

853 – RETAINING WALL SYSTEM

SECTION 853

RETAINING WALL SYSTEM

853.1 DESCRIPTION

The scope of work for wall erection includes; excavation, grading, and compaction of the wall foundation, general and local dewatering as required for proper execution of the work, construction of leveling pads, erection of precast panels or modular block wall elements, placement of soil reinforcing, and placement and compaction of select backfill material within the reinforced soil volume. The scope of work also includes providing and placing cast-in-place concrete coping. Include in the wall foundation all area underlying the leveling pad and the reinforced soil volume.

BID ITEM

Retaining Wall (*)
*Type

UNITS

Square Foot

853.2 MATERIALS

a. General. Provide the complete retaining wall system (engineering design, geogrid, MBW, MSEW precast panels, reinforcing mesh and attachment device, joint filler, and all necessary accessories) from an approved manufacturer in accordance with the acceptable alternates for each particular structure as listed in the Contract Documents.

The Bureau of Construction and Materials will maintain a list of approved systems. Products will remain on the prequalified list as long as Field Performance is satisfactory.

b. Retaining Wall System.

(1) Concrete. Use cement complying with **DIVISION 2000**. Use air entrained concrete with a minimum compressive strength at 28 days of 4000 psi. Retarding admixtures may be used with prior approval of the Engineer. Accelerating agents or any admixture containing chlorides are prohibited.

Provide the MBW elements with a maximum absorption rate of 5% by weight and a minimum face shell thickness of 2 inch and complies with ASTM C1372.

For SSL MSE PLUS face panel 6 inches thick, provide a minimum compressive strength at 28 days of 4000 psi and is normally connected to a W8, W11, W15, W20, and W24 longitudinal wire.

Set in place void formers, tie strips, PVC sleeves, reinforcing steel, laps, galvanized reinforcing mesh, connecting pins, or lifting devices to the dimensions and tolerances shown on the shop plans prior to casting.

(2) Testing and Inspection. MSEW precast panel units will be accepted on the basis of compression tests and visual inspection. The compression testing and sampling for MBW will comply with ASTM C 140-91, Sampling and Testing Concrete Masonry Units, except as noted elsewhere in this specification. The MSEW precast panel units or MBW will be considered acceptable, regardless of curing age, if compression test results comply with the 28-day strength specifications, and if the visual inspection is satisfactorily completed. Provide facilities and perform all necessary sampling and testing. Notify the Engineer a minimum of one week in advance so that he may be present during all sampling and testing.

(3) Casting. Cast the MSEW precast panels in metal forms on a flat area, the front face at the bottom, the back face at the top. Set embed loops, void formers, or connectors in the rear face. Place the concrete in each form without interruption and consolidate by the use of an approved vibrator, supplemented by such hand tamping as may be necessary to force the concrete into the corners of the forms and prevent the formation of stone pockets or cleavage planes. Use clear form oil of the same manufacture throughout the casting operation.

Cast the MBWs in a standard manner acceptable to the National Concrete Masonry Association and in accordance with the testing and inspection.

(4) Curing. Cure the MSEW precast panels in compliance with **SECTION 710** for the concrete to develop the specified compressive strength. Cure the MBW units in a manner acceptable to the National Concrete Masonry Association. Any production lot which does not comply with **subsection 853.2b.(1)**, Compressive Strength, will be rejected.

(5) Removal of Forms. Do not remove the forms until they can be removed without damage to the unit.

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(6) Finish. Finish the front face of MSEW precast panel units in a formed finish complying with **DIVISION 700** and approved by the Engineer. Finish the MBW as specified in the Contract Documents. Screed the rear face of the MSEW precast panel or the non-exposed faces of the MBW to eliminate open pockets of aggregate and surface distortions in excess of 1/4 inch.

(7) Tolerances.

