

SECTION 02374

GROUTED RIPRAP

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Materials requirements and procedures for furnishing, transporting, and installing of grouted riprap and all related materials.

1.2 RELATED SECTIONS

- A. Section 03055: Portland Cement Concrete

1.3 REFERENCES

- A. AASHTO T 27: Sieve Analysis of Fine and Coarse Aggregate
- B. AASHTO T 99: Moisture Density Relations of Soils Using a 5.5 Lb. Rammer and a 12 inch Drop
- C. AASHTO T 180: Moisture Density Relations of Soils Using a 10 lb Rammer and a 18 inch Drop
- D. AASHTO M 288: Geotextile Specification for Highway Applications
- E. ASTM T 104: Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
- F. ASTM C 127: Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
- G. ASTM C 535: Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- H. ASTM C618: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete

1.4 SUBMITTALS

- A. Submit in writing the following at the preconstruction conference:
 - 1. The source for riprap, and gradation.
 - 2. Grout mix-design.
 - 3. Samples for quality assurance testing before use.

1.5 QUALITY ASSURANCE

- A. Grouted Riprap Sample Panel
 - 1. Construct a 4 ft long x 4 ft wide x 1½ ft thick sample panel. Integrate the sample panel in the project quantity. Retain samples of cements, sands, aggregates, and additives used in this sample for comparison with materials used in the project. For small quantities (less than 20 square feet), reduce or revise sample panel size according to the resident engineer directions.
 - 2. Use the accepted 4 ft x 4 ft x 1½ ft sample panel as a standard to judge consistent visual appearance, acceptable workmanship, joint treatment, curing, cleaning and construction techniques to be used through out the project.
 - 3. Remove sample panel upon completion and acceptance of riprap installation.
- B. Riprap Source
 - 1. Set up riprap source location inspection meeting with the Engineer and source material owner prior to delivering materials to project site.
 - 2. Identify stock piling procedure.
 - 3. Provide written certification verifying the quality of riprap existing at the industrial source. Certify that “reactive” stone are not found in the quarry pit. Alkali-silica and alkali-carbon reactions are the most frequent of these reactions. In the absence of a documented 10-year history of use of quarry aggregates in commercial concrete mix designs, perform a petrographic analysis on representative aggregate samples to determine whether reactive stones are present.
 - 4. Provide historic results on reactivity of the rock or petrographic analysis of the proposed materials for rip rap.
- C. Preconstruction Conference
 - 1. Provide
 - a. Proposed source sites
 - b. Material test results
 - c. Grout mix design
 - d. Quality control plan

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and stock pile enough stone onsite for project.
- B. Prevent contamination of the stone surfaces with clays or similar materials.
- C. Remove any stone that does not conform to this specification.
 - 1. The Engineer may reject any stones not conforming to this specification.

PART 2 PRODUCTS

2.1 RIPRAP ELEMENTS

- A. Stone quality
 - 1. Use angular stones that are sound and durable against disintegration, and that have their greatest dimensions no greater than three times their least dimensions.
- B. Meet the following tests minimum requirements for stone.
 - 1. Maximum wear not greater than 40 percent when tested per ASTM C 535.
 - 2. Minimum specific gravity of 2.64 when tested per ASTM C 127.
 - 3. Weighted loss not greater than 10 percent when tested per AASHTO T 104.
- C. Stone gradation
 - 1. For grouted riprap of 1 ½ to 2 feet in thickness provide stones for riprap meeting the gradation requirements detailed in Table 1.

Table 1

Stone Sizes		Gradation (Percent <i>Larger Than Given Stone Size</i>)
Equivalent Diameter (Feet)	Weight	For 1 ½ to 2 foot Grouted Riprap Thickness
2.25	½-Ton	0-5
1.75	¼-Ton	50-100
1.25	200-Lb	- - -
1.00	75-Lb	95-100

- D. Use gradations that allow full grout penetration around the rocks.

