

# CHAPTER 6

## STRUCTURES

# STANDARD CONSTRUCTION SPECIFICATIONS

## 6 - STRUCTURES

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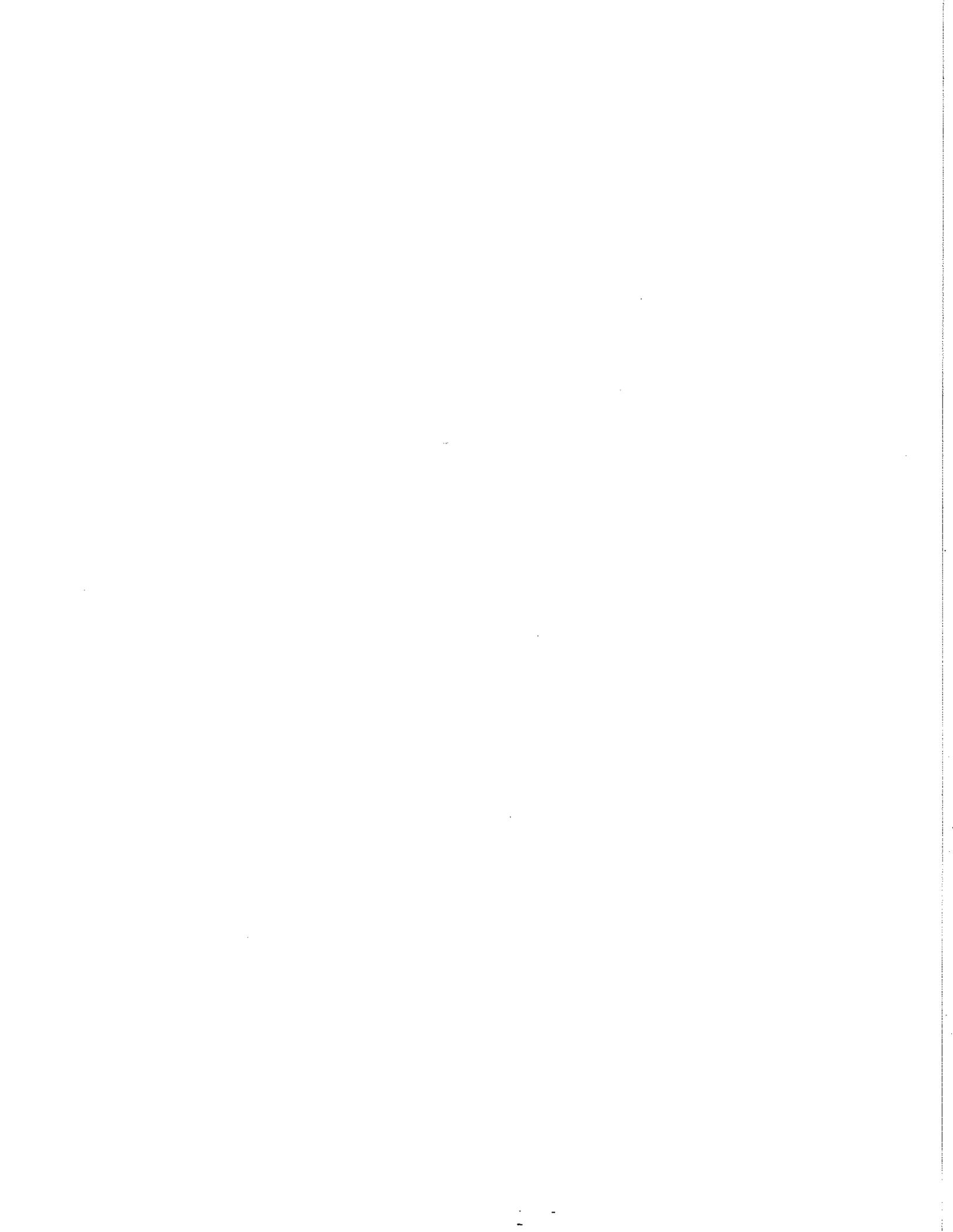
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# STANDARD CONSTRUCTION SPECIFICATIONS

## 6 - STRUCTURES

### 601 - Reserved

### 602 - Concrete Structures

#### 602.01.00 Description

This Section covers Portland Cement concrete, plain or reinforced, precast or cast-in-place, in bridges, box culverts, retaining walls, catch basins, abutments, piers, footings, foundations, and similar structures.

#### 602.02.00 Materials

##### 602.02.01 Portland Cement

Conform to **Section 205 - Materials**.

##### 602.02.02 Aggregates

###### 602.02.02A - General

Use aggregates which conform to requirements of **Section 205 - Materials**, and the additional requirements contained herein.

If Contractor desires to furnish aggregates which deviate from gradations contained herein, obtain written approval from Engineer prior to incorporation of any materials in any part of the work.

###### 602.02.02B - Fine Aggregate

Fine aggregate must be graded from coarse to fine within the following limits:

All fine aggregate shall meet the requirements of ASTM C 33.

Grading Requirements Fine Aggregate - Portland Cement Concrete	
Sieve Size Passing	Percentages (by weight)
3/8" (9.525 mm)	100
No. 4	90 - 100
No. 16	45 - 75
No. 30	25 - 55
No. 50	5 - 30
No. 100	0 - 8

Use fine aggregate which has a sand equivalent of not less than 68, and which develops in the mortar strength test taken at seven days, a compressive strength of at least 95 percent of mortar using Ottawa sand.

Sand for mortar shall conform to the requirements of AASHTO M45; testing shall conform to the ODOT standard test for mortar strength.

#### 602.02.02C - Coarse Aggregate

Coarse aggregate must conform to the specified maximum size, and when each maximum size is separated into designated sizes, the separated designated sizes shall be as follows:

Maximum Size of Aggregates	Separated Sizes
2 inch (50.80 mm)	(2" - 1"), (1" -No.4) (50.80-25.40 mm), (25.40 mm -No. 4)
1 ½ inch (38.10 mm)	(1 1/2" - 3/4"), (3/4" -No. 4) (38.10-19.05 mm), (19.05 mm -No. 4)
1 inch (25.40 mm)	(1" -No. 4) (25.40 mm No. 4)
3/4 inch (19.05 mm)	(3/4" -No. 4) (19.05 mm -No. 4)

Do not allow oversized and undersized materials to exceed a combined 15 percent of any separated size, nor allow any pieces to have any dimension greater than twice the maximum square screen size for the specified grading.

Grading of each of specified separated sizes of coarse aggregate shall conform with the following:

Grading Requirements Coarse Aggregate - Portland Cement Concrete				
Separated Sizes				
Sieve Size Passing	2" - 1" (50.8mm - 25.4mm)	1 1/2" - 3/4" (38.1mm-19.05mm)	1" - No. 4 (25.4 mm - No. 4)	3/4" - No. 4 (19.05 mm - No.4)
Percentages (by weight)				
2 1/2" (63.5 mm)	100			
2" (50.8 mm)	90 - 100	100		
1 1/2" (38.1 mm)	35 - 70	90 - 100	100	
1" (25.4 mm)	0 - 15	30 - 65	90 - 100	100
3/4" (19.05 mm)		0 - 15	50 - 80	90 - 100
3/8" (9.525 mm)			15 - 40	20 - 50
No. 4			0 - 10	0 - 10

When a tolerance range is set forth in the above grading requirements, it shall be understood that the midpoint of the tolerance range is the target value and the product shall conform as closely as realistically possible to this target value. The purpose of the tolerance range is only to permit occasional minor variations from the target value that are, for practical reasons, unavoidable.

When coarse aggregate is to be separated into two sizes as set forth hereinabove, control grading of material in each separated size within the applicable range of percentages given in grading requirements for coarse aggregate hereinabove so that the quantity of each separated size measured into the batch shall be not less than 35 percent nor more than 65 percent of total quantity of coarse aggregate measured into the batch.

#### 602.02.03 Water

Conform to **Section 205 - Materials.**

#### 602.02.04 Admixtures

##### 602.02.04A - Air-entraining Admixtures

Air-entraining admixtures shall conform to AASHTO M 154 (ASTM C 260) using one or another of several tests as directed by the Engineer. Chloride content of admixture must not exceed 0.5 percent by weight.

##### 602.02.04B - Water-reducing, Retarding, and Accelerating Admixtures

Water reducing, retarding, and accelerating admixtures shall conform to AASHTO M 194 (ASTM C 494) using one or more of several tests as Engineer may direct. Chloride content of admixture must not exceed 0.5 percent by weight.

#### 602.02.05 Curing Materials

Use curing material(s) conforming to one or more of the following requirements or as specified:

White Burlap-Polyethylene Sheets for Curing Concrete	AASHTO M 171
Waterproof Paper for Curing Concrete	AASHTO M 171
Liquid Membrane-Forming Compounds for Curing Concrete* (white-pigmented)	AASHTO M 148
White Polyethylene (Film) for Curing Concrete	AASHTO M 171
Burlap Cloth (Jute or Kenaf)	AASHTO M 182

\* Not permitted on bridges, reservoirs, and box culverts.

#### 602.02.06 Joint Materials

##### 602.02.06A - Preformed Expansion Joint Fillers

Use preformed expansion joint fillers for concrete conforming to AASHTO M 153 or AASHTO M 213 except that those furnished under AASHTO M 213 shall be tested in conformance to ASTM D 1751. Fillers conforming to AASHTO M 213, except that the binder, if other than bituminous material, may also be used provided that they otherwise meet these Standard Construction Specifications and provided further that they have been demonstrated to be rot and vermin proof for a period of at least five years.

602.02.06B - Prefomed Elastomeric Joint Seals

Utilize prefomed elastomeric joint seals conforming to AASHTO M 220.

602.02.06C - Poured Filler

Utilize poured filler for concrete joints conforming to AASHTO M 173.

602.02.07 Water Stop

602.02.07A - Plastic

Plastic water stops shall be fabricated with a uniform cross section, free from porosity or other defects, to the nominal dimensions shown on the plans. An equivalent standard shape may be furnished, if approved by the Engineer.

The material from which the water stop is fabricated shall be a homogeneous, elastomeric, plastic compound of basic polyvinyl chloride and other material which, after fabrication, will meet the requirements tabulated herein. No reclaimed material shall be used. The Contractor shall furnish a certificate from the producer, showing values for the designated properties. The Contractor shall furnish samples, in lengths adequate for making designated tests, as ordered by the Engineer.

Required Properties and Test Methods Plastic Water Stop			
Property	No. 406 Method Standards Federal Test	ASTM Equivalent	Requirement
Tensile strength	1011	D638	Min. 1400 psi (9.65 MPa)
Elongation at breaking	1011	D638	Minimum 250 percent
Hardness (Shore)	1082	D2240	60 to 75
Specific gravity	5011		Max. + or - 0.02 from manufacturer's value
Resistance to alkali  (7 days using 10% NaOH)	7011	D543	Max. weight change 0.10% to + 0.25%  Max. hardness change + or - (Shore); Max. tensile strength decrease: 15%
Water absorption (48 hours)	7031	D570	Maximum 0.5 percent
Cold bending	(1)	(1)	No cracking
Volatile loss	6081	D1203	Not more than manufacturer's value

- (1) The cold bend test will be made by subjecting a 1 inch by 6 inch by 1/8 inch (25.40 mm by 152.40 mm by 3.175 mm) strip of plastic water stop to a temperature of minus 20 degrees Fahrenheit (6.67°C) for two hours. The strip will immediately thereafter be bent 180 degrees around a rod of 1/4 inch (6.35 mm) diameter by applying sufficient force to hold the sample in intimate contact with the rod. The sample will then be examined for evidence of cracking. At least three individual samples from each lot will be tested and the result reported.

#### 602.02.07B - Rubber

Rubber water stops may be molded or extruded and shall have a uniform cross section, free from porosity or other defects, conforming to the nominal dimensions shown on the plans. An equivalent standard shape may be furnished, if approved by the Engineer.

The water stop may be compounded from natural rubber, synthetic rubber, or a blend of the two, together with other compatible materials which will produce a finished water stop meeting the requirements tabulated herein. No reclaimed material shall be used. The Contractor shall furnish a certificate from the producer to show the general composition of the material and values for the designated

properties. The Contractor shall furnish samples, in lengths adequate for making designated tests, as ordered by the Engineer.

