SECTION 0A596 - MECHANICALLY STABILIZED EARTH RETAINING WALLS

(Follow all instructions. If there are no instructions above a subsection, paragraph, sentence, or bullet, then include them in the project. The specifications may be modified to include project specific specifications, but all additions, deletions, or modifications must be sent to the ODOT Technical Resource and Senior Specifications Engineer for review and approval.)

Section 0A596, which is not a Standard Specification, is included in this Project by Special Provision.

Description

0A596.00 Scope - This work consists of furnishing and constructing Mechanically Stabilized Earth (MSE) retaining walls as shown and specified.

(Use the following Proprietary MSE Walls language when a permanent proprietary MSE Wall is required. Do NOT use the following language when only a temporary retaining wall is required.)

[Begin Proprietary MSE Walls language.]

(Use the following subsection .01 and bullets when the contractor will be required to select a proprietary MSE wall system. List at least three walls. For "Bridge" retaining walls and "Highway" retaining walls, fill in the blank with the structure number. If the retaining wall does not have a structure number, delete the phrase ", structure no. ____ ,".)

0A596.01 Proprietary MSE Walls - Select one of the following preapproved proprietary MSE retaining wall systems for the wall, structure no. ____ , as shown:

(Fill in the blanks with the proprietary retaining wall system name (including the "™" symbol), company name and telephone number from the ODOT Geotechnical Design Manual, appendix 15-D.)

- _____ MSE Retaining Wall System, provided by _____ , telephone: _____ .
- _____ MSE Retaining Wall System, provided by _____ , telephone: _____ .
- _____ MSE Retaining Wall System, provided by _____ , telephone: _____ .

0A596.02 Cost Reduction Proposals - According to 00140.70, cost reduction proposals will be considered for proprietary retaining wall systems that are preapproved by the Agency before advertisement of the Project.

[End Proprietary MSE Walls language.]

0A596.03 Definitions:

Alternate Gabion Basket Joint Fasteners - Spiral binders, high tensile locking spring steel clips, or clamp-on ring type fasteners that are an alternate to tie wire for assembling and joining gabion units.

Appurtenances - Traffic barriers, guardrail, fences, non-standard coping, drainage structures, sign supports, lighting supports, sound barriers, foundations, and utilities that are not part of the retaining wall system but are connected to, resting on, or passing through the retaining wall system.

Batter - The slope of the wall facing from vertical that is expressed as degrees, or as a ratio of the horizontal change in inches for each 12 inches of vertical change. A vertical face has a zero batter.

Extensible Tensile Reinforcements - Geosynthetic reinforcement where the deformation under load is equal to or greater than the reinforced backfill.

Inextensible Tensile Reinforcements - Steel reinforcement where the deformation under load is significantly less than the reinforced backfill.

Manufacturer - The fabricator having exclusive production rights for a proprietary retaining wall system.

Mechanically Stabilized Earth Retaining Wall System - A gravity retaining wall system composed of wall facing and granular backfill reinforced with either extensible or inextensible soil reinforcements connected to the facing elements.

Nonproprietary Retaining Wall System - A retaining wall system that is not patented or trademarked and is shown on the plans.

Piecemark - An alpha-numeric marking that identifies a specific type of retaining wall component. All components with the same piecemark are considered identical. Piecemarks shown on the working drawings identify placement of the component.

Preapproved Proprietary Retaining Wall System - A wall system that is listed in Appendix 15-D of the Geotechnical Design Manual (GDM).

Preapproved Proprietary Retaining Wall System Options - Acceptable preapproved proprietary retaining walls listed in 0A596.01 when proprietary retaining wall systems are required.

Preapproved Proprietary Retaining Wall System Alternates - Acceptable preapproved proprietary retaining walls listed in 0A596.01 when non-proprietary retaining wall systems are shown.

Proprietary Retaining Wall System - A retaining wall system that is protected by trademark, patent, or copyright and is produced or distributed by a manufacturer having exclusive rights.

Retained Backfill - Unreinforced backfill behind the back of MSE reinforced backfill.

Retaining Wall System - An engineered system of structural and geotechnical components that restrains a mass of earth. The terms "retaining wall system", "retaining structure", and "retaining wall" are used interchangeably.

(Use the following subsection .04 when a permanent proprietary MSE Wall is required. Do NOT use the following subsection when only a temporary retaining wall is required.)

0A596.04 Proprietary Retaining Walls - Submit the following at least 30 Calendar Days before beginning construction of proprietary retaining walls:

- Complete stamped working drawings and design calculations prepared by the Manufacturer according to 00150.35.
- Manufacturer's field construction manual.
- Manufacturer's field representative name and qualifications.

Field verify existing ground elevations and bottom of wall elevations before preparing and submitting working drawings.

Obtain the Engineer's written approval before beginning construction of the wall system.

(a) Working Drawings - Working drawings, according to 00150.35, are drawings that meet the requirements of the project documents, the AASHTO LRFD Bridge Design Specifications, as modified by the ODOT GDM, and are consistent with the preapproved retaining wall system.

Include the following items in the working drawings, as applicable:

- **General Notes** - Information for design and construction of the retaining wall.
- **Plan View:**
  - Construction centerline and related horizontal curve data.
  - Centerline station and offset to the wall control line or face of wall including the beginning and ending points of the retaining wall.
  - Location, type, and size of all appurtenances.
  - Location of right-of-way and easement boundaries, staged construction, designated wetlands, and other highway structures, features, facilities, or construction constraints.
  - Length, size, number, and layout of soil reinforcements.
  - Wall stations where changes in the soil reinforcement length occur.
- **Elevation View:**

- Wall vertical curve data and wall elevations at a sufficient number of points along the top of wall that defines the top of wall alignment.
- Field verified elevations of original and final ground lines along face of the wall and top of leveling pad.
- Vertical dimensions of steps along the top of leveling pad.
- Centerline stations and elevations at the beginning and ending of the wall.
- Horizontal offsets.
- Changes in the top of wall slope.
- Type and size of facing components.
- Layout of MSE wall panels, including wall finish pattern.

- **Typical Sections:**

  - Typical sections at intervals of 50 feet or less along the wall.
  - Wall construction and limits of reinforced backfill.
  - Locations, length, size, and number of soil reinforcements.
  - Original and final ground lines across typical sections, including roadways, highway structures, and other facilities.
  - Construction centerline stationing at each typical section.

