Reinforced Zone Aggregate Parameters

Aggregate Type	Unit Weight (γ) pcf	Friction Angle (ϕ) degrees	Cohesion (c) psf
Coarse	110	38	0
Fine	115	34	0

Table 6. In Situ Assumed Material Parameters

Material Type	Unit Weight (γ) pcf	Friction Angle (ϕ) degrees	Cohesion (c) psf
Backfill and Foundation	120	30	0

2. Two sets of example calculations for a wall with a traffic barrier impact (i.e., Design Cases 3 and 4). One calculation with traffic surcharge load and the other without traffic surcharge load. FHWA traffic barrier impact analyses using MSEW software (version 3.0 with 14.98 update, or later, by ADAMA Engineering, Inc. is required) for each reinforcement type (e.g., grid, strip, etc.) and geosynthetic reinforcement product line sealed by a Professional Engineer for Design Cases 3 and 4 in accordance with Section 7.2.1 of the (2009) FHWA MSE Wall Manual, except use the following for geosynthetic reinforcement rupture (from NCDOT MSE wall provision):

$$\varphi\, T_{al}\, R_c \;\geq\; T_{max} + \left({}^{T_I}/_{RF_{CR}}\right)$$

Where,

ϕ = resistance factor for tensile resistance in accordance with Section 7.2.1 of the FHWA MSE wall manual,

T_{al} = long-term geosynthetic design strength approved for chosen MSE wall system,

R_c = reinforcement coverage ratio = 1 for continuous geosynthetic reinforcement,

T_{max} = factored static load in accordance with Section 7.2 of the FHWA MSE wall manual,

T_I = factored impact load in accordance with Section 7.2 of the FHWA MSE wall manual, and

RF_{CR} = creep reduction factor approved for chosen MSE wall system.

3. Obstruction calculations including those for a 4-foot square drainage box in the reinforced zone located 2 feet behind the facing, for abutment walls.
4. Example calculations shall be sealed by a Professional Engineer.

Quality Control

1. List of material suppliers and MSE wall vendor approved or licensed precasters covering North Carolina.

Performance History

1. MSE wall system history including design wall heights, dates and current contact information for any state DOT projects within the last 5 years.
2. Reports of any case histories, problems, failures, studies, research or additional testing for the MSE wall system.

Other Information

1. Plan sheets (11- by 17-inch) showing all standard and alternate typical MSE wall details including those for wall elements, connections, and construction.
2. Any other miscellaneous information requested by NCDOT GEU.

[i] Report Ver 1, December 2020.