

**DIVISION 250**  
**Structural Embankments**

## Section 251—Riprap

### Description

**251.01 Work.** Furnish and place riprap for bank protection, slope protection, drainage structures, and erosion control.

Riprap classes are designated as shown in table 705-1.

### Materials

**251.02 Requirements.** Provide materials that conform to requirements in the following subsections:

Geotextiles, Type IV (A, B, C, D, E, or F) .....	714.01
Mortar for Masonry Beds & Joints .....	712.05
Riprap Rock .....	705.02
Rock for Hand-Placed Embankments .....	705.05
Granular Backfill .....	703.03

Provide gravel cushion that meets the gradation requirements SHOWN ON THE DRAWINGS and the quality requirements specified in Subsection 703.06.

### Construction

**251.03 General.** Minimize ground disturbance where practicable in preparing for placement of riprap. Prepare surfaces by removing logs, cutting brush and stumps flush with the ground, or as SHOWN ON THE DRAWINGS. Remove all soft or spongy material to the depths SHOWN ON THE DRAWINGS and replace it with approved material. Perform structural excavation and backfill as specified in Section 206A. Place geotextile as SHOWN ON THE DRAWINGS.

Control gradation by visual inspection. When SHOWN ON THE DRAWINGS, provide two samples of the specified class of rock. Each sample shall be at least 4.5 t or 10 percent of the total riprap weight, whichever is less. Provide one sample at the construction site, which may be a part of the finished riprap covering. Provide the other sample at the quarry. Use these samples as a frequent reference for judging the gradation of the riprap supplied. When specified in the SPECIAL PROJECT SPECIFICATIONS, provide mechanical equipment at the sorting site and the labor needed to assist in checking gradation.

**251.04 Placed Riprap.** Placed riprap is rock placed on a prepared surface to form a well-graded mass.

(a) **Method A, Machine Placed.** Place riprap to its full thickness in one operation to avoid displacing the underlying material. Do not place riprap material by methods that cause segregation or damage to the prepared surface. Place or rearrange individual rocks by mechanical or manual methods to obtain a compact uniform blanket with a reasonably smooth surface.

(b) **Method B, End Dumped.** Dump riprap to its full thickness in one operation. Avoid displacing the underlying material. Distribute larger rocks throughout the mass of stone. Obtain a uniformly thick blanket with a reasonably smooth surface.

**251.05 Keyed Riprap.** Keyed riprap is rock placed on a prepared surface and keyed into place by striking with a flat-faced weight.

Place rock for keyed riprap according to Subsection 251.04. Key the riprap into place by striking the surface with a 1.2 x 1.5-m flat-faced weight that weighs approximately 2,000 kg. Do not strike riprap below the water surface.

**251.06 Mortared Riprap.** Mortared riprap is rock placed on a prepared surface with the voids filled with Portland cement mortar.

Place rock for mortared riprap according to Subsection 251.04. Thoroughly moisten the rocks and wash any excess fines to the underside of the riprap. Place mortar only when the temperature is above 2 °C and rising. Place the mortar in a manner to prevent segregation. Fill all voids without unseating the rocks. Provide weep holes through the riprap as SHOWN ON THE DRAWINGS. Protect the mortared riprap from freezing and keep it moist for 3 days after the work is completed.

Where the depth SHOWN ON THE DRAWINGS for grouting is in excess of 300 mm, place the riprap in lifts of 300 mm or less. Grout each lift prior to placing the next lift. Construct and grout the succeeding lifts before the grout in the previous lift has hardened.

**251.07 Sacked Concrete Riprap.** Ensure that type A and type B sacked concrete riprap is prepared as described below.

(a) **Type A.** Prepare concrete containing at least 195 kg of cement per cubic meter; aggregate with a maximum size of 60 mm; and water limited to that necessary to ensure good workability without loss of cement by seepage through the sacks. Use reasonably clean and strong aggregate of appropriate size gradation. Use sacks that are at least 310 g/m<sup>2</sup> burlap, with a 1,016-mm width, or equivalent. Ensure that minimum weight of the filled sack is 25 kg. Place sacks while contents are moist. Premixed concrete that meets the requirements specified in this section is acceptable.

