

ITEM 432

RIPRAP

432.1. Description. Furnish and place concrete, stone, cement-stabilized, or special riprap.

432.2. Materials. Furnish materials in accordance with the following:

- Item 420, "Concrete Structures"
- Item 421, "Hydraulic Cement Concrete"
- Item 431, "Pneumatically Placed Concrete"
- Item 440, "Reinforcing Steel"
- DMS-6200, "Filter Fabric."

A. Concrete Riprap. Use Class B Concrete unless otherwise shown on the plans.

B. Pneumatically Placed Concrete Riprap. Use Class II concrete that meets Item 431, "Pneumatically Placed Concrete," unless otherwise shown.

C. Stone Riprap. Unless otherwise shown on the plans, use durable natural stone with a minimum bulk specific gravity of 2.40 as determined by Tex-403-A. Provide stone that, when tested in accordance with Tex-411-A, has a maximum weight loss of 18% after 5 cycles of magnesium sulfate solution and 14% after 5 cycles of sodium sulfate solution.

For all types of stone riprap perform a size verification test on the first 5,000 sq. yd. of finished riprap stone at a location determined by the Engineer. Weigh each stone in a square test area with the length of each side of the square equal to 3 times the specified riprap thickness. The weight of the stones, excluding spalls, should be as specified below. Additional tests may be required. Do not place additional riprap until the initial 5,000 sq. yd. of riprap has been approved.

When specified, provide grout or mortar in accordance with Item 421, "Hydraulic Cement Concrete." Provide grout with a consistency that will flow into and fill all voids.

Provide filter fabric in accordance with DMS-6200, "Filter Fabric." For protection stone riprap, provide Type 2 filter fabric unless otherwise shown on the plans. For Type R, F, or Common stone riprap, provide Type 2 filter fabric when shown on the plans.

- 1. Type R.** Use stones between 50 and 250 lb. with a minimum of 50% of the stones heavier than 100 lb.
- 2. Type F.** Use stones between 50 and 250 lb. with a minimum of 40% of the stones heavier than 100 lb. Use stones with at least 1 broad flat surface.
- 3. Common.** Use stones between 50 and 250 lb. Use stones that are at least 3 in. in their least dimension. Use stones that are at least twice as wide as they are thick. When shown on the plans or approved, material may consist of broken concrete removed under the Contract or from other approved sources. Before placement of each piece of broken concrete, cut exposed reinforcement flush with all surfaces.
- 4. Protection.** Use boulders or quarried rock that meets the gradation requirements of Table 1. Both the width and the thickness of each piece of riprap must be at least 1/3 of the length. When shown on the plans or as approved, material may consist of broken concrete removed under the Contract or from other approved sources. Before placement of each piece of broken concrete, cut exposed reinforcement flush with all surfaces. Determine gradation of the finished, in-place, riprap stone under the direct supervision of the Engineer in accordance with Tex-411-A, Part II.

**Table 1
In-Place Protection Riprap Gradation Requirements**

Thickness	Maximum Size (lb.)	90% Size¹ (lb.)	50% Size¹ (lb.)	8% Size¹, Minimum (lb.)
12 in.	200	80–180	30–75	3
15 in.	320	170–300	60–165	20
18 in.	530	290–475	105–220	22
21 in.	800	460–720	175–300	25
24 in.	1,000	550–850	200–325	30
30 in.	2,600	1,150–2,250	400–900	40

1. As defined in Tex-401-A, Part II.

Provide bedding stone that in-place meets the gradation requirements shown in Table 2 or as otherwise shown on the plans. Determine size distribution in accordance with Tex-401-A, Part I.

**Table 2
Protection Riprap Bedding Material Gradation Requirements**

Sieve Size (Sq. Mesh)	% by Weight Passing
3 in.	100
1-1/2 in.	50–80
3/4 in.	20–60
No. 4	0–15
No. 10	0–5

D. Cement-Stabilized Riprap. Provide aggregate that meets Item 247, “Flexible Base,” for the type and grade shown on plans. Use cement-stabilized riprap with 7% hydraulic cement by dry weight of the aggregate.

