

MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
MECHANICALLY STABILIZED EARTH RETAINING WALL SYSTEM

STR:JAB

1 of 15

APPR:RWS:MJF:04-15-26

FHWA:APPR:04-15-26

a. Description. This work consists of the design, manufacture, furnishing and installing of mechanically stabilized earth (MSE) walls in accordance with the plans, standard specifications and as contained herein.

The following definitions apply when used herein and on the plans:

MSE Wall System. A soil-retaining system employing either strip or grid-type metallic tensile soil reinforcement in the soil mass and a facing panel that is vertical or nearly vertical. At a minimum, the system includes precast concrete or wire facing panels, steel reinforcement, connecting hardware, coping, leveling pad, bearings, panel joint materials and special corner components.

Manufacturer. The individual or legal entity that performs part of the work through a contract agreement with the Contractor. This includes an individual or legal entity that owns the patent, product trademark, product copyright or product name for the approved MSE wall system. This includes an individual or legal entity that supplies materials for construction of the MSE wall system. This includes an individual or legal entity that fabricates components of the MSE wall system through a licensing agreement with the owner of the patent, product trademark, product copyright or product name.

Designer. The individual who is a Professional Engineer licensed in the State of Michigan, is employed by a company that is a subcontractor to the Contractor and is responsible for the design and working drawings required herein.

Checker. A Professional Engineer licensed in the State of Michigan who is employed by the same company as the Designer and is responsible for verifying and checking the design and working drawings developed by or under supervision of the Designer.

LRFD. The *AASHTO LRFD Bridge Design Specifications*, which the design must satisfy unless otherwise specified herein.

Select an approved MSE wall system from Table 1 or submit another MSE wall system to be approved by the Engineer.

Table 1: Approved MSE Wall Systems

Manufacturer	Facing Panel Types	
	Precast Concrete	Wire
Hilfiker Retaining Walls 1902 Hilfiker Lane Eureka, California 95503-5711 (800) 762-8962 www.hilfiker.com	None	Welded Wire Wall
Geoquest USA 45610 Woodland Road, Suite 200 Sterling, Virginia 20166 (888) 427-3601 www.geoquest-group.us	Reinforced Earth® Retained Earth™	TerraTrel®
SSL 4740 Scotts Valley Drive, Suite E Scotts Valley, California 95066 (831) 430-9300 www.mseplus.com	MSE Plus™	None

b. Design.

1. Department Responsibility. The Department has performed a settlement analysis and an external stability analysis of the reinforced soil mass in accordance with *LRFD*. The settlement analysis consisted of the magnitude (total and differential ratio) of settlement and time rate of settlement. The external stability consisted of analyzing global stability (deep-seated failures), sliding stability of the reinforced soil mass, overturning of the reinforced soil mass and bearing resistance of the subgrade. The external stability was initially checked using the minimum soil reinforcement length required by *LRFD*. If additional soil reinforcement length was required, the plans indicate the minimum reinforcement length “L” required to achieve external stability. Seismic forces were not included in the external stability analysis. The Department is responsible for drainage of the wall in its final state.

2. Designer Responsibility. The Designer is responsible for the internal stability of the reinforced soil mass and all components of the MSE wall system. Perform the design in accordance with the specific *LRFD* articles referenced and to all other applicable *LRFD* articles, except as specified herein. Specify the facing panel batter necessary to prevent outward rotation of the MSE wall system during loading. Do not apply seismic forces for the internal stability design.

Design MSE walls with precast concrete facing panels for a 100-year service life, permanent wire faced walls for a 100-year service life and temporary wire faced walls for a 3-year service life or project length, whichever is greater, in accordance with *LRFD Article 11.10.6.4.2*.

A. Internal Stability. Satisfy *LRFD Article 11.10.6*. Use only the Simplified Method to compute the internal stability including definition of the failure plane. Use a friction angle of 32 degrees and a unit weight of 120 pcf for soil within the reinforced soil mass. Extend the soil reinforcement sufficiently beyond the failure plane to stabilize the retained backfill material. In the absence of site specific information, assume the retained backfill material behind the reinforced soil mass to be cohesionless with a

friction angle of 30 degrees and a unit weight of 120 pcf.

Account for external loads which affect the internal stability such as those applied through piling, bridge footings, traffic, slopes, surcharges, differential hydrostatic pressures, lateral loads from parapets, traffic barriers, guardrail posts, soundwalls, light poles and sign supports.

Account for vehicle collision force. Design all MSE panels, regardless of location, for vehicular collision force per sections 3.6.5.1 and C3.6.5.1 of the *LRFD*. The vehicular collision force is to be assumed to act in a direction of 15 degrees with the edge of the pavement in a horizontal plane and to be distributed over an area 5 feet long by 2 feet high.