Loosely place the sacks, filled with concrete, to leave room for folding at the top. Make the fold just enough to retain the concrete at time of placing. Immediately after filling the sacks with concrete, place and lightly trample them to cause them to conform with the earth face and with adjacent sacks.

Remove all dirt and debris from the top of the sacks before the next course is laid thereon. Place stretchers so the folded ends will not be adjacent. Place headers with the folds toward the earth face. Do not place more than four vertical courses of sacks in any tier until initial set has taken place in the first course of any such tier.

**(b) Type B.** Provide type B (premixed) sacked concrete riprap containing commercially packaged dry combined materials for concrete. Ensure that each sack weighs at least 30 kg; is about 300 x 450 x 150 mm in size; and is strong enough for the mass of concrete it contains and free of tears and imperfections. Ensure that the concrete has not taken an initial set prior to placing.

Place and lightly compress sacks to cause them to conform with the earth surface and with adjacent sacks. When more than one layer of sacks is required, stagger joints one-half sack width. Do not place more than four vertical courses (one tier) of sacks until initial set has taken place in the first course of any such tier.

After placement, penetrate each sack at least six times from the top through the entire sack thickness, leaving at least a 13- to 25-mm-diameter void in the concrete mixture. Do not damage the sack through these penetrations to the extent that the concrete mixture is spilled or wasted.

When there will not be proper bearing or bond for the concrete because of delays in placing succeeding layers of sacks or because the work is hampered by storms, mud, or other causes, excavate a small trench behind the row of sacks already in place, and fill the trench with fresh concrete before laying the next layer of sacks.

Keep sacked concrete riprap moist and protected from freezing for a period of 4 days after placement.

**251.08 Sacked Soil Cement Riprap.** Sacked soil cement riprap may be composed of any combination of gravel, sand, silt, and clay with the following limitations: do not use topsoil; ensure that at least 55 percent of the mixed soil passes the 4.75-mm (no. 4) sieve, and that not more than 15 percent passes the 75- $\mu$ m (no. 200) sieve; and ensure that the maximum size gravel passes the 37.5-mm sieve. Pulverize the soil so that no lumps exceed 13 mm in diameter. Thoroughly and uniformly mix the cement, soil, and water before placing in sacks. Limit moisture content to that necessary for good mixing without seepage. Provide sacks that are at least 310 g/m<sup>2</sup> burlap, with a 1,016-mm width, or

equivalent. Ensure that the minimum weight of the filled sack is 25 kg. Place sacks while contents are moist.

The cement requirements in percent by volume for each soil group are shown below:

AASHTO Classification (M 145) Soil Group	Percent Cement by Volume
A-1-a .....	7
A-1-b .....	9
A-2 .....	10
A-3 .....	12
A-4 .....	12
A-5 .....	13
A-6 .....	14
A-7 .....	15

**251.09 Hand-Placed Riprap.** Securely bed the rock. Use spalls and small rocks to fill voids. Fill any spaces in back of the hand-placed riprap with compacted material.

**251.10 Granular Filter Blanket.** Place a sheathing material as specified in Subsection 703.04 where SHOWN ON THE DRAWINGS to the full specified thickness of each layer in one operation, using methods that will not cause segregation of particle sizes within the layer. Ensure that the surface of the finished layer is reasonably even and free of mounds or windrows. Place additional layers of filter material in a manner that will not cause mixture of the material in the different layers.

**251.11 Geotextile.** Place the geotextile as SHOWN ON THE DRAWINGS. Provide surfaces upon which the geotextile is to be placed with a uniform slope, and make them reasonably smooth and free of obstructions, depressions, and debris that could damage the geotextile. Have the surfaces approved before placing geotextile.

Loosely lay the geotextile without wrinkles or creases. Sew or overlap adjacent strips at joints. Insert securing pins through both strips of overlapped geotextile at maximum intervals of 900 mm, but not closer than 50 mm to each edge. Prevent the geotextile from being displaced.

