

731-B-205 MSE RETAINING WALL REQUIREMENTS

(Revised 12-18-14)

The Standard Specifications are revised as follows:

SECTION 211, BEGIN LINE 111, DELETE AND INSERT AS FOLLOWS:

(c) Type 3

Structure backfill in accordance with 904.05, except only nominal size aggregates 1 in., 1/2 in., No. 4 or No. 30, and coarse aggregate No. 5, No. 8, No. 9, No. 11, or No. 12 shall be stone or ACBF. *ACBF meeting the size requirements for coarse aggregate No. 5 or No. 8 may also be used.*

SECTION 731, BEGIN LINE 60, INSERT AS FOLLOWS:

731.03 Design Criteria

~~The internal stability shall be the responsibility of the Contractor. The design by the Engineer will consider the external stability of the wall mass including the applied bearing pressure, overturning, sliding, and stability of temporary construction slopes. The design for internal stability shall be in accordance with the AASHTO LRFD Bridge Design Specifications and the requirements specified herein. The internal and external stability shall be the responsibility of the Contractor. The global stability of the wall mass will be the responsibility of the Engineer.~~

The Contractor shall use the information supplied in the contract documents including but not limited to the plans and the geotechnical report when designing the wall. The design of the wall including the internal and external stability shall be in accordance with the AASHTO LRFD Bridge Design Specifications and the requirements specified herein.

The design for internal stability shall include connection strength design. Each design case shall present maximum tension capacity, soil overburden pressure, and horizontal pressure at each reinforcement level, pullout capacity at each reinforcement level, the length of embedment in the resisting zone, and the total length of reinforcement at each level.

The design for the external stability shall include applied bearing pressure, overturning, sliding, and stability of temporary construction slopes.

The value of the pullout resistance factor, F^ , used in design calculations shall be obtained from the AASHTO LRFD Bridge Design Specifications figure 11.10.6.3.2-1.*

SECTION 731, BEGIN LINE 80, DELETE AND INSERT AS FOLLOWS:

The material used as backfill in the reinforced backfill zone shall be assumed to have a unit weight of at least 120 lb/cu ft unless lightweight fill has been specified. The ϕ angle for the internal design of the reinforced backfill shall be assumed 34°. The ϕ angle of the retained backfill behind the reinforced portion of the MSE volume shall be assumed 30° for design. ~~The ϕ angle for the internal design of the foundation soils shall be assumed 30°.~~ For the external design parameters, such as but not limited to, bearing capacity, sliding, overturning, eccentricity, and global stability, the actual soil strength

parameters and the expected settlement of the existing soil under the reinforced backfill zone used, shall be obtained from the geotechnical report.

The coefficient of uniformity, c_u , of the reinforced backfill for all designs using the ribbed steel strips curve from AASHTO LRFD Bridge Design Specifications figure 11.10.6.3.2-1 shall be 4.0.

SECTION 731, AFTER LINE 134, DELETE AND INSERT AS FOLLOWS:

(d) Other Criteria

1. Traffic Load Considerations

Traffic load shall be considered as live load surcharge. The load factor of traffic load shall be 1.75 in accordance with AASHTO LRFD Bridge Design Specifications table 3.4.1-1.

2. Traffic Impact Considerations

Where traffic barriers are constructed above an MSE wall or reinforced backfill zone, the MSE wall supporting traffic shall include computations showing that the Extreme Event II limit state due to traffic impact has been met.

Loadings for MSE wall design for the Extreme Event II limit state shall be in accordance with the following table:

<i>Maximum Nominal Tension Rupture and Pullout Impact Loads</i>		
<i>Layer</i>	<i>Tension Impact Load</i>	<i>Pullout Impact Load</i>
<i>First Top Layer</i>	<i>2,300 lbs/ft</i>	<i>1,300 lbs/ft</i>
<i>Second Top Layer</i>	<i>600 lbs/ft</i>	<i>600 lbs/ft</i>

The Extreme Event II design for the top two layers shall be separately prepared and compared with the routine internal stability design.