- **Structural and Geometric Details:**

  - Leveling pad details, showing depths and limits of proposed excavation beyond the neat lines of the wall.
  - Top of wall elements such as coping, traffic barrier, and impervious membrane.
  - Panel details.
  - Final front face batter.
  - Details of wedges, shims, clamps, or bracing.
  - Reinforcing bar bend details.
  - Surface and subsurface drainage details for the wall, including drainage swale, filters, drains, and collector and outlet pipes.
  - Wall facing and soil reinforcement construction details at utility and drainage facilities, overhead sign support footings, bridge abutments, piles, shafts, and other structures.
  - Wall initiations and terminations.
  - Details for wall slip joints, curves, external, internal, and acute angle corners,
  - Maximum inclinations of wall backslope and foreslope.
  - Elevation, slope, and width of wall bench in front of wall.
  - Locations of anticipated shoring.

- **Appurtenances:**

- Wall appurtenance details needed to construct the wall.
- Wall appurtenance details that are required but not fully detailed on the plans.

- **Facing Components:**

  - Dimensions, including thickness.
  - Details necessary to construct the facing components.
  - Reinforcing steel in the component.
  - Location of tensile soil reinforcement attachment devices embedded in the facing.
  - Class of concrete finish.
  - Architectural treatment, if applicable.

- **Soil Reinforcements** - Soil reinforcement dimensions and details necessary to construct the wall.

- **Wall Construction Methods and Construction Sequence:**

  - Wall construction methods.
  - Construction sequence.
  - Locations of all shoring.

- **Materials and Quantity Summary List** - All items of each wall.

(b) Design Calculations - Design calculations are calculations that meet the requirements of the project documents, AASHTO LRFD Bridge Design Specifications, as modified by the ODOT GDM, and are consistent with the preapproved retaining wall system, and according to 00150.35.

Include the following items in the design calculations, as applicable:

- **Design Limits:**

  - Structural and geotechnical design input parameters and design assumptions.
  - Wall design loads, load combinations, load factors, and resistance factors for each limit state.

- **Methodology:**

  - Design steps with a detailed design narrative explaining the design and demonstrating how the design meets all applicable design requirements.
  - Explanation of all symbols and variables used in the calculations.
  - Hand calculations verifying results of computer generated wall design. Hand calculations are not required if the MSEW® version 3.0 or later software program is used to design the wall.

- **External Stability Calculations** - Calculations showing that the retaining wall system meets external stability requirements, including overturning, sliding, and bearing capacity.

- **Internal Stability Calculations:**

  - Calculations showing that the retaining wall meets internal stability requirements at each level of the wall.
  - Calculations showing adequate resistance against soil reinforcement rupture, pullout, and, reinforcement-facing connection failure.
  - Calculations showing adequate structural resistance of facing elements.
  - Calculations showing all structural details meet internal stability requirements, including construction details to accommodate vertical and horizontal obstructions in the reinforced backfill.

- **Compound Stability** - Calculations showing that the retaining wall meets compound stability requirements.

- **Appurtenances:**

  - Design calculations for wall appurtenances that are required but not fully detailed on the plans.
  - Calculations for all appurtenance load effects on the wall.

(Use the following lead-in paragraph and bullets to list proprietary wall geotechnical and seismic design parameters. Obtain information from the designer. Delete what does not apply. Copy and paste the structure number, station limits, and associated bullets for each separate retaining wall.)

The following retaining wall design parameters have been established for this Project:

Structure No. _____ : Sta. _____ to Sta. _____ (Lt.) (Rt.)

- Foundation soil unit density ..... _____ lbs./cu. ft.
- Foundation soil angle of internal friction ..... _____ degrees
- Foundation soil nominal (unfactored) bearing resistance ..... _____ lbs./sq. ft.
- Retained soil unit density..... _____ lbs./cu. ft.
- Retained soil angle of internal friction..... _____ degrees
- Reinforced soil unit density..... _____ lbs./cu. ft.
- Reinforced soil angle of internal friction..... _____ degrees
- Peak ground acceleration coefficient (*PGA*) ..... _____
- Short period spectral acceleration coefficient (S_S). ..... _____
- Long period spectral acceleration coefficient (S_1) ..... _____
- Site class..... _____
- Peak seismic ground acceleration coefficient

modified by zero period site factor (A_s) ..... _____

- Horizontal seismic acceleration coefficient (k_h) ..... _____

(Use the following bullet and sub-bullet when the Mononabe-Okabe method is <u>not</u> required. Repeat as necessary for variations in wall height and backslope along the wall.).

- Between Station _____ and Station _____ (Lt.) (Rt.):
  - Total (static plus seismic) external seismic thrust (P_{AE}) ..... _____ lbs./ft.

(Use the following bullet and sub-bullets to specify minimum length of soil reinforcement. Repeat as necessary for variations in wall height, backslope, bearing resistance and other parameters which can change along the wall.)

- Between Station _____ and Station _____ (Lt.) (Rt.):
  - Minimum length of soil reinforcement for overall stability ..... _____ft.
  - Minimum length of soil reinforcement for external stability ..... _____ft.

(c) Manufacturer's Field Construction Manual - A field construction manual, according to 00150.37, is prepared by the manufacturer and includes detailed instructions for constructing the retaining wall.

0A596.05 Nonproprietary Retaining Wall - Submit complete unstamped working drawings according to 00150.35 at least 30 Calendar Days before beginning construction of nonproprietary retaining walls. Field verify existing ground elevations and bottom of wall elevations before preparing and submitting working drawings. Obtain the Engineer's written approval before beginning construction of the wall system.

Materials

0A596.10 General:

(a) Proprietary Retaining Wall Systems - Provide all proprietary retaining wall system components from the same wall manufacturer. If there are conflicts between the Manufacturer's requirements and the Agency's requirements, the Agency's requirements prevail.

(b) Nonproprietary Retaining Wall Systems - Provide materials according to the applicable material Specifications.

(c) Quality Control - Provide quality control according to Section 00165.

0A596.11 Backfill:

(a) Gravel Leveling Pads Backfill - Furnish dense graded 1" - 0 or 3/4" - 0 aggregate base material for leveling pads meeting the requirements of 02630.10.

