



SECTION 31 37 19

GROUTED BOULDERS, STACKED GROUTED BOULDERS, AND GROUTED BOULDER RETAINING WALLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This WORK shall consist of subgrade preparation, installing grouted boulders, stacked grouted boulders, and grouted rock retaining walls constructed at the location (s) shown on the DRAWINGS.

1.02 RELATED SECTIONS

- A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 01 57 19, Temporary Environmental Controls
2. Section 03 31 00, Structural Concrete
3. Section 03 60 00, Grouting
4. Section 31 23 00, Excavation and Fill.
5. Section 31 23 19, Dewatering.
6. Section 31 23 33, Trenching and Backfilling.
7. Section 31 25 00, Erosion and Sedimentation Controls
8. Section 31 37 00, Riprap, Boulders, and Bedding

1.03 REFERENCES

- A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. T85, Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate.
 - b. T103, Standard Method of Test for Soundness of Aggregates by Freezing and Thawing.
 - c. T104, Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
2. ASTM International (ASTM):
 - a. C39, Standard Test Method for Compressive Cylindrical Concrete Specimens.



- b. C150, Standard Specification for Portland Cement.
- c. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft³ (600 kN-m/m³)).

1.04 DEFINITIONS

- A. Terms "boulders" and "rock" may be used interchangeably in this section.

1.05 SUBMITTALS

- A. CONTRACTOR shall submit a mix design in writing to ENGINEER for approval prior to placement of any grout.
- B. CONTRACTOR shall cooperate with ENGINEER in obtaining and providing samples of all specified materials.
- C. CONTRACTOR shall submit certified laboratory test certificates for all items required in this section.

1.06 QUALITY ASSURANCE

- A. Mock-up:
 - 1. Prior to the construction of any grouted rock walls, CONTRACTOR or SUBCONTRACTOR who is constructing the walls for CONTRACTOR shall show ENGINEER an example of similar rock walls that they had constructed previously.
 - 2. After acceptance of this previous WORK, CONTRACTOR or SUBCONTRACTOR shall construct approximately one hundred (100) square feet of grouted rock wall as shown on the DRAWINGS for approval by ENGINEER.
 - 3. If the construction is approved, CONTRACTOR or SUBCONTRACTOR shall construct the rest of the grouted rock wall. If the construction is not approved, CONTRACTOR shall make any changes required by OWNER and ENGINEER to obtain approval, and construct the remainder of the wall as approved.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Boulders
 - 1. Boulders shall meet the requirements of Section 31 37 00 Riprap, Boulders, Soil Riprap and Bedding
 - 2. Rhyolite rock shall not be used for any DISTRICT work.
 - 3. Gradation:



- a. Each load of boulders shall conform to the dimensions specified on the DRAWINGS and in Section 31 37 00 Riprap, Boulders, and Bedding
 - b. Boulders for a boulder edge shall have a maximum ratio of largest to smallest rock dimension shall be 1.5 or as shown on the DRAWINGS. Grouted walls shall be constructed of rock size specified on DRAWINGS.
 - c. Control of gradation will be by visual inspection.
 - 1) In the event ENGINEER determines the boulders to be unacceptable, ENGINEER will pick two random truckloads to be dumped and checked for gradation.
 - 2) Mechanical equipment and labor needed to assist in checking gradation shall be provided by CONTRACTOR at no additional cost to OWNER.
4. Color:
- a. The color of boulders shall meet the requirements of Section 31 37 00, Riprap, Boulders, and Bedding.
- B. Grout:
1. Concrete for the grout shall be an approved batch meeting the following requirements:
 - a. All grout shall have a minimum 28-day compressive strength equal to 3,200 psi.
 - b. One cubic yard of grout shall contain a minimum of six (6) sacks of Type II Portland cement.
 - c. A maximum of 25% Type F Fly Ash may be substituted for the Portland cement.
 - d. Aggregate for the grout shall consist of 70% natural sand (fines) and 30% 3/8-inch rock (coarse).
 - e. Slump shall be four (4) inches to six (6) inches.
 - f. Air entrainment shall be 5.5% - 7.5%.
 - g. Grout shall contain one and one-half (1-1/2) pounds of Fibermesh, or approved equivalent, per cubic yard of grout.
 - h. Color Additive in required amounts shall be used when so specified by contract.