Have the installed geotextile approved before covering with granular backfill or other materials. Carefully place the granular backfill on the geotextile to the depth SHOWN ON THE DRAWINGS by methods that will not damage the geotextile. Do not drop riprap placed on the granular backfill a distance greater than 900 mm.

**Measurement**

**251.12 Method.** Use the method of measurement that is DESIGNATED IN THE SCHEDULE OF ITEMS.

**Payment**

**251.13 Basis.** The accepted quantities will be paid for at the contract unit price for each PAY ITEM IN THE SCHEDULE OF ITEMS.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
251 (01) Placed riprap, class _____, method _____ .....	Cubic Meter
251 (02) Placed riprap, class _____, method _____ .....	Ton
251 (03) Placed riprap, class _____, method _____ .....	Square Meter
251 (04) Keyed riprap, class _____ .....	Cubic Meter
251 (05) Keyed riprap, class _____ .....	Ton
251 (06) Mortared riprap, class _____ .....	Cubic Meter
251 (07) Sacked concrete riprap, type _____ .....	Square Meter
251 (08) Sacked concrete riprap, type _____ .....	Cubic Meter
251 (09) Sacked soil cement riprap .....	Square Meter
251 (10) Sacked soil cement riprap .....	Cubic Meter
251 (11) Granular filter blanket .....	Cubic Meter
251 (12) Hand-placed riprap.....	Square Meter
251 (13) Geotextile, type IV, _____ .....	Square Meter

## Section 252—Special Rock Embankment & Rock Buttress

### Description

**252.01 Work.** For special rock embankment, furnish rock and place it mechanically or by hand in fill sections. For rock buttress, furnish rock and place it mechanically or by hand in cut sections.

Special rock embankments and rock buttresses are designated as hand placed or mechanically placed.

### Materials

**252.02 Requirements.** Furnish material that conforms to specifications in the following subsections:

Geotextiles, Type II (A, B, or C) .....	714.01
Rock for Hand-Placed Embankments .....	705.05
Rock for Mechanically Placed Embankments .....	705.04

Control gradation by visual inspection. When SHOWN ON THE DRAWINGS, provide two samples of the specified class of rock. Each sample shall be at least 4.5 t or 10 percent of the total rock weight, whichever is less. Provide one sample at the construction site, which may be a part of the finished rock covering. Provide the other sample at the quarry. Use these samples as a frequent reference for judging the gradation of the rock supplied. When specified in the SPECIAL PROJECT SPECIFICATIONS, provide mechanical equipment at the sorting site and the labor needed to assist in checking gradation.

### Construction

**252.03 Geotextile Installation.** Place the geotextile as SHOWN ON THE DRAWINGS. Ensure that the surfaces upon which geotextile is to be placed have a uniform slope and are reasonably smooth and free of obstructions, depressions, and debris that could damage the geotextile. Have the surface approved by the CO prior to placing geotextile.

Lay the geotextile without tension, stress, wrinkles, or creases. Sew or overlap adjacent strips a minimum of 300 mm at joints. Insert securing pins through both strips of overlapped geotextile at maximum intervals of 900 mm, but no closer than 50 mm to each edge, to prevent the geotextile from being displaced.

Have the installed geotextile approved by the CO prior to covering.

**252.04 Placing Rock.** Perform the work specified in Section 203 or 206A, as required.

Place the rock in a stable orientation with minimal voids. Offset the rock to produce a random pattern. Use spalls smaller than the minimum rock size to chock the larger rock solidly in position and to fill voids between the large rocks.

Construct the exposed face of the rock mass to be reasonably uniform, with no projections beyond the neat line of the slope that are more than 500 mm for mechanically placed rock and 300 mm for hand-placed rock, or as SHOWN ON THE DRAWINGS.

