Construction Specification 62—Grouted Rock Riprap

1. Scope

The work consists of furnishing, transporting, and the installation of grouted rock riprap revetments and blankets, including filter or bedding where specified.

2. Material

Rock for riprap shall conform to the requirements of Material Specification 523, or, if so specified, shall be obtained from designated sources. It shall be free from dirt, clay, sand, rock fines, and other material not meeting the required gradation limits.

At least 30 days before rock is delivered from other than designated sources, the contractor shall designate, in writing, the source from which rock material will be obtained and provide information satisfactory to the engineer that the material meets contract requirements. The contractor shall provide the engineer free access to the source for the purpose of obtaining samples for testing. The size and grading of the rock shall be as specified in section 13 of this specification.

Rock from approved sources shall be excavated, selected, and processed to meet the specified quality and grading requirements at the time the rock is installed.

When specified in section 13 of this specification or when requested by the contracting officer, a gradation quality control check shall be made by the contractor and subject to inspection by the engineer. The test shall be performed at the work site in accordance to ASTM D 5519 Test Method B Size, Size-Range Grading, on a test pile of representative rock. The weight or size of the test pile shall be large enough to ensure a representative gradation of rock from the source and to provide test results within a 5 percent accuracy.

Based on a specific gravity of 2.65 (typical of limestone and dolomite), and assuming the individual rock is shaped midway between a sphere and a cube, typical size/weight relationships are:

Sieve size	Approx. weight of rock	Weight of test pile
16 inches	300 pounds	6,000 pounds
11 inches	100 pounds	2,000 pounds
6 inches	15 pounds	300 pounds

The results of the test shall be compared to the gradation required for the project. Test pile results that do not meet the construction specifications shall be cause for the rock to the rejected. The test pile that meets contract requirements shall be left on the job site as a sample for visual comparison. The test pile shall be used as part of the last rock riprap to be placed.

Filter or bedding aggregates, when required, shall conform to Material Specification 521, Aggregates for Drainfill and Filters, unless otherwise specified.

Portland cement shall conform to the requirements of Material Specification 531 for the specified type.

Pozzolan conforming to Specification ASTM C 618, Class C or F, in amounts not to exceed 25 percent based on absolute volume, may be substituted for an equivalent amount of portland cement in the grout mixture unless otherwise specified in section 13 of this specification.

Aggregates shall conform to the requirements of Material Specification 522, Aggregates for Portland Cement Concrete, except that the grading for coarse aggregate shall be as specified in section 13 of this specification.

Water shall be clean and free from injurious amounts of oils, acid, alkali, organic matter, or other deleterious substances.

Air-entraining admixtures shall conform to the requirements of Material Specification 533, Chemical Admixtures for Concrete.

Curing compound shall conform to the requirements of Material Specification 534, Concrete Curing Compound.

Other admixtures, when required, shall be as specified in section 13 of this specification.

Geotextiles shall conform to the requirements of Material Specification 592.

3. Subgrade preparation

The subgrade surface on which the grouted rock riprap, filter, bedding, or geotextile is to be placed shall be cut or filled and graded to the lines and grades shown on the drawings. When fill to subgrade lines is required, it shall consist of approved material and shall conform to the requirements of the specified class of earthfill.

Rock riprap, filter, bedding, or geotextile shall not be placed until the foundation preparation is completed and the subgrade surface has been inspected and approved.

4. Placement of rock riprap

***Method 1 Equipment-placed rock*—**The rock riprap shall be placed by equipment on the surface and to the depth specified. It shall be installed to the full section thickness in one operation and in such a manner as to avoid serious displacement of the underlying material. The rock for riprap shall be delivered and placed in a manner that ensures that the riprap in place shall be reasonably homogeneous with the larger rocks uniformly distributed and firmly in contact one to another with the smaller rocks and spalls filling the voids between the larger rocks. Some hand placing may be required to provide a neat and uniform surface.

Rock riprap shall be placed in a manner to prevent damage to structures. Hand placing is required as necessary to prevent damage to any new and existing structures.

***Method 2 Hand-placed rock*—**The rock riprap shall be placed by hand on the surface and to the depth specified. It shall be securely bedded with the larger rocks firmly in contact one to another without bridging. Spaces between the larger rocks shall be filled with smaller rocks and spalls. Smaller rocks shall not be grouped as a substitute for larger rock. Flat slab rock shall be laid on its vertical edge except where it is installed like paving stone and the thickness of the rock equals the specified depth of the riprap section.

