

**SECTION 31 35 00**  
**SLOPE PROTECTION**

**PART 1 – GENERAL**

**1.01 SECTION INCLUDES**

- A. Slope paving
- B. Channel paving
- C. Crib walls
- D. Riprap
- E. Hydroseeding

**1.02 MEASUREMENT AND PAYMENT**

- A. General: Measurement and payment for slope protection will be either by the lump-sum method or by the unit-price method as determined by the listing of the bid item for slope protection indicated in the Bid Schedule of the Bid Form.
- B. Lump Sum: If the Bid Schedule indicates a lump sum for slope protection, the lump-sum method of measurement and payment will be in accordance with Section 01 20 00, Price and Payment Procedures, Article 1.03.
- C. Unit Price: If the Bid Schedule indicates a unit price for slope protection, the unit-price method of measurement and payment will be as follows:
  - 1. Measurement:
    - a. Concrete block, concrete paving, shotcrete, stone paving, and rock blanket type slope protection will be measured for payment by the square yard, including bedding material, concrete, mortar, and grout, complete in place.
    - b. Aggregate sub base or base for slope protection will be measured for payment as specified in Section 32 11 17, Aggregate Sub Base Courses, or Section 32 11 23, Aggregate Base Courses.
    - c. Earthwork necessary for construction of slope protection will be measured for payment as specified in Section 31 00 00, Earthwork.
    - d. Crib-wall components will be measured for payment by the pound or by the ton, as appropriate, including wall construction complete in place.
    - e. Riprap will be measured for payment by the ton, including filter aggregate, filter fabric, and placement of stones.
    - f. Hydroseeding will be measured for payment by the square yard complete in place, including any required replacement or reseeding.

2. Payment: Slope protection will be paid for at the indicated Contract unit prices for the computed quantities as determined by the measurement method specified in Article 1.02.C.1.

### 1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM):
  1. ASTM C33/C33M Standard Specification for Concrete Aggregates
  2. ASTM C91/C91M Standard Specification for Masonry Cement
  3. ASTM C144/C144M Standard Specification for Aggregate for Masonry Mortar
  4. ASTM C90 Standard Specification for Loadbearing Concrete Masonry Units
  5. ASTM C150/C150M Standard Specification for Portland Cement
  6. ASTM C270 Standard Specification for Mortar for Unit Masonry
  7. ASTM C568/C568M Standard Specification for Limestone Dimension Stone
  8. ASTM C615/C615M Standard Specification for Granite Dimension Stone
  9. ASTM C915 Standard Specification for Precast Reinforced Concrete Crib Wall Members
- B. State of California, Department of Transportation (Caltrans), Standard Specifications:
  1. Section 21 Erosion Control
  2. Section 53 Shotcrete
  3. Section 96 Geosynthetics

### 1.04 SLOPE PROTECTION CLASSIFICATION

- A. Block Paving: Precast concrete block units with mortar-filled or grouted joints.
- B. Concrete Paving: Monolithic concrete paving.
- C. Crib Wall: Earth-retaining structure constructed of interlocking, reinforced precast concrete crib-wall members; may be "open-faced" or "closed-face" type structure.
- D. Hydroseeding: Slurry mixture of seed, wood fiber, fungicide, fertilizer, and water, applied to ground areas under pressure with hydraulic hydro-seeder equipment.
- E. Riprap: Hard, durable, angular stone or rock placed to produce a well-graded mass of stone not less than 2-feet thick.

- F. Shotcrete (Air-Blown Mortar): Mixed fine aggregate and portland cement pneumatically applied.
- G. Stone Paving: Quarry stone laid in uniform courses with broken joints filled with mortar or grout.
- H. Rock Blanket: Cobblestone laid in irregular courses set in concrete.

