

## **SECTION 03300**

### **CAST-IN-PLACE CONCRETE**

#### **PART 1 - GENERAL**

##### **1.01 DESCRIPTION**

- A. Section includes specifications for cast-in-place Portland cement concrete including mix designs, delivering, and placing.

##### **1.02 REFERENCE STANDARDS**

- A. American Concrete Institute (ACI):
  - 1. 211.1 Selecting Proportions for Normal, Heavyweight and Mass Concrete
  - 2. 301 Specifications for Structural Concrete for Buildings
  - 3. 302.1R Guide for Concrete Floor and Slab Construction
  - 4. 304R Guide for Measuring, Mixing, Transporting and Placing Concrete
  - 5. 305R Hot Weather Concreting
  - 6. 306.1 Cold Weather Concreting
  - 7. 308 Standard Practice for Curing Concrete
  - 8. 318 Building Code Requirements for Reinforced Concrete
- B. American Society of Testing and Materials (ASTM International):
  - 1. C31 Making and Curing Concrete Test Specimens in the Field
  - 2. C33 Concrete Aggregates
  - 3. C39 Compressive Strength of Cylindrical Concrete Specimens
  - 4. C94 Ready-Mixed Concrete
  - 5. C109 Test Method for Compressive Strengths of Hydraulic Cement Mortars
  - 6. C138 Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
  - 7. C143 Test Method for Slump of Portland Cement Concrete
  - 8. C150 Portland Cement

9. C 171 Sheet Materials for Curing Concrete
  10. C173 Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
  11. C231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
  12. C260 Air-Entraining Admixtures for Concrete
  13. C494 Chemical Admixtures for Concrete
  14. C579 Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing and Polymer Concretes
  15. C618 Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
  16. C827 Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
  17. C928 Packaged, Dry, Rigid-Hardening Cementitious Materials for Concrete Repairs
  18. C1017 Chemical Admixtures for Use in Producing Flowing Concrete.
  19. C1107 Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrinkable)
  20. C1059 Latex Agents for Bonding Fresh To Hardened Concrete
  21. C1116 Fiber-Reinforced Concrete and Shotcrete
  22. D1751 Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
  23. E329 Agencies Engaged in Construction Inspection and/or Testing.
- C. State of California, Department of Transportation, Standard Specifications, (Caltrans):
1. Section 51, Concrete Structures
- D. U.S. Army Corps of Engineers, Concrete Research Division (CRD):
1. C621 Nonshrink Grout

### 1.03 SUBMITTALS

- A. Concrete Mix Designs: Submit mix designs for each class of concrete. Indicate locations to be used. Include names and brands of materials, proportions,

slump, strength, gradation of aggregates. Include laboratory test reports of trial strength and shrinkage tests.

- B. Product Data: Submit manufacturer's product data for proposed products, including epoxy adhesive, grout, and concrete admixtures.
- C. Shop Drawings:
  - 1. Submit drawings that indicate the locations of all joints in concrete, including construction joints, expansion joints, isolation joints, and contraction joints. Coordinate with the requirements specified in Section 03100, Concrete Forming.
  - 2. Submit drawings that indicate concrete placement schedule, method, sequence, location, and boundaries. Include each type and class of concrete, and quantity in cubic yards.
  - 3. Submit drawings that detail the type, size, and location of all pipes, conduit, embeds, blockouts, and recesses for all vertical and horizontal concrete construction.
  - 4. Reproductions of contract drawings are unacceptable.
- D. Submit for the Engineer's approval the name, address, and telephone number of the laboratory, agency, mill, or ready-mix plant which the Contractor intends to engage to design the concrete mixes.

#### **1.04 DELIVERABLES**

- A. Certificates of Compliance: For each shipment of materials, submit evidence of compliance with Specification requirements for cement, aggregate, and admixtures.
- B. Batch Tickets: Submit a delivery ticket with each batch of concrete delivered to the site in accordance with the requirements of ASTM C94.
- C. Records and Reports: Report the location in the finished work of each mix design, and the start and completion times of placement of each batch of concrete placed for each date concrete is placed.