PART 3 EXECUTION

3.01 GROUTED BOULDERS AND STACKED GROUTED BOULDERS

- A. Grouted boulders shall be placed at the locations as shown on the DRAWINGS and installed with the following requirements:
1. Subgrade:
 - a. The subgrade to receive each boulder shall be excavated and any unstable material shall be removed and replaced to achieve a stable subgrade.
 - b. Grouted Boulders shall be placed on subgrade without granular bedding or riprap unless approved by ENGINEER. Boulders shall not be perched on any material in order to meet design grade; appropriate boulder dimension is required.
 - c. Material approved by ENGINEER shall be placed and compacted in a minimum of six-inch (6") compacted lifts to ninety five percent (95%) of Maximum Standard Proctor Density (ASTM D698) and tested every foot to re-establish the subgrade of each boulder.
 - d. Unstable material shall be removed from the PROJECT site and disposed of by CONTRACTOR. Removal and replacement of unstable material shall only be completed at the direction of ENGINEER and shall be paid for under Muck Excavation. Failure to provide adequate water control measures shall not be cause for CONTRACTOR to apply Muck Excavation.
 - e. Subgrade shall be excavated a minimum of 6" to a maximum of 12" behind boulders.
 - f. Backfill behind boulders shall be compacted to ENGINEER's satisfaction. Care shall be taken during compaction to avoid disturbing and/or damaging the integrity of the boulder channel edge.
 - g. Finished grades and subgrade for boulders shall be determined from the height of each boulder used.
 2. Boulders
 - a. The top of all boulders shall be as indicated on the DRAWINGS.
 - b. The boulders shall be carefully picked and arranged so that adjacent rock surfaces match within two (2) inches in top elevation and two (2) inches along the vertical exposed face or channel side of rock.
 - c. Boulders shall be placed such that adjacent boulders are one and one-half (1-1/2) to three and one-half (3-1/2) inches away and voids do not exceed four (4) inches to allow grout to penetrate and lock boulders in. It is the intent of construction to minimize voids and grout placed between boulders.



- d. CONTRACTOR shall, if deemed necessary, support the boulders from falling over before and during the placement of grout, backfill, and completing compaction WORK on either side of the boulder.
 - e. Smaller rocks shall be “chinked in” to fill all voids behind the boulders. Smaller rocks shall also be used to "chink in gaps larger than four (4) inches. Placement shall be approved by ENGINEER prior to grouting.
 - f. Subsequent lifts of boulders should be battered no more than four (4) to six (6) inches back from the lower boulder level face.
 - g. Boulders shall be installed a minimum of twelve (12) inches below the final channel invert elevation, unless specified differently.
 - h. Subsequent lifts of boulders may not be perched on riprap or chinking rock, however, one or two smaller pieces of riprap may be used to help level the edge of a boulder so that the top surface is relatively flat.
3. Grouting:
- a. Prior to placing the grout, any type of debris, fines, smaller rock, or silt shall be removed from around or under and on the boulders.
 - b. Dewatering shall be implemented to guarantee that the grout will not be placed in water and for a period of twenty-four (24) hours after the grout has been placed.
 - c. Keep grout contact surfaces on boulders wet at all times prior to receiving grout.
 - d. The concrete grout shall be placed by injection methods by pumping under low pressure, to ensure complete penetration of the grout into the void area as detailed on the DRAWINGS. The grout mix shall be stiffened and other measures taken to retain the grout between the boulders. A vibrator shall not be used to “move” grout horizontally.
 - e. Grout placement shall begin at the bottom of the lowest boulder and proceed upward to ensure no air voids exist between the grout, subbase, and boulders.
 - f. Grout shall be placed up to a height of two-thirds (2/3) of the diameter of the top row of boulders or as directed by ENGINEER and shall be placed in the voids and behind the boulders and not on the surface of the rocks.
 - g. A “pencil” vibrator shall be used to make sure all voids are filled between the boulders from the subgrade and around the boulders to a depth as shown on the DRAWINGS. CONTRACTOR shall use a wood float or brush, when approved by ENGINEER, to smooth and grade the grout around the boulders.