B. Live Load Surcharge. Use a unit weight of 120 pcf for surcharges.

(1) Traffic Loading. Apply live load surcharges in accordance with *LRFD Article 3.11.6.4*. Do not use a surcharge less than 3 feet in height.

(2) Loading other than Traffic. Apply surcharges in accordance with *LRFD Articles 3.11.6.1 through 3.11.6.3*.

C. Traffic Loads on Barriers. Apply impacts to barriers in accordance with *LRFD Article 11.10.10.2*.

D. Hydrostatic Pressures. Satisfy *LRFD Article 11.10.10.3*. Consider the high-water level to be the 100-year event shown on the plans.

E. Obstructions in the Reinforced Soil Mass. Satisfy *LRFD Article 11.10.10.4*. Account for all obstructions/appurtenances behind, in front of, under, mounted upon, or passing through the wall such as drainage structures, traffic barrier, utilities, abutments, piers, piles, guardrail posts or other items shown on the plans in the stability design of the wall and in details of all connections and soil reinforcement. Accurately show all obstructions/appurtenances on the working drawings. Notify the Engineer of any potential irresolvable conflicts prior to fabrication. The splay angle of soil reinforcement is limited to a maximum of 15 degrees per *LRFD C11.10.10.4*.

F. MSE Abutments. Satisfy *LRFD Article 11.10.11* for MSE walls interfacing with bridge abutments, piers, and other structures.

G. Wall Embedment and Leveling Pad. Embed facing panels not less than 42 inches (measured to the top of the leveling pad), unless otherwise specified on the plans. The embedment requirements do not apply to temporary MSE walls with a level slope in front of the wall unless frost heave is anticipated during construction. For temporary MSE walls with sloping ground (1V:4H or steeper) in front of the wall the temporary MSE wall embedment must be per *LRFD Articles 11.10.2.2* and *C11.10.2.2* and a minimum 4 foot wide bench in front of the wall provided. Leveling pad elevations are the responsibility of the Designer unless otherwise shown on the plans. Provide for a leveling pad that is not less than 6 inches high and 12 inches wide.

H. Soil Reinforcement. Satisfy *LRFD Articles 11.10.2.1* and *11.10.6*. Do not use extensible soil reinforcements in the design. Limit vertical spacing of soil reinforcement

for wire faced walls to 2 feet maximum. Connect all designed soil reinforcements placed in the reinforced soil mass to the facing panels. Do not design for a yield strength of more than 65 Kips per square inch (ksi).

Determine the required length of the soil reinforcement by design, but do not use a length less than all of the following for walls without a sloping backslope:

- 0.7 times the wall height (H) as depicted in *LRFD Figure 11.10.2-1*;
- 8 feet or;
- As noted on the plans.

Determine the required length of the soil reinforcement by design, but do not use a length less than all of the following for walls with a sloping backslope:

- 0.8 times the wall height (H) as depicted in *LRFD Figure 11.10.2-1*;
- 8 feet or;
- As noted on the plans.

Use a uniform soil reinforcement length throughout the entire height of the wall for each design wall section.

Use galvanized soil reinforcement for all applications designed for a 100-year service life.

I. Precast Concrete Facing Panels. Satisfy *LRFD Articles 11.10.2.3* and *11.10.6*. Ensure panel size and aesthetics are as specified in the contract. Design panels in such a pattern that the horizontal site line is discontinuous at every other panel to make differential settlement unnoticeable. To accomplish this, erect the lowest panel level with alternating full-height and half-height panels on the leveling pad. Design uniformly sized panels except as required to meet plan dimensions at corners, wall tops and for alternating half-size panels required for the initial panel course. Design for panels not more than 5 feet high and not exceeding a height to width ratio of 1.0 to 3.0. Provide shiplap, tongue and groove or a joint lapping system approved by the Engineer.

J. Wire Facing Panels. Satisfy *LRFD Articles 11.10.2.3* and *11.10.6*.

K. Special Corner Units. Satisfy *LRFD Articles 11.10.2.3* and *11.10.6*. Design special corner units for walls where a change of direction from a straight line creates an included angle of 120 degrees or less. Ensure corner elements are separated from the adjacent panels and secured by means of separate soil reinforcement. Include isolation joints that function similar to corner units in the design and working drawings to increase tolerance for differential settlement when necessary. When two intersecting walls form an enclosed angle of 70 degrees or less, ensure the affected portion of the walls is designed as an internally tied bin structure with at-rest earth pressure coefficients.