**1.05 SITE CONDITIONS**

- A. Do not grout slope or channel paving or place concrete slope paving when the temperature falls below 50 degrees Fahrenheit. During cold weather, provide protective coverings for the work.
- B. Should any work be exposed to temperature of 40 degrees Fahrenheit or below, within 4 days after grouting or concrete placement, cover the work with a 1-foot thick layer of straw, hay, or mulch; then cover with a weighted cover of canvas or plastic sheet.

**PART 2 – PRODUCTS**

**2.01 MATERIALS FOR PAVING**

- A. Concrete Block Pavers: Precast concrete block units conforming to ASTM C90, 4 inches by 12 inches by 16 inches in size unless otherwise indicated.
- B. Stone Pavers: Quarry stone of granite, limestone, or other similar durable stone; rectangular exposed surface with split or quarry face finish; uniform in color; 12 to 28 inches long, 10 to 14 inches wide, 4 to 6 inches thick, conforming with ASTM C568/C568M or ASTM C615/C615M as applicable.
- C. Cobblestone: Cobblestone of granite, basalt, or other similar durable stone; exposed surface with smooth finish; uniform in color; 3 to 8 inches long, 5 to 12 inches wide, 2 to 4 inches thick.
- D. Bedding Material: Clean and graded sand passing a No. 4 U.S. Standard sieve, conforming generally to ASTM C33/C33M, or masonry sand conforming to ASTM C144.
- E. Mortar and Grout: Mortar or grout for filling of joints or voids between block and stone pavers shall be ASTM C270, Type M mortar using ASTM C91/C91M, Type M masonry cement or ASTM C150/C150M, Type I or II portland cement, and ASTM C144 aggregate. Adding of lime will not be permitted. Minimum strength at 28 days: 2,500 psi.
- F. Concrete: Refer to Section 03 30 00, Cast-In-Place Concrete, Section 03 05 15, Portland Cement Concrete, and Section 03 35 00, Concrete Finishing, for requirements. Provide minimum Class 3000 concrete.

- G. Shotcrete: Refer to Section 03 37 13, Shotcrete, and Caltrans Standard Specifications, Section 53, for requirements.

**2.02 CRIB WALLS**

- A. Provide crib-wall units as indicated conforming to ASTM C915.

**2.03 RIPRAP**

- A. Stone: Hard, durable, and angular in shape; resistant to weathering; and free from overburden, spoil, shale, and organic materials. Neither breadth nor thickness of a stone shall be less than one-third its length. Select stones insofar as practicable for size and shape, in order to secure large, flat-surfaced stones that produce a relatively true and even surface with a minimum of voids.

- B. Gradation: Conform to the following approximate limits:

- 1. Percent of Total Weight:

<b>Size of Stone</b>	<b>Percentage Limits</b>
400 pounds or heavier	50 - 100
300 pounds	50 - 80
200 pounds	20 - 50
25 pounds	10 - 30

- 2. Maximum amount passing a 2-inch sieve: five percent.

- C. Drainage and Filter Aggregates: Refer to Section 33 46 00, Sub drainage, for requirements.
- D. Filter Fabric: Conform to requirements of Caltrans Standard Specifications, Section 96, for Geosynthetics.

**2.04 HYDROSEEDING MATERIALS AND EQUIPMENT**

- A. Mulch:
  - 1. Composition: Green-colored, fibrous, 100 percent virgin wood fiber mulch containing no growth or germination-inhibiting factors.
  - 2. Dispersion in Slurry: Mulch shall be manufactured in such manner that, after addition to and agitation in slurry tanks with fertilizer, seed, water, and other approved additives, fibers in the material will become uniformly suspended to form a homogeneous slurry.