Required Properties and Test Methods Rubber Water Stop		
Property	Federal Test Method Standard No. 601	Requirement
Hardness (by Shore durometer)	3021	60 to 70
Compression set	3311	Maximum 30 percent
Tensile strength	4111	Min. 2500 psi (17.24 MPa)
Elongation at breaking	4121	Minimum 450 percent
Tensile stress at 300 percent elongation	4131	Min. 900 psi (6.21 MPa)
Water absorption by weight	6631	Maximum 5 percent
Tensile strength after aging	7111	Min. 80 percent original

#### 602.02.07C - Copper

Sheet copper for water stops or flashings shall meet the requirements of AASHTO M 138 (ASTM B 152) for type ETP light cold-rolled, soft anneal, unless otherwise specified.

#### 602.03.00 Construction

##### 602.03.01 General

When purchasing concrete from others during performance of the contract, be fully responsible for such concrete conforming to all requirements contained herein.

##### 602.03.02 Mix Design

##### 602.03.02A - Classes of Concrete

Classes of concrete shall designate design field strength of concrete in 28 days (psi) (Mpa) followed by maximum size of aggregate to be used in the concrete, i.e.,

Class 3000-1 1/2 shall indicate a compressive strength of 3,000 psi (20.685 Mpa) in 28 days with 1 1/2 inch (38.10 mm) maximum size aggregate used in that concrete.

Use the class of concrete as specified or shown for each component part of the project, and if not so specified or shown, use class 3000-1 1/2 concrete.

In all precast-prestressed concrete members, in the stems of post-tensioned box girders, and in all other members where the spacing of reinforcement is less than 2 inches (50.80 mm), use 1 inch (25.40 mm) maximum size aggregate, unless specified otherwise.

#### 602.03.02B - Classification and Proportioning of Concrete Mixtures

Before beginning any concrete work, the contractor shall have the concrete mix designed by an approved independent testing laboratory, at no expense to the City. Certified copies of all laboratory trial mix reports shall be sent to the Engineer from the testing laboratory. The contractor shall not place concrete prior to approval of the concrete mixes and laboratory test results.

During progress of work, if concrete strength and quality as determined by cylinders and tests taken by Engineer fail to attain the requirements specified, suspend all concrete work and make necessary adjustments to obtain required results.

A mix using different proportions or aggregate sizes of any of the concrete materials in the mix, may be required to satisfy a particular production schedule or for other reasons. Any requested and authorized alteration to proportions of any of the concrete materials in the mix shall be made at no expense to the City.

The Contractor shall design mix to meet the following requirements unless otherwise specified:

1. Entrained air range 3 percent to 6 percent (percent by volume). AASHTO T 152
2. Slump range - 2 inches to 4 inches (50.80 mm to 101.60 mm). AASHTO T 119
3. Maximum water-cement ratio, gallons (liter) of water per 94 pound (42.6384 kg) sack of cement, shall be determined by the Engineer in accordance with the required compressive strength.
4. When using 3/4 inch (19.05 mm) maximum size aggregate, the fine aggregate shall be between 40 percent and 48 percent of the total aggregate used.

5. When using 1 ½ inch (38.10 mm) maximum size aggregate, the fine aggregate shall be between 35 percent and 45 percent of the total aggregate used.
6. When specified, use a water-reducing admixture in conformance with manufacturer's recommendations.
7. Conform to the following minimum cement content per cubic yard (m<sup>3</sup>) for class specified:

Class (Compressive strength f'c')	Minimum Cement Content
2500	518 Pounds (234.96kg) (5.5 sacks)
3000	564 Pounds (255.83kg) (6.0 sacks)
3300	592 Pounds (268.53kg) (6.3 sacks)
4000	658 Pounds (298.47kg) (7.0 sacks)
4500	677 Pounds (307.09kg) (7.2 sacks)
5000	705 Pounds (319.79kg) (7.5 sacks)
5500	733 Pounds (332.49kg) (7.8 sacks)
6000	752 Pounds (341.11kg) (8.0 sacks)

Tests for strength shall be made in accordance with the following:

Molding Concrete Specimens in the Field	AASHTO T 23
Compressive Strength of Molded Cylinders	AASHTO T 22

Curing of cylinders shall conform to AASHTO T 23 except as modified herein.

#### 602.03.03 Consistency

In general, use a mixture which contains the minimum amount of water consistent with required workability. Consistency of concrete shall be gauged by ability of equipment to properly place it without segregating or honeycombing, and not by the difficulty in mixing or transporting.

#### 602.03.04 Measurement of Materials

Provide facilities for weighing and accurately measure all materials by weight, except water, when batching concrete; weigh fine and coarse aggregates separately. Take representative samples and determine moisture content for each kind of aggregate. Store or handle aggregates so that their water content remains reasonably constant during any day's run. Equipment for weighing materials shall provide convenient and positive means of determining quantities in the batch of concrete, and means shall be provided for addition or removal of small quantities of materials to obtain exact weight per batch. Device for measuring water shall show accurately quantity in gallons and be so designed that the water supply will be automatically cut off while water is being discharged into the mixer. Water shall be assumed to weigh 8.34 pounds per gallon (3.78 kg per 3.785 L).

#### 602.03.05 Mixing

##### 602.03.05A - General

Machine mix all concrete. Ready-mixed concrete may be used if approved by the Engineer. Approval will be given if investigation of the plant's delivery system indicates that concrete delivered to the project will conform in all respects to the requirements of ASTM C 94.

##### 602.03.05B - Mixing at Site

Mix concrete thoroughly in a batch mixer of an approved size and type which will insure a uniform distribution of materials throughout the mass.

Equip mixer with adequate water storage and a device for accurately measuring and automatically controlling amount of water used in each batch. Preferably provide mechanical means for recording the number of revolutions for each batch and automatically preventing discharge of mixer until materials have been mixed the specified minimum time.

Remove entire contents of the mixer from drum before materials for a succeeding batch are placed therein. Deposit materials composing a batch simultaneously in the mixer. Do not use any mixer having a rated capacity of less the one-sack batch. Do not charge a mixer in excess of its rated capacity.

Mix all concrete for a period of not less than 1 1/2 minutes after all materials including water, are in mixer. During the period of mixing, operate mixer at a design speed of not less than 14 nor more than 20 revolutions per minute.

The first batch of concrete materials placed in mixer shall contain a sufficient excess of cement, sand and water to coat inside of drum without reducing required mortar content of mix. Upon cessation of mixing to a considerable period, clean the mixer thoroughly.

The above specification contemplates the use of conventional revolving drum type mixers. Other types may be used with written permission of Engineer.

#### 602.03.05C - Truck Mixing

Unless otherwise authorized by Engineer, use only revolving drum type truck mixers that are watertight and so constructed that concrete can be mixed to insure a uniform distribution of materials throughout the mass.

Accurately measure all solid materials for concrete in accordance with **Subsection 602.03.04** and charge into drum at proportioning plant. Except as subsequently provided, equip truck mixer with a tank for carrying mixing water. Place only the prescribed amount of water in tank unless tank is equipped with a device by which quantity of water added can be readily verified. Mixing water may be added directly to the batch in which case a tank will not be required. Truck mixers may be required to be provided with means by which the mixing time can be readily verified by Engineer.

Do not allow any batch in a truck mixer to exceed the maximum rated capacity of mixer as stated by manufacturer and stamped in metal on the mixer. Continue truck mixing for not less than 70 revolutions nor more than 100 revolutions of drum at the rate of rotation designated by manufacturer and stamped in metal on mixer. Commence mixing after all ingredients, including water, are in drum. Additional mixing, if any, shall be of the rate of rotation as designated by manufacturer as agitating speed. Begin mixing within 30 minutes after cement has been added to either the water or aggregate. When cement is charged into a mixer drum containing water or surface-wet aggregate and when the temperature is above 90 degrees Fahrenheit (32.22°C), or when high-early strength Portland Cement is used, reduce this limit to 15 minutes.

The limitation of time between introduction of cement to aggregates and the beginning of mixing may be waived when, in the judgment of Engineer, aggregates are sufficiently free from moisture so that there will be no harmful effects on the cement.

#### 602.03.05D - Partial Mixing at Central Plant

When a stationary mixer is used for partial mixing of concrete (shrink-mixing), mixing time in stationary mixer may be no more than is required to intermingle the ingredients. After transfer to a truck mixer, further mixing at a designated mixing speed will be required only as necessary to meet requirements for uniformity of concrete as specified for truck mixing.

#### 602.03.05E - Plant Mix

Conform mixing at a central plant to requirements for mixing at site.

#### 602.03.05F - Time of Hauling and Placing Mixed Concrete

Completely discharge and place in the forms all concrete transported to project in a truck mixer or truck agitator within 90 minutes after the introduction of mixing water to cement and aggregate, or cement to aggregate, or before 250 revolutions of the truck drum or blades, whichever comes first.

As directed by Engineer, reduce this time during conditions which contribute to accelerated setting of concrete, or when temperature of concrete is 85 degrees Fahrenheit (29.44°C), or above.

Add no water to concrete during hauling or before discharge, unless ordered by Engineer. Engineer will not approve any water addition which increases the slump by more than 1 inch (25.40 mm) or exceeds the design water-cement ration.

#### 602.03.05G - Delivery

Utilize a plant capacity and transportation equipment which are adequate to insure continuous delivery of concrete during concreting operations and which will provide for proper handling, placing and finishing of concrete. Use a rate of delivery such that interval between batches does not exceed 20 minutes. Methods of delivery and handling concrete shall allow placing with a minimum of rehandling and without damage to the structure or concrete. Time interval may be reduced when deck concrete is being placed. Control delivery of concrete for decks so that deck pour will progress at a rate of not less than 20 feet (6.096 m) per hour unless some other rate of pour is approved.

#### 602.03.05H - Retempering

Mix concrete only in such quantities as are required for immediate use and do not use any which has developed initial set. Concrete which has partially hardened shall not be retempered or remixed.

#### 602.03.06 Falsework

For structures requiring poured-in-place concrete superstructures, working drawings and calculations for falsework prepared by an Engineer registered to practice in the State of Oregon may be required to be submitted for approval.

For designing falsework, assume a weight of 150 pounds (68.04 kg) per cubic foot (0.028 32 m<sup>3</sup>) for green concrete. Design and construct all falsework to support the total applied loads with a deflection/span ratio not to exceed 1/500 in any falsework span. Employ screw jacks or hardwood wedges to take up any settlement in formwork either before or during placing of concrete. Set falsework to give finished structure the camber specified or shown. Design falsework for post-tensioned structures to carry full dead load and any additional vertical or horizontal loads caused by the prestressing operation.

Contractor is directed to the fact that post-tensioned structures are not self-supporting until post-tensioning is complete and Contractor shall consider this fact in the design, maintenance, and protection of falsework.

#### 602.03.07 Forms

Make all forms mortar-tight, set them so finished concrete will conform to proper dimensions and contours, and make them sufficiently rigid to prevent distortion due to pressure of the concrete and other loads incident to construction operations. Construct and maintain forms to prevent warping and opening of joints.

Design forms to withstand effect of vibration of concrete as it is placed.

Support deck forms for concrete box girder spans by girder stems. Posts or other supports for deck forms will not be permitted to come in contact with bottom slab of box girder.

Make wood forms for concrete surfaces not subject to backfill of dressed lumber of uniform thickness with a form liner of an approved type. Wood forms for interior cells of box girders may be made with or without a form liner. Shiplap or S4S boards are acceptable provided forms are mortar-tight. Plywood will be acceptable as a form liner if supported in an approved manner. Insure that all formwork for

exposed concrete surfaces is smooth with grain running in the same direction to give a good finished appearance. Construct metal ties or anchorages within forms to permit their removal to a depth of at least 1 inch (25.40 mm) from face without injury to concrete. Where wire ties are permitted, all wires, upon removal of forms, shall be cut back at least 1/4 inch (6.35 mm) from face of concrete with chisels or nippers; for green concrete, nippers are necessary. Design all fittings for metal ties so that, upon their removal, cavities which are left will be of smallest possible size. Fill cavities with cement mortar and leave surface sound, smooth, even and uniform in color.

Fillet forms at all sharp corners and bevel or draft in the case of all projections, such as girders and copings, to insure easy removal. For narrow walls and columns, where bottom of form is inaccessible, leave lower form boards loose so that they may be removed for cleaning out extraneous material immediately before placing of concrete.

Keep forms in place for periods, which shall be determined as hereinafter specified. When forms appear to be unsatisfactory in any way, either before or during placing of concrete, work may be ordered stopped until defects have been corrected.

Maintain shape, strength, rigidity, watertightness, and surface smoothness of re-used forms at all times. Do not re-use warped or bulged lumber, and do not re-use any forms which, in the opinion of Engineer, are unsatisfactory in any respect. Thoroughly clean re-used forms of all dirt, mortar, and foreign matter.

Treat all forms with an approved form oil or wax or saturate with water immediately before placing concrete. Do not use material which will adhere to or discolor concrete.