L. Part-Width Construction. Provide all required MSE wall details necessary for construction when bridge substructure is built using part-width construction techniques.

M. Leveling Pad. Proportion the leveling pad to extend a minimum of 3 inches on either side of the panel thickness. Leveling pads may need to be wider for curved wall alignments.

Do not use a leveling pad less than 12 inches wide nor less than 6 inches in thickness.

Panels overhanging leveling pads are prohibited.

N. Copings. Use cast in place copings at the beginning and ends of walls, corners (both horizontal and vertical) and at stage line construction joints.

c. Submittals. Submit complete design calculations, working drawings, notes, and material specifications for the proposed wall system to the Engineer for review prior to fabrication. Do not start fabrication until approval has been received from the Department. The Department will require 21 calendar days for each review cycle and revisions may be required following each review. No extension of time or additional compensation will be granted due to delays in preparing the final working drawings, calculations and material specifications or securing approval from the Department. An exception may be granted for an extension of time only in the case that the Department's review of a submittal exceeded 21 calendar days and if it can be shown that such a delay impacts the final project completion date.

Include detailed design calculations, working drawings, notes, and material specifications in every submittal. Ensure all submittals are in PDF files submitted to the Engineer. Hard copies of submittals will not be accepted. A submittal set, indicating revisions to be made, will be returned following each review. Revise and furnish the final detailed design calculations, working drawings, notes, and material properties sealed by the Designer for distribution. Ensure the Designer's seal is clearly visible on the calculations and working drawings.

Submittal requirements contained herein apply to both permanent and temporary MSE walls.

1. Calculations. Provide detailed design calculations, notes, and material specifications on 8.5 by 11 inch sheets and include the Department's project designations (Control Section and Job Number), wall designations, page number, date of preparation and initials of the Designer and Checker.

Provide design calculations and explanatory notes that are legible and that demonstrate the design criteria have been met. Include example hand calculations for the tallest wall and most severe external loading conditions for project specific sections which illustrate conformance of the computer programs with the design criteria. Clearly indicate the factored loads and factored resistance in the calculation of sliding, pullout, overturning and the applied bearing pressure. At a minimum, include the design of the facing panels, connections, and soil reinforcement in the calculations.

2. Working Drawings. Prepare working drawings on 11 by 17 inch sheets including borders. Provide a title block in the lower right hand corner of each sheet. Include the sheet number, wall name or designation and the Department's project designations (Control Section and Job Number) within all title blocks.

Include all details, dimensions, quantities, and cross sections on the working drawings necessary to construct the wall for full or part-width construction including, but not limited to the following items:

A. Plan and elevation sheets for each wall showing the following:

(1) Elevation views of the walls must note top of wall elevations (defined as

where the finished grade intersects the back of the wall face) at all horizontal and vertical break points and at least every 50 feet along the wall face; top of leveling pad elevations at all steps and at least every 50 feet along the wall face; wall panel designations; length, type and size of soil reinforcement; location of changes in soil reinforcement embedment length and type; original and final ground lines; and applied bearing pressure.

(2) Plan views of the walls must note the offsets from the construction centerline to the wall reference line at all changes in horizontal alignments and beginning and ending stations of the wall. The location and size of any obstructions/appurtenances that are behind, in front of, under, mounted upon, or passing through the wall (i.e. drainage structures, traffic barrier, utilities, abutments, piers, piles, or guardrail posts or other items shown on the plans) must also be clearly shown.

(3) Typical cross sections showing the relationship between existing ground elevations and proposed grades, construction limits, excavation limits and fill requirements. Include obstructions/appurtenances that are behind, in front of, under, mounted upon, or passing through the wall such as drainage structures, traffic barrier, utilities, abutments, piers, piles, guardrail posts or other plan items.

(4) Construction and material specification notes.

(5) Horizontal and vertical curve data for laying out and constructing the walls.

(6) Summary of material quantities on the elevation sheet of each wall.

B. Detail sheets for each wall showing the following:

(1) Leveling pad details showing elevations and dimensions at all steps for the full length of the wall.

(2) Facing panel details which show all dimensions necessary to construct the panel, placement of steel reinforcement and the location of soil reinforcement connection elements embedded in the panels. Include position tolerances for connection elements in the details.

(3) Parapet barriers, copings, curbs, sidewalks, etc. to be placed on top of the wall.

(4) Construction around obstructions/appurtenances that are behind, in front of, under, mounted upon, or passing through the wall such as drainage structures, traffic barrier, utilities, abutments, piers, piles, guardrail posts or other items shown on the plans. Show details for diverting reinforcement elements around obstructions for each specific occurrence.