SLOPE PROTECTION

3. Absorption Capacity: When hydraulically sprayed on the ground, mulch shall form a blotter-like ground cover impregnated uniformly with seed which will allow the absorption of moisture and rainfall to percolate to the underlying soil.
  4. Weight: Weight specifications of this material from suppliers, and for all applications, refers to air-dry weight of the fiber material. Absolute air dry weight is based on standards of the Technical Association of the Pulp and Paper Industry for wood cellulose and is considered equivalent to 10 percent moisture.
  5. Labeling: Each package of cellulose fiber shall be marked by the manufacturer to show the air-dry weight content.
- B. Seed: California native grasses and forbes mix as commercially available, mixed in the following proportions:
- Festuca rubra/Molate Red Fescue – 16.6 lbs per acre/0.038 lbs per 1,000 sf
- Agrostis pallens/Bentgrass – 16.6 lbs per acre/0.038 lbs per 1,000 sf
- Stipa pulchra/Purple Needle Grass – 16.6 lbs per acre/0.038 lbs per 1,000 sf
- Eschscholzia californica/California poppy – 0.50 lbs per acre/0.0012 lbs per 1,000 sf
- Lupinus nanus/Sky Lupine – 0.50 lbs per acre/0.0012 lbs per 1,000 sf
- C. Fertilizer: A complete fertilizer composed of natural organic material or derivatives, containing 16 percent nitrogen, 6 percent phosphoric acid, and 8 percent potash.
- D. Water: Potable water. Furnish and transport as required.
- E. Hydroseeding Slurry Mix: Mixture shall be composed of the following proportions for each 1,000 square feet of coverage:
1. Mulch                      28 pounds
  2. Seed                        10 pounds
  3. Fertilizer                11 pounds
  4. Water                      40-60 gallons
- F. Hydroseeding Equipment:
1. Mixer: Commercial type hydro-seeder for application of slurry. Equipment shall have a built-in agitation system with an operating capacity sufficient to agitate, suspend, and homogeneously mix the slurry.
  2. Distribution Lines: Large enough to prevent stoppage and to provide even distribution of slurry over the ground.
  3. Pump Capacity: 150 psi at the nozzle.

4. Slurry Tank: Minimum capacity of 1,000 gallons, mounted on a traveling unit with the slurry tank and spray nozzles in proximity close enough to the areas to be seeded to provide uniform distribution without waste.

## **PART 3 – EXECUTION**

### **3.01 SLOPE PAVING**

- A. Aggregate Base: Place concrete blocks, stone, or concrete over an approved compacted aggregate subbase or base in accordance with applicable requirements of Section 32 11 17, Aggregate Subbase Courses, or Section 32 11 23, Aggregate Base Courses.
- B. Block Paving: Lay block pavers in minimum 2-inch thick sand bedding material, in uniform courses with joints not exceeding one inch in width. Securely bed pavers and then fill joints with mortar or grout to the top of the paved surface. Minimum thickness or depth of mortar joints: 2 inches. Cover completed paving and keep wet for a minimum period of 5 days.
- C. Stone Paving: Comply with requirements specified above for block paving, except that stone paving shall have broken joints not exceeding two inches in width. Where necessary, chink interstices with smaller stones. Fill joints with mortar or grout to top of paved surface.
- D. Rock blanket: Excavate areas to receive rock blanket to the depth shown after clearing. Where rock blanket is to be placed adjacent to existing curbs, dikes, pavement, sidewalks or walls, excavate so that the finished rock blanket elevation adjacent to those items will maintain the planned flow lines, slope gradients, and contours of the job site. After excavation, grade subgrade to receive rock blanket to a smooth, uniform surface, and compact to not less than 90 percent relative compaction. Place concrete to a minimum thickness of 4 inches. Rock must be placed while concrete is still plastic. Space rocks a maximum of 1/2 inch apart. Rocks must have a 1-inch maximum separation between the top of adjacent rock surfaces. Remove concrete adhering to the exposed surfaces of the rock by approved methods. Loose rocks, or rocks with a gap greater than 3/8 inch, must be reset by methods accepted by the Engineer. The rock gap is measured from the edge of the rock to the surrounding concrete bedding. Place mortar as directed by Engineer.
- E. Concrete Paving: Comply with applicable requirements of Section 03 30 00, Cast-In-Place Concrete, and Section 03 35 00, Concrete Finishing. Provide minimum 4-inch thick concrete. Provide coarse "broom finish" and curing as specified in Section 03 35 00, Concrete Finishing.
- F. Shotcrete: Comply with applicable requirements of Section 03 37 13, Shotcrete, and Caltrans Standard Specifications, Section 53.