(b) MSE Granular Wall Backfill - Furnish dense graded 3/4" - 0 aggregate base material for walls meeting the requirements of 02630.10 and the following:

(1) Material Passing No. 200 Sieve - The amount of material passing the No. 200 sieve shall not exceed 15 percent by weight. Test according to AASHTO T 27 and AASHTO T 11.

(2) Plasticity Index - The plasticity index of the material passing the No. 40 sieve shall not exceed 6. Test according to AASHTO T 90.

(3) Electrochemical Properties:

Backfill with Steel Soil Reinforcement

Property	Limits	Test Procedure
pH	5.0 - 10.0	AASHTO T 289
Resistivity*	5,000 Ω-cm (min.)	AASHTO T 288
* Backfill material with resistivity between 5,000 Ω-cm and 3,000 Ω-cm is acceptable if it meets the following:		
Property	**Limits**	**Test Procedure**
Chlorides	100 PPM (max.)	AASHTO T 291
Sulfates	200 PPM (max.)	AASHTO T 290

Backfill with Geosynthetic Soil Reinforcement

Property	Limits	Test Procedure
pH	4.5 – 9.0*	AASHTO T 289
* 3.0 – 10.0 for temporary retaining walls.		

(4) Organic Content - The organic content of material finer than the No. 10 sieve shall not exceed 1.0 percent. Test according to AASHTO T 267.

(c) Modular Block Core and Drainage Backfill - Furnish 3/4" - No. 4 PCC aggregate material meeting the requirements of 02690.20 (a) through (f) and the requirements of 0A596.11(b-3).

(d) Pipe Drain Backfill - Furnish granular drain backfill material for drainage pipes meeting the requirements of 00430.11.

(e) Gabion Basket fill - Furnish a durable 4 to 8 inch size rock material meeting the requirements of 00390.11(b).

0A596.12 Concrete:

(a) Cast-in-Place Concrete for Leveling Pads - Furnish commercial grade concrete for leveling pads meeting the requirements of Section 00440.

(b) Dry Cast Concrete Modular Block Facing - Furnish dry cast concrete blocks with the following properties:

(1) Aggregate, Strength, Freeze-Thaw Durability, Unit Weight, and Water Absorption:

- Aggregate meeting the requirements of ASTM C 33.
- Blocks meeting the requirements of ASTM C 1372.
- The average of three coupons or cores have a minimum compressive strength of 4,000 psi as tested according to ASTM C 140.
- Individual coupons or cores have a minimum compressive strength of 3,500 psi as tested according to ASTM C 140.
- A minimum oven-dry unit weight of 125 pcf as tested according to ASTM C 140.
- Test, no longer than 18 months before delivery, freeze-thaw durability of five test specimens made with the same materials, concrete mix design, manufacturing process, and curing method that will be used on the project. At least four of the five test specimens shall have a weight loss of not more than 1 percent of the block's initial weight after 150 freeze-thaw cycles as tested according to ASTM C 1262.
- A maximum water absorption of 1 percent above the water absorption of the sublot of blocks that were produced and passed the freeze thaw test. For the water absorption testing, do not use the same blocks used for the freeze-thaw test.

(2) Portland Cement - Portland cement meeting the requirements of 02010.10.

(3) Blended Hydraulic Cement - Blended hydraulic cement meeting the requirements of 02010.20.

(4) Tolerances - Manufacture within the following geometric tolerances:

- Molded length and width dimensions within ± 1/8 inch of the block manufacturer's nominal length and width dimensions.
- Molded height dimension within ± 1/16 inch of the block manufacturer's nominal height dimension.
- Rear height does not exceed the front height.
- Top and bottom face groove dimensions within the tolerances specified by the manufacturer.

(5) Color - Consistent natural color of dry cast concrete.

(6) Finish - Split-face units that, when viewed from a distance of 10 feet under diffused light, chips, cracks, and other imperfections are not detectable.

(7) Acceptance of Blocks - Acceptance will be determined on tolerances, visual inspection, compressive strength, water absorption, freeze-thaw durability, and unit weight. Acceptance of compressive strength, water absorption, and unit weight will be based on production sublots. The maximum number of blocks per production

sublot is 2,000 blocks. Test blocks at the frequency of one set for each production sublot. Acceptance of freeze-thaw durability will be based on the freeze-thaw testing requirements of 0A596.12(b-1).

(8) Marking - Indicate the date of manufacture and the production sublot number on each sublot of dry cast concrete blocks.

(9) Handling, Storing, and Shipping - Do not allow chipping, discoloration, cracks, or fractures during handling, storing and shipping.

(10) Rejection - Blocks not meeting the requirements of this subsection will be rejected.

(c) Wet Cast Concrete Modular Block Facing - Furnish wet cast concrete blocks with the following properties:

(1) Concrete - Commercial grade concrete meeting the requirements of Section 00440.

(2) Marking - The rear face of each block is scribed with the date of manufacture, the production sublot number, and the piecemark.

(3) Color - Consistent natural color of wet cast concrete.

(**4) Finish** - Smooth face units that, when viewed from a distance of 10 feet under diffused light, chips, cracks, and other imperfections are not detectable.

(5) Tolerance - Molded length and width dimensions within 1/4 inch of the manufacturer's dimensions. Molded height dimension within 1/8 inch of the manufacturer's dimension.

(**6) Handling, Storing, and Shipping** - Do not allow chipping, discoloration, cracks, or fractures during handling, storing, and shipping.

(7) Acceptance of Blocks - Acceptance will be determined by tolerances, visual inspection, and concrete strength. Concrete strength will be based on production sublots. A production sublot is 20 blocks or a single day's production, whichever is less. The production sublot will be represented by a single compressive strength sample of one set of cylinders.

(8) Rejection - Blocks not meeting requirements of this subsection, or any of the following defects will be rejected:

- Honeycombed or open texture concrete.
- Extreme color variation on front face of block.

(d) Cast-in-Place Concrete Panel Facing - Furnish Class 4000 - 3/4 structural concrete for cast-in-place concrete panel facings meeting the requirements of Section 02001.

(e) Precast Concrete Panel Facing - Furnish precast concrete panel facings with the following properties:

(Use one of the following subsection (1)'s as instructed below. Delete the one that does not apply.)

[Begin subsection (1)]

[Use this subsection (1) when an ARES™ wall system is <u>not</u> specified.]