**Measurement**

**252.05 Method.** Use the method of measurement that is DESIGNATED IN THE SCHEDULE OF ITEMS.

**Payment**

**252.06 Basis.** The accepted quantities will be paid for at the contract unit price for each PAY ITEM DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
252 (01) Special rock embankment, _____ .....	Cubic Meter
252 (02) Special rock embankment, _____ .....	Square Meter
252 (03) Special rock embankment, _____ .....	Ton
252 (04) Rock buttress, _____ .....	Cubic Meter
252 (05) Rock buttress, _____ .....	Square Meter
252 (06) Rock buttress, _____ .....	Ton
252 (07) Geotextile, type II, _____ .....	Square Meter



## Section 253—Gabions

### Description

**253.01 Work.** Construct gabion structures and mattresses.

### Materials

**253.02 Requirements.** Ensure that material conforms to specifications in the following subsections:

Gabion Material .....	720.02
Gabion Rock .....	705.01
Geotextiles, Type IV (A, B, C, D, E, or F) .....	714.01
Structural Backfill .....	704.04

### Construction

**253.03 General.** Perform the work specified in Section 206A.

**253.04 Basket Assembly.** Do not damage wire coatings during basket assembly, structure erection, cell filling, or backfilling. Rotate the basket panels into position and join the vertical edges with fasteners according to Subsection 253.05. Temporary fasteners may be used for basket assembly if they are supplemented during structure erection with permanent fasteners according to Subsection 253.05.

Rotate the diaphragms into position and join the vertical edges according to Subsection 253.05.

**253.05 Structure Erection.** Place the empty gabion baskets on the foundation and interconnect the adjacent baskets along the top and vertical edges using fasteners.

Where lacing wire is used, wrap the wire with alternating single and double loops every other mesh opening and not more than 150 mm apart. Where spiral binders are used, crimp the ends to secure the binders in place. Where alternate fasteners are used, space the fasteners in every mesh opening and not more than 150 mm apart.

In the same manner, interconnect each vertical layer of baskets to the underlying layer of baskets along the front, back, and sides. Stagger the vertical joints between the baskets of adjacent rows and layers by at least one cell length.

**253.06 Cell Filling.** Remove all kinks and folds in the wire mesh, and properly align all the baskets. Place rock carefully in the basket cells to prevent the baskets from bulging and to minimize voids in the rock fill. Maintain the basket alignment.

Place internal connecting wires in each unrestrained exterior basket cell greater than 300 mm in height. This includes interior basket cells left temporarily unrestrained. Place internal connecting wires concurrently with rock placement.

Fill the cells in any row or layer so that no cell is filled more than 300 mm above an adjacent cell. Repeat this process until the basket is full and the lid bears on the final rock layer.

Secure the lid to the sides, ends, and diaphragms according to Subsection 253.05. Make all exposed basket surfaces smooth and neat, with no sharp rock edges projecting through the wire mesh.

**253.07 Geotextile Installation.** Place the geotextile according to Section 221 or as SHOWN ON THE DRAWINGS. Ensure that the surfaces upon which geotextile is to be placed have a uniform slope and are reasonably smooth and free of obstructions, depressions, and debris that could damage the geotextile. Have the surface approved by the CO prior to placing geotextile.

Lay the geotextile without tension, stress, wrinkles, or creases. Sew or overlap adjacent strips a minimum of 300 mm at joints. Insert securing pins through both strips of overlapped geotextile at maximum intervals of 900 mm, but no closer than 50 mm to each edge, to prevent the geotextile from being displaced.

Have the installed geotextile approved by the CO prior to backfilling with structural backfill or other approved material.

**253.08 Backfilling.** Backfill behind the gabion structure concurrently with the cell-filling operation. Backfill the area behind the gabion structure with structural backfill or acceptable roadway excavation, as approved by the CO. Compact each layer in accordance with Subsection 203.16(b), method 4.

**253.09 Gabion Mattresses.** Place a geotextile according to Section 221. Construct revet mattresses according to Subsections 253.04 through 253.06. Anchor the mattresses in place. Place geotextile against the vertical edges of the mattress, and backfill against the geotextile using structural backfill or other material, as approved by the CO. Overfill gabion mattresses by 30 to 50 mm.