**3.02 CHANNEL PAVING**

- A. Comply with requirements specified above for slope paving.

**3.03 CRIB WALLS**

- A. Provide crib-wall construction as indicated and in accordance with applicable requirements of ASTM C915. Crib-wall construction shall be “open-faced” or “closed-face” as indicated or appropriate for the soil conditions. Provide wall surface that is approximately parallel to, and within 6 inches of, the slope indicated.

**3.04 RIPRAP**

- A. Place filter aggregate and filter fabric on prepared slope or area in such a manner as to produce a well-graded surface, then place mass riprap stone with minimum practicable percentage of voids and a minimum thickness of 24 inches. Place stone to its full course thickness in one operation and in such a manner as to avoid displacing the underlying material. Placing of stone in layers or by dumping into chutes or by similar methods likely to cause segregation will not be permitted. Place and rearrange stones by hand or by mechanical equipment as necessary to produce a compact riprap protection in which all sizes of stones are placed in their proper proportions.
- B. Place riprap in conjunction with the construction of the embankment with only sufficient lag in construction of the riprap protection to allow for proper construction of the embankment and to prevent mixture of embankment and riprap material. Maintain elevation of riprap to within five feet of elevation of embankment during construction.

**3.05 HYDROSEEDING**

- A. Examination:
  1. Verify that areas to receive hydroseeding are clear of stones larger than one and one half inches in diameter, weeds, debris, and other extraneous materials.
  2. Verify that grades are within 1 inch, plus or minus, of the required finished grades.
  3. Verify that topsoil is in proper planting condition to receive and accept hydroseed slurry.
- B. Preparation: Apply water, as necessary, to bring soil to optimum moisture content for planting.
- C. Slurry Mixing:
  1. Perform slurry preparation at the site.

SLOPE PROTECTION

2. Add water to tank when engine is at half throttle. When water level has reached height of agitator shaft, establish proper circulation and add seed.
  3. Do not permit seed to remain more than 30 minutes in the slurry.
  4. Add fertilizer, followed by mulch. Mulch shall be added to the mixture after the seed, and when the tank is at least one-third filled with water.
  5. Open engine throttle to full speed when tank is half-filled with water. Add all mulch by the time tank is two-thirds to three-quarters full. Commence spraying immediately when tank is full.
- D. Application:
1. Apply slurry mix in a sweeping motion to form a uniform mat at the specified rate. Keep hydroseeding within designated areas and keep from contact with other plant materials.
  2. Slurry mixture that has not been applied within 4 hours of mixing shall be discarded. Promptly remove from the site.
- E. Reseeding: Reseed areas and parts of areas which fail to show a uniform stand of grass after 21 days, until all areas are covered with a satisfactory stand of grass.
- F. Cleanup and Protection:
1. Wash off slurry overspray from other plant materials, planting areas, and paved areas.
  2. Do not operate any equipment over hydroseeded areas.
- G. Establishment of Hydroseed:
1. The work includes a grass-establishment period of 30 calendar days, commencing immediately after completion and acceptance of the initial hydroseeding application.
  2. If, during the establishment period, areas are lacking in sufficient grass seeding to assure an adequate stand of grass, such areas shall be recultivated and reseeded within 24 hours after written notification from the Engineer.
  3. The establishment period, in this case, shall be continued until the work meets specified requirements.
  4. The establishment period shall include continuous operation of watering, weeding, mowing, fertilizing, spraying, insect and pest control, and any other normal operation required to assure proper growth.

**END OF SECTION 31 35 00**