(1) Portland Cement Concrete - Class 4000 - 3/4 structural concrete meeting the requirements of Section 02001.

[Use this subsection (1) when an ARES™ wall system is specified.]

(1) Portland Cement Concrete - For ARES™ retaining wall systems use Class 4500 - 1 1/2 or 3/4 structural concrete meeting the requirements of Section 02001. For all other retaining wall systems use Class 4000 - 3/4 structural concrete meeting the requirements of Section 02001.

[End subsection (1)]

(2) Casting - Set soil reinforcement connection devices on the rear face of the precast panel and secure them for concrete placement and consolidation. Do not allow loop embeds, tie strips, or other devices used to connect soil reinforcements to facing panels to contact the face panel reinforcement steel. Place concrete in each panel without interruption and consolidate with an approved vibrator. Use a release agent throughout the casting operation.

(3) Supporting and Curing - Maintain full support, cure the panels, and do not strip or remove the forms from the units until the concrete has obtained a minimum compressive strength of at least 1,000 psi.

(4) Finish - Finish the panel front face with a general surface finish according to 00540.53(a). Screed the panel back face to eliminate surface distortions and open pockets of aggregate.

(5) Tolerance - Manufacture within the following tolerances:

a. Panel Dimensions - Within ± 1/2 inch between diagonals. Within ± 3/16 inch for all other panel dimensions.

b. Soil Reinforcement Connection Devices:

- Tie strip connection devices within ± 1 inch of the plan location.
- Loop embeds within ± 3/16 inch of the plan location.
- Retention slots within ± 1 inch of the plan location. Slot openings do not exceed 1/8 inch. Check all slot openings with a manufacturer supplied feeler gauge according to the manufacturer's recommendations. Panels from which the feeler gauge is pulled from the slot will be rejected.

c. Panel Face - Smooth formed surfaces within ± 3/32 inch when measured with a 3 foot straight edge. Textured-finish surfaces within ± 3/16 inch when measured with a 3 foot straight edge.

d. Rear Face - Rear surface distortions within ± 1/4 inch.

(6) Acceptance of Panel Concrete Strength - Acceptance will be according to 00540.17 except:

- Acceptance of concrete strength will be determined based on production sublots. A production sublot will consist of either 40 panels or a single day's production, whichever is less. Cast one set of cylinders for each production sublot.
- Precast panel concrete strength may be conditionally accepted if the 7-day initial strength exceeds 85 percent of the required 28-day strength. Final acceptance of precast panel concrete strength will be based on the required 28-day test results.

(7) Marking - On the rear face of each panel scribe the date of manufacture, the production sublot number, and the piecemark.

(8) Handling, Storing, and Shipping - Do not allow chipping, discoloration, cracks, fractures, and connecting device damage during handling, storing, and shipping. Support stored panels on firm blocking.

(9) Rejection - Panels not meeting the requirements of this subsection will be rejected.

0A596.13 Steel:

(a) Steel Reinforcement for Concrete - Furnish steel reinforcement for concrete meeting the requirements of Section 00530.

(b) Steel Components - Furnish steel components meeting the requirements of Section 00560 and the following:

(1) Soil Reinforcing Strips - Hot rolled from bars to the required shape and dimensions meeting the requirements of AASHTO M 223 Grade 65 (ASTM A 572) and galvanized according to AASHTO M 111 (ASTM A 123) to a minimum thickness of 3.4 mils.

(2) Soil Reinforcing Mesh:

- Shop fabricated welded wire reinforcement from cold drawn steel wire meeting the requirements of AASHTO M 32 (ASTM A 82), welded into the finished mesh according to AASHTO M 55 (ASTM A 185) and galvanized after fabrication according to AASHTO M 111 (ASTM A 123) to a minimum thickness of 3.4 mils.
- Twisted mesh soil reinforcing mesh meeting the requirements of Section 02340.

(3) Tie Strips - Shop-fabricated hot rolled steel meeting the requirements of ASTM A 1011 Grade 50 and galvanized according AASHTO M 111 (ASTM A 123) to a minimum thickness 3.4 mils.

(4) Fasteners - Galvanized high-strength bolts meeting the requirements of 02560.20.

(5) Connector Pins and Mat Bars - Fabricated from cold drawn steel wire meeting the requirements of AASHTO M 32 (ASTM A 82) and galvanized according to AASHTO M 111 (ASTM A 123) to a minimum thickness of 3.4 mils.

(c) Gabion Baskets - Furnish gabion baskets meeting the requirements of Section 02340.

0A596.14 Geosynthetics:

(a) Geotextile Filter Layer for Subsurface Drainage Systems - Furnish Type 1, Level B, drainage geotextile according to Section 02320.

(b) Gabion Facing Geotextile Filter - Furnish Type 2, Level B, riprap geotextile for gabion wall filter according to Section 02320.

(c) Precast Concrete Facing Panel Joint Cover - Furnish Type 1, Level B, drainage geotextile for concrete wall facings according to Section 02320.

(d) Modular Block Drainage Fill Geotextile Filter - Furnish Type 1, Level B, drainage geotextile according to Section 02320.

(e) Welded Wire Facing Geotextile Filter - Furnish Type 1, Level B, drainage geotextile according to Section 02320.

(f) Geosynthetic Soil Reinforcements:

(1) Geotextile - Provide geotextile according to Section 02320.

(2) Geogrid - Provide geogrid according to Section 02320.

0A596.15 Elastomeric Bearing Pads for Precast Concrete Facing Panels - In horizontal and diagonal joints between precast concrete panels, furnish either preformed ethylene propylene diene monomer (EPDM) rubber pads meeting the requirements of ASTM D 2000 Grade 2, Type A, Class A, with a Durometer Hardness of 70, or preformed high density polyethylene (HDPE) pads with a minimum density of 0.946 grams per cubic centimeter according to ASTM D 1505. Determine the stiffness, size, and number of bearing pads so that the final joint opening is 3/4 inch ± 1/8 inch or as shown.

(Use the following subsection .16 when KeySystem I™, LANDMARK™, or MESA™ wall systems are specified in 0A596.01.)

0A596.16 Concrete Modular Block Facing Connection Devices -

(Use the following paragraph when the KeySystem I™ wall system is specified.)

For KeySystem I™ wall systems, furnish connection pins that conform to AASHTO M 32 and are galvanized after fabrication according to AASHTO M 111.

