Section 2507. Concrete and Stone Revetment

2507.01 DESCRIPTION.

A. Place a layer of stone or concrete for protection of earth slopes against erosion from stream flow or wave action. Place according to the contract documents for the class of revetment specified. When specified, place a filter course beneath the revetment.

B. When specified furnish, transport, and place concrete grout within the voids of rock revetment as shown in the contract documents. The intent is to fill the voids of the revetment rock placement without over consolidation.

2507.02 MATERIALS.

A. Revetment.
Meet requirements of Division 41 for the material specified.

B. Grout.

1. General.
- **a.** The Engineer may require adjustment of the mix proportions to achieve proper solids suspension and optimum flowability. After the mix has been designated, do not change it without the Engineer's approval.
- **b.** Use proportioning and mixing equipment that meets the requirements of Articles 2001.20 and 2001.21. Provide mixers with sufficient mixing capacity to permit the intended pour to be placed without interruption.

2. Cement.
Use cement complying with Section 4101, at the rate of 10 sacks (940 pounds) per cubic yard (558 kg per cubic meter).

3. Fly Ash.
Meet the requirements of Section 4108. Fly ash may be substituted for cement for up to 25% by weight (mass) of cement.

4. Fine Aggregate.
Meet the requirements of Section 4110. Use 2100 pounds (surface dry weight) per cubic yard (1246 kg (surface dry weight) per cubic meter).

5. Water.
Meet the requirements of Section 4102. Use 45 gallons (375 pounds) per cubic yard (170 L (221 kg) per cubic meter), or enough to provide a thick creamy consistency.

6. Air-entraining Admixtures.
Meet the requirements of Section 4103. 6% to 10%.

7. Liquid Curing Compounds.
Meet the requirements of Section 4105.

C. Filter Blanket.
Apply Article 2107.03, K.

D. Engineering Fabric.
Meet requirements of Section 4196 and listed on Materials I.M. 496.01, Appendix G.

2507.03 CONSTRUCTION.

A. General.

1. For each of the five classes of revetment, begin construction in a trench dug to the elevation shown in the contract documents. Shape the slopes upon which revetment is to be placed and dress them to the extent that, when the revetment is placed to the specified depth, the revetment surface will be in compliance with the lines and grades shown in the contract documents.

2. For control of placement, mark (in a system of grids) those areas designated to receive stone protection. Spot and distribute loads over the surface marked in grids to provide the thickness shown in the contract documents. Control distribution based on the assumed density of 100 pounds per cubic foot (1600 kg/m^3) and the actual weights (mass) delivered.

3. Immediately prior to placing the revetment, the Engineer will inspect the prepared base.

4. After completion of Class A, B, and C revetment, place the excavated material into the trench as backfill.

B. Revetment.

1. Class A Revetment.
- **a.** A layer of the stone specified over the areas indicated in the contract documents.
- **b.** Place this layer so that each stone is firmly bedded against the bank and in close contact with adjacent stones. The stones need not be laid in courses.
- **c.** Drive spalls into openings remaining after the layer of stone is placed.
- **d.** Place this layer to a thickness of approximately 15 inches (0.4 m), with no portion having a thickness less than 12 inches (0.3 m).
- **e.** Chip portions of individual rocks projecting more than 2 inches (50 mm) above the general contour of the surface to within these limits.

2. Class B and C Revetment.
Place by bucket, clam shell or other mechanical means in a manner that will:
- Uniformly distribute the material as shown on the plans,
- Prevent damage to the filter blanket or fabric, and
- Limit disturbance of foundation soils.

3. **Class D and Class E Revetment.**
   a. Meet the requirements of Section 4130. If using recycled PCC, meet requirements of Materials I.M. 210. If filter blanket is required, refer to the contract documents for the material specified.
   b. Place revetment stone on the filter blanket. When filter blanket is not required, place revetment stone directly on the prepared slope or area in a manner which will produce a reasonably well graded mass of stone with the minimum practical percentage of voids. Place the entire mass of stone in compliance with the lines, grades, and thicknesses shown in the contract documents. Place revetment to its full course thickness in one operation and in such a manner as to avoid displacing underlying material. Do not place revetment in layers or by dumping into chutes and similar methods likely to cause segregation.
   c. Ensure the larger stones are well distributed. The entire mass of stone should comply with the gradation specified in Section 4130. Place the revetment and distribute so that there are no large accumulations of either the larger or smaller sizes of stone.
   d. Some roughness in surface is desirable to break up wave action and decrease the velocity of the water, but the mass should be fairly compact with all sizes of material placed in their proper proportions. Hand placing or rearranging of individual stones by mechanical equipment may be required to the extent necessary to secure the results specified.
   e. When the embankment is constantly exposed to erosion, place the revetment protection in conjunction with the construction of the embankment with only sufficient lag to allow for proper stabilization of the embankment. Do not allow embankment materials to mix with revetment materials. When the embankment to be protected is constructed in lifts, revetment can be dumped directly in place from the surface of each lift.

C. Bank Shaping.

When the revetment is to be placed on an existing slope, prepare the foundation for areas on which the revetment is to be placed by shaping, trimming, and dressing. Bring these areas into compliance with the slopes, grades, and cross sections shown in the contract documents. Where such areas are high or low, bring into compliance by cutting and filling, and compact the area so the earth is well compacted.

