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APPENDIX SS-01

Modified Supplemental Specification 840
(Contract Document)

State of Ohio
Department of Transportation
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Innerbelt Bridge
Construction Contract Group 1 (CCG1)

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5 - Addendum No. 5 - New Appendix

STATE OF OHIO
DEPARTMENT OF TRANSPORTATION
Modified SUPPLEMENTAL SPECIFICATION 840
MECHANICALLY STABILIZED EARTH WALL

June 3, 2010

840.01 Description.
This work consists of designing for internal stability, preparing working drawings, and fabricating and constructing a mechanically stabilized earth (MSE) wall using an accredited MSE Wall System. This specification supersedes recommendations by the MSE wall system supplier.

840.02 Definitions.
For the purposes of this specification, the following definitions are used:

A. MSE Wall System. A retaining wall system that consists of select granular backfill, reinforcing elements, and facing elements connected to the soil reinforcement.

B. Soil Reinforcement. A material placed within a soil mass to increase the strength of the select granular backfill. Soil reinforcement for MSE walls are typically placed horizontally and consist of steel strips, welded wire mesh, or geogrids (polymer mesh).

C. Facing Panels. The component of an MSE wall used to contain the Select Granular Backfill in position at the face of the wall. Facing panels for MSE walls are typically made of precast concrete.

D. Connection Device. The item used to connect the soil reinforcement to the facing panel.

E. MSE Wall System Supplier. The Contractor or Consultant that designs the MSE wall system for internal stability and in accordance with the plans, designs the components of the MSE wall system and prepares the working drawings.

F. Accredited MSE Wall System. An MSE wall system approved for use by the Department. Each accredited MSE wall system has specific designs for the soil reinforcement, facing panels, and connection devices. The following table lists the accredited MSE wall systems and the associated MSE wall system suppliers.

TABLE 840.02-1

Accredited MSE wall system	MSE wall system supplier
Reinforced Earth	The Reinforced Earth Company
Rtained Earth	The Reinforced Earth Company
MSE Plus	SSL, LLC
Tricon Retained Soil	Tricon Precast
ARES	Tensar Earth Technologies
EarthTrac HA	EarthTec

Do not use the ARES system for MSE walls that support bridge abutments on spread footings.

G. Precaster. A manufacturer certified by the Department according to Supplement 1073 to produce precast concrete products. The Precaster furnishes the facing panels for the accredited MSE wall system.

840.03 Materials.

A. Precast Concrete Facing Panels. Furnish materials conforming to the following:

Portland cement ..... 701.02, 701.04, or 701.05
Reinforcing steel 709.00
Microsilica 701.10
Ground granulated blast furnace slag (GGBFS) 701.11
Fly ash 701.13
Fine aggregate 703.02
Coarse aggregate 703.02
Air-entraining admixture 705.10
Chemical admixtures 705.12

B. Soil Reinforcement. Furnish soil reinforcements and connection devices conforming to the requirements for the appropriate accredited MSE wall system listed below. Provide certified test data for all of the requirements. Refer to the working drawings for the shape and dimensions of soil reinforcements.

Store soil reinforcements off the ground and protect against weather by covering with tarps. Do not bend steel soil reinforcements after galvanizing.

1. Reinforced Earth

Furnish soil reinforcement consisting of steel strips conforming to ASTM A 572, Grade 65 (ASTM A 572M, Grade 450) and galvanized according to the requirements of ASTM A 123 (ASTM A 123M). Furnish connection devices consisting of tie strips conforming to ASTM A 1011, Grade 50 (ASTM A 1011M, Grade 340) and galvanized according to the requirements of ASTM A 123 (ASTM A 123M). Furnish bolts conforming to ASTM A 325 or ASTM A 449. Furnish nuts conforming to ASTM A 563 and washers conforming to ASTM F 436. Furnish bolts, washers and nuts that are galvanized according to the requirements of ASTM F 2329 or ASTM A 153 (ASTM A 153M).

2. Retained Earth

Furnish soil reinforcement consisting of welded wire mesh conforming to ASTM A 185 (ASTM A 185M) and galvanized according to the requirements of ASTM A 123 (ASTM A 123M). Furnish connection devices consisting of clevis loops and connector rods conforming to ASTM A 82 (ASTM A 82M) and galvanized according to the requirements of ASTM A 123 (ASTM A 123M).

3. MSE Plus

Furnish soil reinforcement consisting of welded wire mesh conforming to ASTM A 185 (ASTM A 185M) and galvanized according to the requirements of ASTM A 123 (ASTM A 123M). Furnish connection devices consisting of loop embeds and connecting pins conforming to ASTM A 82 (ASTM A 82M) and galvanized according to the requirements of ASTM A 123 (ASTM A 123M).

4. Tricon Retained Soil

Furnish soil reinforcement consisting of welded wire mesh conforming to ASTM A 185 (ASTM A 185M) and galvanized according to the requirements of ASTM A 123 (ASTM A 123M). Furnish connection devices consisting of panel anchors and locking rods conforming to ASTM A 82 (ASTM A 82M) and galvanized according to the requirements of ASTM A 123 (ASTM A 123M).

5. ARES

Furnish soil reinforcement consisting of high density polyethylene (HDPE) geogrids and connection devices consisting of HDPE geogrids and bodkin bars. Furnish either UX1400MSE, UX1500MSE, UX1600MSE or UX1700MSE geogrids from Tensar Earth Technologies, that conform to the following requirements.

TABLE 840.03-1

	UX1400MSE	**UX1500MSE**	**UX1600MSE**	**UX1700MSE**
Minimum Tensile Strength ASTM D 6637	4,800 lb/ft (70 kN/m)	7,810 lb/ft (114 kN/m)	9,870 lb/ft (144 kN/m)	11,990 lb/ft (175 kN/m)

6. EarthTrac HA

Furnish soil reinforcement consisting of steel strips conforming to ASTM A 572, Grade 50 (ASTM A 572M, Grade 345) and galvanized according to the requirements of ASTM A 123 (ASTM A 123M). Furnish connection devices consisting of either single lugs conforming to ASTM A 572, Grade 50 (ASTM A 572M, Grade 345) or double lugs conforming to ASTM A 36. Furnish connection devices that are galvanized according to the requirements of ASTM A 123 (ASTM A 123M). Furnish bolts and nuts conforming to ASTM A 325 (ASTM A 325M) and galvanized according to the requirements of ASTM A 153 (ASTM A 153M).