#### 602.03.08 Removal of Falsework and Forms

Assume all responsibility for all damage resulting from premature removal of forms. Do not place earth backfill against walls below grade, and do not remove forms and shoring from structural slabs or beams until concrete has reached an actual field strength equal to 75 percent of the specified 28 day design field strength. Actual field strength shall be determined from field cured test cylinders which shall be cured under conditions equivalent to the most unfavorable conditions for the portions of concrete which the cylinders represent.

Do not use methods of form removal likely to cause over-stressing of concrete. Do not remove forms and their supports without approval. Remove supports in such a manner as to permit concrete to uniformly and gradually take the stresses due to its own weight.

Remove all formwork from cells of concrete box girders to which access is provided, and all formwork except that necessary to support deck slab, from remaining cells of box girder.

#### 602.03.09 Weather Limitations

##### 602.03.09A - General

Assume full responsibility for the concrete work during any unusual weather conditions including but not limited to hot and cold weather. Any work not in conformance to the plans and specifications may be rejected by Engineer and replaced or repaired at Contractor's expense.

##### 602.03.09B - Hot Weather

Take special precautions for hot weather in placing, finishing, and curing concrete when the ambient temperature reaches 85 degrees Fahrenheit (29.44°C) or higher or whenever relative humidity, wind velocity, or exposure to sun at lower air temperatures are expected to cause hot weather conditions for the concrete. Specify cool materials for the mix, add additional water to forms, subgrades, and to other areas to be in contact with concrete but allow no standing water when concrete is placed; schedule work carefully to place and finish concrete as rapidly as possible, reduce evaporation from concrete with windbreaks, covers, and fog nozzles and begin curing as soon as possible.

##### 602.03.09C - Cold Weather

Do not place concrete when ambient temperature is below 35 degrees Fahrenheit (1.67°C) without written permission of Engineer. When directed by Engineer, enclose structure in such a way that concrete and air within enclosure can be kept above 60 degrees Fahrenheit (15.56°C) for a period of seven days after placing concrete. If high-early strength cement is used, this period may be reduced by Engineer. When enclosures are used to maintain specified temperatures, furnish a 24-hour temperature recording thermometer to record all temperature within enclosure.

Supply heating apparatus such as stoves, salamanders, or steam equipment and the necessary fuel. When dry heat is used, provide means of maintaining atmospheric moisture. Heat all aggregates and mixing water to a temperature of at least 70 degrees Fahrenheit (21.11°C), but not more than 150 degrees Fahrenheit (65.56°C); aggregates may be heated by either steam or dry heat.

Where practicable, forms insulated with at least 2 inch thick (50.80 mm) blankets, made of fiberglass, rock wool, balsam wool, or similar commercial material capable of maintaining surface of concrete at no less than 50 degrees Fahrenheit (10.0°C) may be used in lieu of other protection of concrete involving housing and heating. When forms are insulated, protect exposed horizontal surfaces with a similar layer of the insulating materials securely fastened in place. If insulated forms do not maintain proper temperature at surface of concrete, use auxiliary protection and heat.

#### 602.03.10 Handling and Placing

##### 602.03.10A - General

Do not place any concrete without the approval of Engineer. Concrete placed without Engineer's approval may be rejected and removal required. Provisions of this Subsection shall apply to precast piling and other precast members, except that manufacturers' methods of vibrating may be used if approved.

In preparation for placing of concrete, remove all sawdust, chips, and other construction debris and extraneous matter from interior of forms. Remove struts, stays, and braces, serving temporarily to hold forms in correct shape and alignment prior to placing of concrete, when the concrete placing has reached a position rendering their service unnecessary. Remove these temporary members entirely from the forms and do not leave buried in the concrete.

Do not use concrete which does not reach its final position in forms within time stipulated in **Subsection 602.03.05F**.

Place concrete so as to avoid segregation of material and displacement of reinforcement. Do not use long troughs, chutes, and pipes for conveying concrete from mixer to forms except with written authorization of Engineer. In case an inferior quality of concrete results from the use of such conveyors, Engineer may order discontinuance of their use and substitution of a satisfactory method of placing material.

For open troughs and chutes, use steel or steel lined material. Where steep slopes are required, equip chutes with baffles or make in short lengths that reverse direction of movement. Keep all chutes, troughs, and pipes clean and free from coating of hardened concrete by thoroughly flushing with water after each run; discharge water used for flushing clear of structure and do not discharge into any sewer or culvert or appurtenances thereto.

When placing operations would involve dropping concrete more than 3 feet (0.9144 m), deposit through an approved elephant trunk. Aluminum pipe will not be allowed.

After initial set of concrete, do not jar forms nor place strain on ends of reinforcing bars which project.

Thoroughly compact concrete during and immediately after depositing.

Provide compaction by mechanical vibration subject to the following provisions:

1. Use internal vibration unless special authorization of other methods is given by Engineer or as provided herein.
2. Use vibrators of an approved type and design, capable of transmitting vibration to concrete at frequencies of not less than 4,500 impulses per minute.
3. Provide intensity of vibration such as to visibly affect mass of concrete of 1 inch (25.40mm) slump over a radius of at least 18 inches (457.20 mm).
4. Provide a sufficient number of vibrators to properly compact each batch, immediately after it is placed in forms.
5. Manipulate vibrators so as to thoroughly work concrete around reinforcement and embedded fixtures and into corners and angles of forms.
6. Apply vibration at point of deposit and in area of freshly deposited concrete. Insert vibrators and withdraw from concrete slowly. Use vibration of sufficient duration and intensity to thoroughly compact concrete but do not continue so as to cause segregation. Do not continue vibration at any one point to the extent that localized areas of grout are formed.
7. Make application of vibrators at points uniformly spaced and not farther apart than twice the radius over which vibration is visibly effective.
8. Do not apply vibration directly or through reinforcement to sections or layers of concrete which have hardened to the degree that concrete ceases to be plastic under vibration. Do not use vibration to make concrete flow in forms over distances so great as to cause segregation, nor to transport concrete in forms.

9. Supplement vibration by such spading as is necessary to insure smooth surfaces and dense concrete, along form surfaces and in corners and locations impossible to reach with vibrators.

Place concrete in horizontal layers not more than 12 inches (304.80 mm) thick except as hereinafter provided. When less than a complete layer is placed in one operation, terminate in a vertical bulkhead. Place each layer and compact before preceding layer has taken initial set to avoid surfaces of separation between layers. Compact each layer so as to avoid formation of a surface of separation with a preceding layer.

When placing of concrete is temporarily discontinued, and after concrete has become firm enough to retain its form, clean off laitance and other objectionable material to a sufficient depth to expose sound concrete. Smooth top surface of concrete adjacent to forms with a trowel. Where a feather edge might be produced at a construction joint, as in the sloped top surface of a wing wall, use inset formwork to produce a blocked out portion in the preceding layer which produces an edge thickness of not less than 6 inches (152.40 mm) in succeeding layer. Do not discontinue work within 18 inches (457.20 mm) of top of any face, unless provision has been made for a coping, in which case, a construction joint shall be made at under side of coping.

#### 602.03.10B - Footings, Base Slabs, Walls, and Columns

Place base slab or footings and allow to set before walls are constructed. Make provision for bonding walls to base by means of a construction joint. Use a construction joint conforming to the requirements for construction joints as hereinafter specified.

Stop concrete pours in columns and walls at bottoms of caps, cross-beams, girders, or any widened portion of the column or wall, and allow concrete to obtain shrinkage and settlement before pour is continued. Delay a minimum of two hours for pours less than 4 feet (1.2192 m) in height and a minimum of 12 hours for pours over 4 feet (1.2192 m) in height. At horizontal construction joints in walls and columns, provide a rough concrete surface or form shear keys, as shown.

#### 602.03.10C - Girders and Elevated Slabs

Deposit concrete by beginning at center of span and working from center toward ends unless otherwise permitted. For concrete in girders, deposit uniformly for full length of girder and bring up evenly in horizontal layers.

Stop concrete pours in T-beams and box girders over 4 feet (1.2192 m) in depth at bottom of deck or deck fillet and allow concrete to obtain shrinkage and settlement before pour is continued. Delay a minimum of 12 hours. Incorporate similar delays into concrete pours at intersection of any structural members where concrete settlement could cause cracking at intersection. Form mechanical shear keys between girder stems and slabs, and in vertical construction joints where permitted. In general, suitable keys may be formed by use of timber blocks approximately 2 inches by 4 inches (50.80 mm by 101.60 mm) in cross-section and having a length 4 inches (101.60 mm) less than width of girder stem. Place keys along girder stem as required, but do not exceed 1 foot (0.3048 m) center to center. Bevel key blocks and oil to insure their ready removal. Remove as soon as concrete has set sufficiently to retain its shape.

For concrete in bottom slab of box girder structures, pour to bottoms of beam stems or stem fillets. Before stems are poured, allow bottom slab concrete to cure a minimum of three days at ambient temperatures of 40 degrees Fahrenheit (4.44°C) or above, or for at least five days at ambient temperatures below 40 degrees Fahrenheit (4.44°C). In box girder spans, place construction joints at locations designated.

#### 602.03.10D - Pumping

Placement of concrete by pumping will be permitted provided approved clean equipment is used which is of sufficient size and capacity to satisfactorily handle the concrete mix specified. For discharge line of pump, use steel or rubber pipe. Provide additional cement or additives required to obtain a pumpable mix at no expense to the City.

Furnish evidence of backup means of placing structural concrete in the event of failure of equipment during placement.

#### 602.03.10E - Depositing Concrete Under Water

Approval of Engineer is required for depositing concrete under water. Deposit concrete carefully in water by means of a tremie in a compact mass, in its final position, and do not disturb after depositing. Maintain still water at point of deposit.

Place concrete seals continuously from start to finish; keep surface of concrete as nearly horizontal as practicable at all times. To insure thorough bonding, place each succeeding layer of a seal before preceding layer has taken initial set.

A tremie shall consist of a tube having a minimum diameter of 10 inches (254.0 mm), of sufficient length to reach from bottom of excavation up to concrete placing elevation above water line with an attached receptacle or hopper for receiving concrete. A jointed tremie will be permitted, provided joints are of flanged and gasketed type and waterproof. Support tremies to permit free movement of discharge end over entire top surface of work and to permit rapid lowering when necessary to retard or stop flow of concrete. At start of work and on any withdrawal of pipe for moving to a new location, close discharge end to prevent water from entering pipe. During progress of work, seal pipe entirely at all times and keep full of concrete to bottom of hopper. When a batch is dumped into hopper, induce flow of concrete by slightly raising discharge end, always keeping it in deposited concrete. Place concrete continuously until work is completed.

Dewatering may proceed when concrete seal is of sufficient strength as determined by tests. Remove all laitance or other unsatisfactory material from exposed surface by scraping, chipping, or other means which will not injure surface of the concrete.

#### 602.03.11 Construction Joints

##### 602.03.11A - General

Use construction joints only where shown or designated on the plans, unless otherwise approved. Taper wooden key forms and pre-soak or treat to prevent swelling. When placing operation is interrupted for any reason, place construction joints as approved by Engineer and provide with keys to resist shear and dowels to develop bond as directed by Engineer.

##### 602.03.11B - Bonding

Before depositing new concrete on or against concrete which has hardened, the forms shall be retightened. The surface of the hardened concrete shall be roughened as required by the Engineer, in a manner that will not leave loosened particles of aggregate or damaged concrete at the surface. It shall be thoroughly cleaned of foreign matter and laitance and saturated with water. At the juncture of the hardened and the newly deposited concrete, the cleaned and saturated surfaces, including vertical and inclined surfaces, shall first be thoroughly covered with a coating of mortar or neat cement grout against which the new concrete shall be placed before the grout has attained its initial set.

The placing of concrete shall be continuous from joint to joint. The face edges of all joints which are exposed to view shall be carefully finished true to line and elevation.

### 602.03.12 Expansion and Fixed Joints

Construct all joints according to details shown or as approved.

#### 602.03.12A - Open Joints

Place open joints in location shown. Construct by insertion and subsequent removal of a template of approved material without chipping or breaking corners of the concrete. Do not extend reinforcement across an open joint unless so shown.

#### 602.03.12B - Filled Joints

Construct poured expansion joints similar to open joints. When premolded types are specified, drive nails at about 1 foot (0.3048 m) on centers through filler to provide anchors into concrete when it is placed. Place premolded joint filler in forms in proper rigid position before concrete is poured. Install premolded joint filler in all walks to provide expansion and contraction joints at maximum 18 foot (5.4864 m) intervals and at all changes in direction, at intersections and at each side of driveway entrances.

