SECTION 700

STRUCTURES

SECTION 701 – STRUCTURAL PORTLAND CEMENT CONCRETE

701-1 DESCRIPTION

This item shall consist of either reinforced or non-reinforced structural portland cement concrete, prepared and constructed in accordance with these specifications at the locations and of the form and dimensions shown on the plans. The concrete shall be composed of coarse aggregate, fine aggregate, portland cement, admixtures, and water.

701-2 MATERIALS

701-2.1 GENERAL. Only approved materials conforming to the requirements of these specifications shall be used in the work. They may be subject to inspection and tests at any time during the progress of their preparation or use. The source of supply of each of the materials shall be approved by the ENGINEER before delivery or use. Representative preliminary samples of the materials shall be submitted by the CONTRACTOR, when required, for examination and test. Materials shall be stored and handled to insure the preservation of their quality and fitness for use and shall be located to facilitate prompt inspection. All equipment for handling and transporting materials and concrete must be clean before any material or concrete is placed therein.

Identify an acceptable concrete wash out area(s). Dumping concrete or concrete waste within the CITY's right-of-way or easements including the storm water system or on adjacent properties is prohibited without the written consent of the CITY or the affected property owner.

In no case shall the use of pit-run or naturally mixed aggregates be permitted. Naturally mixed aggregate shall be screened and washed, and all fine and coarse aggregates shall be stored separately and kept clean. The mixing of different kinds of aggregates from different sources in one storage pile or alternating batches of different aggregates will not be permitted.

Prior to construction, the CONTRACTOR shall submit for approval by the ENGINEER a Certified Analysis of materials listed in Sub-Section 701-2.2, 701-2.7, 701-2.8 and 701-2.9.

701-2.2 PORTLAND CEMENT. The cement used in the work shall be Air Entrained Portland Cement, Type 1A, meeting the requirements of ASTM C150 or Portland Cement, Type 1, meeting the requirements of ASTM C150 with admixtures for producing air entrainment meeting the requirements of ASTM C260.

701-2.3 AGGREGATE. The CONTRACTOR shall notify the ENGINEER of the source of the coarse and fine aggregate which is proposed for use on the contract. Sufficient time shall be allowed so that sampling and testing can be completed prior to the beginning of construction. During the construction period, the CONTRACTOR shall at all times make available to the ENGINEER sampling of aggregate. All aggregate shall meet the requirements of these specifications.

701-2.4 COARSE AGGREGATE. Except as noted herein, the coarse aggregate used shall conform to the requirements of ASTM C33. Coarse aggregate shall consist of gravel or broken stone composed of strong, hard, durable, uncoated pebbles or rock fragments washed clean and free from injurious amounts of shale, coal, clay, lumps, soft fragments, dirt, glass, organic or any other deleterious substances.

Coarse aggregate shall be graded from coarse to fine within one of the following limits when tested in conformity with ASTM C136. Either gradation may be used, but once adopted, no change in gradation will be made during the course of the work.

COARSE AGGREGATE SIZE

Square Mesh	Percent by Weight Passing	Percent by Weight Passing
2"		
1½"	100	
1"	95-100	100
3/4"		90-100
1/2”	25-60	
3/8”		20-55
No. 4	0-10	0-10
No. 8	0-5	0-5
No. 200	0-1	0-1

701-2.5 FINE AGGREGATE. Except as noted herein, the fine aggregate shall conform to the requirements of ASTM C33. Fine aggregate shall be natural sands washed clean consisting of hard, strong, sharp uncoated grains free of dust, lumps, mica, shale, organic matter or other deleterious substances.

Fine aggregate shall be graded within the following limits when tested to conformity with ASTM C136.

FINE AGGREGATE SIZE

SQUARE MESH SIEVE SIZE MORTAR SAND	PERCENT BY WEIGHT PASSING	SQUARE MESH SIEVE SIZE CONCRETE SAND	PERCENT BY WEIGHT PASSING
No. 4	100	3/8”	100
No. 8	95-100	No. 4	95-100
		No. 8	80-100

		No. 16	50-85
		No. 30	25-60
		No. 50	5-30
No. 100	25 (max.)	No. 100	0-10
No. 200	10 (max.)		

The quality, sampling, and testing of mortar sand for use in cement mortar shall conform to ASTM C144.

701-2.6 WATER. Water use in mixing concrete shall be clean and shall not contain deleterious amounts of acids, alkalies, or organic materials. Water shall be subject to testing and approval by the ENGINEER.