E. Special Riprap. Furnish materials for special riprap according to the plans.

432.3. Construction. Dress slopes and protected areas to the line and grade shown on the plans before the placement of riprap. Place riprap and toe walls according to details and dimensions shown on the plans or as directed.

A. Concrete Riprap. Reinforce concrete riprap with 6 × 6 – W2.9 × W2.9 welded wire fabric or with No. 3 or No. 4 reinforcing bars spaced at a maximum of 18 in. in each direction unless otherwise shown. Alternative styles of welded wire fabric that provide at least 0.058 sq. in. of steel per foot in both directions may be used if approved. A combination of welded wire fabric and reinforcing bars may be provided when both are permitted. Provide a minimum 6-in. lap at all splices. At the edge of the riprap, provide a minimum horizontal cover of 1 in. and a maximum cover of 3 in. Place the first parallel bar at most 6 in. from the edge of concrete. Use approved supports to hold the reinforcement approximately equidistant from the top and bottom surface of the slab. Adjust reinforcement during concrete placement to maintain correct position.

As directed, sprinkle or sprinkle and consolidate the subgrade before the concrete is placed. All surfaces must be moist when concrete is placed.

After placing the concrete, compact and shape it to conform to the dimensions shown on plans. After it has set sufficiently to avoid slumping, finish the surface with a wood float to secure a smooth surface or broom finish as approved.

Immediately after the finishing operation, cure the riprap according to Item 420, “Concrete Structures.”

B. Stone Riprap. Provide the following types of stone riprap when shown on the plans:

- **Dry Riprap.** Dry riprap is stone riprap with voids filled with only spalls or small stones.
- **Grouted Riprap.** Grouted riprap is Type R, F, or Common stone riprap with voids grouted after all the stones are in place.
- **Mortared Riprap.** Mortared riprap is Type F stone riprap laid and mortared as each stone is placed.

Use spalls and small stones lighter than 25 lb. to fill open joints and voids in stone riprap, and place to a tight fit.

Do not place mortar or grout when the air temperature is below 35°F. Protect work from rapid drying for at least 3 days after placement.

Unless otherwise approved, place filter fabric with the length running up and down the slope. Ensure fabric has a minimum overlap of 2 ft. Secure fabric with nails or pins. Use nails at least 2 in. long with washers or U-shaped pins with legs at least 9 in. long. Space nails or pins at a maximum of 10 ft. in each direction and 5 ft. along the seams. Alternative anchorage and spacing may be used when approved.

- 1. Type R.** Construct riprap as shown in Figure 1 and as shown on the plans. Place stones in a single layer with close joints so that most of their weight is carried by the earth and not by the adjacent stones. Place the upright axis of the stones at an angle of approximately 90° to the embankment slope. Place each course from the bottom of the embankment upward with the larger stones in the lower courses.

Fill open joints between stones with spalls. Place stones to create a uniform finished top surface. Do not exceed a 6-in. variation between the tops of adjacent stones. Replace, embed deeper, or chip away stones that project more than the allowable amount above the finished surface.

When the plans require Type R stone riprap to be grouted, prevent earth, sand, or foreign material from filling the spaces between the stones. After the stones are in place, wet the stones thoroughly, fill the spaces between the stones with grout, and pack. Sweep the surface of the riprap with a stiff broom after grouting.