5. Filter or bedding

When the contract specifies filter, bedding, or geotextile beneath the rock riprap, the designated material shall be placed on the prepared subgrade surface as specified. Compaction of filter or bedding aggregate

is not required, but the surface of such material shall be finished reasonably smooth and free of mounds, dips, or windrows.

6. Design of the grout mix

The mix proportions for the grout mix shall be as specified in the construction details in section 13 of this specification. During installation, the engineer may require adjustment of the mix proportions whenever necessary. The mix shall not be altered without the approval of the engineer.

7. Handling and measurement of grout material

Material shall be stockpiled and batched by methods that prevent segregation or contamination of aggregates and ensure accurate proportioning of the mix ingredients.

Except as otherwise provided in section 13 of this specification, cement and aggregates shall be measured as follows:

- Cement shall be measured by weight or in bags of 94 pounds each. When cement is measured in bags, no fraction of a bag shall be used unless weighed.
- Aggregates shall be measured by weight. Mix proportions shall be based on the batch weight of each aggregate saturated, surface-dry weight plus the weight of surface moisture it contains at the time of batching.
- Water shall be measured, by volume or by weight, to an accuracy within 1 percent of the total quantity of water required for the batch.
- Admixtures shall be measured within a limit of accuracy of plus or minus 3 percent.

8. Mixers and mixing

The mixer, when operating at capacity, shall be capable of combining the ingredients of the grout mix into a thoroughly mixed and uniform mass and of discharging the mix with a satisfactory degree of uniformity.

The mixer shall be operated within the limits of the manufacturer's guaranteed capacity and speed of rotation.

The time of mixing after all cement and aggregates have been combined in the mixer shall be a minimum of 1 minute for mixers having a capacity of 1 cubic yard or less. For larger capacity mixers, the minimum time shall be increased 15 seconds for each cubic yard or fraction thereof of additional capacity. The batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates, with the balance of the mixing water introduced into the mixer before a fourth of the total minimum mixing time has elapsed.

When ready-mix grout is furnished, the contractor shall furnish to the engineer at the time of delivery a ticket showing the time of loading and the quantities of material used for each load of grout mix delivered.

No mixing water in excess of the amount required by the approved job mix shall be added to the grout mix during mixing or hauling or after arrival at the delivery point.

9. Conveying and placing

The grout mix shall be delivered to the site and placed within 1.5 hours after the introduction of the cement to the aggregates. In hot weather or under conditions contributing to accelerated stiffening of the concrete, the time between the introduction of the cement to the aggregates and complete discharge of the grout batch shall be a maximum of 45 minutes. The engineer may allow a longer time provided the setting time of the grout is increased a corresponding amount by the addition of an approved set-

retarding admixture. In any case concrete shall be conveyed from the mixer to the final placement as rapidly as practicable by methods that prevent segregation of the aggregates, loss of mortar, displacement of the rock riprap, or a combination of these.

Grout mix shall not be allowed to free fall more than 5 feet unless suitable equipment is used to prevent segregation.

The grout mix shall not be placed until the rock riprap has been inspected and approved by the engineer for the placement of grout.

Rock to be grouted shall be kept moist for a minimum of 2 hours before grouting.

The rock riprap shall be flushed with water before placing the grout to remove the fines from the rock surfaces. The rock shall be kept moist before the grouting and without placing in standing or flowing water. Grout placed on inverts or other nearly level areas may be placed in one operation. On slopes, the grout shall be placed in two nearly equal applications consisting of successive lateral strips about 10 feet in width starting at the toe of the slope and progressing upward. The grout shall be delivered to the place of final deposit by approved methods and discharged directly on the surface of the rock. A metal or wood splash plate is used to prevent displacement of the rock directly under the grout discharge. The flow of grout shall be directed with brooms, spades, or baffles to prevent grout from flowing excessively along the same path and to assure that all intermittent spaces are filled. Sufficient barring shall be conducted to loosen tight pockets of rock and otherwise aid in the penetration of grout to ensure the grout fully penetrates the total thickness of the rock blanket. All brooming on slopes shall be uphill. After the grout has stiffened, the entire surface shall be rebroomed to eliminate runs and to fill voids caused by sloughing. The surface finish, following the completion of grout installation, shall consist of one-third of the rock extended above the level of grout. The exposed rock will not have a plastered appearance.

After completion of any strip or panel, no individual(s) or equipment shall be permitted on the grouted surface for 24 hours. The grouted surface shall be protected from injurious action by the sun, rain, flowing water, mechanical injury, or other potential damaging activity.