C. Bearing Pads. Furnish bearing pads that will provide a long term horizontal joint spacing of at least 3/8 inch (10 mm). Provide bearing pads to the dimensions shown in the working drawings.

D. Facing Panel Joint Cover. Furnish a woven, 100 percent monofilament, geotextile fabric conforming to AASHTO M 288 Table 1, Class 2 less than 50 percent elongation; with UV stability (retained strength)

according to ASTM D4355 of 90 percent after 500 hours, and conforming to AASHTO M 288 Table 2 requirements for less than 15 percent in situ soil passing 0.075 mm sieve. Provide certified test data for the geotextile fabric.

Use an adhesive that secures the fabric to the wall during construction. Use a minimum geotextile fabric width of 24 inches (610 mm). Before installation, protect the geotextile fabric from exposure to direct sunlight.

E. Select Granular Backfill. Furnish select granular backfill (SGB) material conforming to either 703.17, Aggregate Materials for 304, or 703.11, Structural Backfill Type 2, and the requirements listed below.

1. Do not use slag materials or recycled portland cement concrete.

2. Ensure the SGB material has an internal angle of friction equal to or greater than 34 degrees when tested according to AASHTO T 236 and the following requirements:

   a. Obtain the test sample from the portion of the SGB material which passes a No. 10 sieve.

   b. Determine the maximum dry density and optimum moisture of the test sample according to AASHTO T 99, Method A.

   c. Compact the sample for direct shear testing to 98 percent of the maximum dry density and within one percent of optimum moisture content as determined in 840.03.E.2.b.

   d. Perform the direct shear test three times at normal stresses of 10, 20, and 40 pounds per square inch (70, 140, 280 kPa).

   e. Plot the maximum shear stress versus the normal stress for each test. Draw a straight line that is a best fit to the three points using the least-squares method. Determine the internal angle of friction by measuring the angle of the best fit line from horizontal.

   If the internal angle of friction is less than 34 degrees and the SGB has a significant amount of material retained on the No. 10 sieve, then the DBT may submit an alternate shear test procedure that includes the material larger than the No. 10 sieve in the test sample.

3. For MSE wall systems that use steel soil reinforcements and connection devices, ensure that the SGB material meets the following requirements:

   a. A pH between 5.0 and 10.0 when tested according to AASHTO T 289.

   b. A resistivity greater than 3000 ohm-cm when tested according to AASHTO T 288. If the SGB material has a resistivity greater than 5000 ohm-cm, the ICQM will waive testing for chloride and sulfate levels.

   c. A chloride level less than 100 ppm when tested according to AASHTO T 291.

   d. A sulfate level less than 200 ppm when tested according to AASHTO T 290.

4. For MSE wall systems that use geogrid soil reinforcement, ensure that the SGB material meets the following requirements:

a. A pH between 4.5 and 9.0 when tested according to AASHTO T 289

Obtain all acceptance samples from the material stockpile.

Thirty days before the MSE wall construction, provide certified test data from an independent testing laboratory that verifies the SGB material meets all requirements. The ICQM will conditionally accept the SGB material based upon a visual inspection of the SGB material and a review of the certified test data. Final acceptance of SGB material will be based on testing of quality assurance samples by the Department and ICQM to verify that the certified test data is accurate. The ICQM will sample the SGB material when the SGB material is delivered to the project before it is placed in the MSE wall. The ICQM will provide the sample and the certified test data to the Office of Materials Management.

F. Backfill Drainage Material. Furnish materials conforming to:

Plastic Pipe 707.33
Filter Fabric, Type A 712.09

Furnish porous backfill consisting of gravel or stone with a No. 57 size gradation according to Table 703.01-1. Use material with a sodium sulfate soundness loss less than 15 percent (5 cycle) when tested according to AASHTO T 104.

Furnish bedding and backfill for non-perforated pipe consisting of natural sand, gravel or sand manufactured from stone conforming to 703.11, Structural Backfill Type 2, except 100 percent of the material shall pass through a ¾-inch (19.0 mm) sieve.

For perforated pipe installed within the SGB, the DBT may furnish fabric-wrapped perforated pipe instead of wrapping filter fabric around the perforated pipe in the field. The fabric-wrapped perforated pipe must come from the supplier with the filter fabric completely surrounding the pipe and securely attached to the pipe. Ensure that the pipe and filter fabric meet the above requirements.

G. Foundation Preparation Materials.

1. Geotextile Fabric. Furnish a woven, 100 percent monofilament, geotextile fabric conforming to AASHTO M 288 Table 1, Class 2 less than 50 percent elongation; conforming to AASHTO M 288 Table 2 requirements for less than 15 percent in situ soil passing 0.075 mm sieve. Provide certified test data for the geotextile fabric.

2. Furnish crushed carbonate stone, gravel, durable sandstone, durable siltstone, or granulated slag conforming to 703.16.C, Granular Material Type C.

H. Concrete Coping. Furnish materials conforming to:

Concrete, Class C 511
Epoxy coated reinforcing steel 709.00
Preformed expansion joint filler 705.03

I. Leveling Pad. Furnish Class C Concrete according to Item 511.

J. Concrete Sealer. Furnish epoxy-urethane sealer conforming to 705.23.A.

K. Pile Sleeves Materials.

1. Plastic Pipe. Furnish corrugated polyethylene smooth lined pipe conforming to either 707.33 or ASTM F 2648, or PVC corrugated smooth interior pipe conforming to 707.42. Furnish sleeves with an inside diameter at least 2 inches (50 mm) greater than the pile's diameter or diagonal dimension.

If furnishing plastic pipe manufactured from recycled polyethylene, submit certified test data that shows the pipe conforms with ASTM F 2648. Clearly mark all pipe manufactured from recycled polyethylene so that it is used only for pile sleeves on the project.