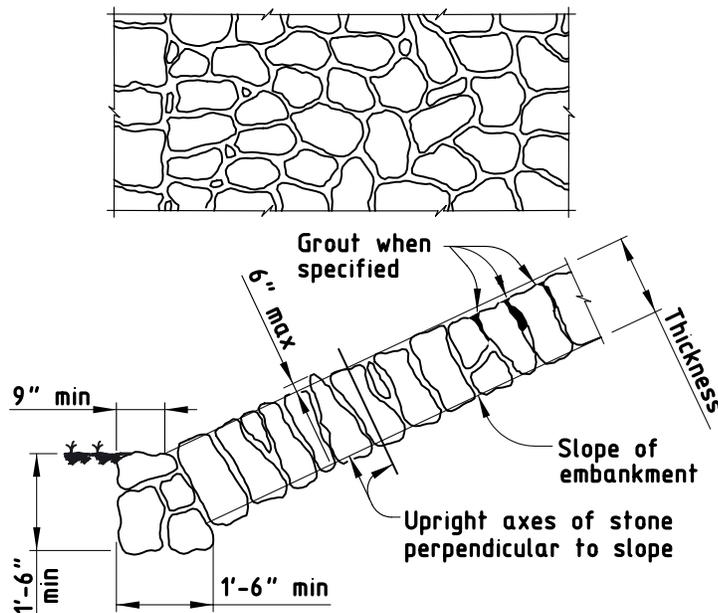


Figure 1
Type R stone riprap, dry or grouted.

- 2. Type F.**

- a. Dry Placement.** Construct riprap as shown in Figure 2. Set the flat surface on a prepared horizontal earth bed, and overlap the underlying course to secure a lapped surface. Place the large stones first, roughly arranged in close contact. Fill the spaces between the large stones with suitably sized stones placed to leave the surface evenly stepped and conforming to the contour required. Place stone to drain water down the face of the slope.

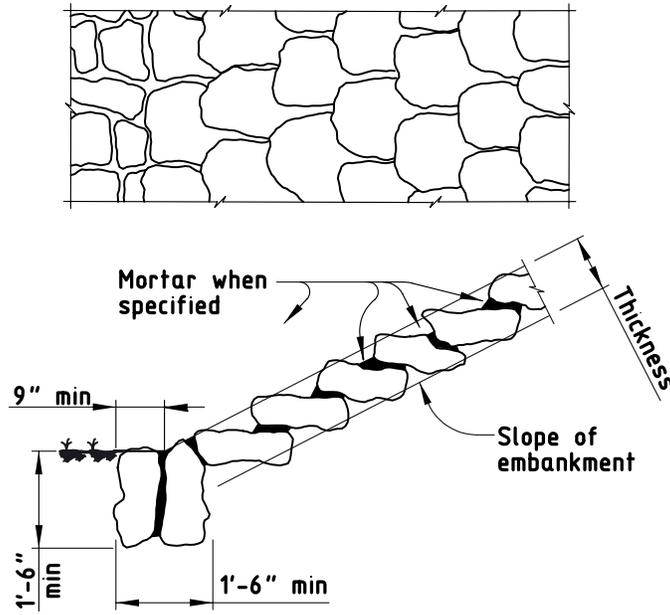


Figure 2
Type F stone riprap, dry or mortared.

- b. Grouting.** Construct riprap as shown in Figure 3. Size, shape, and lay large flat-surfaced stones to produce an even surface with minimal voids. Place stones with the flat surface facing upward parallel to the slope. Place the largest stones near the base of the slope. Fill spaces between the larger stones with stones of suitable size, leaving the surface smooth, tight, and conforming to the contour required. Place the stones to create a plane surface with a maximum variation of 6 in. in 10 ft. from true plane. Provide the same degree of accuracy for warped and curved surfaces. Prevent earth, sand or foreign material from filling the spaces between the stones. After the stones are in place, wet them thoroughly, fill the spaces between them with grout, and pack. Sweep the surface with a stiff broom after grouting.