(Use the following paragraph and table when the LANDMARK™ wall system is specified.)

For LANDMARK™ wall systems, furnish lock bars that are made of a rigid, polyvinyl chloride polymer conforming to the following requirements:

Property	Limits	Specification
Specific Gravity	1.4 (min.)	ASTM D 792
Tensile Strength (at yield)	2,700 psi (min.)	ASTM D 638

(Use the following paragraphs and tables when the MESA™ wall system is specified.)

For MESA™ wall systems, furnish block connectors for block courses with geogrid reinforcement that are glass fiber reinforced, high density polypropylene conforming to the following minimum material requirements:

Property	Limits	Specification
Polypropylene: Group 1, Class 1, Grade 2	73% ± 2%	ASTM D 4101
Fiberglass Content	25% ± 3%	ASTM D 2584
Carbon Black	2% (min.)	ASTM D 4218
Specific Gravity	1.08 ± 0.04	ASTM D 792
Tensile Strength (at yield)	8,700 psi ± 1,450 psi	ASTM D 638
Melt Flow Rate	(0.37oz. ± 0.16 oz.)/10 minutes	ASTM D1238

For MESA™ wall systems, furnish block connectors for block courses without geogrid reinforcement that are glass fiber reinforced, high density polyethylene (HDPE) conforming to the following minimum material requirements:

Property	Limits	Specification
HDPE: Type III, Class A, Grade 5	68% ± 3%	ASTM D 1248
Fiberglass Content	30% ± 3%	ASTM D 2584
Carbon Black	2% (min.)	ASTM D 4218
Specific Gravity	1.16 ± 0.06	ASTM D 792
Tensile Strength (at yield)	8,700 psi ± 725psi	ASTM D 638
Melt Flow Rate	(0.11 oz. ± 0.07 oz.)/10 minutes	ASTM D 1238

Labor

0A596.30 Quality Control Personnel - Provide technicians with CAgT, CDT, and CEBT certifications.

0A596.31 Manufacturer's Representative Qualifications and Duties - Provide a Manufacturer's representative meeting the following qualifications:

- Is a licensed Professional Engineer in the State of Oregon or, when the licensed Professional Engineer is in "responsible charge" of the work, a qualified unlicensed designee assigned by the licensed Professional Engineer.
- Has been trained by the Manufacturer in the construction, installation, and inspection of the selected proprietary retaining wall system.

A Manufacturer's representative is required to perform the following duties:

- **Preconstruction Conference** - Meet with the Engineer and all contractor supervisory personnel and subcontractors involved in construction of the proprietary retaining wall at the preconstruction conference to discuss methods of accomplishing all phases of work required to construct the proprietary retaining wall.

- **Initial Wall Construction** - Be present at the retaining wall construction site and provide technical assistance to the Contractor and Engineer during all wall construction activities from the beginning of wall construction until at least 10 percent of the total wall length is successfully installed and backfilled to a height of at least 10 feet, or the actual wall height, whichever is less.

  Submit daily field observation reports no later than noon of the next working day. Include the following information in the daily field observation reports:

  - Date of observation.
  - Description all work observed and whether or not the work was acceptable.
  - Documentation of all communications with the Contractor and Engineer.
  - Name and signature.

- **Remaining Wall Construction** - Be available by phone or in person as needed throughout the remaining construction of the proprietary retaining wall to provide technical assistance to the Contractor and Engineer.

- **Final Field Observation Meeting** - Conduct a final field observation meeting after completing retaining wall construction with the Engineer and Contractor. Submit a final field observation meeting report that includes the following information within five Calendar Day after the final field observation meeting:

  - Date of observation.
  - Documentation of all retaining wall deficiencies.
  - Recommendation to accept or reject the retaining wall construction.

Provide a stamped final report to the Engineer no later than 10 Calendar Days after the final field observation meeting. Include the following information in the final report:

- Preconstruction meeting minutes.
- All daily field observation reports.
- Transcripts of all communications with the Contractor and the Engineer during the remaining wall construction phase.
- Final field observation report.

Construction

0A596.40 General:

(a) Proprietary Retaining Walls - Construct proprietary retaining walls according to Agency requirements, Manufacturer's working drawings, and the Manufacturer's field construction manual. If the Manufacturer's working drawings or the Manufacturer's field construction manual conflict with Agency requirements, Agency requirements take precedence.

Follow instructions and recommendations of the representative if approved by the Engineer.

(b) Nonproprietary Retaining Walls - Construct nonproprietary retaining walls as shown.

0A596.41 Excavation and Foundation Preparation - Perform excavation and prepare and backfill wall foundations according to Section 00510 and the following:

- Grade the foundation level for a width equal to the combined width of the bottom soil reinforcements plus the facing component thickness plus 1.0 feet on each side.
- Place backfill material in nearly horizontal layers not more than 8 inches thick. Compact the entire surface of each layer with at least three coverages, using equipment made specifically for compaction. Routing hauling and grading equipment over the surface is not acceptable for compaction.
- Do not construct backfill when the backfill, the foundation, or the embankment on which it would be placed is frozen, or unstable.

0A596.42 Leveling Pads:

(a) Cast-in-Place Leveling Pad - Construct cast-in-place leveling pads with:

- Unreinforced concrete.
- A width of at least the block front face to block back face plus 12 inches (6 inches on each side of the facing units).
- A thickness of 6 inches ± 1/4 inch.
- A location tolerance of ± 1 inch of the design location.
- A top pad tolerance of ± 1/8 inch of the design elevation.

Cure cast-in-place leveling pads at least 12 hours before placing the wall facing.

(b) Gravel Leveling Pads - Construct gravel leveling pads with:

- A width of at least the width of the facing plus 12 inches (6 inches on each side of the facing units).
- A thickness of at least 6 inches.
- A location tolerance of ± 1 inch of the design location.
- A top pad tolerance of ± 1/8 inch of the design elevation.

Compact gravel leveling pads in 3 to 4 inch lifts using a minimum of three passes of a walk behind vibratory plate compactor with a gross static weight of not less than 125 pounds and a total compaction static plus dynamic force of not less than 2,000 pounds.

(c) Leveling Pad Types - Construct the following types of leveling pads:

- **Leveling Pads for Precast Concrete Panel Facing** - Unreinforced cast-in-place concrete leveling pad at each facing foundation level.