2. Granular Fill. Furnish granular material conforming to 703.11, Structural Backfill Type 2, except 100 percent of the material shall pass through a ¾-inch (19.0 mm) sieve.

L. Natural Soil. Furnish A-4a, A-6 or A-7-6 natural soil meeting the requirements of 203.02.I.

840.04 Design and Submittal Requirements.

A. Design Requirements. Design the MSE wall conforming to the requirements listed below and either Section 5.8 of the AASHTO Standard Specifications for Highway Bridges, 17th edition, 2002, (AASHTO 2002) or Section 11.10 of the AASHTO LRFD Bridge Design Specifications, 4th edition, 2007 (AASHTO LRFD). Use the same version of the AASHTO design specifications as used to develop the plans. In the event of a conflict between this specification and the AASHTO specification, this specification will govern.

1. Only use an accredited MSE wall system.

2. Unless a longer minimum soil reinforcement length is given in the plans, provide soil reinforcement with a length that is equal to 70 percent of the wall height but not less than 8 feet (2.4 m). If the wall will be located at an abutment, measure the wall height from the top of the leveling pad to the profile grade elevation at the face of the wall. For all other walls, measure the wall height from the top of the leveling pad to the top of the coping.

3. Use the following soil parameters in the design. These parameters are not to be used for material acceptance.

TABLE 840.04-1

Fill Zone	Type of Soil	Design Soil Unit Weight	Friction Angle	Cohesion
Reinforced Soil	Select Granular Backfill	120 lbs/ft3 (18.9 kN/m^3)	34°	0
Retained Soil (Soil behind the Reinforced Soil Zone)	On-site soil varying from sandy lean clay to silty sand	120 lbs/ft3 (18.9 kN/m^3)	34°	0

4. Use the simplified method or the coherent gravity method for internal stability calculations. The coherent gravity method as described in AASHTO LRFD may also be used for a design otherwise conforming to AASHTO 2002.

5. Include a live load surcharge of 250 psf (12.0 kPa) unless the backfill above the wall is sloped steeper than 4H:1V. Include a live load surcharge even if there is an approach slab at the bridge abutment.

6. Assume a water level within the reinforced soil at the invert elevation of the drainage pipe.

7. Use the following reduction factor values for geogrid soil reinforcement.

TABLE 840.04-2

	Reduction Factors		
Accredited MSE Wall System	**Installation Damage, RF_{ID}**	**Creep, RF_{CR}**	**Durability, RF_D**
ARES	1.25	3.1	1.1

8. Provide a design life of 100 years.

9. Use a 9-foot (2.75 m) minimum length of wall between leveling pad elevation changes. Design the facing panel overhang at the end of the leveling pad of less than 6 inches (150 mm). Do not design vertical steps in the leveling pad greater than 2.5 feet (0.75 m).

10. Use standard panels with maximum dimensions of 5 ft high × 10 ft wide (1.52 × 3.05 m). Special panels along the top and bottom of the wall may have maximum dimensions of 7 ft high × 10 ft wide (2.13 × 3.05 m)

11. Use a separate corner element when two wall sections meet with an interior angle of 130 degrees or less. Do not place two facing panels next to each other with an interior angle of 130 degrees or less. Design the corner element to overlap the adjoining facing panels. Attach soil reinforcements to the corner element.

12. Design the wall to provide a coping as shown on the plans. Provide joints in the coping no more than every 20 feet (6 m) along the length of the wall. Locate coping joints to align with the joints between facing panels.

13. Do not provide a design that bends soil reinforcements. Splaying soil reinforcements up to 15 degrees from perpendicular to the facing panel without bending in order to avoid obstacles in the reinforced soil zone is acceptable. If more than a 15-degree splay is required, then provide a special design to avoid the obstacle, such as a structural frame or attaching steel angles to panels. Show the details of the special design in the working drawings.

14. Use the same soil reinforcement design within the zone of influence of a spread footing abutment as that required under the footing (see Figure 840.04-1). The zone of influence for the spread footing extends a distance x/2 beyond the ends of the footing, where x is the distance between the bottom of the footing and the top of the leveling pad.

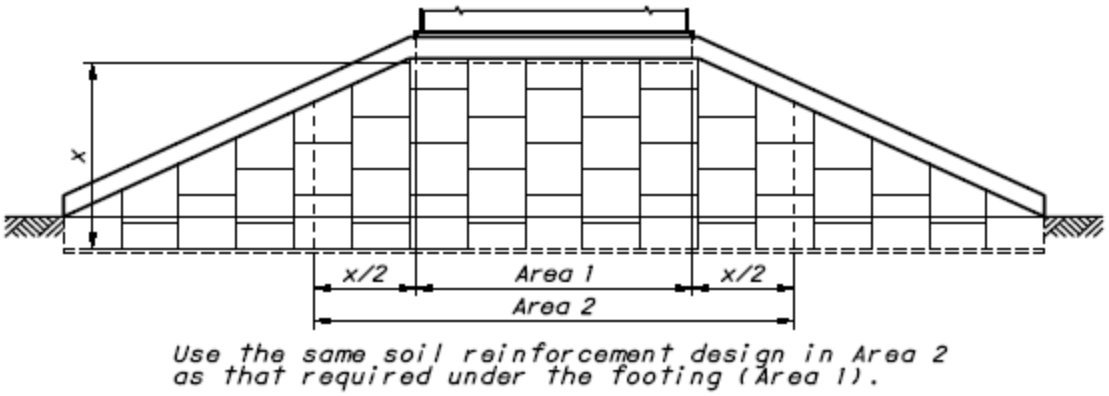

Figure 840.04-1 Zone of Influence

B. Submittal of Working Drawings and Calculations. Prepare design calculations according to the above requirements. Prepare working drawings and include at least the following information in the working drawings:

1. A site plan for the full length of the retaining wall that shows:

   a. Station and offset at the face of the wall measured from the centerline of construction for the ends of the wall and any changes in wall alignment, obtained from the contract documents.

   b. Horizontal and vertical curve data for curved walls as outlined and shown on the contract documents.

   c. Limits of soil reinforcement.

   d. All obstructions to the soil reinforcement, such as piling or catch basins.