10. Curing and protection

The completed finished surface shall be prevented from drying for a minimum curing period of 7 days following placement. Exposed surfaces shall be maintained in a moist condition continuously for the 7-day curing period or until curing compound has been applied as specified in this section. Moisture shall be maintained by sprinkling, flooding, or fog spraying or by covering with continuously moistened canvas, cloth mats, straw, sand, or other approved material. Water or moist covering shall be used to protect the grout during the curing process without causing damage to the grout surface by erosion or other mechanisms that may cause physical damage.

The grouted rock may be coated with an approved curing compound as an alternative method to maintaining a continuous moisture condition during the curing period. The compound shall be sprayed on the moist grout surface as soon as free water has disappeared and all surface finishing has been completed. The compound shall be applied at a minimum uniform rate of 1 gallon per 175 square feet of surface and shall form a continuous adherent membrane over the entire surface. Curing compound shall not be applied to surfaces requiring bond to subsequently placed grout and/or concrete. If the membrane is damaged during the curing period, the damaged area shall be resprayed at the rate of application specified for the original treatment.

Grout mix shall not be placed when the daily minimum temperature is less than 40 degrees Fahrenheit unless facilities are provided to ensure that the temperature of the material is maintained at a minimum temperature of 50 degrees Fahrenheit and not more than 90 degrees Fahrenheit during placement and

the curing period. Grout mix shall not be placed on a frozen surface. When freezing conditions prevail, rock to be grouted must be covered and heated to within a range of 50 to 90 degrees Fahrenheit for a minimum of 24 hours before placing grouting material.

11. Inspecting and testing fresh grout

The grout material shall be checked and tested throughout the grouting operation. Sampling of fresh grout shall be conducted in conformance with ASTM C 172. The volume of each batch will be determined by methods prescribed in ASTM C 138.

The engineer shall have free access to all parts of the contractor's plant and equipment used for mixing and placing grout during the period of the contract. Proper facilities shall be provided for the engineer to sample material and view processes implemented in the mixing and placing of grout as well as for securing grout test samples. All tests and inspections shall be conducted so that only a minimum of interference to the contractor's operation occurs.

For ready-mixed grout, the contractor shall furnish to the engineer a statement-of-delivery ticket for each batch delivered to the site. The ticket shall provide as a minimum: weight in pounds of cement, aggregates (fine and coarse), water; weight in ounces of air-entraining agent; time of loading; and the revolution counter reading at the time batching was started.

12. Measurement and payment

Method 1—For items of work for which specific unit prices are established in the contract, the volume of grouted rock riprap, including filter layers or bedding, is determined to the nearest cubic yard from the specified thickness shown on the drawings and the area on which acceptable placement has been installed. Payment for grouted rock riprap is made at the contract unit price. Such payment is considered full compensation for all labor, material, equipment, and all other items necessary and incidental to the completion of the grouted rock riprap, filter layers and bedding, and geotextile material.

Method 2—For items of work for which specific unit prices are established in the contract, the volume of riprap and the volume of filter layers or bedding is determined to the nearest cubic yard from the specified thickness shown on the drawings and the area in which acceptable placement has been installed. The volume of grout is determined from the calculated batch volume and the number of mixed batches delivered to the site and placed in accordance with the specification. The area of geotextile is determined to the nearest square yard from measurements of geotextile material installed according to the contract requirements. Payment is made at the contract unit price for each type of rock riprap, filter or bedding, concrete grout, and geotextile. Such payment is considered full compensation for all labor, material, equipment, and all other items necessary and incidental to the completion of the work.

Method 3—For items of work for which specific unit prices are established in the contract, the quantity of each type of rock riprap placed within the specified limits is computed to the nearest 0.1 ton by actual weight. The quantity of each type of filter or bedding aggregate delivered and placed within the specified limits is computed to the nearest 0.1 ton. For each load of rock riprap placed as specified, the contractor shall furnish to the engineer a statement-of-delivery ticket showing the weight to the nearest 0.1 ton. For each load of filter or bedding aggregate, the contractor shall furnish to the engineer a statement-of-delivery ticket showing the weight to the nearest 0.1 ton. The volume of grout is determined from the calculated batch volume and the number of mixed batches delivered to the site and placed in accordance with the specifications and drawings. The area of geotextile is determined to the nearest square yard from measurements of geotextile material installed according to the contract requirements. Payment is made at the contract unit price for each type of rock riprap, filter or bedding, concrete grout, and geotextile. Such payment is considered full compensation for all labor, material, equipment, and all other items necessary and incidental to the completion of the work.

***All methods*—**The following provision applies to all methods of measurement and payment. Compensation for any item of work described in the contract, but not listed in the bid schedule is included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in section 13 of this specification.

13. Items of work and construction details