701-2.7 ADMIXTURES. Substances other than cement, water, aggregates, and air-entraining agents shall not be used in the concrete except as otherwise required or when permitted in writing by the ENGINEER. Unless otherwise provided in the plans or Special Provisions, no reduction will be made in the specified cement content of the concrete mixture by reason of using any admixtures. Admixtures containing calcium chloride must be preapproved. No admixture shall be used which interferes with proper control or the entrained air content of concrete. Permission to use any admixtures may be withdrawn at any time if the properties of the admixture are not uniform or if satisfactory results are not being obtained.

Should the CONTRACTOR request and obtain permission to use admixtures for its own benefit, no additional compensation will be allowed for the cost of furnishing the admixtures and incorporating them into the concrete mixture.

Should the ENGINEER direct the CONTRACTOR to use admixtures when their use is not required by these Specifications or by the Plans or Special Provisions, furnishing the admixtures and incorporating them into the concrete mixture will be paid for as extra work as provided in Section 126.

701-2.8 REINFORCING STEEL. Reinforcing steel except as otherwise specified shall be Grade 60 deformed bars rolled from billet stock and shall conform to the requirements of ASTM A615.

Dowel bars shall be intermediate grade plain bars rolled from billet stock and shall conform to the requirements of ASTM A663 or A675.

Wire mesh reinforcement shall comply with the requirements of ASTM A185.

Approved type of bar supports and separators shall be used to support reinforcing bars. Premolded concrete blocks may be used at bottom of girders, slabs, or similar locations where the weight of the reinforcing is heavier than average. Bar spacers shall be used between layers of bars. The spacers shall be constructed of steel and must be of sufficient strength and spaced to support the load without distortion. Steel bar spacers shall not come in contact with the forms.

Approved type of bar supports and separators shall be used to support reinforcing bars. Premolded concrete blocks may be used at bottom of girders, slabs or similar locations where the weight of the reinforcing is heavier than average. Bar spacers shall be used between layers of bars. The spacers shall be constructed of steel and must be of sufficient strength and spaced to support the load without distortion. Steel bar spacers shall not come in contact with the forms.

Tie wire shall be No. 16 gauge annealed wire. Reinforcing steel shall be incidental to "Structural Portland Cement Concrete."

701-3 CONSTRUCTION REQUIREMENTS

701-3.1 GENERAL. The CONTRACTOR shall furnish all labor, materials, and services necessary for and incidental to the completion of all work as shown on the drawings and specified herein. All machinery and equipment owned or controlled by the CONTRACTOR shall be of sufficient size to meet the requirements of the work and shall produce satisfactory work. All work shall be subject to the inspection and approval of the ENGINEER. The CONTRACTOR shall employ at all times a sufficient force of workmen of such experience and ability that the work can be completed in a satisfactory and workmanlike manner.

701-3.2 MATERIALS STORAGE.

(a) Portland Cement. Portland Cement shall be stored as specified in ASTM C150. The Portland Cement shall be stored in such manner as to permit easy access for proper inspection and identification of each shipment and in a suitable weather tight building that will protect the Portland Cement from becoming damp and minimize warehouse set. Storage shall be of such capacity to provide ample space for consignments of cement as may be required to carry on the work in accordance with the approved progress schedules.

(b) Aggregates. Aggregates shall be stored in such a manner as to afford good drainage, prevent the intrusion of foreign matter, and preserve the gradation. Any material which has deteriorated or which has been damaged shall not be used for concrete.

To avoid changes in consistency, the aggregates shall be obtained from a source which will insure uniform quality and grading during any single day's operation, and they shall be delivered to the project and handled in such a manner that variations in moisture content will not interfere with the steady production of concrete of uniform quality and consistency.

701-3.3 ADVANCE DESIGN OF CONCRETE MIXES. Designs and tests for each concrete mix to be used under this contract shall be made, using aggregates which have been approved for this work. Except as otherwise specified, mixes shall be designed in accordance with ACI 613 to attain the required strengths using the various

slumps (including the maximum allowable), the various sized aggregates expected to be used in the work and the admixtures as called for by the ENGINEER. The concrete mixes shall be designed by an independent testing laboratory and paid for by the CONTRACTOR.

Advance tests of each of the proposed mixes shall be made in accordance with ASTM C192. Six (6) standard six inch (6") diameter compression test cylinders shall be made for each mix design, three (3) shall be tested at seven (7) days and three (3) at twenty-eight (28) days. Concrete tested shall contain all required and/or proposed admixtures and in addition to the testing required by ASTM C192 shall be tested for air content by ASTM C231.

