

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SUMMARY

- A. Provisions of Division 01 apply to this section
- B. Section Includes:
 - 1. Cast-in-place normal weight and lightweight concrete, placement and finishing.
- C. Related Section:
 - 1. Section 03371: Shotcrete.

1.02 REFERENCES

- A. American Concrete Institute (ACI) Publication:
 - 1. ACI 117 – Specifications for Tolerances for Concrete Construction and Materials.
 - 2. ACI 301 – Specifications for Structural Concrete.
 - 3. ACI 302.1R – Guide for Concrete Floor and Slab Construction.
 - 4. ACI 305.1 - Specification for Hot Weather Concreting.
 - 4. ACI 306.1 – Standard Specification for Cold Weather Concreting.
 - 5. ACI 318 - Building Code Requirements for Structural Concrete, as modified by CBC Sections 1903A and 1908A.
- B. American Society for Testing and Materials (ASTM) Standards:
 - 1. ASTM C31 – Standard Specification for Making and Curing Concrete Test Specimens in the Field.
 - 2. ASTM C33 - Standard Specification for Concrete Aggregates.
 - 3. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - 4. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

5. ASTM C88 - Standard Test Method for Soundness of Aggregates by use of Sodium Sulphate or Magnesium Sulphate.
6. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
7. ASTM C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
8. ASTM C150 - Standard Specification for Portland Cement.
9. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete.
10. ASTM C172 – Standard Practice for Sampling Freshly Mixed Concrete.
11. ASTM C173 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
12. ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete.
13. ASTM C289 - Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method).
14. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
15. ASTM C330 - Standard Specification for Lightweight Aggregates for Structural Concrete.
16. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
17. ASTM C567 - Standard Test Method for Determining Density of Structural Lightweight Concrete.
18. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
19. ASTM C845 - Standard Specification for Expansive Hydraulic Cement
20. ASTM C989 - Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
21. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
22. ASTM C1064 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
23. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures

24. ASTM C1567 - Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
25. ASTM D1751 - Standard Test Method for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
26. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
27. ASTM E1155 - Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers.
28. ASTM E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
29. ASTM E1745 - Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

1.03 SUBMITTALS

- A. Mix Design Data: Submit concrete mix designs as specified herein and in Article 2.02.
 1. Submit name, address and telephone number of the concrete production facility which the contractor intends to engage to design the concrete mixes. Submit name and qualifications of the proposed concrete technologist.
 2. Mix Design: Submit a concrete mix design for each strength and type of concrete indicated in the drawings or specified. Include water/cement ratio, source, size and amount of coarse aggregate and admixtures. Predict minimum compressive strength, maximum slump and air content percentage. Clearly indicate locations where each mix design will be used.
 3. Test Reports: Submit copies of test reports showing that the proposed mixes produce concrete with the strengths and properties specified. Include tests for cement, aggregates and admixtures. Provide gradation analysis.
- B. Certificates: Submit certification that each of the following conforms to the standards indicated:
 1. Portland cement: ASTM C150.
 2. Normal weight concrete aggregates: ASTM C33.
 3. Lightweight concrete aggregates: ASTM C330.
 4. Aggregates: Submit evidence that the aggregate is not reactive in the presence of cement alkalis. In the absence of evidence, aggregate shall be tested per

ASTM C289. If results of test are other than innocuous, aggregates shall be tested per ASTM C1567 as required by CBC, Section 1903A.3.

5. Curing materials: ASTM C171.

E. Admixtures: Submit product data for proposed concrete admixtures.

1.04 QUALITY ASSURANCE

A. Continuous inspection shall be provided at the batch plant and for transit-mixed concrete to run check sieve analysis of aggregate, check moisture content of fine aggregate, check design of mix, check cement being used with test reports, check loading of mixer trucks, and certify to quantities of materials placed in each mixer truck.

B. Inspection shall be performed by a representative of a testing laboratory selected by the Owner. Owner will pay for inspection costs. Notify the laboratory 24 hours in advance of time concrete is to be mixed. Notify the laboratory of postponement or cancellation of mixing within at least 24 hours of scheduling time.

C. Contractor shall assist the testing laboratory in obtaining and handling samples at the project site and at the source of materials.

D. Continuous batch plant inspection requirement may be waived in accordance with CBC Section 1704A4.4. Waiver shall be in writing, including DSA approval. When batch plant inspection is waived by DSA, the following requirements shall be met:

1. Approved inspector of the testing laboratory shall check the first batching at the start of work and furnish mix proportions to the licensed weightmaster.

2. Licensed weightmaster shall positively identify materials as to quantity and certify to each load by a ticket.

3. Tickets shall be transmitted to the IOR by a truck driver with load identified thereon. The IOR will not accept the load without a load ticket identifying the mix and will keep a daily record of placements, identifying each truck, its load and time of receipt and approximate location of deposit in the structure and will transmit a copy of the daily record to DSA.

4. At the end of the project, the weightmaster shall furnish an affidavit to DSA certifying that all concrete furnished conforms in every particular to proportions established by mix designs.

E. Special Inspections and Tests shall be in accordance with CBC Chapter 17A, CBC Section 1916A and Specification Section 01420.

1.05 DELIVERY, STORAGE AND HANDLING

A. Store cement and aggregate materials so as to prevent their deterioration or intrusion by foreign matter. Deteriorated or contaminated materials shall not be furnished.

B. Packaged materials shall bear the manufacturers and brand name label, and shall be stored in their original unbroken package in a weather tight place until ready for use in the work.

