SECTION 44 – SHOTCRETE, CAST CONCRETE CHANNEL LINING, AND GROUTED COBBLE

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44-1 SHOTCRETE

44-1.01 Description

This work consists of lining ditches and channels, embankment protection, and constructing warped sections and other similar features with shotcrete in accordance with the Contract and these Specifications.

Shotcrete must consist of concrete or mortar pneumatically applied onto a surface. Shotcrete must be applied by the dry-mix or wet-mix process. The shotcrete must be applied by a nozzleman certified by the American Concrete Institute The dry-mix process must consist of delivering dry mixed aggregate and cement pneumatically to the nozzle body and adding water and mixing the materials in the nozzle body.

The resulting surface must be uniform and free from humps or depressions.

44-1.02 Materials

Portland cement must conform to the requirements of Section 50-5, “Portland Cement”, of these Specifications.

Sand must be clean, sharp, and free from clay, silt and loam. Sand must be well graded and suitable for the purpose intended with no particles larger than 3/8 inch.

The sand must contain between 3 and 5 percent moisture by weight.

44-1.03 Proportions

The proportion of cement to sand must be based on dry and loose volume and must not be less than 1 part portland cement to 4-1/2 parts sand. The water content must be maintained at a practical minimum and not in excess of 3 gallons per 94 pounds of cement as placed.

44-1.04 Mixing

Before being charged into the machine, the cement and sand must be thoroughly mixed dry in an approved power batch mixer equipped with a device for accurately measuring the quantity of sand and timing the mixing operation. The mixture must be mixed for at least 1-1/2 minutes during which time the mixer must rotate at a peripheral speed of 200 feet per minute. The dry mixed materials must be used promptly after their preparation and any material that has been mixed for more than 45 minutes cannot be used. Rebound must not be used on any portion of the Work.

44-1.05 Surface Preparation

When shotcrete is to be placed on an earth slope for embankment protection, the earth surface must be cleaned of grass, roots, and other deleterious matter. The surface must be made smooth and must be well watered and compacted. Header board must be placed as shown on the Plans. All surfaces must be damp, but not wet to the extent that free water exists at the time of application.

When shotcrete is applied to steel or concrete structures, the surface must be cleaned of all loose material and be damp, as specified above, at the time of application of the material.

44-1.06 Placing

The velocity of the material as it leaves the nozzle must be such that minimum rebound occurs. Velocities of the material must be constant. The nozzle must be held in a position and at a distance that the stream of flowing material will impinge at approximately right angles to the surface being covered and that excessive impact will be avoided.

Pneumatic pressure at the machine must not be less than 30 psi when the length of hose does not exceed 100 feet. Pressure must be increased 5 psi for each additional 50 feet of hose or fraction thereof. Water used for hydration at the nozzle must be supplied at pressure of at least 15 psi greater than the air pressure. The shotcrete must have uniform consistency.

After the shotcrete has been applied to the surface to finished grade, the surface of the shotcrete must be checked with a minimum 10-foot straightedge. Low spots must be raised by additional application of shotcrete. The final surface of the shotcrete must be finished with a wood float.

44-1.07 Curing and Protection

Curing must be as specified in Section 30-13, “Curing”, of these Specifications. Protection must be as specified in Section 30-14, “Protecting Concrete”, of these Specifications.

44-1.08 Reinforcement

Reinforcement must be as shown on the Plans and must conform to Section 31, “Reinforcement”, of these Specifications. Reinforcement must be placed in the shotcrete as it is applied. Reinforcement must be not less than 1/4 inch from unexposed faces and 3/4 inch from exposed faces.

44-1.09 Expansion Joints

When premoulded joint filler is shown or specified in the Contract, the filler must be placed in correct position before shotcrete is placed. The edges of the shotcrete at the joint must have a finished edge, edged with a 1/4-inch radius edging tool. Unless otherwise specified in the Contract, expansion joint material must be as specified in Section 50-4, “Premoulded Expansion Joint Filler”, of these Specifications.

44-1.10 Measurement and Payment

Unless otherwise specified in the Contract, quantities of shotcrete in lining ditches and channels, embankment protection, and constructing warped sections and other similar features will be measured by the square foot, computed from measurements along the slope of actual areas placed. Shotcrete placed outside the dimensions shown on the Plans or to fill low foundations will not be paid for. The price paid per square foot for shotcrete includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in placing shotcrete, including surface preparation, reinforcement, joint filling material, and finishing, as shown or specified in the Contract, as specified in these Specifications, and as directed by the Agency. No additional compensation will be allowed for rebound.