(5) Foundation underdrains and impervious membranes detailed on the plans.

(6) Architectural treatments such as texturing, custom imprints, and graphics.

3. Notice of Beginning Work. Follow subsection 708.03.B of the Standard Specifications for Construction for shop inspection and prefabrication meeting requirements.

d. Materials. The basis of acceptance for all materials not addressed by the standard specifications or specified herein will be a Test Data Certification in accordance with the *MQAP Manual*. Provide all test data certifications to the Engineer prior to material use.

1. Precast Concrete Facing Panel. Fabricate panels in accordance with Division 10 and section 706 of the Standard Specifications for Construction, except as specified below:

A. Concrete. Use PCC meeting the requirements for Grade 4000 concrete in accordance with section 1004 of the Standard Specifications for Construction, except as modified herein. Use coarse aggregate originating only from geologically natural sources meeting physical requirements of Class 6AA in accordance with Table 902-2 with the exception that the maximum freeze-thaw dilation is 0.010 percent per 100 cycles. Determine maximum aggregate size in accordance with *LRFD* standards.

B. Form Liners. Use smooth, custom formed elastomeric form liners to produce the concrete texture(s) detailed on the plans. Multi-use, ABS plastic, or single-use polystyrene are prohibited.

C. Form Release Agents. Use only form release agents that are compatible with the selected liners. Obtain written certification from the manufacturer that the product is compatible, non-reacting, and non-staining. Use a single product for the entire project.

D. Curing. Do not use curing compound. Cure panels by moisture retention for at least 3 days following concrete placement.

E. Steel Reinforcement. Use Grade 60 epoxy coated steel reinforcement in accordance with section 905 of the Standard Specifications for Construction.

F. Connection Devices. Galvanize in accordance with *AASHTO M111*. Use steel connections and hardware in accordance with *AASHTO M270, Grades 36 or 50* for strip-type soil reinforcement. Use connections in accordance with *AASHTO M32* and *AASHTO M55* for grid-type soil reinforcement.

G. Lifting Devices. Galvanize in accordance with *AASHTO M111*.

H. Acceptance of PCC for facing panels will be based upon 20SP-708A - Quality Control and Acceptance of Structural Precast Concrete, except as specified herein:

(1) Production Lot. Acceptance of concrete panels will be determined on the basis of production lots. A production lot is defined as a group of panels that will be represented by a single average compressive strength consisting of the average 28-day compressive strength of two test cylinders and will consist of either 30 panels or a single day's production, whichever is less.

Acceptance of a production lot will be made if the compressive strength test result is greater than or equal to 4000 psi.

(2) Rejection. Units will be rejected because of failure to meet any of the requirements specified above. In addition, any or all of the following defects, determined by the Engineer, will be sufficient cause for rejection:

- (a) Defects that indicate imperfect molding.
- (b) Defects indicating honeycombed or open texture concrete.
- (c) Cracks or severely chipped panels.
- (d) Color variation on front face of panel due to excess form oil or other reasons.
- (e) Excessive surface distortion.
- (f) Tolerance violation.

I. Provide a General Certification in accordance with the *MQAP Manual* that all precast concrete facing panels have been inspected to ensure they are true to size, free from defects that may impair their strength and durability, and all other contract requirements are being met.

2. Wire Facing Panel. Fabricate from cold drawn steel wire in accordance with *AASHTO M32* and welded into the finished configuration in accordance with *AASHTO M55*. Galvanize after wire mesh is fabricated in accordance with *AASHTO M111*. The wire facing panel does not need to be galvanized if it is part of a completely independent temporary wall in service 7 months or less (and not through the Seasonal Suspension).

3. Soil Reinforcement. Galvanize soil steel reinforcement for permanent walls in accordance with *AASHTO M111* for strip-type or *ASTM A641* for grid-type. Galvanize soil reinforcement for temporary walls in accordance with *AASHTO M111* for strip-type or *ASTM A641* for grid-type where the reinforced soil mass for the temporary wall overlaps the reinforced soil mass for a permanent wall or when specified by the Designer.

A. Strip-Type. Ensure steel strip reinforcement is hot-rolled to the required shape and dimensions. The steel must conform to *ASTM A572*, Grade 65.

B. Grid-Type. Fabricate soil reinforcement and connectors from cold drawn steel wire in accordance with *AASHTO M32* and welded into the finished configuration in accordance with *AASHTO M55*. Perform galvanization after grid is fabricated.

C. Provide a General Certification in accordance with the *MQAP Manual* that all soil reinforcement components have been inspected to ensure they are true to size and free from defects that may impair their strength and durability.