3. Tributary Area – Design Basis

For internal stability analysis of MSE walls, each layer of reinforcement is assigned a tributary area, A_{trib} in accordance with FHWA publication no. FHWA-NHI-10-025, Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Volume II and as follows:

$$A_{trib} = (w_p)(S_{vt})$$

where:

w_p = the wall system concrete panel width of the precast facing element, and

S_{vt} = the vertical tributary spacing of the reinforcement based on the location of the reinforcement above and below the level of the reinforcement under consideration.

For a wall system with steel reinforcement, within each tributary area, the factored reinforcement tensile resistance, T_r , and the factored pullout resistance, P_{rr} , shall be no

less than the maximum factored tension load, T_{max} . If the calculated minimum number of strips is a decimal number, the minimum number required shall be rounded up to the next whole number.

731.04 Submittals

The Contractor shall submit working drawings ~~and design calculations~~ in accordance with 105.02. *The Contractor shall submit design calculations in accordance with 105.02 and the following additional requirements. In case of discrepancy, the requirements listed below supersede those listed in 105.02. Design calculations shall include each design case of the MSE wall analyzed. Calculations may be in either longhand or computer-printout format and shall follow a systematic and logical methodology. A summary sheet that shows design assumptions and their source, controlling parameters and load cases, and other pertinent input and output information shall be included with the calculations package.* Wall construction operations shall not begin until the Contractor receives written notice that the working drawings are approved.

SECTION 731, BEGIN LINE 208, INSERT AS FOLLOWS:

Fly Ash	901.02
Geotextile	918.02
Joint Spacers and Joint Covering	901.10(b)

SECTION 731, BEGIN LINE 239, DELETE AND INSERT AS FOLLOWS:

731.07 Foundation Preparation

~~The~~ *Prior to wall construction, the foundation for the structure shall be graded level for a width equal to or exceeding the length of the ground reinforcement or as shown on the plans. Prior to wall construction, the foundation, if not in rock, shall then be compacted in accordance with 203. After the foundation has been compacted, the resulting grade of the foundation shall be 1 in. per foot sloped from the back of the foundation downward toward the leveling pad. The portion of the foundation beneath the leveling pad shall not be sloped. The base of the wall excavation foundation shall be proofrolled with approved compacting equipment in accordance with 203.26. If unsuitable foundation material is encountered, it shall be removed and replaced with B borrow in accordance with 211.02 and compacted in accordance with 211.04.*

After proofrolling has been completed and all unsuitable foundation material has been removed and replaced, compaction of the portion of the foundation beneath the reinforced backfill zone will be verified by dynamic cone penetrometer, DCP, testing in accordance with ITM 509.

One DCP measurement for every 500 sq ft within the reinforced backfill zone and five DCP measurements per end bent will be performed.

A DCP measurement is defined as the number of blows per 6 in. increment for a total penetration of 30 in., based on five sets of DCP readings at each location. A minimum of five blows of the DCP for each 6 in. increment is considered acceptable.

Unsuitable areas shall be removed, replaced, and compacted in accordance with 203 and 211. DCP verification of compaction beneath the reinforced backfill zone will

not be required if the foundation is in an embankment section that is constructed in accordance with 203.

An unreinforced concrete leveling pad shall be provided at each foundation level as shown on the plans. The leveling pad shall be cured in accordance with 702.22 for a minimum of 12 h before placement of concrete face panels.

SECTION 731, BEGIN LINE 348, DELETE AND INSERT AS FOLLOWS:

~~The work shall also include B borrow backfilling above a theoretical 1:1 slope behind the ground reinforcement as shown on the plans.~~

MSE wall backfill shall consist of structure backfill type 3 in the reinforced backfill zone and structure backfill type 3 or B borrow in the retained backfill zone as shown on the plans.

