DIVISION 03

CONCRETE

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete form work.

B. Floors and slabs on grade.

C. Concrete foundation walls and vaults.

D. Concrete reinforcement.

E. Joint devices associated with concrete work.

F. Miscellaneous concrete elements, including equipment pads, thrust blocks, manholes, and other miscellaneous items.

G. Concrete curing.

1.02 REFERENCES

A. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; American Concrete Institute International.

B. ACI 301 - Specifications for Structural Concrete for Buildings; American Concrete Institute International.

C. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International.

D. ACI 305R - Hot Weather Concreting; American Concrete Institute International.

E. ACI 306R - Cold Weather Concreting; American Concrete Institute International.

F. ACI 308 - Standard Practice for Curing Concrete; American Concrete Institute International.

G. ACI 309R - Guide for Consolidation of Concrete; American Concrete Institute.

H. ACI 318 - Building Code Requirements for Reinforced Concrete and Commentary; American Concrete Institute International.

I. ACI 347 - Guide to Form work for Concrete; American Concrete Institute.

J. ASTM A 185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.

K. ASTM A 615/A 615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

L. ASTM C 31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.

M. ASTM C 33 - Standard Specification for Concrete Aggregates.

N. ASTM C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

O. ASTM C 94 - Standard Specification for Ready-Mixed Concrete.

P. ASTM C 143 - Standard Test Method for Slump of Hydraulic Cement Concrete.

Q. ASTM C 150 - Standard Specification for Portland Cement.

R. ASTM C 171 - Standard Specification for Sheet Materials for Curing Concrete.

S. ASTM C 173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

T. ASTM C 260 - Standard Specification for Air-Entraining Admixtures for Concrete.

U. ASTM C 309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

V. ASTM C 494 - Standard Specification for Chemical Admixtures for Concrete.

W. ASTM C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.

X. ASTM C 881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

Y. ASTM C 1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

Z. ASTM C 1116 - Standard Specification for Fiber-Reinforced Concrete and Shotcrete.

AA. ASTM D 994 - Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).

AB. ASTM D 1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).

AC. COE CRD-C 572 - Corps of Engineers Specifications for Polyvinylchloride Waterstop; Corps of Engineers.

AD. Use the latest issue of the above reference standards as of the date of the Project.

1.03 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Submit manufacturers' data on manufactured products.

C. Samples: Submit one, four inch long samples of waterstops and construction joint devices, as directed.

D. Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent construction for concrete accessories.

E. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.

1.04 QUALITY ASSURANCE

A. Perform work of this section in accordance with ACI 301 and ACI 318.

B. Acquire cement from same source and aggregate from same source for entire project.

C. Follow recommendations of ACI 305R when concreting during hot weather.

D. Follow recommendations of ACI 306R when concreting during cold weather.

PART 2 PRODUCTS

2.01 FORM WORK

A. Form Materials: Contractor 's choice of standard products with sufficient strength to withstand hydrostatic head without distortion in excess of permitted tolerances.

1. Form Facing for Exposed Finish Concrete: Contractor 's choice of materials that will provide smooth, stain-free final appearance.

2. Form Coating: Release agent that will not adversely affect concrete or interfere with application of coatings.

3. Form Ties: Snap-Off type that will leave no metal within 1-1/2 inches of concrete surface. Use of tie wire as form ties will not be permitted.

2.02 REINFORCEMENT

A. Reinforcing Steel: ASTM A 615/A 615M Grade 60 (420).

1. Deformed billet-steel bars.

2. Unfinished.

B. Welded Steel Wire Fabric: ASTM A 185, plain type.

1. Coiled Rolls or flat sheets.

2. Mesh Size and Wire Gage: As indicated on drawings.

C. Reinforcement Accessories:

1. Tie Wire: Annealed, minimum 16 gage.

2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.