**Measurement**

**253.10 Method.** Use the method of measurement that is DESIGNATED IN THE SCHEDULE OF ITEMS.

**Payment**

**253.11 Basis.** The accepted quantities will be paid for at the contract unit price for each PAY ITEM DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
253 (01) Gabions, galvanized- or aluminized-coated .....	Square Meter
253 (02) Gabions, epoxy- or polyvinylchloride (PVC)- coated .....	Square Meter
253 (03) Gabions, galvanized- or aluminized-coated .....	Cubic Meter
253 (04) Gabions, epoxy- or PVC-coated .....	Cubic Meter
253 (05) Geotextile, type IV, _____ .....	Square Meter

## Section 254—Crib Walls

### Description

**254.01 Work.** Construct concrete, metal, or timber crib retaining walls.

### Materials

**254.02 Requirements.** Ensure that material conforms to specifications in the following subsections:

Bed Course .....	704.09
Crib Wall Backfill .....	704.12
Hardware & Structural Steel .....	716.02
Geotextiles, Type IV (A, B, C, D, E, or F) .....	714.01
Metal Bin Type Crib Walls .....	720.03
Precast Concrete Units .....	725.11
Structural Backfill .....	704.04
Treated Structural Timber & Lumber .....	716.03

### Construction

**254.03 General.** Perform the work specified in Section 206. When the wall is set on a rocky foundation, place 200 mm of bed course under the wall base elements.

**254.04 Erection.** Furnish all necessary bolts, nuts, and hardware for complete assembly of the units into a continuous wall of connected units. Erect the crib wall according to the fabricator's or manufacturer's instructions. On curves, obtain the proper curvature for the face by using shorter stringers in the front or rear panels. Construct the wall to within 25 mm per 3 m from the lines and elevations, as SHOWN ON THE DRAWINGS.

(a) **Concrete Crib Wall.** Remove and replace all concrete members that are cracked or damaged.

(b) **Metal Crib Wall.** Torque bolts for metal crib walls according to manufacturer's recommendations.

(c) **Timber Crib Wall.** Construct timber cribs according to Section 557.

**254.05 Geotextile Installation.** Place the geotextile as SHOWN ON THE DRAWINGS. Ensure that the surfaces upon which geotextile is to be placed have a uniform slope and are reasonably smooth and free of obstructions, depressions,

and debris that could damage the geotextile. Have the surface approved by the CO prior to placing geotextile.

Lay the geotextile without tension, stress, wrinkles, or creases. Sew or overlap adjacent strips a minimum of 300 mm at joints. Insert securing pins through both strips of overlapped geotextile at maximum intervals of 900 mm, but no closer than 50 mm to each edge, to prevent the geotextile from being displaced.

Have the installed geotextile approved by the CO prior to backfilling.

**254.06 Backfilling.** Backfill the inside of the cribs formed by the wall members with crib wall backfill in 150-mm layers. Place crib wall backfill, structural backfill, or acceptable roadway excavation behind cribs. Maintain an equal elevation of fill behind and inside cribs during backfilling operations. Compact each layer according to Subsection 203.16(b), method 4.

**Measurement**

**254.07 Method.** Use the method of measurement that is DESIGNATED IN THE SCHEDULE OF ITEMS.

**Payment**

**254.08 Basis.** The accepted quantities will be paid for at the contract unit price for each PAY ITEM DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
254 (01) Concrete crib retaining wall .....	Square Meter
254 (02) Metal crib retaining wall .....	Square Meter
254 (03) Treated timber crib retaining wall .....	Square Meter
254 (04) Crib wall backfill .....	Cubic Meter
254 (05) Geotextile, type IV, _____ .....	Square Meter

## Section 255—Mechanically Stabilized Earth Walls

### Description

**255.01 Work.** Construct mechanically stabilized earth walls.

### Materials

**255.02 Requirements.** Ensure that material conforms to specifications in the following section and subsections:

Geotextiles, Type IV (A, B, C, D, E, or F) .....	714.01
Mechanically Stabilized Earth Wall Material .....	720.01
Minor Concrete Structures .....	602
Select Granular Backfill .....	704.10
Structural Backfill .....	704.04

### Construction

**255.03 General.** Perform the work specified in Section 206. Grade the foundation for a width equal to the length of reinforcing mesh or strips plus 500 mm. Where the wall is set on a rocky foundation, place 150 mm of select granular backfill under the reinforcing mesh or strips.