- MSEW Precast Panel: Manufacture all units within the following tolerances:
 - Dimensions: Lateral position of tie strips, within 1 inch.
 - All other dimensions, within 3/16 inch.
 - Squareness: As determined by the difference between the two diagonals, not exceeding ½ inch.
 - Surface defects of formed surfaces measured on a length of 5 feet: not exceeding 1/8 inch.
- MBW: Manufacture all units within 1/8 inch of the length and width plan dimension. Manufacture the units within 1/16 inch of the specified height and connection slots within 3/16 inch of plan dimension. Provide MBW units with a minimum of:
 - 1.0 sq ft of face area each for full units.
 - 0.5 sq ft of face area for each cap unit.

Provide a MBW system with angled sides capable of concave or convex alignment curves with minimum radius of 4.5 to 6 feet.

(8) Compressive Strength. Acceptance of the concrete MSEW precast panels or MBW with respect to compressive strength will be determined on a production lot basis. A lot consists of each 40 production panels or 10,000 production blocks or fraction thereof produced in 1 day.

MSEW: Prepare a minimum of 6 standard 6 x 12-inch cylinders from samples selected at random from concrete used in the production lot and in accordance with Kansas Test Methods. Cure 3 cylinders in accordance with Kansas Test Methods and test at 28 days. Cure at least 3 of the cylinders in the same manner as the panels and test at 7 days or later. Additional sets of 3 cylinders cured in the same manner as the panels may be tested at other dates beginning at 7 days. A test result will be the average compressive strength of a set of cylinders. Acceptance of the lot will be made if the average of any set of 3 is greater than 4,000 psi and no single cylinder has a compressive strength less than 3600 psi.

MBW: Select no less than 3 units at random from each lot to represent the production lot. Acceptance of the lot for compressive strength will be made if the average of any set of 3 is greater than 4000 psi and no single unit has a compressive strength less than 3600 psi.

(9) Rejection. Units will be rejected because of failure to comply as specified above, or any of the following defects:

- Defects that indicate imperfect molding
- Honeycombed or open texture concrete surfaces
- Any damage that would prevent making a satisfactory joint
- Chipped facing panel/unit edges
- Discolored panels or blocks beyond reasonable variances in the opinion of the Engineer.

(10) Marking.

- MSEW Precast Panel: Prominently scribe the date of manufacture on the rear face of each panel.
- MBW: Prominently display the date of manufacture and lot number on each production lot stored at the casting plant in a manner acceptable to the Engineer.

(11) Handling, Storage, and Shipping. Handle, store and ship all units in a manner as to eliminate the danger of staining, chipping, cracks, fractures, and excessive bending stresses. Support blocks or panels in storage on firm foundations in a manner that will protect the exposed exterior finish.

(12) Basis of Acceptance. The Retaining Wall System will be accepted on the basis of satisfactory results of materials test, compliance with dimensional requirements and visual inspection at the point of usage.

c. Backfill. Provide aggregates for backfill complying with **DIVISION 1100**.

d. Concrete for Leveling Pads. Provide the following:

- Leveling pads. Commercial Grade (AE) concrete complying with **SECTIONS 401, 402 and 1102**.

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e. Coping. Provide the following:

- Cast-in-Place copings. Grade 3.0 (AE) concrete complying with **SECTIONS 401, 402 and 1102.**
- Pre-cast Cap Blocks for MBW. Meet the requirements of **subsection 853.2b.** of this specification.

f. Soil Reinforcing. Use soil reinforcing shown in the Contract Documents.

(1) Reinforcing Strips and Tie Strips. (Reinforced Earth Company)

Use tie strips of shop fabricated hot rolled steel that complies with the minimum requirements of ASTM A570, Grade 50, or equivalent.

Use reinforcing strips that complies with the following:

- hot rolled from bars to the required shape and dimensions.
- Physical and mechanical properties that complies with ASTM A572, Grade 65, or equivalent.
- Cut to lengths and tolerances shown in the Contract Documents.
- Punch holes for bolts in the locations shown.

Galvanize the reinforcing and tie strips to comply to ASTM A123 after fabrication is completed. Inspect all reinforcing and tie strips so that they are true to size and free from defects that may impair their strength and durability. The reinforcing and tie strips will be accepted on the basis of a Type A Certification and visual inspection.