44-2 CAST CONCRETE CHANNEL LINING

44-2.01 Description

This work consists of lining channels with cast-in-place concrete in accordance with the details and dimensions shown or specified in the Contract and these Specifications.

44-2.02 Materials

Materials for cast-in-place concrete lining must be Class "B" concrete as specified in Section 50-5, “Portland Cement Concrete”, of these Specifications. Slump for concrete channel lining must not exceed 4 inches as determined by the slump cone method of ASTM C143 or an equivalent slump as determined by California Test 533. Lesser slumps may be required by the Agency if the concrete begins to develop surface cracks. At the Contractor’s option, shotcrete conforming to Section 44-1, “Shotcrete”, of these Specifications may be used for side lining only.

When shown or specified in the Contract, grouted cobbles conforming to Section 44-3, “Grouted Cobbles”, of these Specifications must be used for side or bottom lining.

44-2.03 Placement and Thickness

The thickness of the bottom lining in channels must not be less than 4 inches. The thickness of the side lining in channels must not be less than 3 inches.

Lining must be placed as shown on the Plans and Standard Drawing 9-24, and as directed by the Agency.

The appearance of the lining must be neat and uniform conforming to the lines shown on the Plans or as directed by the Agency. A 2 by 4 inch header board placed along the top of the lining or other method approved by the Agency must be used as a control while placing the lining.

The surfaces of areas to be lined must be evenly graded to the lines and grade and sections as shown on the Plans. The surfaces must be moistened thoroughly. All surfaces must be free from standing water, mud, and debris and must be firm enough to prevent contamination of the fresh lining by earth or other foreign material. The excavated channel must be approved by the Agency before the Contractor begins concrete placement.

Grade control points must be placed in accordance with Section 18-4.02, “Grade Control - Lined Channels”, of these Specifications.

After the concrete has been placed, the surface must be checked with a minimum 10-foot straightedge. Low spots must be filled to finish grade. The finished concrete surface must be smooth and uniformly constructed to the design finish grade.

44-2.04 Reinforcement

The channel lining must be reinforced with 4 by 4 inch – W4 x W4 welded wire fabric conforming to ASTM A185. The welded wire fabric reinforcement must be embedded in the concrete so that it will be a minimum of 1 inch clear from either face of the concrete, unless otherwise shown on the Plans. The wire fabric must be maintained at the required minimum clear distance from the soil through the use of dobies or other methods approved by the Agency before and during concrete placement.

44-2.05 Joints

Joints in cast concrete channel lining consist of construction joints, transverse expansion joints, and transverse contraction joints. Joints must be true to a uniform line and neat in appearance.

Construction joints must be square, and must have a finished edge, edged with a 1/4-inch radius edging tool. The edge must be thoroughly wetted before the next section of lining is placed. Construction joints must be constructed whenever the operation is halted for a period exceeding 30 minutes. Reinforcement must extend through the construction joints.

Transverse expansion joints must be constructed at intervals of not more than 50 and must be filled with premoulded expansion joint filler material, unless otherwise shown on the Plans. The material must have a minimum thickness of 3/8 inch. The edges of the concrete at the joint must have a finished edge, edged with a 1/4-inch radius edging tool. Unless otherwise specified in the Special Provisions, expansion joint material must be as specified in Section 50- 4, “Premoulded Expansion Joint Filler”, of these Specifications.

Transverse contraction joints must be constructed at intervals of 10 feet and must be scored by troweling a 5/8-inch deep groove, 1/4 inch wide, unless otherwise shown on the Plans.

44-2.06 Weep Holes

On channels with side lining extending more than 18 inches vertically above the channel toe, weep holes must be constructed at intervals of 10 feet midway between contraction joints on each side of the channel. Weep holes must be constructed using perforated 2-inch diameter, schedule 40, polyvinyl chloride (PVC) or acrylonitrite butadine-styrene (ABS) pipe. The pipe must be cut to fit the channel slope and must be placed 1 foot above the toe of slope. The pipe perforations must be a minimum of 1 square inch per linear foot of pipe. The weep holes must be backed by a minimum of 1 cubic foot of aggregate material tied in a burlap bag. The aggregate must extend at least 6 inches above and below and to each side of the weep hole, and at least 10 inches into the side slope. The side and back of the burlap bag must be protected from being coated by concrete during the placing operation by a suitable means approved by the Agency. On the day following concrete placement, each weep hole must be rodded to assure that it has not been blocked.

