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### Section 72 Slope Protection

#### 4-7201 General

This section provides guidelines for inspecting slope protection for work specified under Section 72, “Slope Protection,” of the *Standard Specifications*. The following common types of slope protection are covered in this section:

- Rock slope protection
- Concreted-rock slope protection
- Small-rock slope protection
- Concrete slope protection
- Broken-concrete slope protection
- Slope paving
- Gabions

Other protective devices are used in conjunction with highway construction, and when used, they are included in the contract’s special provisions. The bid item list and plans will specify which type of slope protection is to be performed.

If extensive slope protection problems are anticipated or encountered during construction, refer these to the design engineer and the project manager, who may in turn obtain the advice of the “Caltrans Bank and Shore Protection Committee.”

Resident engineers should be familiar with the material contained Chapters 870, “Bank Protection—Erosion Control,” and 880, “Shore Protection,” of the *Highway Design Manual*.

#### 4-7202 Before Work Begins

Before construction of any type of slope protection, review the plans, *Standard Specifications*, special provisions, any pertinent preliminary test data, and the location of the installation. Note any changes that may have occurred between the preliminary design studies and the start of construction. Decide whether modifications are necessary as a result of changed conditions. In making such a decision, observe the following:

- High water elevations
- Direction of flow and angle of impingement at various water stages
- Capability of adjacent soil types to resist erosion from wash and eddy currents
- Type and security of trees or brush
- Any springs or water courses that might affect the stability of the design.

Take pictures to document existing conditions and verify that Form DOT CEM-3101, "Notice of Materials to Be Used," includes the materials for slope protection. Refer to Section 6-202, "Responsibilities for Acceptance of Manufactured or Fabricated Materials and Products," of this manual for additional information. Obtain initial samples and have them tested for the specified attributes.

#### **4-7203          During the Course of Work**

Take the following steps when inspecting the work and materials for slope protection:

- Obtain rock samples for acceptance tests. The samples will be crushed in the laboratory to sizes needed to perform tests. Testing must follow the frequencies shown in Section 6-1, "Sample Types and Frequencies," of this manual.
- Where applicable, inspect the footing areas and foundations for evidence of instability or areas where hydrostatic pressures may develop. Order corrective work when necessary. The plans indicate the minimum depths of foundations. When evidence exists that the foundation depth is inadequate, obtain both the design and hydraulics engineers' concurrence with a change order to deepen the foundation. Of the various types of instability problems, foundation failures are the most serious and most common.
- Check that slopes and foundation areas are graded and compacted to specified tolerances.
- When changes are made, maintain records of details, depths, heights, and other dimensions, and enter these on the as-built plans.
- Verify that rocks of the specified sizes and shapes are being used. You may check the size of rock by roughly measuring the size and converting the volume to mass. To better control the contractor's selection of rocks for placing, make sure the contractor paints tonnage on large rocks used in foundation construction.
- Verify the types of measurements and records necessary to support payment for the work. Keep records up to date.
- Make sure existing shrubs and trees are protected so that they continue to anchor the surrounding soil. Erosion control is an important element of successful slope protection.

In addition to the general functions listed, the following items apply to specific types of slope protection.

##### 4-7203A Rock Slope Protection

The *Standard Specifications* provide two methods of placement for this type of protection: Method A and Method B. The contract will identify the designated method.

Method A is used where the stability of the rock slope protection is considerably dependent on the manner in which the individual rocks are placed. To assure the

success of Method A, check that the bearing of rocks from one to the other follows specifications and that the use of “chinking” rocks is limited to filling voids. When placing rocks, the contractor should make sure each placed rock is stable and not dependent on the one on top to hold it in place. Otherwise, placement could result in what is known as “rockers” or unstable rocks. Also, make sure the contractor does not drop rock into place; otherwise, cracking or breaking may occur.

Method B is not restrictive with respect to the placement of individual rocks.

When rock slope protection fabric is required for either method, verify that the contractor places the fabric before placing the rock slope protection. Refer to Section 4-96, “Geosynthetics,” of this manual for guidelines for inspecting and accepting rock slope protection fabric. Close observation is required during rock placement to detect any damage to the fabric.

#### 4-7203B Concreted-Rock Slope Protection

The concreted-rock slope protection method is used where large rock is not economically available in large quantities, yet a heavy, service type of protection is required. Protection involves constructing a heavy mass of smaller rocks bound together by concrete.

To provide the desired cleanliness, the contractor may need to sluice the rock or facing. If the rock contains an excess of fines or inadequate voids, the desired results may be impossible to obtain.