(2) Soil Reinforcing Mesh. Provide shop fabricated reinforcing mesh of cold drawn steel wire complying with the minimum requirements of ASTM A82 and weld into the finished mesh fabric in accordance with ASTM A185. Form loops or weld connection plates so the variation in length between the longest and the shortest longitudinal wire in a reinforcing mesh panel is no more than 1/8 inch when measured from the cross-wire nearest the end of the reinforcing mesh panel. Loop fabrication must permit a 5/8 inch diameter rod to pass through all loops on each piece of mesh. Galvanize reinforcing mesh in accordance with ASTM A123. The mesh will be accepted on the basis of a Type A Certification and visual inspection.

(3) Soil Reinforcing Geogrid. Use soil reinforcing geogrid of oriented, drawn, long chain high density polyethylene or polypropylene containing stabilizers and inhibitors added to the base plastic for resistance to ultraviolet and heat degradation. Use the geogrid material as designated in the approved wall system. The designated soil reinforcing geogrid will be accepted on the basis of a Type A Certification.

(4) Soil Reinforcing Geosynthetic. Use soil reinforcing of woven, high tenacity polyester yarns coated with polyvinyl chloride to maintain the integrity of the geosynthetic during handling and placement and to protect it during construction. Use the geosynthetic material as designated in the approved wall system. The designated soil reinforcing geosynthetic will be accepted on the basis of a Type A Certification.

(5) SINEstrips and Connectors (Sine Wall). Use connectors embedded in the concrete panel that comply with the minimum requirements of ASTM A 1011, Grade 50 or equivalent. Galvanize connectors after fabrication in accordance with ASTM A123.

Use configured reinforcing strips (SINEstrips) that comply with the following:

Cold formed from coils to the required shape and dimensions. Depict the strip widths and dimensions on the shop drawings.

Physical and mechanical properties that comply with ASTM A 1011, Grade 65, or equivalent.

Bolt strips to the connectors using ASTM A325 bolts and ASTM A563 nuts galvanized in accordance with ASTM A153.

Galvanize reinforcing strips after fabrication in accordance with ASTM A123. The strips will be accepted on the basis of a Type A Certification and visual inspection.

g. Reinforcing Steel. Use Grade 60 reinforcing steel that complies with **DIVISION 1600.**

h. Fasteners. Use high strength, hexagonal cap screw bolts and nuts complying with ASTM A325 (Type I) or equivalent, and hot-dip galvanized in accordance with ASTM F 2329. Provide fasteners 1/2 inch in diameter, 1-1/4 inch in length with 3/4 inch thread length. The specified fasteners will be accepted on the basis of a Type A Certification.

i. Attachment Devices.

(1) Connectors. Use clevis connectors and connector rods fabricated of cold drawn steel wire complying with ASTM A82 and welded in accordance with ASTM A185 and galvanized in accordance with ASTM A153, or

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approved equal. Place connectors within 1/2 inch from the dimensions shown on the Contract Documents or approved shop drawings.

(2) Tie Bar. Use tie bars fabricated of cold drawn steel wire complying with ASTM A82 and galvanized in accordance with ASTM A153.

(3) Connection Pins. Use Connection Pins fabricated of cold drawn steel wire complying with ASTM A82 and galvanized in accordance with ASTM A153.

(4) Devices will be accepted on the basis of receipt and approval of a Type A Certification and visual inspection.

j. Joint Materials: Use joint material where required and as shown in the Contract Documents.

(1) Vertical Joints. Use a plastic filter fabric cover for horizontal and inclined joints between panels. Use adhesive to temporarily attach the fabric material to the rear of the facing panels as approved by the retaining wall system manufacturer. Cover each side of the joint with a minimum of 6 inches of filter fabric.

(2) Horizontal Joints. Use filler for horizontal joints between panels as shown in the Contract Documents and approved by the Engineer.

(3) Bearing Pads. Use bearing pads made of high-density polyethylene LR73400 with a shore hardness of 66 or as approved by the retaining wall system manufacturer.

