

Section 72 Slope Protection

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Bracketed section numbers refer to the 2006 *Standard Specifications*.

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4-7201 General

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Caltrans uses slope protection described in Section 72, “Slope Protection,” of the *Standard Specifications*. The following common types of slope protection are covered under the heading “During the Course of Work”:

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

Other protective devices are used in conjunction with highway construction, and when used, they are included in the contract’s special provisions.

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 in the publication, *California Bank and Shore Rock Slope Protection Design*, and Section 870, “Channel and Shore Protection—Erosion Control,” of the *Highway Design Manual*.

4-7202 Before Work Begins

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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
- For the record, take pictures of existing conditions.

- Verify that Form 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

4-7203 During the Course of Work

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

- For tests on rocks, submit representative pieces of the rock that will be used in the work. The samples will be crushed in the laboratory to the sizes needed to perform the tests.
- Sample cement according to the procedure outlined in “Material Accepted on the Basis of a Certificate of Compliance,” in Section 6-2, “Acceptance of Manufactured or Fabricated Materials and Products,” of this manual.
- Obtain samples of the concrete aggregate for initial and acceptance 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 to ensure 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.
- Ensure 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, ensure 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 such records up to date.
- Ensure 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 discussed above, 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 ensure the

success of Method A, ensure 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 ensure 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, ensure 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, ensure the contractor places the fabric before placing the rock slope protection. Refer to Section 4-88, “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 specifications stress the desirability of a roughened surface finish. 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, ensure an adequate foundation lies below this type of protection.

At the terminals of protection, ensure the contractor is particularly careful to avoid erosion and undercutting. The contractor must also ensure 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 ensure it has been cleaned of any adhering dirt and clay and is moistened before concrete placement.

Ensure the contractor brushes the surface, exposes the rocks as specified, and cures the work 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.

The *Standard Specifications* provide three material gradations based on required rock layer thicknesses. The contract will designate the required rock layer thickness for each location.

Ensure that the contractor places the fabric before placing the rock slope protection. Refer to Section 4-88, “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.

Ensure 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 ensure 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.

Ensure 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.”

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 contract will specify which type applies at each location. The *Standard Specifications* and special provisions provide the requirements for slope paving. Test panels may be specified for certain slope paving.

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, ensure coloring is added to the concrete.

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

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

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

When slope paving with concrete pavers is specified, ensure 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 mass of the gabions to ensure it meets specifications. If you have any questions about the consistency of the gabions, you may also order the mass to be verified during the course of the work.

4- 7203H Sacked-Concrete Slope Protection

Sacked-concrete slope protection is used when a number of serious failures have occurred. The failures are usually associated with the foundation or water getting behind the slope protection and “peeling off” the protection.

At the terminals and intermediate points, the plans provide for the construction of endwalls, cutoffs, and end returns. These devices are intended to prevent erosion behind the protection, and depending on field conditions, may need to be extended.

When possible, the terminals of slope protection should be tied into existing, undisturbed natural features that resist erosion, such as large boulders or rock outcrops.

The bond between the burlap-type sacks and the courses results from the exuding of mortar through the sacks. Should the bond be inadequate, the contractor can strengthen the bond by driving steel dowels or reinforcing bars through the courses as they are constructed.

“Stretchers” are those sacks placed with their lengths parallel to the bank. “Headers” are placed at right angles to stretchers. Verify that the sacks are placed in the manner specified. Periodically measure the work to ensure that the face coverage is within allowable tolerances.

Observe the curing operation to ensure that water is sprayed onto the slope protection at the specified intervals and for the required length of time. Note such observations in the daily report.

Finally, for measurement purposes, perform California Test 518, “Unit Weight of Fresh Concrete,” to determine the unit weight of the concrete.

4-7204 Measurement and Payment

For details of measurement and payment, review the contract specifications. Make necessary measurements.

For measuring concrete or shotcrete, refer to Section 4-90, “Concrete,” or Section 4-53, “Shotcrete,” of this manual.

4-7204 Measurement and Payment