#### 602.03.12C - Steel Joints

Shape plates, angles, or other structural shapes accurately at the shop to conform to the section of concrete. Fabricate and paint to conform to requirements of these Specifications. Take care to insure that surface in finished plane is true and free of warping. Employ positive methods in placing joints to keep them in correct position during placing of concrete. Opening at expansion joints at normal temperature shall be as shown. Avoid impairment of clearance in any manner.

#### 602.03.12D - Preformed Elastomeric Joint Seals

Use compression joint seals in the longest practicable lengths for longitudinal joints. In transverse joints, one factory splice will be permitted in joint seals where required length of material in any one joint exceeds manufacturers' standard stock lengths. Make such splices true and smooth on outside surfaces with no offsets of abutting sections and with complete bond on all abutting surfaces. Make joints clean and dry and free of spalls and irregularities which would impair a tight seal in service. Place seals in the joint under compression, as recommended by manufacturer, using a lubricant-adhesive as a covering film applied to both sides of the seal just prior to its installation.

For lubricant-adhesive material, use a compound of same base polymer as the joint seal with which it is used, blended with a suitable volatile solvent.

Lubricant-adhesive must be compatible with joint seal and concrete and be relatively unaffected by normal moisture in the concrete. It shall maintain a suitable consistency at the temperature at which joint seal is installed.

Set seal as shown and make sure it contacts walls of joint throughout its length. Longitudinal elongation of an installed seal by 3 percent or more of its original length will be cause for its removal and reinstallation.

Remove all lubricant-adhesive which comes upon the exposed top of an installed seal before it dries, and remove all seals which show twist, curl, nicks, or other malformation, as installed. Seal all ends of preformed elastomeric joint seals with a watertight plug prior to installation of joint seal. Use a foam rubber plug or other acceptable closed cell cellular material which is compressible to 15 percent of its uncompressed thickness. Plug shall be a minimum of 2 inches (50.80 mm) in length and be secured in elastomeric joint seal with an adhesive which will insure a watertight plug.

#### 602.03.13 Surface Finishing

##### 602.03.13A - General

After forms have been removed, carefully point all depressions resulting from removal of form ties or from other causes with mortar conforming to **Section 205 - Materials**. Maintain thorough saturation of concrete surface during pointing and patching. Type of finish to be used shall be as specified or as shown.

##### 602.03.13B - Wall Finishes

1. **Unexposed Wall Finish.** Patch all rock pockets, form tie holes, and other irregularities as specified above. No further finishing will be required.
2. **Ordinary Wall Finish.** Immediately after removal of forms, patch or point up all defects and cure patches. After pointings have set sufficiently, grind or fill all form marks and pointings to give a smooth surface even with the flat wall surface.
3. **Class 1 Surface Finish.** After pointing has set sufficiently, wet entire surface thoroughly and grind with a carborundum stone or an abrasive of suitable quality to remove all form marks and to remove surface film resulting from form treatment or laitance. Then, finish surface by floating with a canvas, carpet faced or cork float, using paste formed by grinding or additional paste of fine sand and cement, to fill all air holes and voids and bring surface to a smooth and uniform texture. Keep surface damp until finish has set so that

dusting will not occur when surface is rubbed. Complete the finish work within six days following placement of concrete except for those areas where it is structurally impossible to remove forms. Finish these areas as soon as forms are removed.

4. **Class 2 Surface Finish.** Prepare surface as for a Class 1 Surface Finish. After paste has been allowed to set for at least 24 hours, saturate surface thoroughly with water and paint, while damp, with a latex emulsion paint as specified. Clean surface thoroughly before painting. Apply a minimum of two coats of paint, with additional coats as necessary to provide uniformity in coverage and appearance. Second coat may be applied when previous coat is sufficiently dry so that it does not adhere to backs of fingers when touched lightly. Do not apply latex emulsion paint until concrete being finished has reached a minimum age of seven days.
5. **Brush Finish.** Finish upper horizontal surfaces such as tops of parapets, copings, and bridge seats by placing an excess of concrete in forms and removing or striking off such excess with a wooden template and forcing coarse aggregate below mortar surface. The use of mortar topping for surfaces falling under this classification will not be permitted.

After concrete has been struck off, work surface thoroughly and float with a wooden, canvas or cork float, the operation to be performed by skilled and experienced concrete finishers. Before this last finish has set, stripe surface lightly, parallel to the long dimension, with a fine brush to remove surface cement film leaving a fine-grained, smooth, but sandy texture.

6. **Float Finish.** In lieu of a Brush Finish, finish surface with a rough carpet or wood float, leaving surface even and free of voids, but distinctly sandy or pebbled in texture.

#### 602.03.13C - Slab Finishes

1. **General.** Refrain from excessive use of "Jitterbugs" or other special tools designed for the purpose of forcing coarse aggregate away from slab surface. Dusting of surfaces with dry materials will not be permitted. Compact slabs and floors thoroughly by vibration. Round off edges of slabs and tops of walls with a ½ inch radius (12.70 mm) steel edging tool, unless specified otherwise.
2. **Monolithic Finish.** Finish by screeding and floating with straightedges to bring surfaces to the required finish elevation shown. While concrete is still green, but sufficiently hardened to bear man's weight without deep imprint,

wood float to a true, even plane with no coarse aggregate visible. Apply sufficient pressure on wood floats to bring moisture to surface. After surface moisture has disappeared, steel trowel concrete to produce a smooth, impervious surface, free from trowel marks. Give an additional troweling to surface for the purpose of burnishing. Final troweling shall produce a ringing sound from the trowel. Do not use dry cement or additional water in troweling. Do not use excessive troweling.

3. **Rough Slab Finish.** Finish slabs to receive fill and mortar setting beds by screeding with straightedges to bring surface to required finish plane. Remove all laitance and leave surface clean. Subject to approval, an acceptable aggregate revealing material may be used and laitance washed off when concrete has set.
4. **Wood Float Finish.** Finish by screeding with straightedges to bring surface to required line as shown. While concrete is still green, but hardened sufficiently to bear cement finisher's weight, work float surface to a true and uniform plane with no coarse aggregate visible.
5. **Broomed Floor Finish.** Finish concrete as specified for monolithic floor finish above, except omit final troweling and finish surface by drawing a fine-hair broom lightly across surface. Do all brooming in same direction and parallel to expansion joints, or in cases of inclined slabs, perpendicular to slope, except for reservoir roof slab, broom surface in radial direction.
6. **Power Machine Finish.** In lieu of hand finishing, an approved power machine may be used for finishing concrete floors and slabs in conformance with directions of machine manufacturer and as approved.
7. **Bridge Roadway Finish.** After concrete is placed and compacted, strike it true to lines, grades, and cross sections shown. Then, float to a smooth, even texture. Quality of workmanship shall be such that the finished work, when tested with a 10 foot (3.048 m) straightedge, shows no deviation greater than 1/8 inch (3.175 mm) from required grade and cross section. After concrete has struck and floated to grade and cross section and hardened sufficiently, give it a broom finish. Use a broom, with a stiff fiber or a steel-tined broom that will mark finished concrete to a depth of not to exceed 1/8 inch (3.175 mm). Make markings of corrugations transverse to roadway center line and full roadway width, except for strips 16 inches (406.40 mm) wide along curb faces; mark these parallel to curb faces.
8. **Bridge Sidewalk Finish.** Strike off surface true to line and grade by means of a strike board and float with a wooden or cork float. Use an edging tool on

all edges and at all expansion joints. Do not allow surface to vary more than 1/8 inch (3.175 mm) under a 10 foot (3.048 m) straightedge. Broom surface at right angles to direction of traffic. Lay out sidewalk surfaces in blocks with an approved grooving tool as shown or as directed.

#### 602.03.14 Curing

Cure concrete surfaces by covering with material conforming to **Subsection 602.02.05**. Place covering as soon as concrete has hardened sufficiently to support covering without damage. Use a covering which is best suited to existing conditions. If such coverings are not required, keep surfaces moist by flushing or sprinkling. Arrange sprinkling system so outside of all forms can be kept damp for a period of seven days after placing of concrete so that no moisture is taken away from concrete by forms. Coordinate curing and finishing when both requirements are to be met at same time.

Protect slab concrete exposed to conditions causing premature drying during placing operations by providing wind breaks, fog spray, or by other approved methods.

#### 602.03.15 Pneumatically Applied Mortar

##### 602.03.15A - General

This Subsection refers to a dry mix method of premixed sand and cement pneumatically applied by suitable mechanism and competent operators, and to which mixture water is added immediately previous to its expulsion from the nozzle.

##### 602.03.15B - Proportion and Application

Use the following proportions of cement to sand based on dry and loose volumes: 1 to 4 for encasement of steel members, 1 to 3 for concrete repair, and unless specified otherwise, 1 to 4 1/2 for special linings. Apply a mortar with a minimum test cylinder strength of 3500 psi (24.1325 MPa), unless otherwise specified.

Maintain water content at a minimum for proper placement, and do not exceed 3 gallons (11.355 L) per sack of cement as place.

Use sand containing not less than 3 nor more than 6 percent moisture by weight. Mix cement and sand thoroughly before charging into the machine. Maintain a uniform velocity of material as it leaves the nozzle at a rate determined by job conditions to produce minimum rebound. Hold nozzle in such a position and at

such distance that stream of flowing material will impinge at approximately right angles to surface being covered without excessive impact. Remove rebound or accumulated loose sand from surface to be covered prior to placing original or succeeding layers of mortar.

#### 602.03.15C - Joints

Slope off pneumatically applied mortar to a thin edge at the end of any day's work or at similar stopping periods. Before placing an adjacent section, clean and wet this sloped portion thoroughly.

#### 602.03.15D - Bond

For surfaces to which pneumatically applied mortar is to be bonded, clean thoroughly of dirt, paint, grease, organic matter, and loose particles. Wet absorptive surfaces before application of mortar.

#### 602.03.15E - Curing

For pneumatically applied mortar, apply, protect, and cure to prevent its temperature from falling below 50 degrees Fahrenheit (10.0°C), or a loss of moisture from the surface for periods of seven days where normal Portland Cement is used, or three days where high early-strength Portland Cement is used. Conform to requirements for curing hereinbefore or as specified.

### 602.04.00 Measurement and Payment

#### 602.04.01 Concrete

Concrete will be measured on a lump sum basis or on a cubic yard (m<sup>3</sup>) basis for payment as shown in the proposal. In all cases the part or parts of work to be measured on each basis shall be as shown and as specified.

When reinforcing steel, metal expansion plates, or miscellaneous metal items are not specified or shown as a separate pay item in the proposal, payment for said item is considered to be incidental to the related item of work and no separate payment will be made.

#### 602.04.01A - Lump Sum Basis

Measurement and payment will be made on a lump sum basis as shown in the proposal.

#### 602.04.01B - Cubic Yard (m<sup>3</sup>) Basis

Measurement and payment will be made on a cubic yard (m<sup>3</sup>) basis for each class of concrete as shown in the proposal.

#### 602.04.02 Pneumatically Applied Mortar

Measurement and payment for pneumatically applied mortar will be made on a square foot (m<sup>2</sup>) basis for the actual number of square feet (m<sup>2</sup>) placed and accepted.

### 603 - Reinforcement

#### 603.01.00 Description

This Section covers work necessary for reinforcing steel, welded wire fabric, dowels, and accessories, for concrete structures, complete.

#### 603.02.00 Materials

##### 603.02.01 Bar Reinforcement

Use steel deformed bars conforming to ASTM A 615, Grade 40, unless otherwise shown, except that longitudinal bars in continuously reinforced concrete pavement and high strength bar reinforcement shall be Grade 60.

##### 603.02.02 Dowels

For concrete pavement, slab, or wall load transfer devices at joints and other elements, use dowels conforming to ASTM A 306, Grade 70, unless otherwise specified. Coat with plastic or other approved material for bond prevention where specified.

##### 603.02.03 Bar Mats

For bar and rod mats, use the clipped type, conforming to ASTM A 184.

##### 603.02.04 Spiral Reinforcement

Use plain wire for spiral reinforcement conforming to ASTM A 82, except that  $f'$  shall be the stress corresponding to a strain of 0.35 percent if design yield strength exceeds 60,000 psi (413.7 MPa).

#### 603.02.05 Welded Wire Fabric

Welded wire fabric shall conform to ASTM A 185.