3. Provide galvanized or plastic coated steel components for placement within 1-1/2 inches of weathering surfaces.

2.03 CONCRETE MATERIALS

A. Cement: ASTM C 150, Type IIA - Air Entraining Portland type.

B. Cement: ASTM C 150, Type V - Sulfate Resistant Portland type. when exposed to sewage.

C. Fine and Coarse Aggregates: ASTM C 33.

D. Fly Ash: ASTM C 618, Class F.

E. Calcined Pozzolan: ASTM C 618, Class N.

F. Water: Clean and not detrimental to concrete.

G. Synthetic Fiber Reinforcement: Comply with ASTM C 1116; 1/2 inch length.

2.04 ADMIXTURES

A. Air Entrainment Admixture: ASTM C 260.

B. Chemical Admixtures: ASTM C 494, Type D - Water Reducing and Retarding.

1. Provide products manufactured by Sika Chemical Corporation or acceptable equal.

2.05 CONCRETE ACCESSORIES

A. Epoxy Bonding System: ASTM C 881, type as required by project conditions.

B. Non-Shrink Grout: ASTM C 1107; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.

1. Minimum Compressive Strength at 48 Hours: 2,400 psi.

2. Minimum Compressive Strength at 28 Days: 7,000 psi.

C. Moisture-Retaining Cover: ASTM C 171; clear polyethylene or white burlap-polyethylene sheet.

D. Liquid Curing Compound: ASTM C 309, Type 1, clear or translucent.

2.06 JOINT DEVICES AND MATERIALS

A. Waterstops: PVC type, COE CRD-C 572.

B. Joint Filler: ASTM D 1751; Asphalt impregnated fiberboard or felt, 1/2 inch thick; tongue and groove profile.

2.07 CONCRETE MIX DESIGN

A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.

B. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.

C. Fibrous Reinforcement: Where indicated, add to mix at rate of 1.5 pounds per cubic yard, or as recommended by manufacturer for specific project conditions.

D. Normal Weight Concrete:

1. Compressive Strength, per ASTM C 39 at 28 days: 4,000 psi.

2. Fly Ash Content: Maximum 15 percent of cementitious materials by weight.

3. Calcined Pozzolan Content: Maximum 10 percent of cementitious materials by weight.

4. Cement Content: Minimum 592.2 pound per cubic yard; 6.3 bag mix.

5. Water-Cement Ratio: Maximum 48 percent by weight.

6. Total Air Content: 4 to 8 percent for concrete exposed to freezing and thawing; and 2 to 4 percent for other concrete; per ASTM C 173.

7. Maximum Slump: 4 to 2 inches for structures; 3 to 1 1/2 inches for blocks and pavement.

8. Maximum Aggregate Size: one inch.

2.08 MIXING

A. Transit Mixers: Comply with ASTM C 94.

B. During hot weather or under other conditions contributing to rapid setting of concrete, mixing times will be reduced as follows:

1. When air temperature is between 85 and 90 degrees (F), reduce mixing time and delivery time from 90 minutes to 75 minutes.

2. When air temperature is above 90 degrees (F), reduce mixing time and delivery time to 60 minutes.

C. Provide batch ticket for each batch used in the work. Ticket shall indicate project identification name and number, date, mix type, mix time, quantity, and amount of water added.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify lines, levels, and dimensions before proceeding with work of this section.

3.02 PREPARATION

A. Form work: Comply with requirements of ACI 301. Design and fabricate forms to support all applied loads until concrete is cured, and for easy removal without damage to concrete.

B. Forms shall be mortar tight, properly aligned, as indicated, to produce concrete surfaces meeting the surface requirements specified herein.

C. Forms shall be constructed so they can be removed without hammering on or prying against concrete, and without damaging concrete in any way.

D. Verify that forms are clean before applying release agent.

E. Coordinate placement of joint devices with erection of concrete form work and placement of form accessories.

F. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.

G. In locations where new concrete is doweled to existing work, drill holes in existing concrete, fill holes with epoxy bonding agent, and insert steel dowels.

H. The Engineer's review of form work will not relieve the Contractor from any responsibility as to the adequacy of the form work, shoring and bracing design. All form work installed by the Contractor shall be solely at his risk. The Engineer's review will not lessen or diminish the Contractor's liability.