For concrete-faced walls, provide a precast reinforced or a nonreinforced cast-in-place concrete leveling pad. Cure cast-in-place leveling pads a minimum of 12 hours before placing wall panels.

**255.04 Wall Erection.** Erect the wall as SHOWN ON THE DRAWINGS and according to the manufacturer's recommendations.

*(a) Concrete-Faced Walls.* Erect panels by means of lifting devices connected to the upper edge of the panel. Align precast facing panels within 19 mm vertically and horizontally when measured with a 3-m straightedge.

Make the joint openings 19 mm  $\pm$  6 mm wide. Install joint material according to the drawings. Cover all joints on the backside of the panels with a 300-mm-wide strip of geotextile. Overlap geotextile splices a minimum of 100 mm.

Hold the panels in position with temporary wedges or bracing during backfilling operations. Erect the wall so the overall vertical tolerance (top to bottom) does not exceed 13 mm per 3 m of wall height.

**(b) Wire-Faced Walls.** Place backing mats and 6-mm hardware cloth in successive horizontal lifts as backfill placement proceeds. Connect, tighten, and anchor soil reinforcement elements to the wall facing units before placing backfill. Do not exceed an individual lift vertical tolerance and an overall-wall (top-to-bottom) vertical tolerance of 25 mm per 3 m of wall height. Place reinforcement elements within 25 mm vertically of the corresponding connection elevation at the wall face. Do not deviate from the designed batter of the wall by more than 25 mm per 3 m of wall height. Do not deviate more than 50 mm at any point in the wall from a 3-m straightedge placed horizontally on the theoretical plane of the design face.

**(c) Gabion-Faced Walls.** Furnish and assemble gabion baskets according to Subsection 253.04. Lay reinforcement mesh horizontally on compacted fill. Place the soil reinforcement mesh normal to the face of the wall. Connect the gabion facing unit to reinforcement mesh with spiral binders or tie wire at 100 mm nominal spacing with alternating single and double locked loops. Join adjacent baskets along vertical edges according to Subsection 253.05. Fill gabion basket cells according to Subsection 253.06. Pull and anchor the reinforcement mesh taut before placing backfill. Place gabion baskets in successive horizontal lifts in the sequence shown on the drawings as backfill placement proceeds.

**255.05 Backfilling.** Backfill and compact the stabilized volume with select granular backfill in accordance with Subsection 203.16(b), method 4. Ensure that no voids exist beneath the reinforcing mesh or strips. Where spread footings used to support bridge or other structural loads are supported by the stabilized volume, compact the top 1.5 m below the footing elevation to at least 100 percent of the maximum density, as determined by AASHTO T 99, method C or D.

Do not damage or disturb the facing, reinforcing mesh, or strips. Compact within 1 m of the wall face with an approved lightweight mechanical tamper, roller, or vibratory system. Correct all damaged, misaligned, or distorted wall elements.

Backfill and compact behind the stabilized volume with structural backfill or suitable roadway excavation.

At the end of each day's operation, slope the last lift of backfill away from the wall face to rapidly direct runoff away from the wall. Do not allow surface runoff from adjacent areas to enter the wall construction site.

## Measurement

**255.06 Method.** Use the method of measurement that is DESIGNATED IN THE SCHEDULE OF ITEMS.

**Payment**

**255.07 Basis.** The accepted quantities will be paid for at the contract unit price for each PAY ITEM DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
255 (01) Mechanically stabilized earth wall .....	Square Meter



## Section 257—Alternate Retaining Walls

### Description

**257.01 Work.** Ensure that various types of retaining walls are constructed at the Contractor's option. The alternate wall types are gabions, crib walls, mechanically stabilized earth walls, permanent ground anchor walls, reinforced concrete retaining walls, and reinforced soil embankments.