D. Erosion Stone.

Use erosion stone meeting the requirements of Section 4130. Place the material as shown in the contract documents.

E. Grouting.

1. **Placement of Grout.**
   a. Do not place the grout until the Engineer has inspected and approved the revetment.
   b. Flush the rock to be grouted with high pressure water to remove the fines prior to placing the grout. Keep the rock to be grouted wet for

at least 2 hours immediately prior to grouting, but do not place the grout in standing or flowing water.

c. Deliver the grout mix to the site and place within 1 1/2 hours after the introduction of cement to the aggregates. Transfer concrete from the mixer to final placement by means which prevent segregation of the aggregate or loss of mortar. Do not allow grout to drop more than 5 feet (1.5 m) vertically unless suitable equipment is used to prevent segregation.

d. Place grout in successive lateral courses starting at the top and progressing to the toe. Discharge the grout directly on the surface of the rock. Direct the flow of grout to prevent it from flowing excessively along the same path and to ensure that all intermittent spaces are filled. Sufficient jarring of rocks may be done to aid penetration of the grout so that all voids are filled and the grout fully penetrates the rock blanket. Work the grout into voids with the use of suitable spades and rods.

e. Do not allow the grouting operation to create a smooth surface. Finish the grout so that face stones are left exposed for one-fourth to one-third of their depth. Finish revetment rock blankets by brooming or other methods to:

- Fill voids caused by sloughing,
- Eliminate runs, and
- Provide a rough surface.

2. Curing and Protection.

a. After completion of any course, do not allow loads on the grouted surface for a period of 24 hours. Protect the grouted surface from injurious action by the sun, rain, flowing water, and mechanical injury.

b. Protect the grouted surface from drying for a curing period of at least 7 calendar days after placement. Keep exposed surfaces moist for the entire period, or until curing compound is applied. Maintain moisture by sprinkling, flooding, fog spraying, or covering with continuously moistened canvas, cloth mats, straw, sand, or other approved material.

c. If compound is used, spray it on the moist finished concrete surface as soon as free water has disappeared. Apply the compound at a uniform rate of no less than 1 gallon per 15 square yards (3 L per 10 m^2) of surface. Form a continuous adherent membrane over the entire surface.

d. Do not apply curing compound to surfaces that will be required to bond to subsequently placed concrete.

3. Limitation of Operations.

a. Do not place grout on frozen ground.

b. Grout batching, mixing, and placing may be started, if weather conditions are favorable, when the temperature is at least 34°F (1°C) and rising. At time of placement, grout shall have a temperature of at least 40°F (4°C). Stop mixing and placing grout when the temperature is 38°F (3°C) or less and falling.

c. Place each course in as continuous an operation as possible.

4. **Inspecting and Testing Fresh Grout.**
    - **a.** The Engineer will inspect materials and processes used in mixing and placing the grout, and will secure samples for air content. Allow the Engineer free entry to all parts of the plant and equipment.
    - **b.** When ready-mixed grout is furnished, provide the Engineer with a statement-of-delivery ticket for each batch delivered to the job site. Ensure tickets show:
        - Batch weights (mass) of cement,
        - Fly ash (if used),
        - Water, fine aggregate, and air entraining agent, and
        - Time of loading and revolution counter reading at the time of batching.

2507.04 METHOD OF MEASUREMENT.

Measurement for the items associated with concrete and stone revetment will be as follows:

A. Class A Revetment: computed in square yards (square meters) from measurements of the surface as constructed to the nearest 0.1 foot (0.1 m).

B. Class B, C, D, and E Revetment and Erosion Stone: tons (megagrams) to the nearest 0.1 ton (0.1 Mg). Only material placed according to the contract documents will be measured.

C. Material for Filter Blanket: tons (megagrams) to the nearest 0.1 ton (0.1 Mg).

D. Engineering Fabric: computed in square yards (square meters) from measurements of the material placed to the nearest 0.1 foot (0.1 meter).

E. Concrete Grout for Revetment or Gabion (if specified in the contract documents): cubic yards (cubic meters) of concrete grout furnished and placed computed from the nominal volume of each batch and a count of batches. The Engineer will estimate and deduct grout that is unused or wasted; however, no deduction will be made for a partial batch remaining at the completion of the operation.

2507.05 BASIS OF PAYMENT.

A. For the construction of revetment of the class specified, payment will be the contract unit price as follows:

1. Revetment furnished and placed: per square yard (square meter) for Class A Revetment, or per ton (megagram) for Class B, C, D, or E Revetment and Erosion Stone.

2. Material for Filter Blanket placed: per ton (megagram).

3. Engineering Fabric placed: per square yard (square meter).

4. Bank Shaping, if required: lump sum contract unit price.

5. When excavation, placing backfill, and (if required) special compaction are designated in the contract documents, payment will be made according to the type of work specified.

B. Payments are full compensation for all work, including bank shaping, furnishing and placing all material, excavation and placing backfill material, and for furnishing all equipment, tools, and labor necessary to complete the work according to the contract documents.

C. When Concrete Grout for Revetment or Gabion is specified in the contract documents, payment will be paid the contract unit price per cubic yard (cubic meter). Payment is full compensation for placing the grout and for furnishing all materials, equipment, and labor necessary to complete the work.