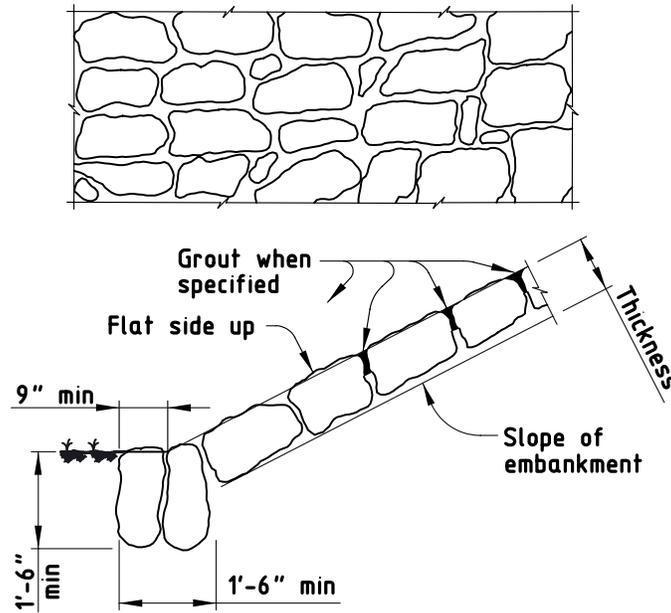


Figure 3
Type F stone riprap, grouted.

- c. **Mortaring.** Construct riprap as shown in Figure 2. Lap courses as described for dry placement. Before placing mortar, wet the stones thoroughly. As the larger stones are placed, bed them in fresh mortar and shove adjacent stones into contact with one another. After completing the work, spread all excess mortar forced out during placement of the stones uniformly over them to fill all voids completely. Point up all joints roughly either with flush joints or with shallow, smooth-raked joints as directed.
3. **Common.** Construct riprap as shown in Figure 4. Place stones on a bed excavated for the base course. Bed the base course of stone well into the ground with the edges in contact. Bed and place each succeeding course in even contact with the preceding course. Use spalls and small stones to fill any open joints and voids in the riprap. Ensure the finished surface presents an even, tight surface, true to the line and grades of the typical sections.

When the plans require grouting common stone riprap, prevent earth, sand, or foreign material from filling the spaces between the stones. After the stones are in place, wet them thoroughly, fill the spaces between them with grout, and pack. Sweep the surface with a stiff broom after grouting.

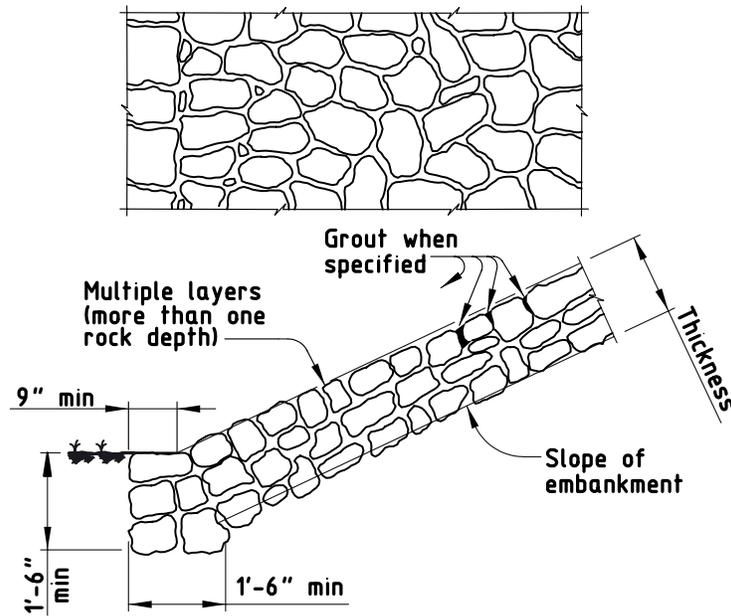


Figure 4
Common stone riprap, dry or grouted.

