VELASCO DRAINAGE DISTRICT
Standard Specification:

Rip Rap

Revision Control

Revision Number	Date	Revision Author
1.0 – Approved for use	11/02/2011	HSS – District Engineer
2.0	03/22/2016	HSS – District Engineer

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1.0 Scope and Discussion

1.1 This specification shall govern work associated with rip rap on the Freeport, and Vicinity, Hurricane Flood Protection System (the federal levee).

1.2 This specification applies to routine levee repairs that do not involve raising the levee (other than a nominal amount for settlement) that does not require approval by the United States Army Corps of Engineers (USACE) as a Section 408 Review.

1.3 For projects requiring raising the levee, or other actions which trigger an USACE Section 408 Review as noted above, contact the Velasco Drainage District before detail planning for the work has begun, as permitting and design criteria will require substantial time when compared to a project without USACE Section 408 Review.

1.3.1 In general, USACE Section 408 Review is triggered by a major action such as relocation of the levee or replacement of a levee component (such as sheet pile with an earthen levee).

1.3.2 Section 408 reviews will add 30-240 days to project time line.

1.4 Follow standard procedures for purging and securing pipelines prior to removal.

2.0 Site Preparation

2.1 Remove roots, organic material, asphalt, concrete and other miscellaneous debris for the rip rap area

3.0 Rip Rap Material

3.1 Conform to the attached TxDOT Specification, Protection Riprap. Table 2 and Table 5.

3.2 Geotextile Separator Fabric:

Property	Test Procedure	Acceptable Values
Grab Breaking Load	ASTM D 4632	200 lbs minimum in any principle direction
Seam Strength	ASTM D 4632	15% minimum in any given direction
Apparent Opening Size	ASTM D 4751	No finer than US Sieve 50 and no coarse than US Sieve 30
Permittivity Flow Rate	ASTM D 4491	0.35 per second minimum 40 gallons .minute/square foot

3.3 Conform to medium weight and gradation as shown in the attached Hudson Formula Calculation

4.0 Rip Rap Construction/ Installation

4.1 Conform to the attached TxDOT Specification, for the type of material required by Velasco

5.0 Construction Documentation

5.1 Prior to Construction

5.1.1 Sections and plan view adequate to identify the repaired section on the ground and to show the side slopes. Note limits of repair, rip rap and other elements of the project.

5.1.2 Provide analysis and soil classification (Atterberg Limits) of proposed levee fill from geotechnical laboratory

5.1.3 All data and designs must bear seal of a Licensed Professional Engineer - Texas. (LPE-T)

5.2 During Construction:

5.2.1 Provide adequate supervision to accurately document that locations, elevations etc. are incorporated in required testing and as built documentation and assure that all provisions are complied with during construction.

5.2.2 Assure that the selected geotechnical laboratory provides compaction and moisture testing as required by this Specification.

5.3 After Construction

5.3.1 Provide As Built drawings, note any deviation from planned drawings as needed.

5.3.2 Provide all geotechnical test reports.

5.3.3 Assure that all submittals under Section 5.3 bear the seal of a Licensed Professional Engineer - Texas. (LPE-T)

END OF SPECIFICATION

Hudson's Equation

H = Estimate of average of the highest 5% of waves

cotθ = cotangent of slope = vertical component of standard XV:1H nomenclature by defination

W_{50} = median weight of armor stone

For A427 Levee

$H := 2.0$

$\cot\theta := \frac{55}{7}$ 7 feet rise in 55 feet

$$W_{50} := \frac{\left[16.7 \cdot \left(H^3\right)\right]}{\cot\theta}$$

$W_{50} = 17.004$

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% Size[1] (lb.)	50% Size[1] (lb.)	8% Size[1], 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.

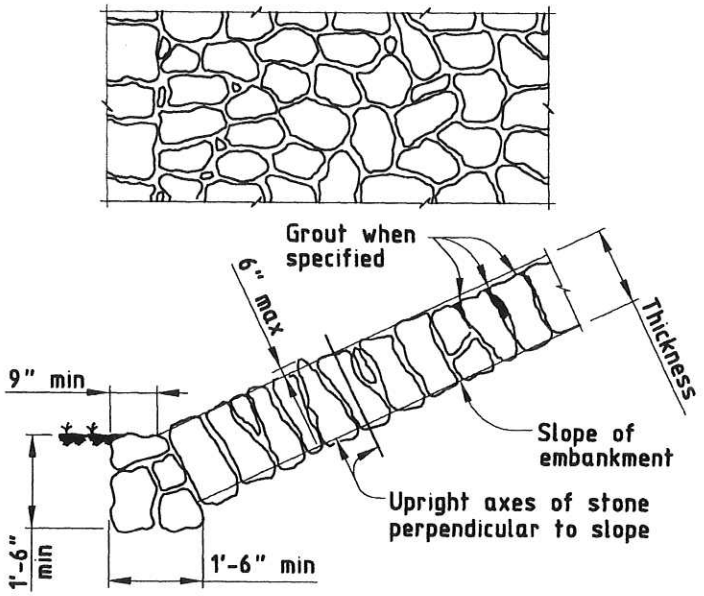

Figure 1
Type R stone riprap, dry or grouted.

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.

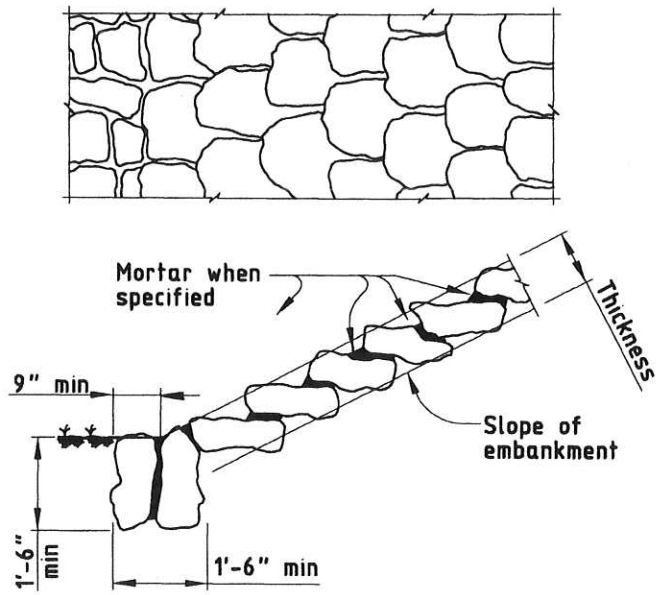

Figure 2
Type F stone riprap, dry or mortared.

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.