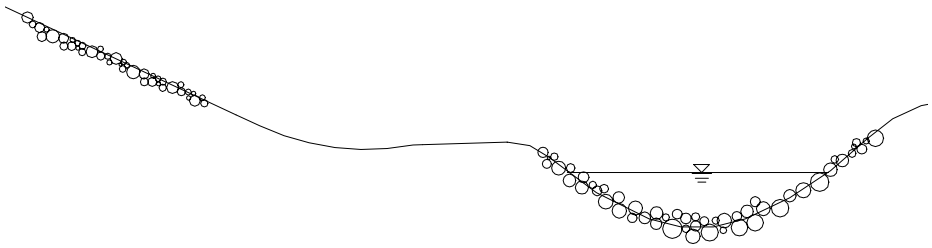
ACTIVITY: Rip-rap

TCP – 20



Targeted Constituents				
● Significant Benefit	◗ Partial Benefit	○ Low or Unknown Benefit		
● Sediment	○ Heavy Metals	○ Floatable Materials	○ Oxygen Demanding Substances	
○ Nutrients	○ Toxic Materials	○ Oil & Grease	○ Bacteria & Viruses	○ Construction Wastes

Implementation Requirements				
● High	◗ Medium	○ Low		
○ Capital Costs	○ O & M Costs	○ Maintenance	○ Suitability for Slopes >5%	○ Training

Description

Used to protect slopes, streambanks, channels, or other areas subjected to erosion.

This practice is only to be used after alternatives have been explored. These alternatives should include vegetation establishment, surface roughening, mulching, nets, mats, geotextiles, terracing, and earth retention structures or other "green", aesthetic or environmentally acceptable method. This management practice is likely to create a significant reduction in sediment by protecting against erosion.

Suitable Applications

- On streambanks or other areas subject to wave action.
- In channels where infiltration is desirable, but velocities are too excessive for vegetative or geotextile lining.
- Around outlets and/or inlets to prevent scour and undercutting.

Installation/ Application Criteria

- Clear the area of all brush, trees, stumps, debris, and trash ensuring that no reduction in the design waterway occurs while preparing the rip-rap subgrade.
- When used as slope protection, rip-rap should be keyed into the slope toe by at least the greater of 6 inches (15.2 cm) or one half the designed rip-rap diameter.
- Rip-rap should not be placed until final subgrade elevation has been verified by the licensed engineer overseeing design and/or construction.
- If a filter or sand/gravel filter on subgrade is required, placement should fall under the direction of approved site plans. Care shall be taken to place rip-rap in such a manner as to avoid displacing or tearing the filter.
- When subgrade filters are not required, the subgrade should be compacted as to prevent undercutting or slumping from occurring.

- Rip-rap should be of masonry stone that is sound, dense, and durable as described below.

Rubble-Stone Rip-rap (Plain)

Rubble-stone rip-rap should consist of at least 90% of the stone not less than 8 inches (20.3 cm) wide by 12 inches (30.5 cm) long by 12 inches (30.5 cm) deep and should be approximately rectangular in shape. Rubble-stone should be hand placed so that the stones are close together, are staggered at all joints as far as possible, and are placed so as to reduce the voids to a minimum. The main stone should be thoroughly "chinked" or anchored in place with 1-in. to 3-in. (2.5- to 7.6- cm) stones by throwing them over the surface in any manner that is practical for the smaller stones to fill the voids.

The standard depth should be 24 inches (61 cm). The average depth should not be less than the required depth and is determined from evaluation of a 25 square foot (2.3 m^2) surface area.

When rubble-stone rip-rap is constructed in layers, the layers should be thoroughly tied together with large stones protruding from one layer into the other.

Rubble-Stone Rip-rap (Grouted)

Stone placement for rubble-stone rip-rap (grouted) is the same as for rubble-stone rip-rap (plain). The grouting procedure is as follows:

When grouting is used, care should be taken to prevent earth or sand from filling the spaces between the stones before the grout is poured. Grout should be composed of one part portland cement and four parts of sand, measured by volume, and mixed thoroughly with sufficient water to a consistency that it will flow into and completely fill the voids.