4. Bolts, Nuts, and Washers. Use galvanized high strength bolts and hardware in accordance with subsection 906.07 of the Standard Specifications for Construction. *ASTM A449* bolts galvanized in accordance with subsection 906.07 are also acceptable.

5. Concrete Facing Panel Joint Materials.

A. Geotextiles. Select a geotextile that meets the physical requirements of Geotextile Liner in accordance with subsection 910.03.B of the Standard Specifications for Construction. Place a 12 inch minimum strip behind all panel joints. Lap fabric joints 4 inches minimum.

B. Bearings. Fabricate bearings from one of the following:

(1) Rubber meeting the requirements of *ASTM D2000, Grade 2, Type A, Class A, durometer hardness (Shore A) 80 ±5, tensile strength 7 megapascal (MPa)*.

(2) Neoprene elastomeric pads having a durometer hardness (Shore A) of 55 ±5.

(3) High-density PE with a minimum density of 59 pcf in accordance with *ASTM D1505*.

6. Backfill for the Reinforced Soil Mass. Provide granular material Class II meeting the requirements of section 902 of the Standard Specifications for Construction and the requirements contained in Table 2 for Backfill, Select. Acceptance will be based on testing by the Engineer. Do not use slag materials, recycled PCC, or lightweight cellular concrete.

Prior to sampling and testing by the Engineer, provide current test results from an *AASHTO* accredited independent testing laboratory (valid for 2 year from completion of testing) for the granular material that is proposed to be used as backfill for the reinforced soil mass.

Use Backfill, Select for permanent and temporary walls. Use only natural mineral aggregate for backfill within the reinforced soil mass that is free from organic materials and is substantially free of shale or other soft, poor durability particles and that has a magnesium sulfate soundness loss of less than 30 percent after 4 cycles.

Backfill, Select will be sampled and tested by the Engineer in accordance with the requirements for granular material Class II specified in the *MQAP Manual*. The sample frequency will be 1 per 5,000 cubic yards.

Table 2: Select Backfill Requirements

Property	Test Method	Requirement
Organic Content	<i>AASHTO T267</i>	1 percent (maximum)
Resistivity (c)	<i>AASHTO T288</i>	30 ohm-m (minimum)
pH	<i>AASHTO T289</i>	5-10
Sulfates (a)(c)	<i>AASHTO T290</i>	200 ppm (maximum)
Chlorides (a)(c)	<i>AASHTO T291</i>	100 ppm (maximum)
Plasticity Index	<i>AASHTO T90</i>	6 (maximum)
Angle of Internal Friction (b, d, e)	<i>AASHTO T236</i> <i>(Direct Shear Test)</i>	32 degrees (minimum)

- If the resistivity is greater than or equal to 50 ohm-m, the chloride and sulfate requirements are waived. Alternate test method *ASTM D4327* may be used to determine sulfate and chloride concentrations.
- Use material passing the #4 sieve compacted to 95 percent of the maximum unit weight of material passing the #4 sieve as determined by the *One-Point Michigan Cone Test* at optimum moisture content. No testing is required for backfills where 80 percent of sizes are greater than 0.75 inches.
- If Select Backfill is used for a completely independent temporary wall then this property does not need to be tested.
- Determine the angle of internal friction by fitting the best fit line through the points. Do not force line through a cohesion of 0 psf. Do not use a negative cohesion in the best fit line.
- The confining pressures should be representative of the range of anticipated vertical pressures.

7. Leveling Pad. Use concrete meeting Grade 3500 requirements in accordance with the standard specifications. The basis for acceptance of cast-in-place leveling pad will be based upon Division 10 of the Standard Specifications for Construction.

8. Non-Shrink Grout. Use non-shrinking grout in accordance with subsection 1005.02 of the Standard Specifications for Construction.

9. Impervious Membrane. Use a PVC liner that is 30 mils thick. Use resins to manufacture the PVC liner that are 100 percent first quality virgin PVC. Ensure the PVC liner is resistant to UV degradation, construction damage and all forms of biological and chemical degradation normally encountered in highway construction applications. Satisfy the physical properties contained in Table 3.

Table 3: PVC Liner Certified Properties (ASTM D7176)

Property	Test Method	Requirement
Thickness Tolerance	<i>ASTM D5199</i>	±1.5 mils
Tensile Properties		
Strength at Break	<i>ASTM D882</i>	73 lb/in.(minimum)
Elongation	<i>ASTM D882</i>	380 percent (minimum)
Modulus at 100 percent	<i>ASTM D882</i>	30 lb/in. (minimum)
Tear Strength	<i>ASTM D1004</i>	8 lb. (minimum)
Dimension Stability	<i>ASTM D1204</i>	3 percent (maximum)
Low-Temperature Impact	<i>ASTM D1790</i>	-20 °F (Pass)

Provide test data certification from the manufacturer with each material shipment, which includes a certified report of quality control test results obtained from the lot(s) of material in the shipment. Label each unit of material to provide product identification sufficient for field identification and correlation to certified test results. Certify the specified physical properties as minimum average roll values (MARV).