44-2.07 Cutoff Walls

Cutoff walls must be constructed around the perimeter at each end of the channel lining and at all locations where the new lining meets structures or an existing lining, and in other locations shown on the Plans. The cutoff walls must be a minimum of 6 inches thick and 18 inches deep measured from the surface of the lining. The channel lining reinforcement must be bent down into the cutoff walls.

44-2.08 Finishing

Cast-in-place concrete channel lining must be placed and tamped until it is thoroughly compacted and mortar flushes to the surface. After striking off to grade, the concrete must be hand floated with wooden floats. The entire surface must then be broomed with a fine hair push broom to produce a uniform surface. Brooming must be done when the surface is sufficiently set to prevent deep scarring and must be accomplished by drawing the broom parallel to the expansion and construction joints.

44-2.09 Curing and Protection

Curing must be as specified in Section 30-13, “Curing”, of these specifications. Protection must be as specified in Section 30-14, “Protecting Concrete”, of these Specifications.

44-2.10 Measurement and Payment

Unless otherwise specified in the Contract, quantities of cast-in-place concrete channel lining will be measured by the square foot computed from measurements along the slope, of actual areas placed. The vertical legs of cutoff walls are not considered surface area. The price paid per square foot for cast-in-place concrete channel lining includes full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in cast-in-place concrete channel lining, including surface preparation, reinforcement, joint filling material, finishing, and constructing cutoff walls, as shown or specified in the Contract, specified in these Specifications, and directed by the Agency.

44-3 GROUTED COBBLES

44-3.01 Description

This work consists of furnishing and placing grouted cobbles in the side or bottom of cast-in-place concrete channel lining. Grouted cobbles must be in accordance with the details shown or specified in the Contract, and these Specifications. Cast-in-place concrete channel lining must conform to Section 44-2, “Cast Concrete Channel Lining”, of these Specifications.

Reinforcement and expansion joints will not be required in grouted cobble channel lining.

44-3.02 Materials and Placement

Cobbles must be clean river rock cobbles having a maximum size of 10 inches and must conform to the following grading:

Sieve Sizes	Percentage Passing
Greater than 4”	40 - 100
4”	0 - 40
1-1/2”	0

Grout must conform to the requirements for Class “B” concrete as specified in Section 50-5 “Portland Cement Concrete”, and these Specifications. Aggregate size must be limited to that necessary to obtain the required penetration into the interstices of the cobbles, as specified below. The water content of the grout must permit gravity flow of the grout into the interstices of the cobbles.

The cobbles must be uniformly placed to a thickness of approximately 12 inches. Minimum penetration of the grout into the interstices of the cobbles must be 4 inches measured from the outer surface of the cobbles.

The surfaces of the cobbles must be cleaned of any adhering soil and then moistened. Grout must be uniformly placed over the cobbles. Grout must not be permitted to flow across the cobbles a distance in excess of 10 feet. The temperature of the grout at the time of placement must not exceed 90 degrees F.

Immediately after placement, the grout must be spaded or rodded into place until minimum required penetration is obtained.

After the grout has been placed, the cobbles must be thoroughly brushed to expose their top surfaces. The outer cobbles must project 1/4 to 1/3 of their diameter above the grout surface. After completion of any 10-foot strip of grouted cobbles, no personnel or equipment is permitted on the surface for a period of 24 hours. Grouted cobbles must be cured as specified in Section 30-13, “Curing”, of these Specifications.

44-3.03 Measurement and Payment

Unless otherwise specified in the Contract, quantities of grouted cobbles will be measured by the square foot computed from measurements, along the slope, of actual areas placed. The vertical legs of cutoff walls are not considered surface area. The price paid per square foot for grouted cobbles includes full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in grouted cobbles, including surface preparation, and finishing, as shown or specified in the Contract, specified in these Specifications, and directed by the Agency.