#### 603.02.06 Ties and Supports

Use ties of 16-gauge, black, soft-annealed wire and bar supports approved by Engineer for intended use. Bar supports in beams and slabs exposed to view after stripping must be galvanized or plastic coated. Use concrete supports for reinforcing in concrete placed on grade. Galvanizing shall conform to ASTM A 153 Class D. Plastic shall not chemically react with concrete, shall be impervious and a minimum thickness of 3/32 inches (2.38125 mm) at point of contact with form.

#### 603.02.07 Certification and Identification

Furnish certification that reinforcing bars identified and delivered to project site are as specified. For identification and tagging, include copies of heat numbers, chemical compositions and physical tests performed on that heat.

#### 603.03.00 Construction

##### 603.03.01 Shop Drawings

Prior to fabrication and before ordering material, submit all order lists and bending diagrams for approval. Such approval by Engineer in no way relieves Contractor of responsibility for correctness of lists and bending diagrams. Any expense incident to the revision of material furnished in accordance with such lists and bending diagrams in compliance with plans, shall be borne by Contractor.

##### 603.03.02 Fabrication

Fabricate, ship, tag, and mark bar reinforcement in conformance with Manual of Standard Practice for Reinforced Concrete Construction of the Western Concrete Reinforcing Steel Institute.

##### 603.03.03 Delivery and Storage

Deliver steel reinforcement with suitable hauling and handling equipment. Protect at all times from injury. Keep free from dirt, detrimental rust or scale, paint, oil, or other foreign substance.

#### 603.03.04 Placing

Place all steel reinforcement accurately in positions shown on plans and hold firmly during placing and setting of concrete. For bars in top mats of footings and deck slabs, tie at all intersections. For all other bars, tie at all intersections except where spacing is less than 1 foot (0.3048 m) in each direction, tie alternate intersections.

Maintain distance from forms by means of stays, blocks, ties, hangers, or other approved supports. For blocks for holding reinforcement from contact with the forms, use precast mortar of approved shape and dimensions and with same compressive strength as concrete in which they are placed. For metal chairs in contact with exterior surface of concrete, fabricate from stainless steel conforming to ASTM A 493, Type 430. Turn legs of chairs up a minimum of 1/8 inch (3.175 mm). Separate layers of bars by precast mortar blocks or by other equally suitable devices. The use of pebbles, pieces of broken stone or brick, metal pipe, and wooden blocks will not be permitted. Reinforcement in any member shall be placed and then inspected and approved by Engineer before placing of concrete begins. Concrete placed in violation of this provision may be rejected and removal required.

If fabric reinforcement is shipped in rolls, straighten it into flat sheets before placing it. For fabric reinforcement, extend fabric to within 2 inches (50.80 mm) of edges of slab, and lap splices at least 1 1/2 courses of fabric with a minimum of 6 inches (152.40 mm). Tie laps and splices in fabric securely at ends and at least every 24 inches (609.60 mm).

#### 603.03.05 Splicing

Furnish all reinforcement in the full lengths indicated on plans. Splicing of bars, except when shown on plans, will not be permitted without written approval of Engineer. Stagger splices as far as possible.

For No. 11 bars and smaller, lap splice as shown on plans. In lapped splices, place bars in contact and wire together in such a manner as to maintain not less than the minimum clearance to the surface of concrete as shown on plans.

Lap splicing of No. 14 and No. 18 bars will not be permitted. Splice these sizes in conformance with the following:

- (a) Splice shall develop at least the specified minimum ultimate strength of reinforcing bars in compression and in tension. Where bars of different sizes or strengths are connected, the governing strength shall be the strength of the smaller or weaker bar.

- (b) Make splices by an approved mechanical butt splicing method utilizing a ferrous filler metal and an enclosing steel sleeve. Submit method to Engineer for approval prior to making splices. Completed splices will be subject to testing at no expense to the City.

#### 603.04.00 Measurement and Payment

##### 603.04.01 Incidental Basis

When not specified or shown as a separate pay item in the proposal, payment for reinforcement is considered to be incidental to related item of concrete work and no separate payment will be made.

Reinforcement in precast or prestressed beams, slabs, piles, and other items, where reinforcement is specified and included in the contract price for other pay items, will not be included in the pay item for reinforcement.

##### 603.04.02 Lump Sum Basis

Measurement and payment for reinforcement will be made on a lump sum basis as shown in the proposal.

##### 603.04.03 Unit Price Basis

Measurement and payment for reinforcement will be made on a unit price per pound (kg) basis as shown in the proposal.

### **604 - Reserved**

### **605 - Steel Structures**

#### 605.01.00 Description

This Section covers work necessary for structural steel, complete, and includes all metal parts required for permanent connection of component parts of structural steel.

#### 605.02.00 Materials

##### 605.02.01 Carbon Steel

Structural carbon steel shall conform to ASTM A 36. Class of carbon steel must, if required, be marked at the mill.

#### 605.02.02 Other Steel

For structural steel other than ASTM A 36, conform to special specifications.

#### 605.02.03 Bolts, Nuts, and Washers

##### 605.02.03A - Unfinished

Unfinished bolts (ordinary machine bolts), nuts, and washers shall conform to ASTM A 307, Grade A, unless otherwise specified.

##### 605.02.03B - High-strength

High-strength bolts, nuts, and washers shall conform to ASTM A 325.

#### 605.02.04 Rivets

Structural rivet steel shall conform to ASTM A 502, Grade 1. High-strength structural rivet steel shall conform to ASTM A 502, Grade 2.

#### 605.02.05 Mill Test Reports

Provide three certified copies of mill test reports of all steel to be used in the work for approval before any fabrication is started on material to be used on the work.

#### 605.03.00 Construction

##### 605.03.01 Shop Drawings

Submit shop drawings to Engineer for approval prior to fabrication.

##### 605.03.02 Workmanship and Finish

Provide workmanship and finish equal to the best general practice in modern fabrication shops. Use materials that are new and free from defects and of best commercial quality for purposes intended. Do not make or enlarge holes for rivets or bolts by flame cutting. Provide openings in members to permit connecting work of other trades who will furnish the necessary templates or such information as may be required. Fabricate framing to exact dimensions. The practice of flame cutting by hand to make incorrect framing fit together will not be acceptable.

### 605.03.03 Straightening Bent Material

Straighten bent or distorted plates, angles, and other shapes or built up members by approved methods that will not produce fracture or other physical or metallurgical damage. Obtain Engineer's approval for each straightening application. Make parts to be heat straightened substantially free of stress and from external forces, except stresses resulting from mechanical means used in conjunction with application of heat. Following straightening of a bend or buckle, inspect metal carefully. Any evidence of fracture is cause for rejection.

### 605.03.04 Oxygen Cutting

Steel may be flame-cut, provided a smooth surface free from cracks and notches is secured, and provided that an accurate profile is secured by use of a mechanical guide. Do not flame cut by hand unless approved by Engineer. When flame cutting is approved, make surface smooth by planing, chipping, or grinding and adjust and manipulate cutting flame so as to avoid cutting beyond prescribed lines. Fillet re-entrant cuts to a radius of not less than 3/4 inch (19.05 mm). Flame-cut surfaces shall meet the ANSI surface roughness rating value of 800. Remove notches less than 1/4 inch (6.35 mm) deep by planing, chipping, or grinding when permitted by Engineer. Engineer's specific approval must be obtained for correction of each type of member. Flare corrections from notches on a bevel of 1 to 24 or less with surface of cut.

Preheat members to be cut to a minimum temperature of 200 degrees Fahrenheit (93.33°C) to prevent edge cracks. Allow sufficient additional width to permit planing, chipping, or grinding to remove rough, burned, cracked, or otherwise defective edges. Grind corners at flame-cut edges to a radius of at least 1/16 inch (1.5875 mm) and remove any evidence of edge cracking by planing, chipping, or grinding to a depth not exceeding 1/4 inch (6.35 mm).

### 605.03.05 Edge Finishing

Plane sheared edges of material more than 5/8 inch (15.875 mm) in thickness to a depth of not less than 1/8 inch (3.175 mm) when so required. Make all sheared and flame-cut edges true to line and free from rough corners or projections. When required, grind all such edges to remove objectionable defects. Fillet re-entrant cuts as large as practicable, but never less than 3/4 inch (19.05 mm) radius, except when otherwise shown. Cut gusset plates with curved edges to exact radius shown and grind to remove any rough corners.

#### 605.03.06 Planing Bearing Surfaces

Grind or saw column ends bearing upon base and cap plates to true surfaces and correct bevels. Assemble caps and baseplates of columns for full contact. For warped or deformed plates, hot-straighten, plane or otherwise treat to secure an accurate and uniform contact. Correspondingly, surfaces of baseplates which are to come in contact with masonry must be rough-finished and free from warp or other deformations.

#### 605.03.07 Abutting Joints

Face abutting ends of compression members accurately to secure an even bearing when assembled in the structure. Face or grind ends of built-up members after they have been fabricated. Rough-finish ends of tension members at splices to secure close and neat but not necessarily to contact fitting joints.

#### 605.03.08 End Connection Angles

Make end connection angles flush with each other and set accurately as to position and length of member. In general, do not finish end connection angles unless required. Faulty assembling, however, may be cause for requiring surfaces to be milled, in which case their thickness must be reduced not to exceed 1/16 inch (1.5875 mm).

#### 605.03.09 Rivet and Bolt Holes

##### 605.03.09A - General

For all connections of main members and any other members indicated on the plans, subpunch and ream or drill holes. This requirement does not apply to holes in lateral bracing, portals, sway bracing, and other secondary members, nor to their connections to main members. For holes where reaming is not required, material 3/4 inch (19.05 mm) or less in thickness may be punched full size. Subpunch and ream, or drill all holes in steel more than 3/4 inch (19.05 mm) larger than nominal bolt diameter, except holes for anchor bolts must be 1/8 inch (3.175 mm) larger.

##### 605.03.09B - Punched Holes

Diameter of die must not exceed diameter of punch by more than 3/32 inch (2.38125 mm). Clean-cut holes without torn or ragged edges. Ream any holes which must be enlarged to admit bolts.

Punch holes so accurately that, after assembling component parts of a member, a cylindrical pin 1/8 inch (3.175 mm) smaller than the nominal diameter of punched holes may be passed through at least 75 of any group of 100 contiguous holes in the same surface, or in like proportion for any group of holes. If this requirement is not fulfilled, badly punched pieces will be rejected. If any holes will not pass a pin 3/16 inch (4.7625 mm) smaller than nominal diameter of the punched hole, it will be cause for rejection.

#### 605.03.09C - Subpunched and Reamed Holes

Punch subpunched and reamed holes for bolts having diameters greater than 3/4 inch (19.05 mm), 3/16 inch (4.7625 mm) less than nominal diameter of the bolt, and for bolts having a diameter 3/4 inch (19.05 mm) or less, punch holes 1/16 inch (1.5875 mm) less than nominal diameter of the bolt. Use punch and die with the same relative sizes as specified for full-size punched holes. After punching, ream holes to a diameter larger than nominal diameter of bolt, as specified.

#### 605.03.09D - Drilled and Reamed Holes

Ream bolt holes with twist drills or with short taper reamers. Do not direct reamers by hand. Do not use oil or grease as lubricant.

Remove burrs with a tool producing a 1/16 inch (1.5875 mm) chamfer around edge of hole.

Drill or ream holes in a completed member only after its component parts are assembled and firmly bolted together. No interchange of reamed parts will be permitted. Holes through assembled material shall not consist of both subpunched or subdrilled holes, and holes punched or drilled full-size.

Ream or drill holes cylindrical and perpendicular to member. Accuracy shall be the same as specified for punched holes except that, after reaming or drilling, 85 percent of any group of contiguous holes shall not show an offset greater than 1/32 inch (0.79375 mm) between adjacent thicknesses of metal.

#### 605.03.10 Assembling

Assemble parts accurately as shown and follow any matchmarks. Handle material carefully so that no parts will be bent, broken, or otherwise damaged. Do no hammering which will injure or distort the members. During assembly, drift holes only to bring parts into position. Do not drift to enlarge holes or distort metal. Ream any holes to be enlarged to admit rivets or bolts. For end connection angles, stiffeners, and similar parts, hold firmly in place until welded, bolted, or riveted.

For bearing surfaces and surfaces to be in permanent contact, clean off rust, loose mill scale, oil, and all other foreign substances before members are assembled. Surfaces that will be in contact when shop assembled need not be painted, unless specified otherwise.

Assemble field connections of main members, such as trusses, plate girders, or rigid frames, in shop with milled ends of compression members in full bearing. Then ream their subsize holes to specified size while connections are assembled.

#### 605.03.11 Bolted Connections

##### 605.03.11A - General

Use bolted connections only as shown. Use standard nuts for bolts and insure that washers under nut, or bolt head, are turned in tightening. Use beveled washers where bearing faces have a slope of more than 1:20 with respect to a plane normal to bolt axis.