Immediately before pouring the grout, the stones should be wetted by sprinkling. Beginning at the lower portion of the rip-rap, the grout should be carefully poured into the voids between the stone and at a slow enough rate to prevent oozing to the surface. The pouring of the grout should be accomplished by the use of vessels, chutes, tubes, or hoses of adequate size and shape. Broadcasting, slopping, or spilling of grout from the vessels on the surface of the rip-rap is not allowed.

As soon as any section of the grouted rip-rap has hardened sufficiently, it should be kept moist with water that is free from salt or alkali for a period of not less than 72 hours.

Sacked Sand-Cement Rip-rap

Sand for sacked sand-cement rip-rap may be manufactured or natural but should conform to state regulations. The same is true for Hydraulic cement. The sand and cement should be mixed dry, with a mechanical mixer, in the proportion of one bag (94 pounds (43.3 kg)) of cement to 5 cubic feet (0.14 m^3) of dry sand, until the mixture is uniform in color. The sand-cement mix should be poured into sacks of approximately 1 cubic foot (0.03 m) capacity until they are approximately ¾ full. Sacks should be of

either cotton or jute standard grade of cloth which will hold the sand-cement mixture without leakage during handling and tamping. The sacks should then be securely fastened with hog rings, by sewing, or by other suitable methods that prohibit leakage of the mixture from the bags.

The sacks of sand-cement should be bedded by hand on the prepared grade with all the fastened ends on the grade and with the joints broken. The completed rip-rap should have a minimum thickness of 10 inches (25.4 cm) with a tolerance of 3 inches (7.6 cm).

The sacks should be rammed and packed against each other in such a manner as to form close contact and secure a uniform surface. Immediately after tight placement, the sacks of sand-cement should be thoroughly soaked by sprinkling with water. Water should not be applied under high pressure. Sacks that are ripped or broken in placement should be removed and replaced before being soaked with water.

Machined Rip-rap

Machined rip-rap should be clean shot rock containing no sand, dust, or organic materials and should be the size designated for the class specified. The stone should be uniformly distributed throughout the size range.

Class A-1

Class A-1 rip-rap should vary in size from 2 inches (5.1 cm) to 1.25 feet (0.4 m) with no more than 20% by weight being less than 4 inches (10.2 cm). The thickness of the stone should be 1.5 feet (0.5 m) with a tolerance of 3 inches (7.6 cm). The material should be dumped and placed by the use of appropriate power equipment in a manner that will produce a surface uniform in appearance. Hand work may be required to correct irregularities.

Class A-2

Class A-2 rip-rap is the same as Class A-1 rip-rap except the depth may be decreased to a minimum of 1 foot when hand placed in accordance with the rubble-stone classification.

Class B

Class B rip-rap should vary in size from 3 inches (7.6 cm) to 2.25 feet (0.71 m) with no more than 20% by weight being less than 6 inches (15.2 cm). The thickness of the layer should be 3 feet (0.91 m) with a tolerance of 4 inches (10.2 cm). The material should be dumped and placed by the use of appropriate power equipment in a manner that will produce a surface uniform in appearance. Hand work may be required to correct irregularities.

Class C

Class C rip-rap should vary in size from 5 inches (12.7 cm) to 3 feet (0.94 m) with no more than 20% by weight being less than 9 inches (22.9 cm). The thickness of the layer should be 3.5 feet (1.1 m) with a tolerance of 6 inches (15.2 cm). The material

should be dumped and placed by the use of appropriate power equipment in a manner that will produce a surface uniform in appearance. Hand work may be required to correct irregularities.

Maintenance

- If properly constructed, rip-rap requires minimal maintenance.
- Check after major storm events for slumping, displacement, or scour around or under the rip-rap.
- Periodically check for brush growth and remove.

Limitations

- If the slope is too steep or rip-rap is too small, displacement may occur.
- If an improper type of filter cloth is used, scour may occur.
- Rip-rap may block channel resulting in erosion along the edge.
- Improperly graded rip-rap results in stone movement and erosion of foundation.

Primary References

Soil Erosion Prevention and Sediment Control – Reducing Nonpoint Source Water Pollution on Construction Sites, University of Tennessee, Knoxville, Department of Civil and Environmental Engineering, August 1998.

Caltrans Storm Water Quality Handbooks, CDM et.al. for the California Department of Transportation, 1997.