If coarse aggregate No. 5, No. 8, No. 9, or No. 11 is used in the reinforced backfill zone and the Contractor elects to use a different material in the retained backfill zone, geotextiles shall be installed at the interface between the reinforced and retained backfill zones. If the Contractor elects to use coarse aggregate No. 5, No. 8, No. 9, or No. 11 in both the reinforced and retained backfill zones, geotextiles shall be installed along the interface between the retained backfill zone and the adjacent soil. In addition, geotextiles shall be installed over the top of the No. 5, No. 8, No. 9, or No. 11 aggregate used in the reinforced or retained backfill zones.

SECTION 731, BEGIN LINE 389, DELETE AND INSERT AS FOLLOWS:

Concrete leveling pad will be measured by the linear foot. Common excavation will be measured by the cubic yard in accordance with 203.27(a) to the neat lines shown on the plans. Structure backfill and B borrow will be measured in accordance with 211.09. Unsuitable foundation materials, if found, will be measured in accordance with 211.09. ~~Geotextile shall be measured in accordance with 616.12, except as otherwise specified herein.~~ *Geotextile used in conjunction with MSE wall construction will not be measured for payment. Underdrains for MSE walls and components of the internal drainage system will be measured in accordance with 718.09. ~~Geotextile materials used as joint covering will not be measured.~~ If unsuitable foundation material is encountered in the portion of the foundation beneath the leveling pad in a section constructed on original ground or in a cut section, the removal, replacement, and compaction of the new material will be measured in accordance with 203 and 211.*

Precast or cast-in-place concrete coping will not be measured.

731.13 Basis of Payment

The accepted quantities of concrete face panels will be paid for at the contract unit price per square foot. Wall erection will be paid for at the contract unit price per square foot. Concrete leveling pad, complete and in place, will be paid for at the contract unit price per linear foot for leveling pad. Common excavation will be paid for in accordance with 203.28. Structure backfill and B borrow will be paid for in accordance with 211.10, *except that structure backfill used in the retained backfill zone will be paid for as B borrow.* Unsuitable foundation materials, if found, will be paid for in accordance with 211.10. ~~Geotextile will be paid for in accordance with 616.13, except as otherwise~~

~~specified herein.~~ Underdrains for MSE walls and components of an internal drainage system will be paid for in accordance with 718.10.

SECTION 731, AFTER LINE 432, INSERT AS FOLLOWS:

If unsuitable foundation material is encountered in the portion of the foundation beneath the reinforced backfill zone in a section constructed on original ground or in a cut section, the cost of removal, replacement, and compaction of new material will be paid for in accordance with 203 and 211.

If unsuitable foundation material is encountered in the portion of the foundation beneath the reinforced backfill zone that is constructed on an embankment section that is constructed under the same contract, the cost of removal, replacement, and compaction of new material will not be considered for payment.

The cost for geotextile used in MSE wall construction shall be included in the cost of the pay items in this section.

SECTION 735, BEGIN LINE 44, DELETE AND INSERT AS FOLLOWS:

735.04 Submittals

The Contractor shall submit working drawings ~~and design calculations~~ in accordance with 105.02. *The Contractor shall submit design calculations in accordance with 105.02 and the following additional requirements. In case of discrepancy, the requirements listed below supersede those listed in 105.02. Design calculations shall show the complete design of the temporary wire-faced wall. Calculations may be in either longhand or computer-printout format and must follow a systematic and logical methodology. A summary sheet that shows design assumptions and their source, controlling parameters and load cases, and other pertinent input and output information shall be attached to the calculations package. Wall construction operations shall not begin until the Contractor receives written notice that the working drawings are approved.*

SECTION 735, BEGIN LINE 121, DELETE AND INSERT AS FOLLOWS:

Common excavation will be measured in accordance with 203.27. Structure backfill and B borrow will be measured in accordance with 211.09. Unsuitable foundation materials, if found, will be measured in accordance with 211.09. ~~Geotextile materials will not be measured.~~ *If unsuitable foundation material is encountered in the portion of the foundation beneath the reinforced backfill zone in a section constructed on original ground or in a cut section, the removal, replacement, and compaction of the new material will be measured in accordance with 203 and 211.*

Geotextile materials will not be measured. Drainage of the backfill including piping, aggregates, and incidentals will not be measured.