The advance mix designs and the results of tests on cylinders made from advance mix designs are required before work of concrete placing is started.

Tests for aggregates, as required in Sub-Section 701-2.3, may be made a part of these tests if suitably referenced on the reports which shall be issued at seven (7) and twenty-eight (28) days.

The above tests shall be repeated if necessary because of changes in materials or unsatisfactory results.

701-3.4 CONCRETE TESTING. During the progress of the work and for each different mix of concrete, the following sets of standard diameter compression test cylinders shall be cast in the field in accordance with ASTM C31 and ASTM C172 for each sample taken:

First Pour - Two (2) 7-day and two (2) 2-day cylinders.

Intermediate Pours as follows:

1-25 CY - Two (2) 28-day cylinders
25-50 CY - Three (3) 28-day cylinders
50-75 CY - Four (4) 28-day cylinders
75-100 CY - Five (5) 28-day cylinders
100-150 CY - Six (6) 28-day cylinders
150-200 CY - Eight (8) 28-day cylinders

The cylinders, comprising one set, shall be made from the same sample of concrete. The required minimum strength of the concrete shall be 4000 lbs./sq. in. at twenty-eight (28) days.

Slump tests made in accordance with ASTM C143 shall be made as necessary to maintain desired concrete consistency. Slump tests shall also be made and recorded for each sample of concrete used in making test cylinders. The maximum allowable slump of the concrete mix shall be three inches (3”). Air content in accordance with ASTM C231 shall also be tested and recorded for each sample of concrete used in

making test cylinders. The air content shall fall within the range of five percent to seven percent (5%-7%).

If any test cylinder shows a strength at twenty-eight (28) days which fails to meet the specified strength for the class of concrete from which the sample was taken, then the concrete represented by such test cylinder shall be further tested by the ENGINEER. If such further tests indicate that concrete has been placed which does not meet the compressive strength requirements established by this specification, then the concrete shall be rejected and shall be removed and replaced with new concrete of the specified strength, at the expense of the CONTRACTOR. The CONTRACTOR shall also pay for all additional testing required.

701-3.5 PROPORTIONING MATERIALS. Concrete shall be composed of Portland Cement, fine aggregate, coarse aggregate, water and admixtures as specified. The mix shall be designed in accordance with Sub-Section 701-3.3 of these specifications.

The amount of water specified shall include the surface moisture carried by the aggregate at the time of mixing. The amount of water shall be determined by tests made by the CONTRACTOR and the quantity of mixing water to be added to the batch shall be added to that found to be carried by the aggregates, to total the rate specified. The number of tests required and the consequent changes in the amount of mixing water to be added will depend on the control exercise in the gradation and moisture contents of the aggregate.

The amount of water shall also include that liquid added to the batch in the form of admixtures.

The amounts and proportions of fine and coarse aggregates to be used in each mix shall be such as to produce a plastic, workable mix, free from harshness, which can be readily placed into the corners and angles of the forms and around reinforcement and other embedded work without undue accumulation of water or laitance on the surface, and such that there will be no honeycombing in the structure.

Proportions of fine and coarse aggregates shall be such that the ratio of the coarse to the fine aggregate shall no be less than one (1) nor more than two (2). On all work under these specifications, a cubic yard (CY) of concrete shall contain not less than six (6) sacks (564 lbs.) of cement.

701-3.6 BATCHING AND MIXING CONCRETE. Mixing of concrete shall be done in a rotary batch mixer of a type acceptable to the ENGINEER. The volume of the mixed material for each batch shall not exceed the manufacturer's rated capacity of the mixer.

The batch materials shall be delivered to the mixer measured accurately to the required proportions and shall be mixed continuously for not less than one and one-half minutes after all materials including water are in the mixer, during which time the mixer shall rotate at the speed recommended by the manufacturer. The entire batch shall be

discharged before recharging the mixer. The mixer shall be cleaned as required to insure adequate and complete mixing.

In lieu of jobsite mixing, ready mixed concrete meeting requirements specified herein and all applicable requirements of ASTM C94 may be approved, provided the quantity and rate of delivery materials will be such as to permit unrestricted progress of the work in accordance with the placing schedule. When air temperatures are above 90°F, the concrete shall be discharged within one (1) hour. When air temperatures are below 90°F, the concrete shall be discharged within a maximum of one and one-half (1½) hours or 300 revolutions of the drum whichever comes first after the introduction of the mixing water to the cement and aggregates.

Truck mixers shall be equipped with a means by which the number of revolutions of the drum, blades or paddles may be readily verified.