2. An elevation view for the full length of the retaining wall that shows:

   a. Location of each individually labeled facing panel.

   b. Elevations at the ends of the wall and any changes in elevation at the top or bottom of the wall.

   c. Required soil reinforcement lengths and locations.

3. Representative cross-sections at each design change.

4. Design details to avoid obstacles in the reinforced soil zone, such as splaying, panel steel angles or structural frames.

5. Shop drawings for fabrication of the facing panels that show:

   a. The Precaster who will produce the facing panels.

   b. Minimum concrete compressive strength at 28 days and for form removal.

   c. Dimensions and tolerances.

d. Soil reinforcement connection details and locations in the facing panels.

e. Reinforcing steel locations, sizes, lengths, type and bending diagrams.

f. Aesthetic surface treatment details.

g. If the plan design calls for MSE Wall alignment on a horizontal curve, then chamfer the back panels along the back vertical joints to maintain the front panel joint tolerance in 840.06.G.

6. Wall drainage details, including:

a. Location and elevation of drainage pipe and outlets, obtained from the contract documents.

b. Locations and details of any required penetrations in the facing panels, obtained from the contract documents.

7. Actual bearing pressures.

8. Allowable bearing capacity, obtained from the contract documents.

9. Design life.

10. Angle of internal friction used for the design.

11. Construction manual for the accredited MSE wall system.

12. Revised quantity of select granular backfill based on the length of soil reinforcement used in the design. Compare revised quantity to the estimated quantity of select granular backfill in the plans and indicate the difference.

Use an Ohio Registered Engineer to prepare, sign, seal and date the working drawings, design calculations and acceptance letter provided in Appendix A. Use a second Ohio Registered Engineer to check, sign, seal and date the working drawings, design calculations and acceptance letter provided in Appendix A.

Submit four copies of the working drawings, design calculations and acceptance letter to the IQF at least 30 days before any part of wall construction begins. Submit drawings on 11×17 inch paper, and calculations on 8½×11 inch paper. Also submit drawings and calculations in electronic tiff format. The IQF will submit the drawings, calculations and acceptance letter to the Department for review. The review will be completed within 21 days.

Ensure all submittals meet the requirements for materials, design, and construction. Ensure all required field measurements are made and included in the drawings. Coordinate all details of the work to be performed by other entities on the project.

840.05 Fabrication and Acceptance of Precast Concrete Facing Panels.

Provide precast mconcrete facing panels from a precast concrete producer certified under Supplement 1073. Do not start facing panel fabrication until the working drawings and design calculations have been accepted by the IQF.

A. Concrete Proportioning. Proportion a concrete mix design that provides the minimum compressive strength required in the working drawings and the minimum over design of ACI 318 and conforms to the air content requirements of Supplement 1073.

B. Form Inspection. Before casting, measure all forms for tolerances defined in 840.05.G and document the measurements. Reject any forms not within tolerances.

C. Casting. Before casting, place the reinforcing steel, soil reinforcement connection devices, and lifting elements at the locations shown on the working drawings and to the tolerances specified below. Design the lifting elements to eliminate concrete spalling during handling. Cast the panels on a flat area, with the front face down. Use clear form oil approved by the MSE wall system supplier and do not substitute the form oil after the casting operation begins.

Leave all forms in place until the concrete panel can be removed without damage. Use the working drawings to define the minimum compressive strength required for form removal. Test and record the strength of the concrete before removing the forms.

D. Curing. Use the curing method recommended by the MSE wall system supplier. Cure the concrete sufficiently to develop the minimum compressive strength required in the working drawings.

E. Concrete Testing. During facing panel production, randomly sample the concrete and test according to ASTM C 172 and Supplement 1073. A single compressive strength sample consists of at least four test cylinders for each production lot. A production lot is either 40 panels or a single day's production, whichever is less. Perform compressive strength testing according to Supplement 1073.

F. Concrete Finish and Aesthetic Treatment. If an aesthetic surface treatment is shown in the plans or working drawings, cast it into the front face of the panels. If an aesthetic surface treatment is not required, finish the front face of the panels to a smooth surface. Finish the back face of the panels to a uniform surface, free of open pockets of aggregate. Ensure that both faces conform to the tolerances specified below.

G. Panel Dimensions and Tolerances. Fabricate the panels with a minimum thickness of 5 ½ inches (140 mm). The minimum thickness does not include the aesthetic surface treatments. Use the tolerances in Table 840.05-1.

TABLE 840.05-1

	Tolerance
Panel dimensions	± 1/8 in. (3 mm)
Panel squareness (difference between two diagonals)	± 1/4 in. (6 mm)
Panel thickness	± 1/8 in. (3 mm)
Location of soil reinforcement connection device	± 1/4 in. (6 mm)
Panel surface (size of surface defect measured over a length of 5 ft (1.5 m))	
Smooth formed finish	± 1/8 in. (3 mm)
Textured finish	± 5/16 in. (8 mm)
Position of reinforcing steel	± 1/8 in. (3 mm)

Inspect and document that the panels are dimensionally correct; that the soil reinforcement connection devices are at the locations shown on the working drawings; that the panel finishes are correct; that concrete's form removal and final strength meet working drawings; and that all tolerances have been met.

H. Precast Panel Rejection, at the plant and field site. Reject panels having any of the following:

1. Defects that indicate imperfect molding.

2. Defects that indicate honeycombed or open texture concrete.

3. Defects in the physical characteristics of the concrete, or damage to the aesthetic surface treatments.

4. Concrete chips or spalls that exceed 4 inches (100 mm) wide or 2 inches (50 mm) deep.
Repair all chips and spalls that are smaller.

5. Stained form faces, due to form oil, curing or other contaminants.

6. Signs of aggregate segregation.

7. Cracks wider than 0.01 inch (0.25 mm) or penetrating more than 1 inch or longer than 12 inches (300 mm).

8. Facing panels that do not meet the specified tolerances.

9. Damaged soil reinforcement or connection devices, including connection devices bent more than 15 degrees.

10. Unusable lifting inserts.

11. Exposed reinforcing steel.

12. Insufficient concrete compressive strength

I. Panel Markings. Permanently mark the back surface of each panel with the date of manufacture, the panel identification from the working drawings, the production lot number, and the precaster's inspection and acceptance mark. The precaster's marks represent the panel meets all specification requirements.