I. Alignment and Tolerances. Form work shall be designed and constructed so that concrete surfaces of finished structures will comply with the tolerances specified in ACI 347; and will conform to the following:

1. Vertical Alignment: maximum allowable variation, from bottom to top of a wall, is plus or minus 3/8 inch.

2. Plumb: maximum allowable variations as follows:
   a. In plumb and surfaces of columns and walls is plus or minus 1/4 inch in any 10-feet of length; and a maximum of one-inch for entire length.
   b. In plumb for exposed corner, control-joint grooves, or other conspicuous lines is plus or minus 1/4 inch in any 20-feet of length; and a maximum of 1/2-inch for the entire length.

3. Wall Thickness: shall not vary more than minus 1/8 inch or plus 1/2 inch.

4. Level or Grade: maximum variation from level or grade indicated shall not exceed plus or minus 1/4 inch in any 10-feet of length; or plus or minus 3/8-inch in any 20-feet of length.

5. Distance: maximum variation in distance between walls, columns, or other members shall not exceed plus or minus 1/4 inch in any 10-feet of length; and not more than one-inch total variation.

3.03 INSTALLING REINFORCEMENT

A. Comply with requirements of ACI 301. Clean reinforcement of loose rust and mill scale, and accurately position, support, and secure in place to achieve not less than minimum concrete coverage required for protection.

B. Install wire fabric in maximum possible lengths, and offset end laps in both directions. Splice laps with tie wire.

C. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with concrete placement.

3.04 PLACING CONCRETE

A. Place concrete in accordance with ACI 304R.

B. Place concrete for floor slabs in accordance with ACI 302.1R.

C. Notify City Engineer or Inspector not less than 24 hours prior to commencement of placement operations. No concrete shall be placed until all form work, construction joints, reinforcing steel, and other items have been completed and accepted by the Engineer.

D. Before placing concrete, inspect and complete form work installations, reinforcing steel placement, and items to be embedded or cast-in.

E. Notify other crafts involved in ample time to permit installation of their work; cooperate with other trades in setting such work

F. All dirt, chips, sawdust, debris, mud, water and other foreign matter shall be removed from within forms or within excavated areas adjacent to forms before any concrete is placed.

G. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.

H. Separate slabs on grade from vertical surfaces with 1/4 inch thick joint filler.

I. Install joint devices in accordance with manufacturer's instructions.

J. Concrete shall be conveyed from mixer to forms as rapidly as possible within specified time limits; and by methods that will prevent segregation of concrete mix.

K. Concrete shall be placed within 15 minutes after it has been discharged from mixer.

L. Provide adequate equipment and labor for conveying concrete to ensure a continuous flow of concrete at delivery point.

M. Concrete shall be deposited as close as possible to its final position in the forms; there shall be no vertical drop greater than 8 feet, except where suitable equipment is provided to prevent segregation of concrete and where specifically authorized.

N. Deposit concrete so that it will be effectively consolidated in horizontal layers not more than 12 inches thick; except that all slabs shall be placed in single layer.

O. Where placement consists of several layers, place each layer while the preceding layer is still plastic to avoid cold joints, and within 30 minutes after placement of preceding layer.

P. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

Q. Place concrete continuously between predetermined expansion, control, and construction joints.

R. Do not interrupt successive placement; do not permit cold joints to occur.

S. Do not use concrete which becomes non-plastic or unworkable, does not meet the required quality control limits, or which has become contaminated by foreign materials. Do not use re-tempered concrete. Remove rejects concrete from the project site and dispose of in an acceptable manner.

T. Place floor slabs in checkerboard or saw cut pattern indicated.

U. Saw cut joints within 24 hours after placing. Use 3/16 inch thick blade, cut into 1/4 depth of slab thickness.

V. Screed floors and slabs on grade level, maintaining surface flatness of maximum 1/4 inch in 10 ft.

W. Concrete shall not be placed in water; nor shall water be allowed to rise over freshly placed concrete until the concrete has set sufficiently to prevent its being damaged thereby.

3.05 CONSOLIDATING

A. Consolidate each layer of concrete immediately after placement with internal vibrators in accordance with ACI 309, except for slabs 4 inches thick or less.

B. Vibrators shall be inserted vertically at uniform spacing over entire area of placement; spacing to be approximately 1-1/2 times radius of action of vibrator. Vibrators shall penetrate rapidly to bottom of layer being placed, and at least 6 inches into the preceding layer.