Cover for horizontal and vertical joints between panels with a Fiber Bond filter fabric complying with AASHTO M 288 surface drainage with less than 15% soil passing No. 200 square mesh sieve, or equal as approved by the retaining wall system manufacturer. Use adhesive to temporarily attach the fabric material to the rear of the facing panels as approved by the retaining wall system manufacturer.

853.3 CONSTRUCTION REQUIREMENTS

a. Technical Representative. Provide a manufacturer's technical representative to be on the project during initial erection and be available during construction of all retaining walls at no additional cost to KDOT. The representative must spend sufficient time with both the Contractor and the Engineer so they are familiar with the proper erection procedures.

b. Wall Excavation. Remove all materials encountered without regard to classification. Coordinate excavation for the wall with the underdrain construction so that drainage pipes will be constructed as specified. Maintain stable sides at all excavations by providing reasonable cut back slopes or shoring where necessary.

c. Foundation Preparation. Grade the foundation for the retained earth volume, reinforced earth volume, strengthened earth or MSE structure volume level with the top of the leveling pad for a width equal to or exceeding the length of the reinforcing mesh, reinforcing strips or geogrid plus 12 inches or to the limits shown in the Contract Documents. Compact the foundations prior to wall construction, with a smooth wheel vibratory roller with a minimum static weight of 8 tons to recompact any loose material the excavation process created to Type AA, MR 3-3 requirements. Remove and replace any foundation soils found to be unstable or unsatisfactory.

Construct an unreinforced concrete leveling pad at foundation level as shown in the Contract Documents. Cure the pad for a minimum of 12 hours before placement of wall panels or blocks. Install the wall drainage system concurrently with the bottom layer of reinforcement and select granular backfill. Do not proceed past the bottom layer of reinforcement until the drainage system is installed and outletted away from the wall.

d. Leveling Pad. No gap between a panel and the vertical step in the leveling pad greater than 4 inches is allowable. If one gap is more than 4 inches, remove the leveling pad and re-cast in that location. If there are more than 3 gaps greater than 4 inches in a wall, remove the leveling pad and re-cast in all locations that have gaps regardless of the width of the gap. Cover gaps less than 4 inches in width with a separation geotextile on the inside of the wall face. No gaps between the leveling pad and a modular block is allowed.

e. Wall Erection. Check the plumbness and tolerances of each panel/modular block row at the face prior to erection of the next panel or modular block row. Should any panels/modular blocks be out of tolerance, remove the fill and reset the panels/modular blocks to their proper tolerances. Do not drape geosynthetic reinforcement over the face of the wall. Do not place more than one row of blocks at one time.

(1) MSEW precast Panel. Place MSEW precast panels vertically with the aid of a light crane. For erection, handle panels by means of a lifting insert precast into the upper edge of the panels. Place panels in successive

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horizontal lifts in the sequence shown in the Contract Documents as backfill placement proceeds. Maintain in vertical position as fill material is placed behind a panel, by means of temporary wooden wedges placed on the external side of the wall in the joint between adjacent panels. External bracing is required for the initial lift. Vertical tolerances and horizontal alignment tolerance shall not exceed $\frac{3}{4}$ -inch when measured with a 10-foot straight edge. Offset each panel from the panel below it as shown in the Contract Documents, with a maximum allowable offset of $\frac{3}{4}$ -inch. The maximum vertical overall tolerance of the wall is $\frac{1}{2}$ -inch per 10 feet of wall height. Remove the wedges as the erection proceeds.

Make horizontal and vertical joint openings between panel's uniform, and between $\frac{1}{2}$ -inch and $1\frac{1}{4}$ -inch.

Check the plumbness and tolerances of each panel row at the face prior to erection of the next panel row. Should any panels be out of tolerance, remove the fill and reset the panels to their proper tolerances.

(2) MBW. Place modular blocks at locations shown in the Contract Documents with the use of small lifting devices or by hand. Place blocks in successive horizontal lifts in the sequence shown in the Contract Documents as backfill placement proceeds. Leave modular block unit cores void unless drainage fill material is specifically called for in the Contract Documents. Take care when placing material behind the blocks to prevent the blocks from moving outward. Vertical tolerances and horizontal alignment tolerance shall not exceed $1\frac{1}{2}$ -inch when measured with a 10-foot straight edge. Offset each block from the block below it as shown in the Contract Documents with a maximum allowable offset of 1-inch. The maximum vertical overall tolerance of the wall is 1-inch per 10 feet of the wall height.