- **Leveling Pads for Dry Cast Modular Concrete Block Facing** - Unreinforced cast-in-place concrete leveling pad or a gravel leveling pad at each facing foundation level.

- **Leveling Pads for Wet Cast Modular Concrete Block Facing** - Unreinforced cast-in-place concrete leveling pad or a gravel leveling pad at each facing foundation level.

- **Leveling Pads for Gabion Unit Facing** - Unreinforced cast-in-place concrete leveling pad or a gravel leveling pad at each facing foundation.

- **Leveling Pads for Welded Wire Facing** - Unreinforced cast-in-place concrete leveling pad or a gravel leveling pad at each facing foundation level.

- **Leveling Pads for Cast-in-Place Concrete Facing** - Unreinforced cast-in-place concrete leveling pad at each facing foundation level.

0A596.43 Subsurface Drainage - Install subsurface drainage before constructing walls.

0A596.44 Erecting Wall Facing:

(a) Dry Cast Modular Concrete Block Facing:

(1) Placement - Begin placing the first course of blocks on top of and in full contact with the lowest foundation level of the leveling pad. Level and align all blocks. Lay blocks as close together as possible and parallel to the straight or curved line of the wall face. Place blocks in vertical or battered positions as shown. Level each course block-to-block and front-to-back. Set each block on the blocks below without rocking. Correct high areas by grinding or shimming with approved shims. Do not use shims within 1 inch of the front face. Do not exceed a shim stack thickness of 1/16 inch. Stack all blocks in a running bond pattern with each block spanning the joint below.

Place MSE granular wall backfill with each course of blocks. When shown, place modular block core backfill and drainage fill backfill, and install drainage fill geotextile and shear pins with each course of blocks. Install soil reinforcements and connect them to the facing. Remove all backfill that is on top of the blocks before installing the next course of blocks or soil reinforcements. Attach the top row of dry cast concrete blocks or cap blocks to the underlying blocks with an adhesive from the QPL. Clean the finished exposed wall face of all foreign material deposits.

(2) Tolerances:

- First course of wall facing located within ± 1/4 inch of the design horizontal alignment.
- Final out of plane concavity or convexity of the front face within ± 3/4 inch in 10 feet.
- Final deviation from the design batter within ± 1 1/4 inch for each 10 feet of wall height.
- Outward leaning batter is zero.
- Each course of blocks within ± 1/16 inch of level when checked with a 4 foot straight edge level.
- Out of plane offset between consecutive rows within 3/4 inch of the planned offset.
- Finished top of wall elevation within ± 1 inch of the design elevation.

(b) Wet Cast Modular Concrete Block Facing:

(1) Placement - Begin placing the first course of blocks on top of and in full contact with the lowest foundation level of the leveling pad. Level and align all blocks. Lay blocks as close together as possible and parallel to the straight or curved line of the wall face. Place blocks in vertical or battered positions as shown. Level and set each block on the blocks below without rocking. Correct high areas by grinding or shimming with approved shims. Do not use shims within 1 inch of the front face. Do not exceed a shim stack thickness of 1/8 inch. Stack all blocks in a running bond pattern with each block spanning the joint below.

Place MSE granular wall backfill with each course of blocks. When shown, place modular block core backfill and drainage fill backfill, and install drainage fill geotextile with each course of blocks. Install soil reinforcements and connect them to the facing. Remove all backfill that is on top of the blocks before installing the next course of blocks or soil reinforcements. Install soil reinforcements and connect them to the facing. Clean the finished exposed wall face of all foreign material deposits.

(2) Tolerances:

- First course of wall facing located within ± 1/4 inch of the design horizontal alignment.
- Final out of plane concavity or convexity of the front face within ± 3/4 inch in 10 feet.

- Final deviation from the design batter within ± 1 1/4 inch for each 10 feet of wall height.
- Outward leaning batter is zero.
- Each course of blocks within ± 1/8 inch of level when checked with a 4 foot straight edge level.
- Front-to-back tilting within ± 1/4 inch of the design batter when measured with a straight edge level long enough to span the entire front-to-back distance of the block.
- Out of plane offset between consecutive rows within ± 3/4 inch from the planned offset.
- Finished top of wall elevation within ± 1 inch of design elevation.

(c) Precast Concrete Panel Facing:

(1) Placement - Maintain vertical alignment with temporary wedges, clamps, or bracing when placing fill material. Use at least two, but not more than three rows of panel wedges in place at all times during wall construction. Place panel joint geotextile and MSE granular wall backfill with each level of panels. Install soil reinforcements and connect them to the facing.

(2) Tolerances:

- First course of wall facing located within ± 1/4 inch of the design horizontal alignment.
- Final out of plane concavity or convexity of the front face within ± 3/4 inch in 10 feet.
- Final deviation from the design batter within ± 1/2 inch for each 10 feet of wall height.
- Outward leaning batter is zero.
- Out of plane offset at panel joints within ± 1/2 inch.
- Final joint openings between adjacent facing panel units within ± 1 inch.
- Finished top of wall elevation within ± 1 inch of design elevation.

Wall sections not conforming to these tolerances shall be reconstructed at no additional cost to the Agency.

(d) Cast-in-Place Concrete and Precast Concrete Fascia with Welded Wire Walls:

(1) Placement - Place cast-in-place concrete fascia after the welded wire walls and backfill are completed to full height, and after anticipated settlement has taken place. Construct cast-in-place fascia and connect to welded wire wall as shown. Maintain vertical and continuous alignment of all expansion joints and deep score joints from bottom to top of wall. Horizontal joints are not allowed.

(2) Tolerances:

- First course of wall facing located within ± 1/4 inch of the design horizontal alignment.
- Final out of plane concavity or convexity within ± 3/4 inch in 10 feet.
- Final deviation from the design batter within ± 1 inch for each 10 feet of wall height.
- Outward leaning batter is zero.
- Out of plane offset at panel joints within ± 1/2 inch.
- Finished top of wall elevation within ± 1 inch of design elevation.

(e) Welded Wire Facing:

(1) Placement - Erect welded wire wall facing including soil reinforcements and other associated elements according to the wall manufacturer's field construction manual. Begin placing the first course of welded wire reinforcement on top of and in full contact with the lowest foundation level of the leveling pad. Level and align all welded wire reinforcement. Place welded wire wall geotextile filter and MSE granular wall backfill with each level of welded wire facing. Install soil reinforcements and connect them to the facing. Place remaining courses in vertical or battered positions as shown.