The precaster shall maintain record fabrication drawings according to Supplement 1073 and this specification for each panel design produced.

J. Handling, Storing and Shipping Panels. Handle, store, and ship panels to avoid chipping, cracking and fracturing the panels; excessive bending stresses; and damaging the soil reinforcement connection devices. Support panels on firm blocking while storing and shipping.

Do not ship panels until concrete has attained the required compressive strength.

Submit 840.05.G shipment documentation to the IQF as the facing panels are delivered to the project along with the TE-24 shipping document.

840.06 Construction.

A. MSE Wall Preconstruction Meeting. Request a meeting at least 15 days before wall construction begins and after the IQF has accepted the working drawings and design calculations. Have a representative from the accredited MSE wall system supplier attend the meeting. Provide a complete written sequence of construction at the meeting and review the sequence, any construction issues, the specifications and the accredited MSE wall system requirements. Determine any issues that need to be resolved for construction. Resolve those issues.

During the MSE wall preconstruction meeting, request sampling of the SGB for verification acceptance.

B. Facing Panel Inspection. Inspect all facing panels for any damage and reject panels according to 840.05.H. Provide acceptable replacement panels for any panels rejected and replace panels.

C. Wall Excavation. Excavate to the limits shown in the plans. Remove unsuitable foundation soils to the limits shown in the plans. Wall excavation is unclassified and includes any rock or shale encountered. Dewater the excavation if water is encountered. Develop and implement a plan to protect the open excavation from surface drainage during construction and until the wall is placed. Protect the excavation against collapse. Dispose of materials not required or suitable for use elsewhere on the project.

D. Foundation Preparation. Level the bottom of the excavation. The IQF will inspect the foundation to verify that the subsurface conditions are the same as those anticipated during the design.

After the foundation has been accepted, place the geotextile fabric on the foundation soil according to 204.07. Spread, place and compact 12 inches (300 mm) of granular material type C on top of the geotextile fabric according to the requirements of 204.07.

E. Leveling Pad Construction. Construct the concrete leveling pad using unreinforced, castin- place concrete. Do not use precast leveling pads. The leveling pad shall be 6 inches (150 mm) thick and 24 inches (610 mm) wide. Cure the concrete and do not start wall erection until specimen beams have attained a modulus of rupture of 400 pounds per square inch (4.2 MPa).

Construct all leveling pads so the top of the pad is within 1/8 inch (3 mm) of the elevation shown on the working drawings. Construct the pads so the surface does not vary more than 1/8 inch in 10 feet (3 mm in 3 m). Check the leveling pad construction before wall erection and report the elevations and surface variation to the IQF.

If the design calls for a change in the leveling pad elevation (i.e. steps), then construct the leveling pad so the facing panel extends no more than 6 inches (150 mm) beyond the end of the leveling pad.

F. Wall Drainage. Install drainage as shown on the plans. Use perforated pipe within the wall limits and non-perforated pipe outside the wall limits. Provide banded or sealed joints. Slope the drainage pipe to provide positive drainage. If it is not possible to outlet the drainage pipe, then notify the IQF.

Where perforated pipe is surrounded by select granular backfill (SGB), use fabric-wrapped perforated pipe or wrap the filter fabric around the perforated pipe, overlapping the ends of the filter fabric at least 9 inches (230 mm). Porous backfill is not required in these locations.

Where perforated pipe is located outside the limits of the SGB, completely surround the perforated pipe with porous backfill. Provide at least 2 inches (50 mm) of porous backfill on all sides of the perforated pipe.

Vibrate, tamp, or compact the porous backfill to approximately 85 percent of the original layer thickness. Completely wrap the porous backfill with filter fabric to prevent piping. Use a 1 foot (0.3 m) overlap for the filter fabric.

Place the bedding and backfill material for non-perforated pipe according to 603.11. Compact the bedding and backfill according to 603.11.C.

If water collects in the excavation at any time, then remove the water from the excavation immediately.

G. Wall Erection. Place facing panels in the sequence shown on the working drawings. Lift panels using the lifting devices set into the upper edge of each panel. Place the initial row of panels on the centerline of the leveling pad and level the panel. Use shims to level the panels. If the shim height is greater than 3/8 inch (10 mm) start the erection over. Do not use bearing pads to level the panels. Do not install panels that overhang the leveling pad transversely. Reconstruct the leveling pad if the panels are transversely overhanging.

Facing panels are allowed to extend beyond the end of the leveling pad up to 6 inches (150 mm) when the leveling pad changes elevation. Fill the void with SGB immediately after the first row of panels are set, wedged, braced and clamped.

Starting with the second row of panels, install at least two bearing pads per panel, uniformly spaced, to properly construct the panels' horizontal joint. After each panel has been placed, ensure the panel is horizontally level.

Construct the panels so the horizontal and vertical joints are ½ to 1 inch (13 to 25 mm) wide. Use ¾ inch (19 mm) spacers to control the joint spacing. Once the joint spacing is achieved, record the joint gap on the working drawings and present this information to the IQF once a week. If the required joint spacing is not achieved, then make the required corrective action.

The IQF will hold a flashlight perpendicular to the facing panel to determine if the fabric is exposed. If the fabric is exposed, then the joint is unacceptable. Submit a repair method to the Department and IQF for protecting the fabric.

Initially, batter the panels back an appropriate amount so that the final vertical position is achieved.

Use external bracing as necessary to stabilize and batter the first panel lift and any other panel lifts requiring external stability. Place panels and backfill in successive horizontal lifts according to the sequence shown on the working drawings.

Once the panels have been erected and the SGB placed to a height matching the outside proposed ground elevation, fill the outside embankment immediately. Follow the requirements of Item 203 for this work. If water has ponded in front of the wall, then pump the water out prior to constructing the embankment.