### Materials

**257.02 Requirements.** Ensure that material conforms to specifications in the following sections:

Crib Walls .....	254
Driven Piles .....	551
Gabions .....	253
Mechanically Stabilized Earth Walls .....	255
Reinforced Soil Embankments .....	259
Reinforcing Steel .....	554
Structural Concrete .....	552

### Construction

**257.03 General.** The designer/supplier furnishing the proposed wall is responsible for the stability of the wall. Do not qualify the responsibility for the design or restrict the use of the drawings or calculations for the proposed alternate. Indemnify the Government from all claims for infringement of proprietary rights by others without the consent of the patent holders or licensees.

**257.04 Submittal.** Submit a proposal using any of the wall types listed. Submit wall type proposals on a site-by-site basis. Different types may be used at individual sites on the project.

Provide drawings of the proposed wall within 120 days of the notice to proceed and at least 90 days before starting wall construction. Verify the limits of the wall before preparing drawings.

All drawings shall be signed by a licensed professional engineer.

Include all details, dimensions, quantities, ground profiles, and cross sections necessary to construct the wall. Submit design calculations on sheets about 200 x 300 mm in size with the project number, wall location, designation, date of

preparation, initials of designer and checker, and page number at the top of the page.

Provide an index page with the design calculations. Ensure that the drawings include, but are not limited to, the following items:

- (a) Plan and elevation drawings for each wall, containing the following:
  - (1) A plan view of the wall, identifying:
    - (a) The offset from the construction centerline to the face of the wall at its base at all changes in horizontal alignment.
    - (b) The limit of widest module, mesh, strip, or anchor.
    - (c) The centerline of any drainage structure or drainage pipe behind, passing through, or passing under the wall.
  - (2) An elevation view of the wall identifying:
    - (a) The elevation at the top of the wall, at all horizontal and vertical break points, and at least every 10 m along the wall.
    - (b) Elevations at the wall base, the top of leveling pads and footings, or the bottom of soldier piles.
    - (c) The wall batter.
    - (d) The distance along the face of the wall to all steps in the wall base, footings, leveling pads, or lagging.
    - (e) The type of panel or depth of module or lagging.
    - (f) The length and type of mesh, strips, or anchors.
    - (g) The distance along the face of the wall to where changes in length of the mesh, strips, or anchors occur.
    - (h) The original and final ground line.
  - (3) General notes for constructing the wall.
  - (4) Horizontal and vertical curve data affecting the wall. Match lines or other details to relate wall stationing to centerline stationing.
  - (5) A listing of the summary of quantities on the elevation drawing of each wall.

- (b) Dimensions and schedules of all reinforcing steel, including reinforcing bar bending details, dowels, and/or studs for attaching the facing.
- (c) Details and dimensions for foundations and leveling pads, including steps in the footings or leveling pads.
- (d) Details and dimensions for:
  - (1) All panels, modules, soldier piles, and lagging necessary to construct the element.
  - (2) All reinforcing steel in the element.
  - (3) The location of mesh, strip attachment, or anchor devices embedded in the panels.
  - (4) All anchors and soldier piling, including the spacing and size of piles and the spacing and angle of anchors.
- (e) Details for constructing walls around drainage facilities.
- (f) Details for terminating walls and adjacent slope construction.
- (g) Architectural treatment details.
- (h) Design notes including an explanation of any symbols and computer programs used in the design of the walls. Specify the factors of safety for sliding, pullout, and overturning. Specify the bearing pressure beneath the wall footing, stabilized earth mass, or soldier piles.
- (i) Verification of the design criteria for the site-specific wall locations with test procedures, results, and interpretations. Include results from creep, durability, construction-induced damage, and junction strength tests.
- (j) Other design calculations.

Process all submissions unless written permission is given for the wall designer/supplier and the CO to communicate directly.

Submit three sets of the wall drawings with the initial submission. One set will be returned with any indicated corrections. If revisions are necessary, make the necessary corrections and resubmit three revised sets.

When the drawings are approved, furnish five sets and a mylar sepia set of the drawings.

**257.05 Construction.** Construct the wall according to the approved drawings and the following sections, as applicable:

- (a) Gabions—Section 253.
- (b) Crib walls—Section 254.
- (c) Mechanically stabilized earth walls—Section 255.
- (d) Permanent ground anchor walls—Sections 551 and 552.
- (e) Reinforced soil embankments—Section 259.