Construct uniform horizontal and vertical joint openings between modular blocks a maximum of $\frac{1}{8}$ inch.

Extend the Mesa Connector into adjoining courses with 2 Mesa standard connectors per unit.

Place Anchor Lock Bar continuously only at elevations where geosynthetic reinforcement is required.

Place KeySystem I steel connection pins at soil reinforcing connection locations only and fiberglass alignment pins at all other pin locations.

Handle and store all geogrids, geomembranes, geotextiles, and geosynthetics according to the manufacturer's recommendations.

Do not remove any geogrid, geomembrane, geotextile, or geosynthetic from its packaging and expose it to the sunlight and the elements for a period exceeding 10 days before it is placed and covered.

Place a geomembrane horizontally above all select granular backfill that contains reinforcing strips or soil reinforcing mesh or any other metallic soil reinforcement. Extend the geomembrane 2 feet beyond the limits of the select granular backfill.

Place a Class 2 geotextile for subsurface drainage above all select granular backfill that contains soil reinforcing geogrid or soil reinforcing geosynthetic or any other polymeric reinforcement. Extend the geotextile 2 feet beyond the limits of the select granular backfill.

f. Backfill Placement. Closely follow the erection of each lift of facing with backfill. At each reinforcing level, roughly level backfill before placing and or attaching the reinforcement. Place reinforcing as shown in the Contract Documents normal to the face of the wall. For geosynthetic reinforcing, the end of the geogrid sheet will terminate with a transverse element at the retained soil limit to prevent curling of the sheet and aid in construction. Tightly draw the reinforcing against the connections at the connectors and stake the end of the geogrid sheet at the retained soil limit before backfilling is allowed, and maintain tautness during backfilling operations. Place backfill in maximum loose lift thickness of 10 inches or less as may be necessary to obtain the specified density.

Construct the MSE wall lifts and reinforcement without deflecting any nearby appurtenances, such as piles, pile casings, etc.

For MBW systems using sand and sand-gravel combinations, provide a 3-foot wide zone immediately behind the facing composed of crushed stone backfill. Separate the crushed stone backfill from the sand or sand-gravel backfill with the use of a Class 2 geotextile for separation.

Compact the entire retained earth volume to 95% of maximum laboratory dry density at a moisture requirement of MR 3-3, **SECTION 205**. For backfills containing more than 30% retained on the $\frac{3}{4}$ -inch sieve, use a method compaction consisting of at least 4 passes of a heavy roller. Accomplish compaction without disturbance or displacement of reinforcing and facing. Begin compaction from the area nearest the wall face to the back of the reinforcing, except for a strip 3 feet wide adjacent to the backside of the facing. Compact this 3-foot strip with light mechanical tampers after compaction of the remainder of the layer. Soil density tests will not be required within this 3-foot area.

Maintain a maximum elevation difference of 3 feet between the retained fill and the select granular backfill.

No shale or weathered shale is permitted in the retained fill zone.

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At the end of each day's operations, shape the last level of backfill to permit runoff of rainwater away from the wall face.

Remove and replace any wall materials that become damaged during backfill placement at the Contractor's expense.

Trim excess geogrid protruding from the face of the wall for MBWs to match the modular block's face. Seal any geogrid permanently exposed from exposure to the elements with the use of epoxy grout, grout, or other methods as approved by the Engineer.

No construction traffic is permitted on galvanized steel reinforcing. Use only rubber tired vehicles going less than 5 mph with no turning on geosynthetic reinforcement.

853.4 MEASUREMENT AND PAYMENT

The Engineer will measure Retaining Wall by the square foot. The Engineer will use the neat lines shown in the Contract Documents to compute the quantities.

Payment for "Retaining Wall (*)" at the contract unit price is full compensation for the specified work.