Maintain the panels in their vertical and battered position by means of temporary wood wedges and clamps placed at the panel joints. Check vertical tolerances with a 6-foot (2 m) level. Check the panel to panel horizontal tolerance with a 6-foot (2 m) straightedge. Do not release the panel from the lifting device until the position of the panel has been checked and the wedges and clamps are in place.

After compacting the backfill behind each row of panels, check the horizontal and vertical alignment of the wall and make adjustments as required. Remove the clamps and wedges prior to placing the next row of panels and after the vertical and horizontal alignment is checked.

Do not exceed a vertical and horizontal alignment tolerance of 1/2 inch (13 mm) at any point along a 10-foot (3 m) straight edge placed against the wall. Do not construct any panel more than 1/2 inch (13 mm) out of vertical or horizontal alignment from the adjacent panels. Do not exceed the final overall vertical tolerance of the wall (plumbness from top to bottom) of ½ inch (13 mm) per 10 feet (3 m) of wall height. Starting with the third row of panels, use a plumb bob to check the overall vertical tolerances for every panel. Continuously monitor the batter, alignment and tolerances. Make adjustments as required.

Do not pull on the soil reinforcement to align the panels.

Remove the wedges as soon as the second panel above the wedged panel is completely erected and backfilled.

Install the geotextile fabric strip over each horizontal and vertical panel joint. Center the fabric over the joint. Use a minimum 12-inch (300 mm) lap between cut sections of the fabric. Clean the concrete to remove dirt by using a brush before applying the adhesive and fabric. Place the fabric so it covers the horizontal and vertical joints by 12 inches (300 mm) on each side of the joint. Attach the fabric to the back of the facing panel using an adhesive that securely bonds the fabric to the facing panel. Apply adhesive to the wall or the fabric for the full perimeter of the installed length and width of the geotextile strip. Follow the adhesive manufacturer's temperature recommendations.

When the fabric is placed around a slip joint, allow some horizontal slack in the fabric to allow for movement.

H. Soil Reinforcement Installation. Place the soil reinforcement perpendicular to the facing panel unless otherwise shown on the working drawings. If steel soil reinforcement cannot be placed perpendicular to the wall, then it may be splayed up to 15 degrees. The transverse wires of welded wire mesh may be cut in order to splay the soil reinforcement. If more than a 15 degree splay is required to place the soil reinforcement, then a special design is required on the working drawings. If a situation is encountered in the field that was not accounted for on the working drawings, notify the IQF.

If bolts are used to connect the soil reinforcement to the facing panel, then place the bolts in the connection from the bottom and attach the washer and nut. Tighten the bolt with a wrench or socket.

If loops and a pin are used to connect the soil reinforcement to the facing panel, then place the pin through all of the loops. Place wooden wedges between the pin and the panel to remove any slack in the connection. Ensure the pin and loops are in contact with each other.

Before placing SGB over the soil reinforcements ensure that:

1. The soil reinforcement matches what is shown on the working drawings.

2. The soil reinforcement is continuous from the panel to the end of the reinforced soil zone.

3. The soil reinforcement is connected to the panel correctly. Replace the panel if necessary to correctly connect the soil reinforcement.

4. For geosynthetic reinforcements ensure the soil reinforcement is pulled taut to eliminate wrinkles or folds and held in place during placement of the SGB.

Do not cut or splice steel soil reinforcements. Do not operate equipment directly on the soil reinforcements.

I. Select Granular Backfill Placement. Transport and handle the Select Granular Backfill (SGB) in a manner that minimizes the segregation of the material. Use the following procedure for placing and compacting the SGB.

1. Place and compact the initial lifts of SGB until it is about 2 inches (50 mm) above the connection for the bottom layer of soil reinforcement. Do not place SGB against the initial row of panels yet. This is Item 1 in Figure 840.06-1.

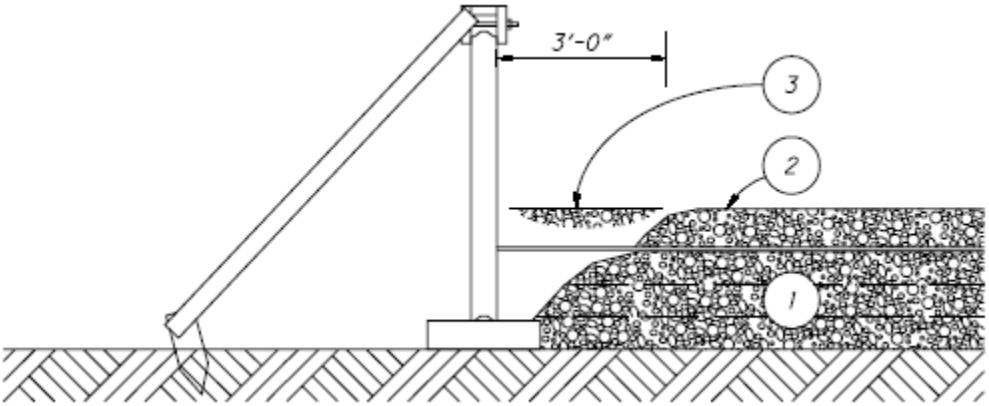

Figure 840.06-1 Backfilling for the First Row of Panels Only

2. Connect the soil reinforcement and place an 8-inch (200 mm) loose lift of SGB on top of it (Item 2 in Figure 840.06-1). Place and compact the SGB at least 3 feet (1.0 m) away from the facing panels and moving parallel to the panels. Continue to place and compact the lift of SGB with additional passes moving away from the panels towards the free end of the soil reinforcement. See Figure 840.06-2.

3. Place SGB between the initial row of facing panels and the previously placed SGB. Place the SGB in one lift until it is about 8 inches (200 mm) above the soil reinforcement (Item 3 in Figure 840.06-1). Compact the material with six passes of a mechanical tamper or vibratory plate compactor that applies an impact or centrifugal force between ½ to 2 tons (0.6 to 2.2 metric tons). Do not perform compaction testing on the material within 3 feet (1.0 m) of the facing panels.

4. Place and compact additional lifts of SGB at least 3 feet (1.0 m) away from the facing panels and moving parallel to the panels. Continue to place and compact each lift of the SGB with additional passes moving away from the panels towards the free end of the soil reinforcement. See Figure 840.06-2.