Revise the drawings when plan dimensions are revised due to field conditions or for other reasons.

**Measurement**

**257.06 Method.** Use the method of measurement that is DESIGNATED IN THE SCHEDULE OF ITEMS.

Measure alternate retaining walls by the lump sum.

**Payment**

**257.07 Basis.** The accepted quantities will be paid for at the contract unit price for each PAY ITEM DESIGNATED IN THE SCHEDULE OF ITEMS.

When plan dimensions are changed by the CO during construction to account for field conditions, the lump sum price of the wall will be adjusted by applying a calculated per-square-meter cost adjustment factor to the added or decreased wall front face area resulting from the change. The adjustment factor will be determined by dividing the lump sum price bid for each wall by its estimated area shown in the PAY ITEM.

The alternate retaining wall lump sum will be paid based on the progress of the work under this section.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
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257 (01) Alternate retaining wall _____	
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(_____ square meters) ..... Lump Sum	
<i>Estimated</i>	

## Section 259—Reinforced Soil Embankments

### Description

**259.01 Work.** Construct reinforced soil embankments. Geogrid soil reinforcement material categories are designated as shown in table 714-7.

### Materials

**259.02 Requirements.** Ensure that material conforms to specifications in the following subsections:

Geogrids, Categories 1, 2, 3, 4, 5, or 6 .....	714.03
Select Granular Backfill .....	704.10

### Construction

**259.03 General.** Lay soil reinforcements at the proper elevation and alignment, as SHOWN ON THE DRAWINGS.

Orient soil reinforcements such that the maximum tensile strength available is in the direction of primary reinforcement, as SHOWN ON THE DRAWINGS.

Do not splice reinforcements in the primary direction. Geogrids may be overlapped three ribs (approximately 25 mm) in the direction transverse to the primary direction, and may be held together with hog rings or other approved devices.

Install soil reinforcements in accordance with manufacturer's recommendations for their intended purpose. Include a copy of those recommendations with project submittals.

Exercise care to prevent wrinkle development and/or slippage of reinforcement during fill placement and spreading. Prior to beginning work, submit a plan indicating how the stretching and staking will be accomplished.

Do not permit construction equipment to operate directly upon the reinforcement material. A minimum fill thickness of 150 mm is required prior to operation of tracked vehicles over the reinforced material. Keep turning of tracked vehicles to a minimum to prevent tracks from displacing the fill and damaging the material.

Ensure that the following tolerances apply to the elevations and dimension as SHOWN ON THE DRAWINGS: install the base of reinforcement material within ± 100 mm of that specified; and do not permit any layer to exceed 300 mm in thickness.

**259.04 Field Adjustments.** The final limits and configuration of the fills or reinforcement sections may vary, depending on the foundation materials encountered during excavation. Ensure that final foundation limits are approved by the CO in writing before placing any backfill material.

At least 48 hours before beginning work, notify the CO to inspect the foundation.

**259.05 Excavation.** Dispose of unsuitable material as SHOWN ON THE DRAWINGS.

**259.06 Performance.** Maintain all construction stakes to control the work.

**259.07 Backfilling.** Provide select granular backfill material that meets requirements specified in Subsection 704.10, unless otherwise SHOWN ON THE DRAWINGS. Place and compact backfill in accordance with Subsection 203.16(b), method 4. Do not use sheepsfoot rollers to obtain compaction. On geogrid fills, place backfill so as to keep tension in the geogrid.

**259.08 Slope Face Treatment.** Treat the face of the reinforced slope for erosion control in accordance with Section 204 and as SHOWN ON THE DRAWINGS.

**Measurement**

**259.09 Method.** Use the method of measurement that is DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment will be based on the contract unit price of reinforcing material placed and accepted. This will be exclusive of overlap and wastage.

**Payment**

**259.10 Basis.** The accepted quantities will be paid for at the contract unit price for each PAY ITEM DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
259 (01) Geogrid category_____	Square Meter