#### **1.05 QUALITY ASSURANCE**

- A. Qualifications of Mix Design Source: Obtain mix designs, including recommended amounts of admixture and water to be used in the mixes, from a qualified independent testing laboratory or agency, or from a mill or ready-mix plant, properly equipped to design concrete mixes. The laboratory, agency, mill, or ready-mix plant shall meet applicable requirements of ASTM E329.
- B. Comply with ACI 304R.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. Concrete Materials:
1. Portland Cement: Conforming to ASTM C150 Type I or II
  2. Air-entraining admixture: Conforming to ASTM C260
  3. Fine aggregate: Conforming to ASTM C33
  4. Coarse aggregate: Conforming to ASTM C33
  5. Water: Potable, clear and free of injurious amounts of oil, acid, alkali, salts, organic matter, and any other substances that may be deleterious to concrete or steel.
  6. Corrosion inhibitor: Equivalent in quality and performance to one of the following:
    - a. DCI by Grace Concrete Products
    - b. Rheocrete 222 by Master Builders, Inc.
- B. Optional Concrete Admixtures and Cementitious Materials: At Contractor's option and with Engineer's acceptance, include accepted concrete admixtures and cementitious materials in the mix to improve the water-cement ratio or water-cementitious ratio or workability of the concrete, providing strengths specified and other desirable characteristics of the concrete can be achieved and maintained. Obtain Engineer's acceptance of proposed admixtures prior to use. Indicate admixtures in design mix. Add admixtures at batch plant and add in solution form, except as otherwise approved.
1. Chemical Admixtures, Water-Reducing: ASTM C494, Type A
  2. Pozzolanic Admixtures: ASTM C618, Class N or F
  3. Fly Ash: ASTM C618, Class F, with a maximum of 25 percent retained on the No. 325 mesh sieve and a loss on ignition of 1.0 percent maximum.
  4. Pigments for integrally colored concrete: Refer to Section 03160, Colored Concrete.
  5. Chemical Admixtures, Plasticizing: ASTM C1017, or ASTM C494 Type F or Type G, high-range water-reducing admixtures.
  6. Prohibited Admixtures: Admixtures containing chlorides or sulfides are not acceptable.

- C. Grout:
1. Cementitious Grout: Provide a prepackaged, nonshrink, nonmetallic, noncorrosive cement-based grout conforming to the following requirements:
    - a. ASTM C1107, Grade B or C, as appropriate for the condition or use. Grout shall be manufactured specifically for use in supporting heavy loads and shall have a minimum compressive strength of 7,500 psi at 28 days.
    - b. Shrinkage at 28 days: No shrinkage before hardening (0.00 shrinkage when tested in accordance with ASTM C827); no shrinkage after hardening (0.00 shrinkage when tested in accordance with CRD-C621.)
  2. Epoxy Grout: Provide a nonshrink, nonmetallic, noncorrosive epoxy grout conforming to the following requirements:
    - a. Gout shall be a 3-component epoxy resin system (two liquid epoxy components and one inert aggregate filler component) manufactured specifically for use in supporting heavy loads. The minimum compressive strength shall be 10,000 psi at seven days when tested in accordance with ASTM C579.
    - b. Shrinkage at 28 days: None (0.00 shrinkage when tested in accordance with ASTM C827 modified procedure) with a minimum bearing area (EBA) of 95 percent coverage of the tested base plate.
  3. Cementitious Grout for Repairs to Concrete Pavements and Structures: Provide a prepackaged, nonshrink, nonmetallic, noncorrosive cement-based grout conforming to the following requirements:
    - a. ASTM C928. Compressive strength of 5000 psi minimum in 28 days, conforming to ASTM C109.
    - b. Rapid-hardening when mixed with water, forming a permanent bond. Initial set shall be in 30 minutes.
- D. Expansion Joint Filler: Pre-molded asphalt impregnated felt conforming to ASTM D1751, 1/2-inch unless otherwise indicated on the Contract Drawings.
- E. Polypropylene Fibers:
1. Fibrillated Polypropylene Fibers: 100 percent virgin polypropylene, MD Graded, containing no reprocessed olefin materials, and specifically manufactured for use as concrete secondary reinforcement, and to protect concrete from stresses which cause cracking initially after placement.

2. Monofilament Polypropylene Fibers: 100 percent virgin polypropylene, MD Graded, containing no reprocessed olefin materials, and specifically manufactured to protect concrete from stresses which cause cracking initially after placement.
  3. The physical characteristics of the polypropylene fibers shall be as follows:
    - a. 1/2 inch or 3/4 inch polypropylene fibers, maximum 3 denier, complying with ASTM C1116, Type III.
    - b. Not less than 50 million individual fibers per pound.
  4. Supply fibers in cellulose fiber bags which disintegrate and disperse fibers during mixing. Other packaging and dispensing means may be acceptable.
- F. Bonding Agent: ASTM C1059 for bonding fresh to hardened concrete.
- G. Curing Materials: Refer to Section 03170, Concrete Finishing.
- H. Expanded Polystyrene: As specified in the Caltrans Standard Specifications, Section 51-1.12D.