SECTION 735, BEGIN LINE 143, INSERT AS FOLLOWS:

The cost of all MSE retaining wall components including wire-facing elements, concrete face panels, ground reinforcing, tie strips, fasteners, soil retention materials, repair or replacement of wire-facing elements damaged or removed due to backfill placement, and incidentals shall be included in the cost of temporary wire-facing.

If unsuitable foundation material is encountered in the portion of the foundation beneath the reinforced backfill zone in a section constructed on original ground or in a cut section, the cost of removal, replacement, and compaction of new material will be paid for in accordance with 203 and 211.

If unsuitable foundation material is encountered in the portion of the foundation beneath the reinforced backfill zone that is constructed on an embankment section that is constructed under the same contract, the cost of removal, replacement, and compaction of new material will not be considered for payment.

The cost of geotextiles shall be included in the cost of the pay items in this section.

SECTION 910, BEGIN LINE 454, DELETE AND INSERT AS FOLLOWS:

2. Clevis Connector

Clevis connectors, if used, shall be attached to the alignment templates using the bars provided with the forms. The vertical and horizontal alignment of the connectors shall be $\pm 1/8$ in. The holes inside the loops shall be free of all concrete and debris, loose or otherwise.

The clevis connector shall be fabricated of cold-drawn steel wire in accordance with ASTM A 1064. Loops shall be galvanized in accordance with ASTM A 153 class B-3, ASTM A 123, coating grade 55, ~~or ASTM B 695 class 55.~~

A type A certification in accordance with 916 shall be furnished for the clevis connector. The results of the tension, bend, and coating adhesion tests, and measurements of coating thickness and average weight of the coating, shall be included on the certification for the clevis connector.

3. Connector Bar

The connector bar, if used, shall be fabricated of cold-drawn steel wire in accordance with ASTM A 1064, and galvanized, if so shown on the plans, in accordance with ASTM A 123, coating grade 55, ~~or ASTM B 695 class 55.~~

A type A certification in accordance with 916 shall be furnished for the connector bars. The results of the coating adhesion test and the measurements of coating thickness, average weight of the coating, and coating flexibility, shall be included on the certification for the connector bar.

SECTION 910, BEGIN LINE 502, DELETE AND INSERT AS FOLLOWS:

Ground-reinforcement units shall be hot rolled from bars to the required shape and dimensions. Physical and mechanical properties of the units shall be in accordance with ASTM A 572, grade 65. Tie strips shall be shop fabricated with hot-rolled steel in accordance with the minimum requirements of ASTM A 1011, grade 50. Galvanization for ground-reinforcing units and tie strips shall be in accordance with ASTM A 123, coating grade 85 ~~or ASTM B 695, class 80,~~ *for strip-type reinforcements or ASTM A 641, class 5 or class C, for bar mat or grid-type reinforcements.* All ground-reinforcement units and tie strips will be inspected to ensure that they are true to size and free from defects which can impair their strength and durability.

A type A certification in accordance with 916 shall be furnished for ground reinforcement prior to use of the materials. The results of the yield strength, coating thickness, and coating adhesion tests shall be shown on the certification.

(c) Fasteners

Fasteners shall consist of 1/2 in. diameter, bolts, nuts, and washers and shall otherwise be in accordance with 910.02(g)1 with the exception that the hardware shall be coated in accordance with ASTM A 153, class C ~~or ASTM B 695, class 55.~~

The supplier shall provide a certificate of compliance with all requirements for high strength bolts, nuts, and washers used in the assembly of MSE retaining walls. The certification, in addition to complying with the applicable requirements of 916, shall include the lot number and heat number on the shipping package and indicate when or where all testing was performed.