##### 605.03.11B - High-strength Bolts

For all high-strength bolts, conform installation and inspection to ASTM A 325.

#### 605.03.12 Welding

##### 605.03.12A - General

Insure that all shop and field welding conforms to American Welding Society standards for the type of welding being done, except for bridge structures which shall conform to AASHTO Standard Specifications for Highway Bridges. Use welders certified under AWS standards for the type of welding being done. All shop and field welding including technique of welding employed, appearance and quality of welds made, and methods of correcting defective work shall conform to Structural Welding Code, AWS D1.1.

##### 605.03.12B - Workmanship

Remove all loose scale, rust, grease, paint, and other foreign material from surfaces to be welded, except that mill scale which will withstand vigorous wire brushing may remain. Do not weld when temperature of base metal is lower than zero degrees Fahrenheit. Make finished members true to line and free from twists.

For edges and ends of pieces to be joined by other than field welding, bevel, groove, or otherwise prepare by grinding or gas-cutting method, as shown.

Take every effort and precaution and use methods in making continuous welds to avoid distortion of member due to welding operation.

Make welds solid and homogeneously a part of metals joined and free from pits or incorporated slag or scale. Remove weld spatter from adjacent areas. Make surfaces of welds uniform and regular and the full area indicated or required to develop necessary strength of joint.

#### 605.03.12C - Inspection

Welds that are required to be corrected must be corrected or redone as directed at no expense to the City.

#### 605.03.13 Erecting Steel

##### 605.03.13A - General

Erect metal work, provide all tools, machinery, falsework, and appliances necessary for expeditious handling of work, remove temporary construction, and do all work required to complete erection.

##### 605.03.13B - Falsework

Design falsework properly and construct and maintain for the loads which will come upon it. If required, prepare and submit for approval plans for falsework or for changes in an existing structure necessary for maintaining it in use.

##### 605.03.13C - Misfits

Do not correct any misfit without the approval of Engineer. Be fully responsible for all misfits resulting from errors in shop fabrication or deformation resulting from handling and transportation, and make all necessary corrections in presence of Engineer. In the opinion of Engineer, when adequate corrections cannot be made, then supply replacement members when ordered by Engineer, and at no expense to the City.

#### 605.03.14 Surface Preparation and Painting

##### 605.03.14A - General

Surface preparation and painting shall conform to **Section 609 - Painting, Galvanizing, and Surface Treatment**, except as modified herein.

#### 605.03.14B - Sandblasting

After fabrication has been completed and immediately before first or shop coat of paint is applied, clean all structural steel by sandblasting. Perform sandblast cleaning by commercial methods in strict accordance with Steel Structures Painting Council Surface Preparation Specification No. 6 for Commercial Blast Cleaning.

Remove all rust, mill scale, dirt, oil, grease, and other foreign substance. Resultant steel surface shall be free from all red or yellow iron rust. Small stained areas may, with approval be left in place. After cleaning, remove all loose dust and dirt remaining on the steel before paint is applied.

#### 605.03.14C - Shop Priming

After cleaning thoroughly by sandblasting as provided for above, paint all structural steel within eight hours of sandblasting with one shop coat of primer as specified. After erection is completed, clean all holidays and damaged areas of the prime coat thoroughly and reprime with paint similar to shop coat, and give a minimum of one field coat, unless otherwise specified.

For surfaces not in contact but inaccessible after assembly or erection, paint with two coats of primer. Do not paint shop contact surfaces. Paint field contact surfaces with a shop coat of paint, except for material where a shop coat of paint would make erection difficult. Give field contact surfaces not painted with shop coat a temporary coat of approved lacquer or other protective coating if it is expected that there will be a prolonged period of exposure before erection. Remove temporary lacquer coat prior to assembly when directed.

Do not paint surfaces which will be in contact with concrete or structural steel which is to be welded before welding is complete. If structural steel is to be welded only in fabricating shop and subsequently erected by bolting, paint with one coat of paint after shop welding is finished and all slag and flux is removed. Give surfaces of iron and steel casting either milled or finished, one coat of paint.

With the exception of abutting joints and baseplates, coat machine-finished surfaces as soon as practicable after being accepted, with a hot mixture of white lead and tallow or other approved coating before removal from shop.

Paint erection marks for field identification of members and weight marks upon surface areas previously painted with shop coat. Do not load material for shipment until it has thoroughly dried, and in any case not less than 24 hours after paint has been applied.

605.04.00 Measurement and Payment

605.04.01 Lump Sum Basis

Measurement and payment for structural steel will be made on a lump sum basis as shown in the proposal.

605.04.02 Unit Price Basis

Measurement and payment for structural steel will be made on a unit price basis as shown in the proposal.

**606 - Reserved**

**607 - Reserved**

**608 - Chain Link Fence and Street Guardrail**

608.01.00 Description

This Section covers work necessary for installation of chain link fence and street guardrail.

608.02.00 Materials

608.02.01 Chain Link Fence

608.02.01A - General

Insure that chain link fence and gates conform to AASHTO M 181. Use new materials and products of recognized, reputable manufacturers or producers. Materials must carry a tag identifying manufacturer and, in case of steel fabric and barbed wire, class of zinc coating. Used, rerolled, regalvanized finish, or open-seam posts are not acceptable. All steel materials must be hot-dip galvanized after fabrication. Insure that posts and other appurtenances have a minimum zinc coating of 2.0 ounces (59.14 L) per square foot (0.0929 0 m<sup>2</sup>) of surface except that weight of galvanizing on all hardware must conform to ASTM A 153. Contractor may use zinc-coated steel, aluminum-coated steel, or aluminum alloy at his/her option provided only one material is used throughout any one project.

#### 608.02.01B - Tension Wire and Wire Ties

For all wire fabric ties, wire ties, hog rings, and tension wire furnished for use in conjunction with zinc-coated steel fabric or with aluminum-coated steel fabric, use zinc-coated steel wire or aluminum-coated steel wire. For those in conjunction with aluminum alloy fabric, use aluminum alloy wire.

Use tension wire having the same strength required for the fabric of the same material. Zinc-coated wire shall be coated with prime western spelter or equal (AASHTO M 120) applied at a rate of not less than 0.8 oz. (23.656 L) per square foot (0.0929 0 m<sup>2</sup>) of uncoated wire surface. Aluminum-coated wire shall be coated with aluminum alloy applied at the rate of not less than 0.4 oz. (11.828 L) per square foot (0.0929 0 m<sup>2</sup>) of uncoated wire surface.

For wire used for zinc-coated or aluminum-coated wire fabric ties, wire ties, and hog rings, use ductile steel coated with prime western spelter or equal (AASHTO M 120) applied at a rate of not less than 0.7 oz. (20.699 L) per square foot (0.0929 m<sup>2</sup>) of uncoated wire surface. For wire ties and hog rings for use with aluminum alloy fabric, use the same alloy.

#### 608.02.01C - Barbed Wire

Use barbed wire, if specified, conforming to ASTM A 121 and consisting of 2-strand 12 ½-gauge wire with 4-point barbs spaced evenly at 5 inch (127.00 m) intervals, with Class 3 galvanizing.

#### 608.02.01D - Top Rail

When top rail is specified, use couplings of outside-sleeve type, minimum of seven inches (177.80 mm) long. Provide springs to permit expansion movement as recommended by manufacturer. Construct top rail to extend through line post tops to form continuous brace from end to end of each stretch of fence.

#### 608.02.01E - Fittings

Include extension arms with fittings for all specified barbed wire, bracket supports, stretcher bars and clamps, clips, tension rods, brace rods, bracket type supports for barbed wire where shown.

#### 608.02.01F - Gates

Provide gates with all fittings, braces, sag rods, ball-and-socket type hinges, and single or plunger bar type latches or semiautomatic outer latches to secure gates in

opened position, as specified. Arrange latches and plunger bars for locking with padlock. Brace gates diagonally with adjustable rods to prevent sagging in conformance with manufacturer's standard practice and as approved.

#### 608.02.02 Street Guard Rails

##### 608.02.02A - Metal Beam Rail

Insure that metal beam rail is formed from either galvanized steel or aluminum alloy sheets. Conform galvanized steel to AASHTO M 180, for Class A rail. Conform zinc coating to Type 2, AASHTO M 180, applied after fabrication and subject to the single spot test. Backup plates will be accepted with ungalvanized edges and bolt holes, provided these areas are field coated with an approved galvanizing substitute. Form aluminum alloy from sheets of a minimum thickness of 0.100 inch (2.54 mm) and, except for galvanizing, meet mechanical properties, configuration, and other pertinent requirements as set forth in AASHTO M 180 for steel rail members.

##### 608.02.02B - Posts

Use Portland Cement concrete conforming to **Section 602** or steel conforming to **Section 605** as specified. Insure that each post is true in form and free from fractures, cracks, surface roughness and other defects. Steel posts must be galvanized to conform with AASHTO M 111.

##### 608.02.02C - Hardware

Provide steel bolts, nuts, washers, and other fittings which are interchangeable with similar parts and galvanized to conform to ASTM A 153. Insulate galvanized hardware used with aluminum alloy rail members from physical contact with aluminum in a manner approved by Engineer.

#### 608.03.00 Construction

##### 608.03.01 General

Construct fence and guard rail true to line, grade, and dimensions specified; do not follow any surface unevenness.

##### 608.03.02 Chain Link Fence

Dig post holes as specified, place post and fill remainder with concrete extending around posts to a point 2 inches (50.80 mm) above finished grade. Crown top

surface with a watershed finish. Fasten chain link fabric to end post with stretcher bars and clamps and to line posts and top rail or top tension wire with wire or bands at approximately 15 inch (381.00 mm) and 24 inch (609.60 mm) centers, respectively. Brace gate posts diagonally to adjacent line post to insure stability. Hang gates and adjust all hardware so that gates operate from open or closed positions as approved.

#### 608.03.03 Street Guard Rail

Excavate to lines and grades established by Engineer and to depths shown on plans. For pavement cuts, use mechanical means, such as knife-edge cutters or rotary drills. For cuts below pavement, use auger or other means which will prevent undue disturbance of abutting areas. Avoid fouling of existing bases and pavements. Repair any materials which do become fouled or replace as directed, at Contractor's expense.

Keep areas to be backfilled free from water or deleterious material which would impair stability of backfill.

In areas occupied by aggregates, bituminous material, and pavements, backfill with like materials placed to same thickness and density as adjacent materials. In other areas, backfill with granular material. Place backfill in layers not exceeding 6 inches (152.40 mm) and compact each layer to a firm, dense condition.

For adjoining areas which become misshapen or disturbed during excavating and backfilling operations, remove, replace, repair, or restore, as directed, at Contractor's expense. Dispose of excess materials in an approved manner.

Posts may be set in prior excavations or they may be driven in place, as the Contractor may elect. Remove posts, anchors, or other components which are damaged during installation and replace with sound components. Set all posts firm and at proper line, grade, and spacing within a tolerance of ½ inch (12.70 mm).

#### 608.04.00 Measurement and Payment

##### 608.04.01 Incidental Basis

When not specified or shown as a separate pay item in the proposal, payment for chain link fence, gates, or street guard rail is considered to be incidental to related items of work and no separate payment will be made.

#### 608.04.02 Lump Sum Basis

When so specified and shown in the proposal, measurement and payment for chain link fence, gates, or street guard rail will be made on a lump sum basis, which will include full compensation for all fence, gates, or guard rail within limits shown or specified.

#### 608.04.03 Unit Price Basis

When so specified and shown in the proposal, measurement and payment for chain link fence and/or guard rail will be made on a unit price basis, which will include full compensation for all chain link fence and/or guard rail work within limits shown or specified.

##### 608.04.03A - Chain Link Fence

Measurement and payment for chain link fence will be made on a linear foot (meter) basis for closed fence and on a per each basis for each width of single and double gate. Measurement will be along line and grade of each continuous run of fence as constructed.

##### 608.04.03B - Guard Rail

Measurement and payment for street guard rail will be made on a linear foot (meter) basis. Measurement will be between post centerlines along top of guard rail.

### **609 - Painting, Galvanizing, and Surface Treatment**

#### 609.01.00 Description

This Section covers work necessary for painting which includes surface preparation, application, protection, and drying of paint coatings, and supplying of all tools, scaffolding, labor, and materials necessary for entire work. Paint systems and areas to be painted for architectural work will be shown. Galvanizing is also included in this Section.

#### 609.02.00 Materials

##### 609.02.01 General

The term "Paint" as used herein includes all protective coatings and incidental materials as required. In all cases the material used as a prime coat shall be a

product recommended or approved by the manufacturer of paint to be used as a finish coat.