2.2 GROUT

- A. Provide grout that meets the following requirements.
 - 1. Minimum 28-day compressive strength of 3000 psi, conform to strength testing requirements of Section 03055.
 - 2. Minimum air content of 5 percent.
 - 3. Use the approved mix design desired by the contractor.
 - 4. Use a minimum of six sacks of type II Portland Cement per cubic yard of grout.
 - 5. Submit a grout mix design that readily flows into the open spaces between the stones with the riprap gradation used.
 - 6. Add 1.5 pounds of fibermesh or equivalent per cubic yard of grout.
 - 7. Do not use calcium chloride admixtures.

2.3 ACCESSORIES

- A. Portland cement: Use Portland cement conforming to Section 03055.
- B. Pozzolan:
 - 1. Use Pozzolans conforming to Section 03055 and specification ASTM C 618. Class F, in amounts not to exceed 25 percent, based on absolute volume.
 - 2. Use an equivalent amount of Portland Cement in the grout mixture as a substitute.
- C. Aggregates: Conform to the requirements of Section 03055.
- D. Water: Use water that conforms to requirement of Section 03055.
- E. Air-entraining admixtures: Refer to Section 03055.
- F. Other admixtures: According to Section 03055.
- G. Use products to clean rock surfaces that are known to be compatible with cementitious grouts. Use in accordance with manufacturer's instructions.

2.4 BEDDING MATERIALS

- A. Conform to AASHTO M 288 for geotextile layer.
- B. Provide a class of geotextile conforming to the requirements for strength detailed in Table 1 of AASHTO M 288 that is appropriate for the installation methods used.

- C. Provide a geotextile conforming to the requirements for subsurface drainage detailed in Table 2 of AASHTO M 288 that is appropriate for the in-situ soils encountered.
- D. Use imported free-draining bedding aggregate material consisting of sand, gravel, or crushed stone meeting the following gradation. Do not use on-site materials.
- E. Provide 6 inches of granular bedding aggregate material under the grouted riprap.
- F. Use Granular Bedding Gradation per AASHTO T 27 meeting Table 2 requirements.

Table 2

U.S. Standard Sieve Size	Percent by Weight <i>Passing</i> Square Mesh Sieves
1½ - inch	100
¾ - inch	20-90
⅜ - inch	- - -
No. 4	0-20
No. 100	- - -
No. 200	0-3

PART 3 EXECUTION

3.1 PREPARATION

- A. Install surface and ground water control measures as needed to perform work in dry conditions. Water control measures include, but are not limited to diversions, culverts, sumps with pumps or other means necessary to maintain the level of groundwater below subgrade elevation and to divert surface water away from the work area.
- B. Remove all topsoil, loose excavated materials, trees, timber debris, soft yielding material and concrete debris, and other objectionable materials from beneath the areas where the grouted riprap is to be placed and as shown on the plans. Do not block natural drainage layers or horizons within the channel bottom.
- C. Place any approved on-site material and compact as specified to the designated subgrade elevation.
 1. Do not backfill depression with shattered shale materials.
 2. Spread fill materials uniformly minimizing segregation.

3. Compact subgrade to 95 percent maximum density; AASHTO T 99, or to a 70 percent relative maximum density; AASHTO T 180.
 4. Smooth graded areas maintaining specified slope with no more than 3 inches change unless closer tolerances are specified.
- D. Install a free draining bedding layer around the weep drains in the location indicated on the plan sheets.
1. Provide sufficient cover to prevent crushing by riprap elements.
- E. Notify the Engineer before placing riprap elements over bedding layer.
- F. Do not place riprap until the Engineer has verified compaction requirements.