C. Vibrators shall be supplemented by hand spading adjacent to forms on exposed surfaces. Concrete shall be compacted and well worked into all corners and angles in forms, and around reinforcement and embedded items.

3.06 FORM REMOVAL

A. Forms shall be removed in a manner that will prevent damage to concrete and ensure complete safety of the structure.

B. Forms shall not be removed until approval is given by the City Engineer or Inspector.

C. Form work for columns, walls and other members not supporting weight of concrete may be removed when concrete has attained sufficient strength to resist damage from removal operation; but not before at least 48 hours after concrete placement.

D. Form work for columns, walls, roof slabs, and other members supporting weight of concrete may not be removed until concrete has attained sufficient strength to carry imposed loads as determined by compression tests, and when directed by the City Engineer or Inspector.

3.07 CONCRETE FINISHING

A. Repair and patch surface defects, including tie holes, on all surfaces immediately after removing form work.

B. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch or more in height.

C. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/4 inch or more in height. Provide finish as follows:

1. Smooth Rubbed Finish: Wet concrete and rub with Carborundum brick or other abrasive, not more than 24 hours after form removal.

2. Grout Cleaned Finish: Wet areas to be cleaned and apply grout mixture by brush or spray; scrub immediately to remove excess grout. After drying, rub vigorously with clean burlap, and keep moist for 36 hours.

D. Concrete Slabs: Finish to requirements of ACI 302.1R, and as follows:

1. Wood float surfaces that will receive trowel finish or other finishes, as indicated.

2. Steel trowel surfaces that will be left exposed.

3. Broom finish exterior concrete to provide non-slip finish.

E. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains at 1:50 nominal.

F. All exposed edges to be chamfered; 3/4 inches minimum.

3.08 CURING AND PROTECTION

A. Comply with requirements of ACI 308. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

1. Normal concrete: Not less than 7 days.

C. Formed Surfaces: Cure by moist curing with forms in place for full curing period.

D. Surfaces Not in Contact with Forms:

1. Start initial curing as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-fog spray, or saturated burlap, as acceptable to the Engineer.

2. Begin final curing after initial curing but before surface is dry.
   a. Moisture-retaining cover: Seal in place with waterproof tape or adhesive.
   b. Curing compound: Apply in two coats at right angles, using application rate recommended by manufacturer.

3.09 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control tests, as specified in Section 01400.

B. Provide free access to concrete operations at project site and cooperate with appointed firm.

C. Submit proposed mix design to engineer and testing firm for review prior to commencement of concrete operations.

D. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.

E. Compressive Strength Tests: ASTM C 39. For each test, mold and cure three concrete test cylinders. Obtain test samples for every 50 cu yd or less of concrete placed.

F. Take two additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.

G. Perform one slump test for each load at point of discharge; and perform slump test with each set of test cylinders taken.

1. If maximum slump for the application is exceeded, it will be assumed that the water content is excessive and the load shall be rejected.

2. If slump is less that the minimum for the application, a measured quantity of water may be added to the mix; quantity shall not exceed 1/6 gallon of water per bag of cement.

3. Water shall be added only in the presence of the Engineer and after a slump test has been made.

4. If concrete has been mixed for more than one hour, the loss of slump shall be considered as being caused by setting of concrete; water shall not be added, and the load shall be rejected.

H. Perform test to determine air content in accordance with ASTM C 231; a minimum of one test shall be done each time a slump test is made. Air content shall be within specified limits.

3.10 DEFECTIVE CONCRETE

A. Test Results: The testing agency shall report test results in writing to City Engineer and Contractor within 24 hours of test.

B. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.

C. Repair or replacement of defective concrete will be determined by the City Engineer or Inspector. The cost of additional testing shall be borne by Contractor when defective concrete is identified.

D. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of City Engineer or Inspector for each individual area.

3.11 SCHEDULE - CONCRETE TYPES AND FINISHES

A. Structure Not Exposed to View: 4,000 psi 28 day concrete; form finish surface, with honeycomb and holes filled and repaired.

B. Exposed Structures: 4,000 psi 28 day concrete; air entrained, smooth rubbed finish.

END OF SECTION