Do not bring any paints, other than those specified or approved, to jobsite. Oils, thinners, and driers delivered to jobsite must be only those approved for use by paint manufacturer. Do not reduce paint or induce faster drying by addition of any product designed for such purposes, except as recommended by paint manufacturer and approved by Engineer.

#### 609.02.02 Architectural Painting

##### 609.02.02A - Painting Materials

Manufacturers' names are stated to indicate type and quality of products. Products of other manufacturers of equal quality may be substituted upon approval. Formulate all paint products for architectural work with nonlead-containing pigments.

##### 609.02.02B - Colors for Architectural Painting

Colors to be used on project are shown for architectural painting. Right is reserved to deviate from any colors indicated, and, prior to commencement or painting operation, to have sample panels made. When required, prepare color panels approximately 18 inches (457.20 mm) or more square on surfaces similar to those to be painted or stained. Do not apply finish coats until sample panels, if required, are approved. Individual rooms or areas may have two or more colors or finishes on walls in one room.

##### 609.02.03 Paint for Metal Work

Formulas for paint for use on metal work shall conform to those specified.

Use factory mixed paint except those paints specified to be furnished as two or more components. Field mix all paint before applying in order to keep pigments in uniform suspension. Mix and grind ingredient material for each formula to produce a homogeneous paint, free of grit, which will not thicken, liver, gel, curdle, or settle badly nor cake in container. Amount of thinner may be modified to produce specified viscosity. Add antiskinning agents. Wetting agents and antidrier absorption agents may be added.

#### 609.02.04 Galvanizing

Materials used for galvanizing and methods of application shall conform to ASTM A 123, A 153, A 384, A 385, and A 386.

#### 609.02.05 Anodizing

Anodizing shall conform to ASTM B 580.

#### 609.03.00 Construction

##### 609.03.01 Intent

All trades employed on the jobsite must leave surfaces of their work in such a condition that only minor cleaning, sanding, and filling is required by the painting trade. Prepare metals as specified. Prepare all surfaces in accordance with printed directions and recommendations of paint manufacturer whose product is to be applied to a given surface.

##### 609.03.02 Paint Delivery and Storage

Deliver all materials to jobsite in unopened containers that plainly show, at time of use, designated name, formula, color, date of manufacture, manufacturer's directions, and name of manufacturer. Store paints in a suitable protected area that is maintained between 40 degrees Fahrenheit (4.44°C) and 100 degrees Fahrenheit (37.78°C), except for epoxy materials which must be stored at 70 degrees Fahrenheit (21.11°C) to 90 degrees Fahrenheit (32.22°C). Keep paint material sealed or covered when not in use.

##### 609.03.03 Protection of Materials Not to be Painted

Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, nameplates on machinery, and other surfaces not intended to be painted. Provide drop cloths to prevent paint materials from falling on or marring any adjacent surfaces. Protect working parts of all mechanical and electrical equipment from damage during surface preparation and painting process.

##### 609.03.04 Surface Preparation for Architectural Painting

Prepare surfaces for architectural painting in conformance with best practice of trade and in strict conformance with paint manufacturer's printed directions and recommendations, and these Specifications. Surfaces must be dry and thoroughly

cleaned of foreign materials. Before applying any coating, inspect surface for defects which would cause paint failure or result in an unsightly surface. Fill defects or remove so that surfaces are in proper condition for painting. Bring any remaining defects to attention of Engineer in writing. If Contractor elects to ignore any unsuitable surface condition and applies his/her coating(s), he/she will be held responsible for any resulting unsatisfactory surface finish, and will be required to refinish work at no expense to the City.

Remove all loose paint, mortar, dirt, and other foreign material from existing masonry walls to be painted. Repair cracks, checks, or other imperfections with approved filler.

Etch concrete floors to be painted with a 10 percent muriatic acid solution until an open faced granular texture is obtained. Thoroughly rinse with fresh water and dry for 72 hours in good drying weather.

#### 609.03.05 Preparation of Metal Surfaces

Clean surfaces of metal to be painted thoroughly, removing rust, old loose paint, loose mill scale, dirt, oil or grease, and other foreign substances. Unless cleaning is to be done by sandblasting, neutralize all weld areas before cleaning with a proper chemical and thoroughly rinse with water. Methods of cleaning are provided herein. Any of these methods may be used unless otherwise specified.

##### 609.03.05A - Hand Cleaning

Remove rust, loose paint, loose mill scale, and dirt by use of metal brushes, scrapers, chisels, hammers, or other approved means. Remove oil and grease by use of an approved solvent or benzine. Wipe excess solvent from work before proceeding with subsequent operations. Use bristle or wood fiber brushes for removing loose dust.

##### 609.03.05B - Sandblasting

Remove all loose mill scale and other substances down to bare metal. Give special attention to cleaning of corners and re-entrant angles. Before painting, remove sand adhering to steel in corners and elsewhere. Obtain Engineer's approval of cleaning prior to painting.

##### 609.03.05C - Flame Cleaning

Clean all metal except exposed inside of boxed members or surfaces inaccessible to flame-cleaning, in accordance with the following operations.

Clean and dehydrate surfaces to be painted, free of occluded moisture, by passage of approved oxyacetylene flames. Apply oxyacetylene flames over surfaces of steel in such manner and at such speed that surfaces are dehydrated. Free dirt, rust, loose scale, blisters or scabs, and similar foreign matter by rapid, intense heating of flames. Do not traverse flames so slowly that loose scale or other foreign matter is fused to surface of steel.

Promptly after application of flames, wire-brush surfaces of steel. Hand-scrape wherever necessary, and then sweep and dust to remove all free material and foreign particles. Use of compressed air for this operation will not be permitted.

#### 609.03.05D - Preparing Galvanized Surfaces

For galvanized and nonferrous metal surfaces which are required to be painted, apply one primer coat of specified formula.

#### 609.03.06 Dry Film Thickness and Number of Coats

Dry film thickness and number of coats of paint for all areas of construction shall be as specified.

Where two successive coats of the same color paint are to be applied, make first coat of a slightly different shade to differentiate it from second coat. Tint undercoats to approximate final color.

Furnish at the project at least one properly calibrated and approved dry film thickness gauge during entire painting process.

#### 609.03.07 Weather Limitations

Do not apply paint in temperatures below 40 degrees Fahrenheit (4.44°C), nor in dust or smoke-laden air, nor in damp or humid weather, unless approved. Do not apply paint upon damp or frosted surfaces, nor upon surfaces hot enough to cause paint to blister. For material painted under cover in damp or cold weather, keep under cover until dry or until weather conditions permit its exposure in the open.

#### 609.03.08 Application

Accomplish painting in a neat and workmanlike manner and in strict conformance with manufacturer's recommendations. Apply paint with hand brushes, pads, rollers, or by spraying. Regardless of method used, apply coating of paint smoothly and spread uniformly so that no excess paint will collect at any point. Follow paint applied with spray equipment immediately by brushing when necessary to secure

uniform coverage and to eliminate wrinkling, blistering, and airholes. When painting indoors, provide indoor illumination of a minimum of 100 foot-candles (10.76 Lumens/m<sup>2</sup>) on surfaces being painted.

Insure that work is free from runs, bridges, shiners, laps, or other imperfections. Prevent settling of dust or any other improper condition while paint is setting and repair any damaged coats at no additional expense to the City.

#### 609.03.09 Inaccessible Surfaces

For surfaces of steel that will be inaccessible to convenient cleaning and painting after complete assembly, such as inside surfaces of boxed members, clean prior to assembly. In welded work, schedule fabrication, cleaning, painting, and assembly resulting in a paint system that is not damaged in any way by welding. Clean, prime, and paint structurally steel members in conformance to **Subsection 605.03.14**.

#### 609.03.10 Drying Time

Allow sufficient time between coats to assure thorough drying of previously applied paint. For materials painted in shop or on ground at jobsite, do not load for shipment nor move until paint is thoroughly dry, and in any case not less than 24 hours after paint has been applied. Touch up material which has been delivered to job with a shop prime coat as required to recoat all abraded areas prior to receiving any additional coatings.

#### 609.03.11 Paint Compatibility

Exact nature of existing coatings is not known in all cases, and, while it is assumed that they have oxidized sufficiently to prevent lifting or peeling when overcoated with paints specified, check compatibility by application to a small area prior to starting painting. If lifting or other problems occur, notify Engineer.

#### 609.03.12 Repairs to Factory-Finished Coatings

Repair abraded areas on factory-finished material in strict accordance with manufacturer's directions. Insure that repaired areas are equal to original finish and not visible.

#### 609.03.13 Galvanizing

Vent all closed or blind pipe sections properly to permit escape of gases or vent as otherwise required by galvanizer. Galvanize all bolts, nuts, washers, and similar

fastening. Hot-dip galvanize all items indicated to be galvanized after fabrication, except that parts bolted together must be galvanized before final assembly. Coat damaged areas with galvanizing repair material as directed.

#### 609.03.14 Electrolytic Protection

Where aluminum is in contact with dissimilar metals or to be embedded in masonry or concrete, apply one coat of coal-tar coating as approved to contact surfaces. Allow paint to dry before installation of material. Protect painted surfaces during installation.

#### 609.03.15 Painting Aluminum

Paint or coat all aluminum surfaces to be in contact with dissimilar materials as specified.

#### 609.03.16 Cleanup of Work Area

Place all cloths and waste that might constitute a fire or other hazard in closed metal containers or destroy at end of each day. Upon completion of work, remove all staging, scaffolding, and containers from site or destroy in an approved manner. Remove paint spots, oil, or stains upon adjacent surfaces and floors completely and leave entire job clean and acceptable.

#### 609.04.00 Measurement and Payment

##### 609.04.01 Incidental Basis

When not specified or shown as a separate pay item in the proposal, payment for painting, anodizing, or galvanizing is considered as incidental to related items of work, and no separate payment will be made.

##### 609.04.02 Lump Sum Basis

When so specified and shown in the proposal, measurement and payment for painting, anodizing, or galvanizing will be made of a lump sum basis.

## 610 - Slope Protection

### 610.01.00 Description

This Section covers work necessary for slope paving or riprap as slope protection.

Slope paving shall consist of precast cement concrete blocks, poured Portland Cement concrete, pneumatically placed Portland Cement concrete, and asphalt concrete paving, constructed on prepared slopes or filter blanket or other places.

### 610.02.00 Materials

#### 610.02.01 Paving Blocks

Precast cement concrete blocks must conform to ASTM C 90 for hollow block and C 145 for solid block, Grade N II. Blocks may be manufactured with integral spacer devices that will provide required ½ inch (12.70 mm) mortar joint.

#### 610.02.02 Wire Mesh

Wire mesh shall conform to ASTM A 185.

#### 610.02.03 Asphaltic Materials

Use asphaltic materials conforming to requirements of **Subsection 205.02.13 Asphalt Materials**.

#### 610.02.04 Broken Stone

For loose riprap, use stone that is hard, durable, angular in shape, resistant to weathering, and meets gradation requirements for class specified. Neither breadth nor thickness of a single stone must be less than one-third its length. Rounded stone or boulders will not be accepted unless authorized. Broken concrete may be substituted for stone. Shale or stone with shale seams is not acceptable.

Select sources from which stone is obtained well in advance of time when material will be required in work. Acceptability of stone will be determined by previous use records or by tests as determined to be appropriate. If testing is required, furnish suitable samples of stone taken in presence of Engineer at least 25 days in advance of time when placing of riprap is expected to begin.

In absence of satisfactory previous use records, insure that stone conforms to the following requirements:

Apparent Specific Gravity (AASHTO T 85)	2.5 Minimum
Percent Absorption (AASHTO T 85)	6 Maximum
Degradation Passing No. 20 Sieve Sediment Height	35 Percent Maximum 8-inch (203.20mm) Maximum
Soundness (AASHTO T 104) Average Loss for 2 1/2" - 1 1/2" (63.50- 38.10mm) and 1 1/2" - 3/4" (38.10-19.05mm) fraction	16 Percent

Use riprap free from overburden, spoil, shale, and organic material.

Grading of loose riprap by class and size of stone shall conform to the following:

Class 50	Class 100	Class 700	Class 2000	Percent (by Weight)
Size of Stone - Pounds (Kg)				
50-30 (22.68-13.61)	100-60 (45.36-27.22)	700-500 (317.52-226.80)	2000-1400 (907.20-635.04)	20
30-15 (13.61-6.804)	60-25 (27.22-11.34)	500-200 (226.80-90.72)	1400-700 (635.04-317.20)	30
15-2 (6.804-0.907)	25-2 (11.34-0.907)	200-20 (90.72-9.072)	700-40 (317.20-18.144)	40
Less than 2 (0.9072)	Less than 2 (0.9072)	Less than 20 (9.072)	Less than 40 (18.144)	10

Grade each load of riprap reasonably well from smallest to maximum size specified.