3.2 PLACEMENT OF BEDDING MATERIALS

- A. Place geotextile loosely with no wrinkles or folds.
1. Use care so that the geotextile is in contact with the soil.
 2. Eliminate all void spaces between the geotextile and the soil surface.
- B. Overlap adjacent edges of geotextile a minimum of 18 inches or as shown on the plans.
- C. Overlap the upstream geotextile over the downstream.
- D. Repair or replace damaged geotextile at no expense to the owner.
- E. Repair damaged geotextile by placing a geotextile patch, extending 3 feet in all directions beyond the damaged area.
- F. Place free-draining bedding aggregate on the geotextile.
1. Prevent damage to the geotextile.
- G. Place drainage aggregate immediately after placing the geotextile.
- H. Maintain 3 inches minimum bedding aggregate thickness.
1. Finish the surface of the drainage aggregate free of mounds.

3.3 PLACEMENT OF RIPRAP ELEMENTS

- A. Install the riprap in place of the specified depth.
1. Distribute larger stones uniformly.
 2. Do not group stones as a substitute for larger stone.
 3. Arrange individual stones as necessary by use of equipment or grapple device or hand in order to maintain the specified gradation and interlock.

- B. Provide adequate access when placing stones in the grout to lower portions of the stone to prevent voids from forming.
 - 1. Place stones to secure a stone mass with the minimum thickness and height indicated.
- C. Provide a riprap surface conforming to the lines and grades and adjacent channel surfaces as shown on the plans.
 - 1. Manipulate the stone if necessary to secure a regular surface of graded size and mass stability.
 - 2. Remove any stones projecting above the finished design grade more than 10 percent of the stone layer thickness.
 - 3. Make smooth transition without cutting or breaking stones.
- D. Do not crush the weep drains extending into the underlying granular drain material.
 - 1. Select drain pipe materials that are compatible with the chosen method of riprap placement.
- E. Place all stones in a dry condition beginning at the toe of the slope or other lowest point.
 - 1. Provide weep holes of 3 inch diameter pipe penetrating the bedding with an average spacing not to exceed 10 feet on center at the toes of slopes.
- F. Form all outer edges and the top of grouted riprap where construction terminates, so that the surface of the work is embedded and even with adjacent slope or ground.

3.4 RIPRAP GROUTING

- A. Do not place grout mix when the daily minimum temperature is less than 40 degrees F.
 - 1. Maintain at minimum temperature of 50 degrees F and not more than 90 degrees F during the placement and the curing periods.
- B. Do not place on frozen surfaces.
 - 1. Cover the grouted stone and heat within a range of 50 and 90 degrees F for a minimum of 24 hours prior to placing grouting materials when temperature is below 40 degrees F and dropping.
- C. Thoroughly wet riprap, bedrock, and foundation surfaces.
 - 1. Allow excess water to drain.
 - 2. Achieve a dry saturated surface condition.

- D. Use low pressure to inject grout into the voids between stones by pumping through a maximum 2-inch diameter hose.
 - 1. Stop the flow at any time.
- E. Deposit grout to fill all voids as stones are placed.
 - 1. Secure maximum compaction and density of the grout.
- F. Place the grout from bottom to top and use sufficient grout to fill all voids between the stones.
 - 1. Fill all voids with grout from the subgrade level through the stone layer.
 - 2. Grout must penetrate to subgrade.
 - 3. Use a “pencil” vibrator fill all voids between and under stones.
- G. Leave grout joints recessed below the surface of the adjacent stones.
 - 1. Leave the top surface of the stones fully exposed.
 - 2. Immediately remove all excess grout with a stiff brush augmented with a cleaning agent if needed.
- H. Do not use grout to cover the surface of the stone.
 - 1. Construct the grouted riprap having a rustic appearance.
 - 2. Match the workmanship of the sample panel.
- I. Do not clog the weep drainpipes or clog the filter drain materials.
- J. Do not re-temper grout mix by adding water in field.

3.5 CURING AND PROTECTION

- A. Keep exposed surfaces continuously moist for the seven-day curing period.
- B. Maintain moisture by sprinkling, fog spraying, or by covering with continuously moistened canvas, cloth mats, straw, sand or similar material.
 - 1. Protect the grout during the curing process without causing damage to the grout surface by erosion or other mechanisms during water or moist covering.

END OF SECTION