## 2.02 MIX CRITERIA

- A. Ready-mix concrete shall conform to ASTM C94, Option B. Proportions shall conform to ACI 211.1, except as modified below.
- B. Concrete shall comply with ACI 301 and ACI 318, as applicable. Ensure that mix designs will produce concrete suited for proper placement and finishing.
- C. Concrete mix:
  1. Compressive strength: 4,000 psi minimum at 28 days, unless otherwise indicated on the Contract Drawings.
  2. Entrained air content: 3 to 4 percent, except as indicated in the following:
    - a. 2 to 4 percent for concrete with a 28 day compressive strength of 5000 psi or greater.
    - b. 3 percent maximum for concrete used for cast-in-place concrete station platforms ramps, and stairs.
  3. Corrosion inhibitor added in accordance with the manufacturer's instructions; 2 gallons DCI or 1 gallon Rheocrete 222 per cubic yard of concrete, minimum.
  4. Include polypropylene fibers in concrete mix of the type shown and where indicated in the Contract Documents. For uniform distribution,

mix in truck for a minimum of 20 minutes after fiber addition. Add fibers at the batch plant to ensure proper mixing. Use the following dosages:

- a. Typical: One pound per cubic yard of concrete unless greater dosage is recommended by the fiber manufacturer.
  - b. Bus Access Lanes and Bus Stop Pads: One and one half pounds per cubic yard.
5. Design concrete mix for pumping to meet requirements specified herein except that mix may be richer in lubricating components in order to allow proper pumping, subject to the Engineer's approval.
- D. Each trial mix shall be developed by an independent testing laboratory in accordance with the requirements of ACI 318 and ACI 301. Quality control relating to mix design shall be provided by the Contractor.

### **2.03 SOURCE QUALITY CONTROL**

- A. The Engineer will perform testing concrete ingredients at their source of supply using an Owner-hired independent testing laboratory.

## **PART 3 - EXECUTION**

### **3.01 PREPARATION**

- A. Inspect forms, earth bearing surfaces, reinforcement, and embedded items, and obtain the Engineer's written approval before placing concrete.
- B. Verify that substrates are in suitable condition to receive the work of this Section. Correct unsuitable conditions prior to proceeding.
- C. Earth bottoms or bearing surfaces for footings and slabs shall be dampened but not saturated or muddied just prior to placing concrete.

### **3.02 PLACEMENT**

- A. Convey and place concrete in compliance with the applicable requirements of ACI 301, ACI 302.1R, ACI 304R, and ACI 318.
- B. Place no concrete until reinforcing is fastened in place and forms are complete. Place no concrete before work that is to be embedded has been correctly set and secured. Do not disturb reinforcing or other materials that have been set in place.
- C. Conform to the requirements of ACI 318. Remove debris, mud and water from surfaces to receive concrete. Clean surfaces of forms and embedded items of all mortar, grout and deleterious materials before placing concrete. Place concrete in dry formwork and prevent water from entering or lying in formwork where concrete is being placed or is setting.