Two (2) copies of the complete data concerning mixing and transportation methods shall be submitted to the ENGINEER for approval.

701-3.7 COLD WEATHER. When the temperature is below 40°F for more than three (3) days or when there is a probability that such temperatures will occur during the 24 hour period after placing, special provisions shall be taken. Except as otherwise specified, mixing, placing and protection shall be in accordance with the latest edition of the Portland Cement Association manual entitled "Design and Control of Concrete Mixtures." Curing shall be as specified in Sub-Section 701-3.17.

Frozen concrete shall be immediately removed upon direction of the ENGINEER and replaced with new concrete at no expense to the Owners.

In order to maintain the temperature specified, the concrete shall be entirely enclosed with tarpaulins, polyethylene plastic sheets, commercial insulating blanket or bat insulation and all fuel and suitable heating equipment and the necessary labor and supervision shall be furnished. Unvented heaters shall not be used. Only commercial insulating blanket or bat insulation will be permitted as a covering without addition of heat. Full responsibility for the protection of the concrete shall be under this section.

During freezing weather, temperature records shall be kept by the CONTRACTOR and furnished to the ENGINEER daily showing the temperature at four (4) hour intervals of the outside air, of the air in the coldest part of the enclosure near the concrete, of the concrete as it is placed, and of the concrete in place at such points as the ENGINEER may direct.

701-3.8 HOT WEATHER. Concrete materials shall be placed at the lowest practicable temperature except as specified in Sub-Section 701-3.7 for cold weather. When hot weather conditions exist that would seriously impair the quality and strength of the concrete, the concrete shall be placed in accordance with the latest edition of the Portland Cement Association Manual entitled "Design and Control of Concrete Mixtures" except as otherwise specified herein.

During hot weather conditions, the temperature of the concrete immediately before it is placed in the forms shall be between 50°F and 90°F.

Shaved ice may be used in the mixing water to reduce the temperature of the concrete at the mixer, but there shall be no ice in the concrete when it is discharged from the mixer.

Retarder admixes shall not be used to control the setting time of the concrete.

701-3.9 FORMS. Concrete shall not be placed until all the forms and reinforcements have been inspected and approved by the ENGINEER. Forms shall be of suitable material and shall be of the type, size, shape, quality and strength to build the structure as designed on the plans. The forms shall be true to line and grade and shall be mortar-tight and sufficiently rigid to prevent displacement and sagging between supports. The CONTRACTOR shall bear responsibility for their adequacy. The surfaces of forms shall be smooth and free from irregularities, dents, sags, and holes. The CONTRACTOR shall obtain approval before framing openings in structural members which are not indicated on the Drawings.

The internal ties shall be arranged so that when the forms are removed, no metal will show in the concrete surface or discolor the surface when exposed to weathering. All forms shall be coated with a non-staining mineral oil which shall be applied shortly before the concrete is placed. Forms shall be constructed so that they can be removed without damaging the concrete or concrete surface. Forms supported by falsework under slabs, beams, girders, arches, and similar construction shall not be removed until tests indicate that at least sixty percent (60%) of the design strength of the concrete has developed.

701-3.10 PLACING REINFORCEMENT. All reinforcement shall be accurately placed as shown on the plans and shall be firmly held in position during concreting. Bars shall be fastened together at intersections. The reinforcement shall be supported by approved metal chairs. Shop drawings, lists, and bending details shall be supplied by the CONTRACTOR when required.

701-3.11 EMBEDDED ITEMS. Before placing concrete, any items that are to be embedded shall be firmly and securely fastened in place as indicated. All such items shall be clean and free from rust, scale, oil, or any foreign matter. The embedding of wood shall be avoided. The concrete shall be consolidated around and against embedded items.

701-3.12 PLACING CONCRETE. All concrete shall be placed during daylight, unless otherwise approved. The concrete shall not be placed until the depth and character of foundation, the adequacy for forms and falsework, and the placing of the steel reinforcing have been approved. Concrete shall be placed as soon as practical after mixing and in no case later than one and one-half (1½) hour after water has been added to the mix as specified in Sub-Section 701-3.6. The method and manner of the placing

shall be such to avoid segregation and displacement of the reinforcement. Troughs, pipes, and chutes shall be used as an aid in placing concrete when necessary. Dropping the concrete a distance of more than five feet (5') or depositing a large quantity at one point, will not be permitted. Concrete shall be placed upon clean surfaces free from running water or upon properly consolidated damp soil.