The finish surface must be roughened by brushing to expose rocks. If excess concrete remains on the surface, the finished product, when used in streams, will be too smooth and, along the protection, velocities will increase beyond those intended during design.

To compensate for the lack of flexibility in the completed structure, make sure an adequate foundation lies below this type of protection.

At the terminals of protection, check that the contractor is particularly careful to avoid erosion and undercutting. The contractor must also assure the construction of adequate “returns” and “keys” at the ends.

For details about concrete production, review Section 4-90, “Concrete,” of this manual.

The method for placing rock will either be Method A or Method B, whichever the contract designates, as discussed under Section 4-7203A, “Rock Slope Protection,” earlier in this section.

Inspect the rock to verify it has been cleaned of any adhering dirt and clay and is moistened before concrete placement.

Make sure concrete is cured by one of the specified methods.

#### 4-7203C Small-Rock Slope Protection

The small-rock slope protection method consists of excavating and backfilling the footing trench, placing rock slope protection fabric as shown, and placing small rocks on the slope.

There are three material gradation requirements based on required rock layer thicknesses. The contract plans will designate the required rock layer thickness for each location.

Make sure that the contractor places the fabric before placing the rock slope protection. Refer to Section 4-96, "Geosynthetics," of this manual for guidelines on inspecting and accepting rock slope protection fabric. Observe closely during rock placement to detect any damage to the fabric.

Check that the equipment used during spreading does not crack the rock.

#### 4-7203D Concrete Slope Protection

The concrete slope protection method consists of paving the embankment with portland cement concrete. The method is particularly adaptable to locations where high-velocity flow is not detrimental, but desirable, and the hydraulic efficiency of smooth surfaces is important.

Review Section 4-90, "Concrete," of this manual for details about concrete production. When shotcrete is to be used, review Section 4-53, "Shotcrete," of this manual.

Check the area to be protected to verify that the required expansion joints are in place.

Review the plans for the location and number of weep holes. Decide whether an adequate number has been provided for the particular installation. If necessary, order additional weep holes.

Make sure that the contractor performs concrete finishing as specified and that the slope paving is cured by one of the specified methods.

#### 4-7203E Broken-Concrete Slope Protection

Broken-concrete slope protection consists of placing broken concrete from job site locations identified within the contract.

Before placement of the broken concrete, inspect the material and be sure the reinforcement has been removed flush to the surface of concrete.

The method for placing rock will either be Method A or Method B, whichever the contract designates, as discussed in Section 4-7203A, "Rock Slope Protection," of this manual.

#### 4-7203F Slope Paving

Slope paving is a broader term that covers a variety of methods for paving slopes, including colored slope paving, exposed aggregate slope paving, and slope paving with concrete pavers. The plans will designate which type applies at each location.

Test panels may be specified in the special provisions.

For details about concrete production, review Section 4-90, "Concrete," of this manual. When shotcrete is to be used, review Section 4-53, "Shotcrete," of this manual.

When specified, verify that coloring is added to the concrete.

Make sure the timber spacers are of the required material and spaced as planned.

Observe construction to verify that the contractor does the placing, finishing, and curing as specified.

When exposed aggregate slope paving is specified, check that any concrete set retarders are used in accordance with manufacturer instructions.

When slope paving with concrete pavers is specified, make sure the special provision requirements are met.

#### 4-7203G Gabions

The gabion method consists of placing wire mesh box-shaped baskets filled onsite with hard, durable rocks. The gabions are placed on filter fabric as detailed in the plans and specifications.

At the start of gabion placement, require the contractor to verify the minimum unit weight of the gabions to make sure it meets specifications. If you have any questions about the consistency of the gabions, you may also order the unit weight to be verified during the course of the work.

#### **4-7204 Level of Inspection**

Suggested levels of inspection for slope protection activities are:

- Benchmark inspection of sampling and testing of rocks.
- Intermittent inspection of placement of slope protection, slope paving, and fabric operations.

#### **4-7205 Quality Control**

Check that the contractor is actively performing quality control on placing slope protection and slope paving throughout the operations.

Review contractor's verification of unit weight of rock-filled gabions.

#### **4-7206 Payment**

For measurement and payment, do the following:

- When slope protection is paid by weight, refer to the discussion of weighing and metering procedures in Section 3-902E, "Weighing Equipment and Procedures," of this manual.
- When slope protection is paid by volume, review the plans and quantity calculations in the resident engineer's file to determine if there is sufficient detail and accuracy to be used in the project records.
- For measuring concrete or shotcrete, refer to Sections 4-90, "Concrete," or 4-53, "Shotcrete," of this manual.