Control of gradation will be by visual inspection as herein set forth. Provide, at a location satisfactory to Engineer and in close proximity to project, a mass of rock sample of at least 5 tons (4.536 metric ton) meeting gradation for class specified. This sample will be used as a frequent reference for judging gradation of riprap supplied. Any difference of opinion between Engineer and Contractor will be resolved by dumping, checking, and estimating the gradation of two random truck loads of stone. Provide mechanical equipment, a sorting site, and labor needed to assist in checking gradation at no additional expense to the City.

#### 610.02.05 Filter Blanket

For a filter blanket, provide one or more layers of gravel or rock of thickness and gradation designated. All material comprising filter blanket must be composed of tough, durable particles, reasonably free from thin, flat, and elongated pieces, and containing no organic matter nor soft, friable particles in quantities in excess of those approved.

#### 610.02.06 Wire Enclosed Stone

##### 610.02.06A - Stone

Provide hard, durable, crushed, quarried, or natural stone, or broken concrete having an apparent specific gravity of not less than 2.4 for stone aggregate. Do not allow absorption to exceed 4 percent, unless otherwise approved. Insure that stone is free of weak laminations and cleavages, and of a quality that will not disintegrate on exposure to water or weathering. For wire-enclosed stone aggregate, use round or angular stones. Not less than 95 percent of stone must be retained on a screen or wire having 2 inch square (1290.40 mm<sup>2</sup>) openings.

##### 610.02.06B - Wire

Provide chain link fabric for wire enclosure meeting AASHTO M 181 for steel fabric, 11-gauge 2 inch (50.80 mm) mesh with Class I coating in accordance with ASTM A 392, knuckled selvage both edges or, welded wire fabric meeting AASHTO M 55 for 11-gauge, 2 inch (50.80 mm) spacing of horizontal and vertical, with Class I coating in accordance with ASTM A 116.

Use galvanized 12 1/2-gauge smooth steel wire for lacing and tie wire. In lieu of lacing, 9-gauge galvanized hog rings at 4 inch (101.60 mm) spacings may be used for fastening ends, sides, and top panels.

#### 610.02.07 Sacked Concrete

Provide Portland Cement concrete in loosely woven burlap sacks of roughly 19.5 by 26 inch (495.30 by 660.40 mm) dimensions. Control slump of cement concrete between 3 and 5 inches (76.20mm - 127.00 mm). Use concrete with a minimum 28 day compressive strength of 2,200 psi (15.169 Mpa).

## 610.03.00 Construction

### 610.03.01 Slope Preparation

Insure that slopes to be protected are free of brush, trees, stumps, and other organic material and dressed to a smooth surface. Remove all soft or spongy material to depth shown or as directed, replace with approved material and compact to density as specified. Dig toe trench when and as shown, and maintain until riprap is placed.

Provide protection for structural foundations as early as foundation construction permits. Clean area to be protected of waste materials and prepare surfaces to be protected as shown.

Shape slopes to allow full thickness of specified riprap and any bedding or filter gravel. Do not make slopes steeper than natural angle of repose of slope as shown or directed. Wherever possible, excavate to undisturbed material, or where this is not possible, compact underlying material to at least 90 percent of maximum at optimum moisture content as determined by AASHTO T 99.

### 610.03.02 Paving Blocks

Place specified paving blocks in a uniform plane and in such a manner that they rest firmly and evenly against slope with no rocking. Place blocks in horizontal parallel courses and break joints in successive courses with preceding course to form a running bond. Grout joints between blocks to provide neat appearing, dense, and impervious joints, using a grout which has a thick, creamy consistency.

### 610.03.03 Poured Portland Cement Concrete

Place cement concrete upon slope in such a manner as to form a compact, dense and impervious concrete with a uniform plane surface. Make thickness 4 inches (101.60 mm) unless otherwise shown or specified.

Lap wire mesh a minimum of one mesh spacing. Fasten laps securely at ends. During placement of concrete, place wire mesh reinforcement, and hold so as to provide a minimum of 1 1/4 inches (31.75 mm) of cover.

Cure where applicable in conformance with requirements contained in **Section 602**.

Make two test cylinders for each full day's operation. Furnish cylinders 6 inches (152.40 mm) in diameter and 12 inches (304.80 mm) high, in conformance with AASHTO T 23.

Cylinders must develop a minimum compressive strength of 3,000 pounds (1 360.8 kg) per square inch (645.2 mm<sup>2</sup>) at age of 28 days.

#### 610.03.04 Pneumatically Placed Portland Cement Concrete

Obtain Engineer's approval of type of equipment and method of operation before placement of any portion of slope protection.

Lap wire mesh a minimum of one mesh spacing. Fasten laps securely at ends. During placement of concrete, hold reinforcement so as to provide a minimum of 1 1/4 inches (31.75 mm) of cover.

Protect all retaining walls, columns, and structures from concrete splash or overspray. Provide suitable covering if such protection is deemed necessary.

#### 610.03.05 Asphalt Concrete Slope Paving

Apply a prime coat as herein specified to the prepared slope surface before paving with asphalt mix. Deposit and compact asphalt concrete mix on slope in such a manner so as to form a compact, dense, and impervious asphalt pavement with a uniform plane surface. Provide a total thickness of 4 inches (101.60 mm), compacted in two layers. After each lift of asphalt bituminous mixture has been spread, struck off, and surface irregularities and other defects remedied, compact thoroughly and uniformly to a minimum of 95 percent of relative maximum density as determined by AASHTO T 230. Maximum density shall be determined by AASHTO T 245 or AASHTO T 246.

As specified, place wire mesh between two layers of asphalt concrete.

Apply a tack coat as specified between each lift.

If specified, apply an asphalt seal coat to compacted finished surface of the asphalt concrete pavement.

#### 610.03.06 Broken Stone Riprap

Place broken stone riprap on the prepared area in a manner which will produce a reasonable well graded uniform mass of stone. Place to full course thickness in one operation in such a manner as to avoid displacing underlying material.

Distribute larger stones well and conform entire mass of stone approximately to gradation specified.

Place and distribute all material going into riprap protection so that there will be no large accumulations of either larger or smaller sizes of stone.

Place all sizes of riprap in proper proportions to produce a fairly compact stone protection. Hand placing or rearranging of individual stones by mechanical equipment may be required to the extent necessary to secure results specified.

Unless otherwise approved, place riprap in conjunction with construction of embankment with only sufficient lag in construction of stone protection as may be necessary to allow for proper construction of the portion of embankment protected and to prevent mixture of embankment and stone. Maintain broken stone slope protection until accepted and replace any material displaced by any cause at no additional expense to the City.

Where riprap and filter material are placed under water, increase thicknesses as shown or as directed, and use methods that will minimize segregation and insure that minimum required thickness of well graded material will be obtained in both stone and filter.

#### 610.03.07 Grouted Stone Riprap

Place stones on the prepared slope substantially to dimensions shown. Moisten stones thoroughly and sluice any excess of fines to underside of riprap before grouting.

Deliver grout which has a thick, creamy consistency to the place of final deposit by any means that will insure uniformity and prevent segregation of the grout. Spade or rod grout into interstices to completely fill voids in the riprap. During pressure grouting, do not unseat stones. Penetrate with grout to depth shown on plans. When a rough surface is specified, brush stone until from one-quarter to one-half of depth of surface stone is exposed. For a smooth surface, fill interstices with grout to within a half-inch (12.70 mm) of the surface.

Provide weep holes though riprap if shown or directed. Where depth specified for grouting is in excess of 12 inches (304.80 mm), place riprap in lifts of 12 inches (304.80 mm) or less and grout each lift prior to placing next lift. Construct and grout succeeding lifts before grout in previous lift has hardened.

Do not place grout in freezing weather or when there is frost on riprap. Protect grout from freezing after placement.

#### 610.03.08 Filter Blanket

When specified, place a filter blanket on prepared area to full thickness of each layer in one operation, using methods which will not cause segregation of particle sizes within the layer. Make surface of finished layer reasonably even and free from mounds or irregularities. Place additional layers of filter material, when required, in same manner, using methods which will not cause mixture of material in different layers.

#### 610.03.09 Wire Enclosed Stone

Hand or machine form wire enclosure segments to dimensions shown. Place, lace and fill them to provide uniform, dense, protective coat, shaped and located as approved.

Tie each wire cage to all adjoining cages along all contacting edges at intervals of 6 inches (152.40 mm). Install wire cages and riprap according to manufacturer's instructions, or as approved.

#### 610.03.10 Sacked Concrete

Use approved burlap sacks as herein specified and fill with concrete, allowing only enough space in sack for folding at top. Place bags on prepared slope as soon after mixing as possible. Place bags by staggering joints of each successive tier. Place bags as shown or as directed.

#### 610.03.11 Finishing Slope Paving

Finish newly constructed cement concrete surfaces by means of a wood float and score as shown.

Roll or compact newly constructed asphalt surfaces to a smooth surface free from irregularities. Finished surface of both cement concrete and asphalt surfaces must not vary more than 0.03 foot (9.144 mm) from planned grades, dimensions or elevations at any point.

#### 610.03.12 Riprap Finishing

Install riprap so surfaces present a reasonably neat and regular appearance and generally conform to within 0.2 foot (60.90 mm) of planned grades, dimensions, or elevations as approved.

## 610.04.00 Measurement and Payment

### 610.04.01 Measurement by Square or Cubic Yard (m<sup>3</sup>)

Measurement of quantities of slope protection to be paid for on a square yard (m<sup>2</sup>) basis or a cubic yard (m<sup>3</sup>) basis will be determined from dimensions shown or limits established by Engineer for type of slope protection placed and accepted. Slope protection placed outside of these dimensions or limits will be considered to have been constructed for Contractor's convenience and no payment will be made therefor.

### 610.04.02 Measurement by Ton (metric ton)

#### 610.04.02A - Asphalt Concrete, Stone

Measurement will be based on number of tons (metric ton) of slope protection material, as weighed on approved and tested scales. Present trip tickets at the end of each day to Engineer to verify the material is delivered.

On each trip ticket, show date and time of delivery, truck number or driver's name, and net weight of material.

#### 610.04.02B - Asphalt Prime, Tack, Seal Coats

Quantities of bituminous cements normally shipped in tank cars or tank trucks, when they are to be paid for by the ton (metric ton), will be determined from volume computations of materials when at a temperature of 60 degrees Fahrenheit (15.55°C), with standard recognized correction factors applied when materials are measured at any temperature other than 60 degrees Fahrenheit (15.55°C). When bituminous materials are shipped by truck or transport, net certified weights or volume, subject to correction for loss or foaming, may be used for computing quantities. Water added to emulsion will not be paid for as emulsified asphalt. Pay quantity shall be amount of undiluted emulsion used.

### 610.04.03 Payment on Lump Sum Basis

When shown in the proposal, payment will be made on a lump sum basis and this payment will include full compensation for all work and materials necessary for the slope protection within limits shown and as specified.

#### 610.04.04 Payment on Unit Price Basis

Payment will be made for any or all of the following items as are listed as pay items in proposal for any particular contract:

	Payment Item	Unit of Measure
1.	Preparation of Slopes	Per S.Y. (m <sup>2</sup> )
2.	Paving Block Slope	Per S.Y. (m <sup>2</sup> )
3.	Poured Cement Concrete Slope Paving	Per S.Y. (m <sup>2</sup> )
4.	Pneumatically Placed Cement Concrete Slope Paving	Per S.Y. (m <sup>2</sup> )
5.	Asphalt Concrete Slope Paving (with or without wire mesh specified)	Per S.Y. (m <sup>2</sup> ) or Ton (metric ton)
6.	Asphalt Prime Coat	Per Ton (metric ton)
7.	Asphalt Seal Coat	Per Ton (metric ton)
8.	Broken Stone Riprap (class of stone specified)	Per C.Y. (M <sup>3</sup> ) or Ton (metric ton)
9.	Grouted Stone Riprap (class of stone specified)	Per C.Y. (M <sup>3</sup> ) or Ton (metric ton)
10.	Filter Blanket (gradation specified)	Per C.Y. (M <sup>3</sup> ) or Ton (metric ton)
11.	Wire Enclosed Stone	Per C.Y. (M <sup>3</sup> )
12.	Sacked Concrete	Per C.Y. (M <sup>3</sup> )