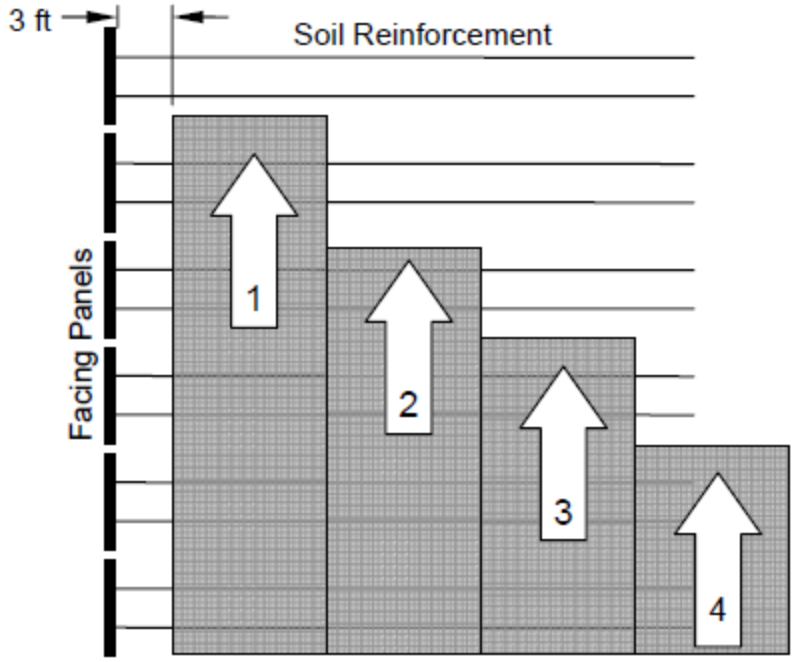

Figure 840.06-2 Procedure for SGB Placement and Compaction (Plan View)

5. Place and compact SGB in the 3-foot (1 m) area between the facing panels and the previous lift of SGB. Compact the material with six passes of a mechanical tamper or vibratory plate compactor that applies an impact or centrifugal force between ½ to 2 tons (0.6 to 2.2 metric tons). Do not perform compaction testing on the material within 3 feet (1.0 m) of the facing panels.

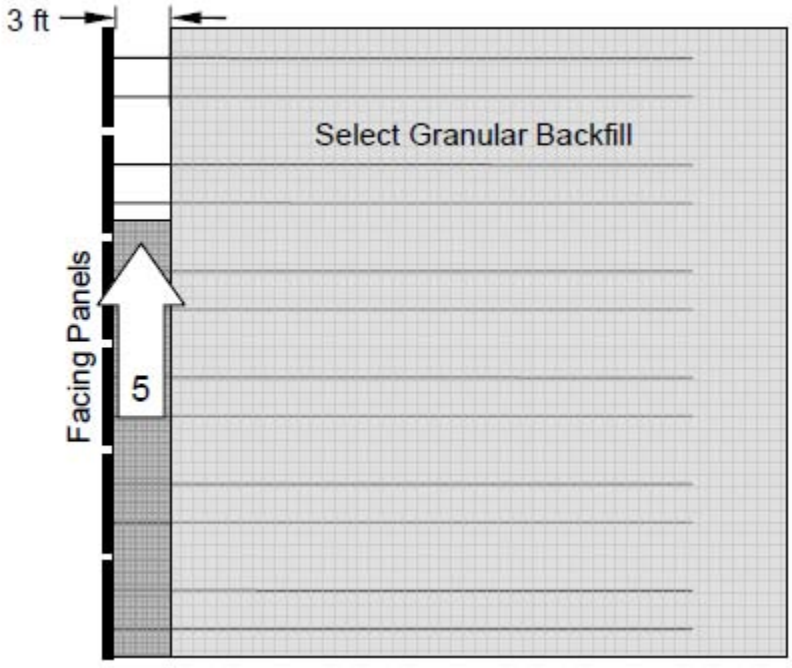

Figure 840.06-3 SGB Placement and Compaction Next to Facing Panels (Plan View)

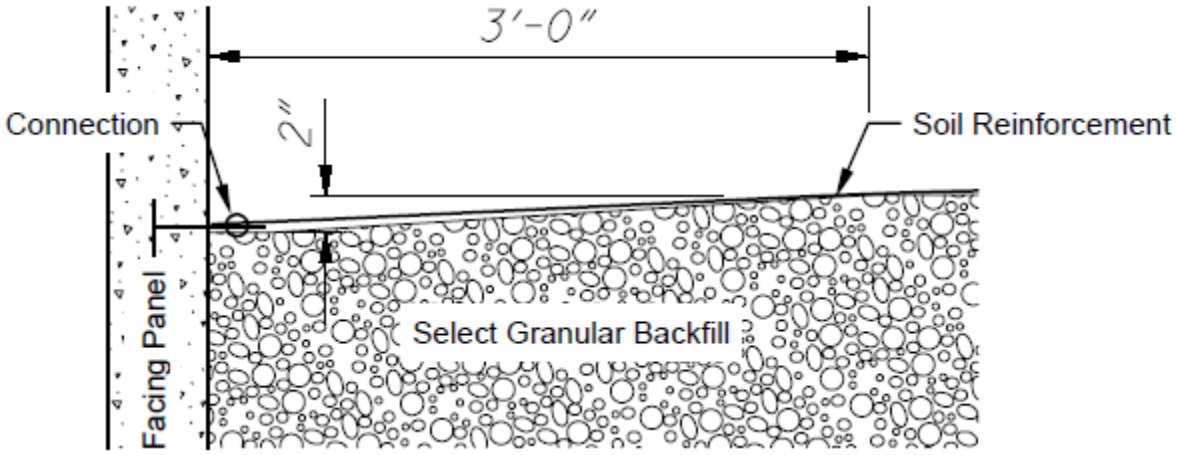

Figure 840.06-4 SGB at Connection

6. When the SGB reaches the next layer of soil reinforcement, place the SGB that is more than 3 feet (1 m) away from the facing panels to a level 2 inches (50 mm) above the soil reinforcement connection. Slope the SGB that is within 3 feet (1 m) of the facing panels as shown in Figure 840.06-4.