- D. Place concrete immediately after mixing. Do not use concrete after it has begun to stiffen. Do not retemper concrete by adding water in the field. If chuting is used, prevent segregation. Concrete at time of placing shall have 4 inches slump maximum, unless otherwise specified or approved with mix design, and temperature of 50 to 90 degrees F. Concrete with temperature exceeding 90°F at time of placement will be rejected and shall be removed from the job site.
- E. Minimum Concrete Cover (Unless otherwise indicated on the Contract Drawings):
  - 1. Concrete deposited against ground: 3 inches
  - 2. Formed surfaces exposed to weather: 2 inches
  - 3. Slab-on-grade with one layer of reinforcement: Centered
- F. Conform to ACI 305R and 306.1 for placement of concrete in hot and cold weather, respectively.
- G. Transfer concrete from mixer to point of placement as rapidly as practical preventing formation of cold joints. Use equipment and methods that permit rapid placing of concrete of the required consistency and prevent segregation.
  - 1. Convey concrete with conveyors, pipes, chutes, or spouts to a point not more than 3 feet from its final position.
  - 2. Do not change material proportions or consistency of the concrete to accommodate mixing and placing.
  - 3. Use no pipes, chutes or other equipment made of aluminum.
- H. Regulate air entrainment and slump within specified limits.
- I. Deposit concrete vertically in forms as nearly as practical in its final position, in approximately horizontal layers.
- J. Pumping: Concrete may be placed by pumping where approved by the Engineer.
  - 1. Use equipment for pumping of such size and design as to ensure a practically continuous flow of concrete at the delivery end without separation of materials. Pump shall be piston or squeeze pressure type. Pipeline shall be steel pipe or heavy duty flexible hose. Inside diameter of the pipe shall be at least three times the maximum size of the coarse aggregate. Distance to be pumped shall not exceed the limits recommended by pump manufacturer. Supply concrete continuously to the pump. When pumping is completed, eject the concrete remaining in the pipeline without contaminating the concrete in place. After each operation, thoroughly clean equipment. Waste flushing water outside the forms in compliance with storm water pollution prevention requirements specified in Section 01560, Temporary Controls.
  - 2. Do not pump concrete through aluminum pipes.

3. Provide full-time inspection of all pumping operations by a recognized testing laboratory approved by the Engineer.
- K. Avoid formation of laitance and accumulation of excessive water on surface of concrete as it is deposited. Remove accumulated water before placing additional concrete.

### 3.03 CONSTRUCTION JOINTS

- A. Construction joints will be permitted only where indicated or approved by the Engineer.
- B. Make construction joints straight and as inconspicuous as possible, and in exact vertical and horizontal alignment with the structure, as the case may be.
- C. Locate joints which are not indicated so that the strength of the structure is not impaired and where shown on approved shop drawings.
- D. Provide and prepare construction joints and install waterstops in accordance with the applicable requirements of ACI 301 and ACI 304R, and as specified in Section 03100, Concrete Forming.
- E. Use approved key, at least 1-1/2 inches in depth, at joints unless otherwise indicated or approved by the Engineer.
- F. Thoroughly clean the surface of the concrete at construction joints and remove laitance, loose or defective concrete, coatings, sand, sealing compound and other foreign material. Prepare surfaces of joints by sandblasting or other approved methods to remove laitance and expose aggregate uniformly.
- G. Immediately before new concrete is placed, wet the joint surfaces and remove standing water. To allow for shrinkage, do not place new concrete against the hardened concrete side of a construction joint for a minimum of 72 hours.
- H. Ensure that reinforcement is continuous across construction joints.
- I. Where bonding of the joint is required, provide bonding agent.
- J. Retighten forms and dampen concrete surfaces before concrete placing is continued.
- K. Allow at least 72 hours to elapse before continuing concrete placement at a construction joint. Approval for accelerating the minimum time elapsing between adjacent placements will be based on tests and methods which confirm that a minimum moisture loss at a relatively constant temperature will be maintained for the period as necessary to control the heat of hydration and hardening of concrete, and to prevent shrinkage and thermal cracking.

### 3.04 CONSOLIDATION AND FINISHING

- A. Thoroughly work concrete into all corners and around all embedded items and into corners and shapes of formwork, leaving no excessive voids in the concrete or honeycombed surfaces.
- B. Consolidate concrete with a mechanical vibrator of type and size acceptable to the Engineer. Vibrators shall be operated in such a manner as to reach all concrete areas, but minimize the amount of contact with reinforcing steel and formwork.
- C. All concrete shall be fully consolidated within 15 minutes of placement.
- D. Obtain a uniform surface by floating as necessary. Concrete surface shall be within 1/4 inch laterally and 1/8 inch vertically from specified line and grade, except where stricter tolerances are indicated.
- E. Apply a uniform broomed finish to the concrete surface unless indicated otherwise. Broom marks shall not exceed 1/8 inch in depth.
- F. Tool all edges with a 2-inch wide, 1/4-inch radius rounded edger.
- G. Refer to Section 03170, Concrete Finishing, for additional finishing requirements.