10. Copings.

A. Concrete. For precast copings, meet the same requirements as specified for precast concrete facing panels. For cast-in-place copings, use Grade 4000HP concrete in accordance with section 1004 of the Standard Specifications for Construction.

B. Steel Reinforcement. Use Grade 60 epoxy coated steel reinforcement in accordance with section 905 of the Standard Specifications for Construction.

C. Adhesive Anchors. Use adhesive anchors in accordance with subsection 712.03.J of the Standard Specifications for Construction.

11. Geotextile Behind Wire Facing Panels. Select a geotextile that meets the physical requirements for a non-woven geotextile separator in accordance with Table 910-1 in the Standard Specifications for Construction.

e. Construction. Ensure fabrication plants are *NPCA*, *ACPA*, or *PCI Group B1* certified. Construct in accordance with the approved working drawings and as specified below:

1. Precast Concrete Facing Panels.

A. Test Section(s). Prior to form liner placement, construct a test section using each of the approved form liner(s). Test section must demonstrate the quality of concrete mix design, forming, consolidation technique, reveals, joints and seams in form liner panels, and textured corners. Demonstrate patching and repair procedures for spalled concrete and voids caused by honeycombing or bug holes. Obtain written approval from the Engineer for the test section(s).

B. Cast panels on a level surface and fully support them until the concrete reaches a minimum compressive strength of 1,500 psi or as calculated by a Professional Engineer licensed in the State of Michigan, whichever is greater. The units may be shipped after reaching a minimum compressive strength of 4000 psi.

C. Do not allow galvanized connection elements, hardware, and soil reinforcements to come in contact with steel reinforcement. Provide a minimum of 0.5 inches of clearance between galvanized elements (connections, hardware, soil reinforcement, etc) and steel reinforcement for the concrete panel. The use of spacers to achieve the 0.5 inch minimum clearance is permitted if the spacer material is HDPE or PVC.

D. Provide a Type A surface for the front face panels unless otherwise shown on the plans. Screenshot the rear face of panels to eliminate honeycombing and surface distortions in excess of 0.25 inches.

E. Clearly scribe the date of manufacture, the production lot number, and the wall panel designation on an unexposed face.

F. Manufacture all panels within the following tolerances:

(1) Dimensions. Position panel connection devices within 1 inch of their intended location, except position coil and loop embeds within 3/16 inch of their intended position. All other dimensions must be within 3/16 inch tolerance.

(2) Squareness. Do not allow the difference between the two diagonals to exceed 0.5 inches.

(3) Surface Finish. Do not allow surface defects on smooth formed surfaces to exceed 0.125 inches per foot. Do not allow surface defects on textured surfaces to exceed 0.25 inches per foot.

G. Handle, store, and ship panels in such a manner as to minimize the risk of chipping, discoloration, cracks, fractures, and excessive bending stresses. Support panels in storage on firm blocking to protect the panel connection devices and the exposed exterior finish.

2. Copings. Construct copings in accordance with the approved working drawings. Attach copings using adhesive anchored steel reinforcement in accordance with subsection 712.03.J of the Standard Specifications for Construction. Fill lifting device recesses with a non-shrink grout in accordance with 1005.02 of the Standard Specifications for Construction.

3. Bearings. Place bearing pads in horizontal panel joints and on leveling pads in

accordance with the approved working drawings.

4. Subgrade Preparation. Excavate a level grade to the necessary elevation for a width equal to the reinforced soil mass plus 3 feet. Inspect the subgrade and compact if necessary, prior to wall construction in accordance with subsection 205.03.1.1 of the Standard Specifications for Construction. Undercut unsuitable material as directed by the Engineer. Replace undercut soils with Embankment, Structure, CIP compacted to 95 percent of its maximum unit weight in accordance with section 205 of the Standard Specifications for Construction unless otherwise directed by the Engineer. Ensure frost susceptible foundation soils within 5 feet of the wall face are removed and replaced in the same manner as undercut soils. Sound earth is not permitted as an alternate material for backfilling undercut soils within the region of influence below the reinforced soil mass.

5. Leveling Pad. Construct the concrete leveling pad in accordance with the working drawings and section 706 of the Standard Specification for Construction. Cure the leveling pad a minimum of 12 hours before placement of facing panels. Precast leveling pads may be used at no additional cost to the Department.