7. Repeat steps 4 through 6 until placement of the SGB and soil reinforcements is complete.

Except as stated otherwise in the procedure above, place and compact the SGB as follows. Place the SGB in loose lifts no greater than 8 inches (200 mm) thick. Compact SGB using a vibratory roller with a static weight between 6 to 10 tons (7 and 11 metric tons). Operate compaction equipment in a direction parallel to the facing panels. Test the compaction according to Supplement 1015. Use either Test Section Method A or B according to Supplement 1015 and 203.07. Sample the SGB material and create a moisture density curve according to AASHTO T 99, Method C for each type and source of material. Compact the SGB to a minimum of 98 percent of the test section maximum dry density.

Do not disturb, damage, or distort soil reinforcements, facing panels or joint coverings during compaction.

At the end of each day's operations, shape the last lift of SGB to direct rain water runoff away from the wall face. Prevent surface drainage from adjacent areas from entering the wall construction site.

J. Pile Sleeves. When piles are located within the reinforced soil zone, install pile sleeves during MSE wall construction. Place the bottom of the sleeves at the bottom of the SGB or at the bottom of the undercut whichever is deeper. Maintain the vertical alignment of the pile sleeve during construction of the MSE wall. After driving the pile, place granular fill into the sleeve around the pile in a uniform manner so there are no unfilled voids within the pile sleeve.

K. Coping. Cast the coping in place according to Item 511 and the plans. Do not use precast concrete coping. When the panels have an aesthetic surface treatment, use expanding foam to fill the voids between the facing panel and the forms for the coping. Remove any visible foam after the concrete coping has cured.

L. Concrete Sealing. Seal exterior surfaces of all panels and coping with an epoxy-urethane sealer according to Item 512 after the completion of wall construction. Do not damage the fabric covering the panel joints when preparing the surface before applying the sealer.

M. Natural Soil Placement. Once the SGB and the coping are completed, place the natural soil along the slope in 12-inch (300 mm) loose lifts. The ICQM will use 95 percent of the standard Proctor maximum dry density for compaction acceptance.

N. Inspection and Compaction Testing. Perform all of the work described in Modified SS 878 Inspection and Compaction Testing as it pertains to MSE walls. Hire compaction personnel described in Section 878.02 of Modified Supplemental Specification 878 Inspection and Compaction Testing of Unbound Materials. Provide a summary report of all inspections, compaction tests and measurements every 2 weeks to the IQF. Include all inspections, measurements, compaction test forms, test section data, failing tests and lots and moisture checks. Notify the IQF when each lift is complete and provide the compaction test data. The IQF will perform quality assurance (QA) density tests on every fifth lift. Make the required correction when QA tests fail.

840.07 On-Site Assistance.
Have a representative from the accredited MSE wall system supplier provide on-site technical assistance for the number of days shown in the contract. This is done to ensure that the DBT and the IQF understand the recommended construction procedures for the accredited MSE wall system.

Appendix A

MSE Wall Acceptance Letter

Project No.	
Wall No.	
Name of Accredited MSE Wall System	

Design Data	
Design Life	100 years
Angle of Internal Friction - Reinforced Soil Zone	34 degrees
Actual Bearing Pressure at base of reinforced soil mass	
Allowable Bearing Pressure at base of reinforced soil mass (Reproduced from project plans)	

We hereby certify that the design calculations for the internal stability of the mechanically stabilized earth retaining structure and the detail drawings included in this construction submission are in complete conformance with the MSE wall Supplemental Specification 840 and either the AASHTO Standard Specifications for Highway Bridges, 17th Edition, 2002 or the AASHTO LRFD Bridge Design Specifications, 4th edition. We further certify that the design data provided above and data assumed for the design calculation submitted herein is accurate for the above referenced wall.

Engineer's Seal	Engineer's Seal
Signature:	Signature:
Date:	Date:

(Provide an MSE Wall Acceptance Letter for each wall designated in the project plans.)

Designer Note: This Specification is to be used on this project when using MSE Walls. See the Bridge Design Manual for technical design information. If the predicted differential settlement along the face of the MSE wall will exceed 0.5 percent, then include a plan note that limits the maximum width of the facing panels to 5 feet (1.52 m). If the predicted differential settlement along the face of the MSE wall will exceed 1 percent, then limit the width of the panels and show slip joints on the plans as recommended in the Bridge Design Manual.

Show and describe any aesthetic surface treatments in the plans. During construction, the Design Soils Consultant will be required to perform a site visit and inspection to ensure the existing foundation is consistent with the designed foundation. This Specification includes excavation to 12 inches below the leveling pad. If the foundation of the wall requires more excavation, then increase the amount of wall excavation to remove the unsuitable soil. Show the deeper excavation limits on the plans and include an “As per plan” item for Foundation Preparation that places the geotextile at the bottom of the excavation.

Design the wall subsurface drainage system as low as possible but still provide drainage to an outlet. Drains should be located near the front of the wall and at the ends of the soil reinforcement. The drain at the front of the wall can be located in front of the facing panels to minimize conflicts with the soil reinforcement. Include a detail showing the porous backfill and fabric in the wall limits. The minimum height of the fabric and porous backfill is 12" (300 mm). Detail the non-perforated pipe and sand outlet outside the wall limits. This should show the sand from the pipe invert to 12" (300 mm) over the pipe and 6" (150 mm) on each side of the pipe. This sand is a secondary outlet to be used if the outlet is crushed in the future.

Evaluate the drainage outlet conditions to ensure a positive outlet is available. If a positive outlet is not readily available, then consider elevating the entire run of underdrain starting with setting a positive outlet elevation and progressing upstream on a 1 percent slope. Provide a 1 percent minimum grade on all pipes in the MSE wall subsurface drainage system.

The outside limits of the exposed SGB needs to be covered with 2 feet (0.6 m) of natural soil to prevent erosion during and after construction. Show a detail and quantities for this work in the plans.