The concrete shall be consolidated by suitable mechanical vibrators. When necessary, vibrating shall be supplemented by hand spading with suitable tools to assure proper and adequate consolidation. Vibrators shall be manipulated so as not to displace reinforcement or forms. The vibration at any point shall be of sufficient duration to accomplish consolidation but shall not be prolonged to the point where segregation occurs. Concrete deposited under water shall be carefully placed in a compact mass in its final position by means of a tremie, a closed bottom bump bucket, or other approved method and shall not be disturbed after being deposited.

701-3.13 CONSTRUCTION JOINTS. When the placing of concrete is suspended, necessary provisions shall be made for joining future work before the placed concrete takes its initial set. For the proper bonding of old and new concrete, such provisions shall be made for grooves, steps, keys, dovetails, reinforcing bars or other devices as may be prescribed. The work shall be arranged so that a section begun on any day shall be finished during daylight of the same day. Before depositing new concrete on or against concrete which has hardened, the surface of the hardened concrete shall be cleaned, thoroughly wetted, and given a thin coating of neat cement mortar.

701-3.14 EXPANSION JOINTS. Expansion joints shall be constructed at such points and of such dimensions as may be indicated on the drawings. The premolded filler shall be cut to the same shape as that of the surfaces being joined. The filler shall be fixed firmly against the surface of the concrete already in place in such manner that it will not be displaced when concrete is deposited against it.

701-3.15 DEFECTIVE WORK. Any defective work disclosed after the forms have been removed shall be immediately removed and replaced. If any dimensions are deficient, or if the surface of the concrete is bulged, uneven, or shows honeycomb, which in the opinion of the ENGINEER cannot be repaired satisfactorily, the entire section shall be removed and replaced at the expense of the CONTRACTOR.

701-3.16 SURFACE FINISH. All exposed concrete surfaces shall be true, smooth, free from open or rough spaces, depressions, or projections. The concrete in horizontal plane surfaces shall be brought flush with the finish top surface at the proper elevation and shall be struck-off with a straightedge and floated.

When directed, the surface of exposed concrete shall be a rubbed finish. If forms can be removed while the concrete is still green, the surface shall be wetted and then rubbed with a wooden float until all irregularities are removed. If the concrete has hardened before being rubbed, a carborundum stone shall be used to finish the surface. When approved, the finishing can be done with a rubbing machine.

701-3.17 CURING AND PROTECTION. All concrete shall be properly cured and protected by the CONTRACTOR. The work shall be protected from the elements, flowing water, and from defacement of any nature during the building operations. The concrete shall be cured as soon as it has sufficiently hardening by covering with an approved material. Water-absorptive coverings shall be thoroughly saturated when placed and kept saturated for a period of at least three (3) days. All curing mats or blankets shall be sufficiently weighted or tied down to keep the concrete surface covered and to prevent the surface from being exposed to currents of air.

Traffic shall not be allowed on concrete surfaces until tests indicate that sufficient strength has been reached.

701-3.18 DRAINS OR DUCTS. Drainage pipes, conduits, and ducts that are to be encased in concrete shall be installed by the CONTRACTOR before the concrete is placed. The pipe shall be held rigidly so that it will not be displaced or moved during the placing of the concrete.

701-3.19 FILLING JOINTS. All joints which require filling shall be thoroughly cleaned, and any excess mortar or concrete shall be cut out with proper tools. Joint filling shall not be started until after final curing and shall be done only when the concrete is completely dry. The cleaning and filling shall be carefully done with proper equipment and in a manner to obtain a neat looking joint free from excess filler.

701-3.20 SEALING JOINTS. Joints shall be sealed per details or as directed by the Engineer.

Joints shall be filled with joint-sealing material within fourteen (14) days of construction. Prior to sealing, each joint shall be thoroughly cleaned of all foreign material, including membrane curing compound. Joint faces shall be cleaned and surface-dry when seal is applied. Material for sealing applied hot shall be stirred during heating to prevent localized overheating.

Any excess material on the surface of the concrete shall be removed immediately and the concrete surface cleaned. The use of sand or similar material to cover the seal shall not be permitted. Joint sealing material shall not be placed when the air temperature in the shade is less than 40 degrees Fahrenheit, unless approved by the ENGINEER.

701-4 MEASUREMENT AND PAYMENT

701-4.1 STRUCTURAL PORTLAND CEMENT CONCRETE. Structural Portland Cement Concrete shall be measured by the cubic yard (CY) computed in place from plan dimensions with no deductions made for volumes of steel or embedded items. Payment will be made at the unit price bid for "Structural Portland Cement Concrete" complete in place and accepted by the ENGINEER.