6. Wall Erection. Provide an on-site technical representative from the Manufacturer, as necessary or as requested by the Engineer, during the wall erection to assist the Contractor and Engineer. Provide the Engineer with a copy of the Manufacturer's construction manual prior to erection.

A. Place facing panels so that their final position is vertical or battered as shown on the working drawings. Handle precast concrete facing panels during erection by means of lifting devices connected to the upper edges of the panel. Place panels in successive horizontal lifts in the sequence shown on the working drawings as backfill placement proceeds. Place a 12 inch strip of geotextile behind all panel joints and lap fabric joints a minimum of 4 inches. Use temporary wedges or bracing to maintain the position of panels as backfill is placed in accordance with the Manufacturer's recommendations. Do not exceed 0.75 inch per 10 feet of vertical and/or horizontal wall misalignment. Do not exceed 0.75 inch of offset in any panel joint during construction. Do not exceed 0.2 inch per foot for the overall vertical tolerance of the wall (top to bottom). Correct any misalignment or distortion of the facing panels in excess of the tolerances specified herein at no cost to the Department.

Do not exceed 3 inches of vertical and/or horizontal wall misalignment for wire face walls. Remove and re-erect wire facing panels, at no cost to the Department and no additional time, if the wire face wall exceeds 3 inches of vertical and/or horizontal wall misalignment.

B. Place soil reinforcement in accordance with the details on the working drawings and around any obstruction. If the obstruction conflicts with placement of the soil reinforcement perpendicular to the wall face, follow the alternatives listed in *LRFD 11.10.10.4*. Reinforcement may be splayed a maximum of 15 degrees horizontally and/or vertically to avoid and provide adequate clear space around obstructions. The splay angle is measured from a perpendicular line to the wall face.

Uniformly tension soil reinforcement to remove any slack in the connection or material. Compact backfill beneath each layer of soil reinforcement prior to placement of soil reinforcement.

7. Backfill Select Placement for Reinforced Soil Mass.

A. Follow erection of each course of facing panels closely with backfill. Place backfill near the rear and middle of the reinforced soil mass first and work toward the facing panels. Carefully place backfill to avoid damaging or disturbing the wall materials or soil reinforcement. Remove and replace, at no cost to the Department, any damaged or misaligned wall materials and soil reinforcement as a result of the backfill placement. Place backfill at each soil reinforcement level to an elevation 1 inch above the level of the connection to eliminate voids beneath the soil reinforcement.

B. Compact backfill to 95 percent of its maximum unit weight. For applications where spread footings are used to support bridge or other structures, compact backfill to 100 percent of its maximum unit weight within the limits of 1V:1H slopes spreading outward in all directions from the bottom edge of the structure footings for a depth of 5 feet below the footing elevation.

C. Ensure uniform moisture content throughout each layer of the backfill prior to and during compaction. Place backfill with a moisture content less than or equal to the optimum moisture content. Remove and rework backfill placed with moisture content in excess of the optimum moisture content until the moisture content is uniformly acceptable to the Engineer throughout the entire lift.

D. Place backfill in lifts measuring not more than 12 inches in thickness. Decrease the maximum lift thickness as required to obtain the specified density.

E. Perform compaction within 3 feet of the back face of the wall by making at least three passes with a lightweight mechanical tamper, roller, or vibratory system. Density testing will not be performed within this 3 foot zone.

F. Slope the last lift of backfill away from the wall facing at the end of each day's operation to rapidly direct runoff away from the wall face. Do not allow surface runoff from adjacent areas to enter the wall construction site. Control/redirect surface runoff away from the top of wall, bottom of wall, select backfill, wall face and sides of the wall.

G. Do not use sheeps foot or grid-type rollers for compaction within the reinforced soil mass.

8. Impervious Membrane. Place the PVC liner on prepared areas free of wrinkles as shown on the plans. Construction equipment or vehicles of any kind are not allowed directly on the PVC liner. Unless otherwise specified, a 24 inch shingle-lap of adjacent pieces of PVC liner may be used instead of field seams. Slope the PVC liner away from the wall face with a 0.5 percent minimum grade and maintain 8 inches minimum clearance over soil reinforcement.

f. Measurement and Payment. The completed work, as described, will be measured and paid for at the contract unit price using the following pay items:

Pay Item	Pay Unit
Mechanically Stabilized Earth Wall, Precast, Furn	Square Foot
Mechanically Stabilized Earth Wall, Precast, Install	Square Foot