4. **Protection.** Construct riprap as shown in Figure 5. Place riprap stone on the slopes within the limits shown on the plans. Place stone for riprap on the bedding material to produce a reasonably well-graded mass of riprap with the minimum practicable percentage of voids. Construct the riprap to the lines and grades shown on the plans or staked in the field. A tolerance of +6 in. and -0 in. from the slope line and grades shown on the plans is allowed in the finished surface of the riprap. Place riprap to its full thickness in a single operation. Avoid displacing the bedding material. Ensure that the entire mass of stones in their final position is free from objectionable pockets of small stones and clusters of larger stones. Do not place riprap in layers, and do not place it by dumping it into chutes, dumping it from the top of the slope, pushing it from the top of the slope, or any method likely to cause segregation of the various sizes. Obtain the desired distribution of the various sizes of stones throughout the mass by selective loading of material at the quarry or other source or by other methods of placement that will produce the specified results. Rearrange individual stones by mechanical equipment or by hand if necessary to obtain a reasonably well-graded distribution of stone sizes.

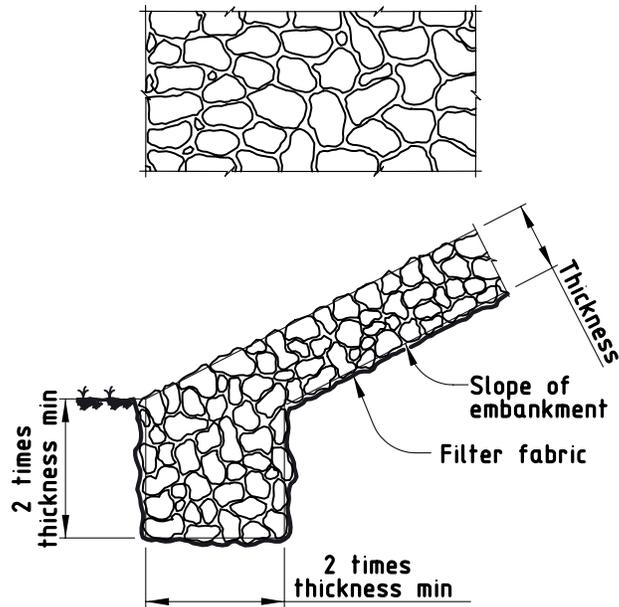


Figure 5
Protection stone riprap.

- C. Pneumatically Placed Concrete Riprap, Class II.** Meet Item 431, “Pneumatically Placed Concrete.” Provide reinforcement following the details on the plans and Item 440, “Reinforcing Steel.” Support reinforcement with approved supports throughout placement of concrete.
- Give the surface a wood-float finish or a gun finish as directed. Immediately after the finishing operation, cure the riprap with membrane-curing compound in accordance with Item 420, “Concrete Structures.”
- D. Cement-Stabilized Riprap.** Follow the requirements of the plans and the provisions for concrete riprap except when reinforcement is not required. The Engineer will approve the design and mixing of the cement-stabilized riprap.
- E. Special Riprap.** Construct special riprap according to the plans.

432.4. Measurement. This Item will be measured by the cubic yard of material complete in place. Volume will be computed on the basis of the measured area in place and the thickness and toe wall width shown on the plans.

For stone riprap for protection, the quantity of the bedding material to be paid for will be measured by the cubic yard as computed from the measured area in place and the bedding thickness shown on the plans.

432.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Riprap” of the type, thickness, and void-filling technique (Dry, Grout, Mortar) specified, as applicable. This price is full compensation for furnishing, hauling, and placing riprap and for filter fabric, expansion joint material, concrete and reinforcing steel, grout and mortar, scales, test weights, equipment, labor, tools, and incidentals.

Payment for excavation of toe wall trenches, for all necessary excavation below natural ground or bottom of excavated channel, and for shaping of slopes for riprap will be included in the unit price bid per cubic yard of riprap.

When bedding is required for protection stone riprap, payment will be made at the unit price for “Bedding Material” of the thickness specified. This price is full compensation for furnishing, hauling, placing, and maintaining the bedding material until placement of the riprap cover is completed and accepted; excavation required for placement of bedding material; and equipment, scales, test weights, labor, tools, and incidentals. No payment will be made for excess thickness of bedding nor for material required to replace embankment material lost by rain wash, wind erosion, or otherwise.