### 3.05 CURING AND PROTECTION

- A. Curing of concrete shall conform to applicable requirements of ACI 301 and ACI 308, except that the curing duration shall be a minimum period of ten days. Curing with earth, sand, sawdust, straw, and hay will not be permitted.
- B. Keep concrete in a moist condition from the time it is placed until it has cured for at least ten days. Keep forms damp and cool until removal of forms.
- C. Immediately upon removal of forms, exposed concrete surfaces shall be kept moist by applying an approved curing compound or by covering with damp curing materials as specified in Section 03170, Concrete Finishing.
- D. Do not permit concrete to dry during the curing period because of finishing operations.
- E. Protect fresh concrete from hot sun, drying winds, rain, damage, or soiling. Fog spray freshly placed slabs after bleed water dissipates and after finishing operations commence. Allow no slabs to become dry at any time until finishing operations are complete.
- F. Finishing and curing of slabs are specified in Section 03170, Concrete Finishing.
- G. Protect concrete from injurious action of the elements and defacement of any kind. Protect exposed concrete corners from traffic or use which will damage them in any way.

- H. Protect concrete during the curing period from mechanical and physical stresses which may be caused by heavy equipment movement, subjecting the concrete to load stress, load shock, or excessive vibration.
- I. Fog Spray: Keep the entire surface of concrete damp by applying water with a nozzle that so atomizes the flow that a mist and not a spray is formed, until the surface of the concrete is covered with a curing medium. The moisture from the nozzle shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface.
- J. Maintain a minimum temperature of 50 degrees F in the concrete for not less than 6 days for concrete subject to loads.

### **3.06 GROUT**

- A. Surface Preparation:
  - 1. Concrete surfaces to receive grout shall be prepared by chipping, water blasting, or other accepted methods to remove defective concrete, laitance, dirt, oil, grease, and other foreign matter to achieve sound, clean concrete surfaces. Lightly roughen concrete for bond, but not to interfere with proper placement of grout.
  - 2. Cementitious Grout: Saturate concrete surfaces with clean water for 24 hours prior to grouting, and remove excess water immediately before grouting.
  - 3. Epoxy Grout: Apply only to a clean, dry, roughened, sound concrete surface.
- B. Mixing:
  - 1. Mix grout ingredients for both cementitious and epoxy grout in accordance with the respective manufacturer's mixing instructions and recommendations. Mix grout materials in proper mechanical mixers.
  - 2. Mix grout as close to work area as possible.
- C. Placing:
  - 1. Cementitious Grout:
    - a. Place in accordance with manufacturer's instructions.
    - b. Completely fill all spaces and cavities below the bottom of baseplates.
    - c. Provide forms where baseplates and bedplates do not confine grout.

- d. Where exposed to view, finish grout edges smooth. Taper edges at an angle of 60 degrees when measured from the horizontal, or as indicated on the Contract Drawings.
  - e. Protect against rapid moisture loss by covering with wet rags or polyethylene sheets.
  - f. Wet cure grout for seven days, minimum.
2. Epoxy Grout:
- a. Place in accordance with manufacturer's instructions.
  - b. Completely fill all spaces and cavities around dowels and anchors without voids.
  - c. Obtain manufacturer's field technical assistance as required to ensure proper placement.
  - d. Cure grout as recommended by the manufacturer.

### 3.07 FIELD QUALITY CONTROL

- A. The Engineer will perform field testing listed herein by use of an Owner-hired independent testing laboratory. The Engineer will determine test locations. Test results will be made available to the Contractor. Provide assistance to the testing laboratory in taking samples upon the Engineer's request.
- 1. At least one set of three cylinders made in accordance with ASTM C31 and cured under laboratory conditions for each day of placing concrete or grout.
  - 2. At least one slump testing in accordance with ASTM C143 and air content test in accordance with ASTM C138, C173, or C231 made for each day of placing concrete or grout.
  - 3. The three concrete cylinders will be broken after 28 days to determine the compressive strength of the concrete. Compressive strength will be tested in accordance with ASTM C39.
  - 4. The one grout cylinder will be broken after 7 days, and two grout cylinders will be broken after 28 days to determine the compressive strength of the grout. Compressive strength will be tested in accordance with ASTM C39.
- B. If the average compressive strength of any set of three concrete cylinders, or any set of two grout cylinders broken at 28 days, does not achieve the specified amount, the Engineer may require the Contractor to do one or more of the following, at the Contractor's expense:
- 1. Additional field testing by coring or impact hammer to determine if in-place compressive strength meets specified requirement. The Contractor shall repair all core holes as approved by the Engineer.

2. Removal and replacement of work.
3. Other procedures determined by the Engineer.

**END OF SECTION**