(2) Tolerances:

- First course of wall welded wire reinforcement facing located within ± 1/4 inch of the design horizontal alignment.
- Final out of plane concavity or convexity within ± 2 inches in 10 feet.
- Final deviation from the design batter within ± 1 inch for each 10 feet of wall height.
- Outward leaning batter is zero.
- Out of plane offset between consecutive rows within ± 1 inch of the planned offset.
- Finished top of wall elevation within ± 1 inch of design elevation.

(f) Gabion Basket Facing:

(1) Placement - Use the same style of mesh for the gabion panel bases, ends, sides, diaphragms, and lids. Use the same method of joining the edges of a single gabion unit. Use the same method of tying successive gabion units and soil reinforcement together throughout each structure. Place gabion facing geotextile filter and MSE granular wall backfill with each level of gabion facing. Install soil reinforcements and connect them to the facing. Place remaining courses in vertical or battered positions as shown.

(2) Tolerances:

- First course of gabion basket facing within ± 1/4 inch of the design horizontal alignment.
- Final out of plane concavity or convexity within ± 2 inches in 10 feet.

- Final deviation from the design batter within ± 1 inch for each 10 feet of wall height.
- Outward leaning batter is zero.
- Out of plane offset between consecutive rows within ± 1 inch from the planned offset.
- Finished top of wall elevation within ± 1 inch of design elevation.

(g) Wrapped-Face Construction (Temporary Geotextile Reinforced Wrapped Face MSE Retaining Wall**):**

(1) Placement - Geotextile wrapped-face construction shall be in accordance with Section 00350 and the ODOT GDM.

(2) Tolerances:

- Along base, construct face of wall within 2 inches (horizontally) of location staked on the ground.
- Place geotextile soil reinforcement and tail geotextile sheets vertically within 1 inch of elevation shown on plans.
- Maximum outward bulge of the face between soil reinforcement layers shall not exceed 6 inches.
- Final out of plane concavity or convexity within 5 inches in 10 feet.
- Final deviation from the design batter within 3 inches for each 10 feet of wall height.
- Outward leaning batter is zero.
- Finished top of wall elevation within 2 inches of design elevation.

0A596.45 Geotextile Placement:

(a) Precast Concrete Facing Panel Joint Cover Geotextile - Cover all joints, gaps, and openings on the back side of walls with at least 12 inch wide precast concrete facing panel joint cover geotextile centered over the joints, gaps, and openings. Attach with an approved adhesive. Apply adhesive to the wall panel before applying the geotextile to the panel. Overlap geotextile seams at least 4 inches.

(b) Gabion Facing Riprap Geotextile Filter - Install gabion facing riprap geotextile filter according to Section 00350 except place geotextile against the back of the gabion wall before placing backfill material and provide at least 12 inch overlaps.

(c) Modular Block Facing Drainage Fill Geotextile Filter - Install modular block facing drainage fill geotextile according to 00350.41.

(d) Welded Wire Wall Geotextile Filter - Install welded wire wall facing geotextile according to 00350.41.

0A596.46 Soil Reinforcement Placement - Connect all soil reinforcement to the wall facing units as shown. Field cut soil reinforcement only when shown. Submit stamped working drawings and calculations according to 00150.35 if field conditions require splaying

or skewing of soil reinforcement or for other obstruction avoidance methods. Do not misalign wall facings or damage soil reinforcements when placing reinforced backfill material. Remove and replace all misaligned wall facings or damaged soil reinforcements at no additional cost to the Agency.

(a) Inextensible Soil Reinforcement Components - Place the soil reinforcement components normal to the face of the wall. Connect all reinforcements to the wall facing units as shown. At each soil reinforcement level, level and compact backfill to the grade of the connection before placing the next level of soil reinforcement. Install the soil reinforcement no lower than the connection elevation but no more than 2 inches above the connection elevation. Maintain at least 3 inches of vertical separation between overlapping soil reinforcements.

To avoid vertical obstructions along a horizontal plane at the reinforcing level, a deviation up to 15 degrees from normal to the wall face (splay angle) may be allowed for strip reinforcements with bolted connections. Grid reinforcements may be splayed up to 15 degrees if the connection is properly designed and fabricated to accommodate the splay and is approved by the Agency.

To avoid horizontal obstructions, it is permissible to deflect soil reinforcements up to 15 degrees along a vertical plane normal to the wall face (vertical skew). Soil reinforcement deflections shall be gradual and smooth to avoid damage to the steel galvanization.

(b) Extensible Soil Reinforcement Components - Orient geogrid soil reinforcements with the highest strength axis perpendicular to the face of the wall. Connect all reinforcements to the wall facing units as shown. Use geogrid soil reinforcements that are continuous throughout their embedment lengths. Do not splice connections along the highest strength axis. Do not cut geogrid soil reinforcements unless approved.

Place geogrid soil reinforcement directly on the compacted backfill horizontal surface. Before placing a subsequent layer of backfill, pull the geogrid soil reinforcement taut and maintain tautness until the layer of backfill is placed. Install the geogrid soil reinforcement no lower than the connection elevation but no more than 2 inches above the connection elevation. Maintain at least 3 inches of vertical separation between overlapping geogrid soil reinforcement where geogrid soil reinforcement layers overlap.

0A596.47 Reinforced Backfill Placement and Compaction:

(a) Concrete Modular Block Facing - Complete all drainage fill, core fill, and block opening fill before proceeding to the next level. Do not construct backfill higher than the installed facing blocks.

(b) Soil Reinforcement - Place backfill material by moving equipment parallel to or away from the wall facing. Do not brake suddenly or make sharp turning movements.

On extensible soil reinforcement:

- Maintain the reinforcement in a taut condition.
- Do not operate equipment on it until at least 6 inches of backfill is placed over it.

On inextensible soil reinforcement:

- Maintain reinforcement perpendicular to the wall face.
- Do not operate equipment on it until at least 3 inches of backfill is placed over it.

(c) Compaction - Meet the following requirements:

(1) Maximum Density and Optimum Moisture Content - Determine maximum density and optimum moisture content of the MSE granular backfill material according to AASHTO T 99 Standard Proctor Method A, with coarse particle correction according to AASHTO T 224.

