

44-1 SHOTCRETE

44-1.01 Description

This work shall consist of lining ditches and channels, embankment protection, and constructing warped sections and other similar features with shotcrete in accordance with the details and dimensions shown or specified in the Contract and as specified in these Specifications.

Shotcrete shall consist of concrete or mortar pneumatically applied onto a surface. Shotcrete shall be applied by the dry-mix process. The dry-mix process shall 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 shall be uniform and free from humps or depressions.

44-1.02 Materials

Portland cement shall conform to the requirements of Section 50-5, "Portland Cement", of these Specifications.

Sand shall be clean, sharp, and free from clay, silt and loam. Sand shall be well graded and suitable for the purpose intended with no particles larger than three-eighths inch (3/8"). The sand shall contain not less than three percent (3%) nor more than five percent (5%) moisture by weight.

44-1.03 Proportions

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

44-1.04 Mixing

Before being charged into the machine, the cement and sand shall 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 shall be mixed for at least one and a half (1-1/2) minutes during which time the mixer shall rotate at a peripheral speed of two hundred (200) feet per minute. The dry mixed materials shall be used promptly after their preparation and any material that has been mixed for more than forty-five (45) minutes shall not be used. Rebound shall 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 shall be cleaned of grass, roots, and other deleterious matter. The surface shall be made smooth and shall be well watered and compacted. Header board shall be placed as shown on the Plans. All surfaces shall be damp, but not wet to the extent that free water may exist at the time of application.

When shotcrete is applied to steel or concrete structures, the surface shall be cleaned of

all loose material and be damp, as above specified, at the time of application of the material.

44-1.06 Placing

The velocity of the material as it leaves the nozzle shall be such that minimum rebound occurs. Velocities of the material shall be constant. The nozzle shall be held in such position and at such 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 shall not be less than thirty pounds per square inch (30 psi) when the length of hose does not exceed one hundred feet (100'). Pressure shall be increased five pounds per square inch (5 psi) for each additional fifty feet (50') of hose or fraction thereof. Water used for hydration at the nozzle shall be supplied at pressure of not less than fifteen pounds per square inch (15 psi) greater than the air pressure. The shotcrete shall have uniform consistency at all times.

After the shotcrete has been applied to the surface as nearly as practicable to finished grade, the surface of the shotcrete shall be checked with a minimum ten-foot (10') length straightedge. Low spots shall be raised by additional application of shotcrete. The final surface of the shotcrete shall be finished with a wood float.

44-1.07 Curing and Protection

Curing shall be as specified in Section 30-13, "Curing"; protection shall be as specified in Section 30-14, "Protecting Concrete", of these Specifications.

44-1.08 Reinforcement

Reinforcement shall be as shown on the Plans and shall conform to Section 31, "Reinforcement" of these Specifications. Reinforcement shall be placed in the shotcrete as it is applied. Reinforcement shall be not less than one-quarter inch (1/4") from unexposed faces and three-quarters inch (3/4") from exposed faces.

44-1.09 Expansion Joints

When premoulded joint filler is shown or specified in the Contract, the filler shall be placed in correct position before shotcrete is placed. The edges of the shotcrete at the joint shall have a finished edge, edged with a one-quarter-inch (1/4") radius edging tool. Unless otherwise specified in the Special Provisions, expansion joint material shall 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 Special Provisions, 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 shall include 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 City.

No additional compensation will be allowed for rebound.

44-2 CAST CONCRETE CHANNEL LINING

44-2.01 Description

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

44-2.02 Materials

Materials for cast-in-place concrete lining shall be Class "B" concrete as specified in Section 50-5, "Portland Cement Concrete", of these Specifications. Slump for concrete channel lining shall not exceed four inches (4") as determined by the slump cone method of ASTM Designation: C 143 or an equivalent slump as determined by California Test Method 533. Lesser slumps may be required by the City if the concrete begins to develop surface cracks. At the Contractor's option, shotcrete conforming to Section 44-1, "Shotcrete", in this Section 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", in this Section of these Specifications shall be used for side or bottom lining.

44-2.03 Placement and Thickness

The thickness of the bottom lining in channels shall not be less than four inches (4"). The thickness of the side lining in channels shall not be less than three inches (3").

Lining shall be placed as shown on the Plans, and as directed by the City.

The appearance of the lining shall be neat and uniform conforming to the lines shown on the Plans or as directed by the City. A two-inch by four-inch (2" x 4") header board placed along the top of the lining or other method approved by the City shall be used as a control while placing the lining.

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

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

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

44-2.04 Reinforcement

The channel lining shall be reinforced with 6" x 6" – W6 x W6 welded wire fabric conforming to ASTM Designation: A 185. The welded wire fabric reinforcement shall be

embedded in the concrete so that it will be a minimum of one inch (1") clear from either face of the concrete, unless otherwise shown on the Plans. The wire fabric shall be maintained at the required minimum clear distance from the soil through the use of dobies or other methods approved by the City before and during concrete placement.

44-2.05 Joints

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

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

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

Transverse contraction joints shall be constructed at intervals of ten feet (10') and shall be scored by troweling a five-eighths-inch (5/8") deep groove, one-quarter inch (1/4") wide, unless otherwise shown on the Plans.

44-2.06 Weep Holes

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

44-2.07 Cutoff Walls

Cutoff walls shall 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 as shown on the Plans. The cutoff walls shall be a minimum of six inches (6") thick and eighteen inches (18") deep measured from the surface of the lining. The channel lining

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reinforcement shall be bent down into the cutoff walls.

44-2.08 Finishing

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

44-2.09 Curing and Protection

Curing shall be as specified in Section 30-13, "Curing"; protection shall be as specified in Section 30-14, "Protecting Concrete", of these Specifications.

44-2.10 Measurement and Payment

Unless otherwise specified in the Special Provisions, 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 will not be 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 City.

44-3 GROUTED COBBLES**44-3.01 Description**

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

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

44-3.02 Materials and Placement

Cobbles shall be clean river rock cobbles having a maximum size of ten inches (10") and shall conform to the following grading:

Sieve Sizes	Percentage Passing
Greater than 4"	40 – 100
4"	0 – 40
1 – ½"	0

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Grout shall conform to the requirements for Class “B” concrete as specified in Section 50-5 “Portland Cement Concrete”, and these Specifications. Aggregate size shall 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 shall be such as to permit gravity flow of the grout into the interstices of the cobbles.

The cobbles shall be uniformly placed to a thickness of approximately twelve inches (12”). Minimum penetration of the grout into the interstices of the cobbles shall be four inches (4”) measured from the outer surface of the cobbles.

The surfaces of the cobbles shall be cleaned of any adhering soil and then moistened. Grout shall be uniformly placed over the cobbles. In no case shall grout be permitted to flow across the cobbles a distance in excess of ten feet (10’). The temperature of the grout at the time of placement shall not exceed 90°F.

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

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

44-3.03 Measurement and Payment

Unless otherwise specified in the Special Provisions, 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 will not be 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 City