Mechanically Stabilized Earth Wall, Wire Faced, Temp, Furn.....	Square Foot
Mechanically Stabilized Earth Wall, Wire Faced, Temp, Install.....	Square Foot
Mechanically Stabilized Earth Wall, Wire Faced, Permanent, Furn.....	Square Foot
Mechanically Stabilized Earth Wall, Wire Faced, Permanent, Install.....	Square Foot
Mechanically Stabilized Earth Wall Coping, Precast.....	Foot
Mechanically Stabilized Earth Wall Coping, CIP.....	Foot
Mechanically Stabilized Earth Wall, Leveling Pad, Conc.....	Foot
Backfill, Select.....	Cubic Yard
Liner, PVC, 30 mil.....	Square Yard

1. **Mechanically Stabilized Earth Wall, Precast, Furn** will be measured in place as the area from the bottom of the coping to the top of the leveling pad along the wall.

Mechanically Stabilized Earth Wall, Precast, Furn includes the design, furnishing all wall components including, but not limited to precast concrete facing panels, special corner units, soil reinforcement, connection devices and hardware, geotextiles, and all joint materials. Payment also includes all costs associated with test section(s) and obtaining Engineer approval. All costs associated with aesthetic details and texturing precast concrete facing system shown on the plans are included in the pay item **Mechanically Stabilized Earth Wall, Precast, Furn**.

2. **Mechanically Stabilized Earth Wall, Precast, Install** will be measured in place as the area from the bottom of the coping to the top of the leveling pad along the wall.

Mechanically Stabilized Earth Wall, Precast, Install includes subgrade preparation, technical representatives and placement of soil reinforcement, precast concrete facing panels, special corner units and all joint materials to the lines and grades shown on the plans.

3. **Mechanically Stabilized Earth Wall, Wire Face, Temp, Furn** will be measured in place as the area from the top of the wall to the bottom of the wall (top of subgrade) along the wall. **Mechanically Stabilized Earth Wall, Wire Face, Temp, Furn** includes the design, furnishing all wall components including, but not limited to wire facing panels, special corner units, soil reinforcement, connection devices and hardware, geotextiles, and all joint materials.

4. **Mechanically Stabilized Earth Wall, Wire Face, Temp, Install** will be measured in place from the top of the wall to the bottom of the wall (top of subgrade). **Mechanically Stabilized Earth Wall, Wire Face, Temp, Install** includes subgrade preparation, technical representatives and placement of soil reinforcement, wire facing panels, special corner units and all joint materials to the lines and grades shown on the plans.

5. **Mechanically Stabilized Earth Wall, Wire Face, Permanent, Furn** will be measured in place as the area from the top of the wall to the bottom of the wall (top of subgrade) along the wall. **Mechanically Stabilized Earth Wall, Wire Face, Permanent, Furn** includes the design, furnishing all wall components including, but not limited to wire facing panels, special corner units, soil reinforcement, connection devices and hardware, geotextiles, and all joint materials.

6. **Mechanically Stabilized Earth Wall, Wire Face, Permanent, Install** will be measured in place from the top of the wall to the bottom of the wall (top of subgrade). **Mechanically Stabilized Earth Wall, Wire Face, Permanent, Install** includes subgrade preparation, technical representatives and placement of soil reinforcement, wire facing

panels, special corner units and all joint materials to the lines and grades shown on the plans.

7. **Mechanically Stabilized Earth Wall Coping, Precast** will be measured in place along the wall reference line and top of wall surface. **Mechanically Stabilized Earth Wall Coping, Precast** includes furnishing, fabricating, and installing precast concrete coping.

8. **Mechanically Stabilized Earth Wall Coping, CIP** will be measured in place along the wall reference line and top of wall surface. **Mechanically Stabilized Earth Wall Coping, CIP** includes constructing cast-in-place concrete coping.

9. **Mechanically Stabilized Earth Wall, Leveling Pad, Conc** will be measured in place along the wall reference line. **Mechanically Stabilized Earth Wall, Leveling Pad, Conc** includes constructing the leveling pad.

10. **Backfill, Select** includes furnishing, placing, and compacting the backfill. The Engineer will not measure material placed outside the maximum pay limits shown on the approved working drawings.

11. **Liner, PVC, 30 mil** will be measured in place without credit for laps or wasted material. **Liner, PVC, 30 mil** will include furnishing and properly placing the liner in accordance with the plans and this special provision.

Underdrains will be paid for separately in accordance with the standard specifications.

Excavation, Fdn and Embankment, Structure, CIP required for undercutting unsuitable subgrade soils will be paid for separately in accordance with the standard specifications. The bottom of the reinforced soil mass and the bottom of the leveling pad will be considered the bottom of footing for measurement purposes.