(2) Moisture Content - Prepare the reinforced backfill material to within minus 4% to plus 2% of optimum moisture content at the time of compacting. Add water to material that does not contain sufficient moisture and thoroughly mix. Remove excess moisture by manipulation, aeration, drainage, or other means before compacting.

(3) Density:

a. Reinforced Backfill Placed 3 Feet or More Behind Wall Facing Units - Compact reinforced backfill that is placed 3 feet or more behind wall facing units to 95% of maximum density determined by the nuclear gauge testing method.

b. Reinforced Backfill Placed Within 3 Feet Behind Wall Facing Units - Compact reinforced backfill that is placed within 3 feet behind wall facing units to 95% of maximum density determined by the test pad testing method. Use walk-behind vibratory rollers or vibratory plate compactors that have sufficient static and dynamic forces to achieve compaction without causing distortion of the wall facing units and keeping the wall facing units within the tolerances listed in 0A596.44. Compact backfill within this zone by making at least 3 compaction equipment passes.

c. Spread Footing for Bridge Abutment on MSE Retaining Wall - Compact reinforced backfill that is placed in the spread footing foundation support zone to 100% of maximum density determined by the nuclear gauge testing method. The spread footing foundation support zone has a depth which is twice the footing width or six feet, whichever is greater. Extend the spread footing zone laterally the width of the footing beyond the bottom edge of the footing in all directions, except only extend this zone a minimum 18 inches for steel soil reinforcements or 36 inches for geogrid soil reinforcements between the back of the MSE wall facing and the front edge of the adjacent bridge spread footing for spread footings.

(4) Testing Methods and Frequency:

a. Nuclear Gauge Method - Test in-place field density according to AASHTO T 310. Test at the frequency required in the ODOT Manual of Field Test Procedures.

b. Test Pad Method - Determine the number of compaction equipment passes necessary to achieve the specified density by constructing a test pad that is at least 5 feet wide, 15 feet long, and 2 feet deep. Construct test pad fill in layers no more than 8 inches thick using the same equipment and methods that will be used to compact the wall backfill. Perform at least one density test according to AASHTO T 310 on each test pad layer. Construct and test a new test pad when changes in material occur or different equipment is used during the construction of the wall backfill.

(5) Deflection Requirement - Conduct at least one deflection test, witnessed by the Engineer, on each compacted layer of backfill placed 3 feet or more behind wall facing units according to ODOT TM 158. If the tested layer exhibits yielding, deflection, reaction, or pumping, rework the area to provide acceptable test results before placing the next layer.

Maintenance

0A596.60 Protecting Work - Protect and repair work as follows:

- Do not allow runoff from adjacent areas to enter the wall construction site during construction operations.
- At the end of each day's operation, direct potential runoff away from the wall by sloping the last lift of backfill away from the wall facing.
- Rework and repair all damaged subgrade areas to the depth where undamaged work is encountered.

(Completely delete the following Measurement and Payment subsections when SP00596A is only included because it is required by SP00256 and there are no pay items for Section 0A596 in the Schedule of Items.)

Measurement

0A596.80 Measurement - No measurement of quantities will be made for retaining walls.

The estimated quantity of retaining walls are:

(Provide wall area below. The wall area is bounded by the beginning and end of the wall, top of the wall (excluding wall coping), and top of the footing or leveling pad. If no footing or leveling pad exists, the bottom of the wall is used. Copy and paste more lines, as necessary, to list estimated areas for each retaining wall.)

Structure Number _____ :

Station Limits	**Area**
Sta. _____ to Sta. _____ (Lt.) (Rt.)	___ (Wall area here) ___ sq. ft.

(NOTES to Specification Writer:

(1) The bid item quantity for MSE retaining walls is "Lump Sum," and includes all labor, materials, and inclusive items necessary to complete the work. Items such as excavation, shoring, reinforced backfill, and standard copings are considered inclusive items to the wall pay item, but items such as sidewalk copings, traffic barrier, moment slabs, guardrail and fencing are considered appurtenances along with the following items and should be included as separate bid items:

- ***Items associated with referenced standard drawings and details such as architectural treatments, geomembrane barriers, drainage pipes and geocomposite drainage panels.***
- ***Items associated with incidental work, such as scour protection, dewatering, or foundation improvement.***
- ***Larger structures such as culverts.***
- ***Items that cost more than 5 percent of the lump sum cost.***

(2) For proprietary retaining wall systems, where details of wall construction are generally not known until after the construction contract is awarded, do not include estimated quantities for inclusive items.)

(Use the following paragraph to list estimated quantities for nonproprietary retaining wall systems only. Ensure that the Wall (Bridge) Designer provides estimated quantities for all inclusive items such as excavation, shoring, reinforced backfill, leveling pads, wall drainage backfill/geotextile, and standard coping. Copy and paste more lines, as needed, to list estimated quantities for each nonproprietary retaining wall.)

The estimated quantities of listed materials are:

Structure No. _____: Sta. _____ to Sta. _____ (Lt.) (Rt.)

Material	Estimated Quantities
_____	____ cu. yd.
_____	____ foot
_____	____ lb.

(Use the following paragraph when Type "F" traffic barrier coping is required.)

The quantities of Type "F" traffic barrier coping with moment slab will be measured on the length basis, from end to end of coping.

(Use the following paragraph when sidewalk coping is required.)

The quantities of sidewalk coping will be measured on the area basis, from end to end and from top of curb to exterior edge of coping.

Excavation below elevations shown will be measured according to 00510.80(b).

Payment

0A596.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item **Unit of Measurement**

(Modify this list of pay items to only include project specific pay items. Delete those that are not required on the project. Re-alphabetize the list if necessary.)

(a) Retaining Wall, MSE ..... Lump Sum
(b) _____ inch Type "F" Traffic Barrier Coping with Moment Slab ..... Foot
(c) Sidewalk Coping ..... Square Foot

(Use the following paragraph when Type "F" traffic barrier coping is required.)

In item (b), the height of barrier will be inserted in the blank.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Excavation below elevations shown will be paid for according to 00510.90(c).

No separate or additional payment will be made for:

- manufacturer's representative
- excavation, shoring, leveling pads, and specified backfill
- wall drainage and filter systems
- soil reinforcement
- cast-in-place and precast standard coping