- h. Grout between boulders shall be recessed one third (1/3) the diameter of the boulders on the side facing the channel.
 - i. Grout should be raked out and finished to minimize visibility.
 - j. Clean and wash any spillage before the grout sets so the visual surfaces of boulders will be free of grout to provide a clean, natural appearance, or if washing does not clean off grout residue, CONTRACTOR shall wash off any grout residue with a wire brush or muriatic acid and water, using a brush to scrub off the residue.
 - k. Grout shall receive cold or hot weather protection in accordance with Section 03 31 00, Structural Concrete.
4. Cold Joints:
- a. No cold joints shall be allowed in the basin area.
 - b. A piece of #4 rebar, three feet (3') long, shall be installed between each boulder embedded 18" into the initial pour.
 - c. The cold joint shall have a roughened edge and be cleaned of all dirt and debris to allow the pours to bond.
 - d. All cold joints on cutoff walls must have a keyway formed in the top of the initial pour that shall be two inches (2") deep and four inches (4") wide and shall have #4 rebar placed every two feet (2') horizontally, which extends a minimum of 12 inches from the initial pour height.
 - e. CONTRACTOR shall leave the cold joint in a non-linear, jigsaw manner.

3.02 GROUTED BOULDER RETAINING WALLS

- A. Grouted boulder retaining walls shall be placed at locations as shown on the DRAWINGS and installed with the following requirements:
 - 1. The grouted boulder walls shall be constructed to the dimensions shown on the DRAWINGS and shall be constructed with a one (1) horizontal to four (4) vertical batter on the front and back face, with a minimum width of one (1) foot at the top of the wall.
 - 2. The stone of the wall shall be laid to form substantial masonry presenting a neat, finished appearance.
 - 3. Headers shall hold the heart of the wall to the face and shall occupy at least twenty percent (20%) of the area and they shall be evenly distributed.
 - 4. The length of stretchers shall not exceed three (3) times their rise.
 - 5. Spalls and pinnars shall be used in the backing only where necessary and will not be allowed in the face.



6. Face Stones:

- a. Face stones shall be laid to break joints so that each rock laid rests on two beneath it.
- b. Rock shall be hand graded so that only the larger stones are used in the face.
- c. All face stones shall be pitched to a string line on straight walls or laid to batter stakes for curved walls such that the batter is consistent with respect to all parts of the wall and shall meet the minimum requirements set forth in the detail.
- d. The degree of roughness on the exposed face shall be measured with a six-foot (6') straightedge supported between adjacent projections and stone face.
- e. Variations in excess of three (3) inches, measured from the straight edge to the extreme depression in the stone, will not be permitted.
- f. Rear faces shall present approximately plane surfaces and shall in general conform to the detail.

7. Grouting:

- a. Prior to placing the grout, any type of debris, fines, smaller rock, or silt shall be removed from around or under and on the boulders.
- b. Dewatering shall be implemented to guarantee that the grout will not be placed in water and the area will remain dewatered for a period of twenty-four (24) hours after the grout has been placed.
- c. The grout contact surfaces on boulders shall be wet at all times prior to receiving grout.
- d. Grout shall be placed to fill all voids between, under, and throughout the boulder walls and shall be recessed approximately one-third (1/3) the diameter of the boulders from the face of the wall in order to give a "dry stacked" appearance. This may require a gloved finish to accomplish.
- e. A "pencil" vibrator shall be used to make sure all voids are filled between the boulders from the subgrade and around the boulders to a depth as shown on the DRAWINGS. CONTRACTOR shall use a wood float or brush, when approved by ENGINEER, to smooth and grade the grout around the boulders.
- f. Any "loose" rocks shall be regouted by machine or hand methods.
- g. Clean and wash any spillage before the grout sets on the outside face and top of walls such that the visual surfaces of the rocks are free of grout to provide a clean natural appearance, or, if washing does not clean off grout residue, then CONTRACTOR shall wash off any



grout residue with muriatic acid and water, using a brush to scrub off the residue.

- h. Grout shall receive cold or hot weather protection in accordance with Section 03 31 00, Structural Concrete.

8. Cold Joints:

- a. A piece of #4 rebar, three (3) feet long, shall be installed between each boulder embedded 18" into the initial pour.
- b. For top row, cut bar length to provide three (3) inches of grout cover over bar.
- c. The cold joint shall have a roughened edge and be cleaned of all dirt and debris to allow the pours to bond.

END OF SECTION



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