1.06 PROJECT CONDITIONS

- A. Cold Weather Requirements: Batching, mixing, delivering and placing of concrete in cold weather shall comply with the applicable requirements of ACI 306.1.
- B. Hot Weather Requirements: Batching, mixing, delivering and placing of concrete in hot weather shall comply with the applicable requirements of ACI 305R.
- C. Concrete temperature of freshly mixed concrete shall be determined per ASTM C1064.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Cement: ASTM C150. Portland Cement.
- B. Aggregates: Conform to the following standards:
 - 1. Normal weight concrete: ASTM C33
 - 2. Lightweight concrete: ASTM C330, with fine aggregates per ASTM C33.
 - 3. Aggregate shall be tested for Potential Alkali Reactivity of Cement-Aggregate Combinations per ASTM C289.
 - 4. Nominal maximum size of coarse aggregate shall be no larger than:
 - a. 1/5 the narrowest dimension between sides of forms, nor
 - b. 1/3 the depth of slabs, nor
 - c. 3/4 the clear spacing between individual reinforcing bars or wires, bundles of bars, individual tendons, or ducts.
 - d. Contractor may request the Architect and DSA waiver of the above limitations per CBC Section 1903A.3, provided that the workability and methods of consolidation are such that the concrete can be placed without honeycombs or voids.
- C. Water: Water for concrete mixes, curing and cleaning shall be potable and free from deleterious matter.
- D. Admixtures: Shall be shown capable of maintaining essentially the same composition and performance throughout the work as the product used in establishing concrete proportions in accordance with ACI 318, Section 3.6.
 - 1. Admixtures containing chlorides or sulfides are not permitted.
 - 2. Air-entraining admixtures shall comply with ASTM C260. Air-entrained admixtures shall not be used for floor slabs to receive steel trowel finish.

3. Admixtures for water reduction and setting time modification shall conform to ASTM C494.
4. Admixtures for producing flowing concrete shall conform to ASTM C1017.
5. Fly ash, pozzolan and ground granulated blast-furnace slag: Modify ACI 318 Sections 3.6.6 and 3.6.7 as follows:
 - a. Fly ash or other pozzolan used as a partial substitution for ASTM C150 Portland cement shall meet the following requirements:
 - 1) Shall conform to ASTM C618 for Class N or F materials (Class C is not permitted).
 - 2) [] per cent by weight of fly ash or other pozzolans shall substitute for ASTM C150 Portland cement provided the mix design is proportioned per Section 1905A.3 and the durability requirements of Section 1904A are met.
 - b. Ground-granulated blast-furnace slag used as a partial substitution for ASTM C150 Portland cement shall meet the following requirements:
 - 1) Shall conform to ASTM C989.
 - 2) [] per cent by weight of ground-granulated blast-furnace slag shall substitute for ASTM C150 Portland cement provided the mix design is proportioned per Section 1905A.3 and the durability requirements of Section 1904A are met.
6. Admixtures containing ASTM C845 expansive cements shall be compatible with the cement and produce no deleterious effects.
7. Silica fumes used as an admixture shall conform to ASTM C1240.
- E. Reinforcement Fibers: Chop strands of alkali-resistant polypropylene or nylon fibers added to the concrete mix for protection against shrinkage cracks.
- F. Expansion Joint Fillers: Preformed strips, non-extruding and resilient bituminous type, of thickness indicated, conforming to ASTM D1751.
- G. Curing Paper: Shall conform to ASTM C171 and consist of two sheets of kraft paper cemented together with a bituminous material in which are embedded cords or strands of fiber running in both directions. The paper shall be light in color, shall be free of visible defects, with uniform appearance.
- H. Floor Hardener: Water soluble, inorganic, silicate-based curing, hardening, sealing and dustproofing compound. Aquaseal W20 by Monopole Inc., Kure-N-Harden by BASF, Chem Hard by L&M, Liqui-Hard by W. R. Meadows, or equal.

2.02 CONCRETE MIX

- A. Mix shall be signed and sealed by a Civil or Structural Engineer currently registered in the State of California.
- B. Strength of Concrete: Strengths and types of concretes shall be as indicated in the Drawings. Unless otherwise indicated or specified, concrete shall be provided with **minimum 28-day strength of 3000 psi (f'c)**.
- C. The required strength and durability of concrete shall be determined by compliance with the proportioning, testing, mixing and placing provisions of CBC Sections 1905A.1 through 1905A.13. Concrete mix shall meet the durability requirements of ACI 318, Chapter 4.
- D. Concrete proportioning shall be determined on the basis of field experience and/or trial mixtures shall in accordance with ACI 318, Section 5.3. Proportions of materials shall provide workability and consistency to permit concrete to be placed readily into forms and around reinforcement under conditions of placement to be employed, without segregation or excessive bleeding.
- E. Ready-Mixed Concrete: Mix and deliver in accordance with requirements of ASTM C94.

PART 3 - EXECUTION

3.01 GENERAL

- A. Surfaces to receive concrete shall be free of debris, standing water, and any other deleterious substances before start of concrete placing.
- B. Time of Placing: Do not place concrete until reinforcement, and other embedded materials are securely fastened in place. Contact the IOR at least 24 hours before placing concrete; do not place concrete until inspected by the IOR.
- C. Pouring Record: A record shall be kept on the Project site of time and date of placing concrete in each portion of structure. Such record shall be maintained on the Project site until Substantial Completion and shall be available for examination by the Architect and DSA.

3.02 TOLERANCES

- A. Concrete construction tolerances shall be as specified in ACI 117 and as modified herein.
- B. Refer to ACI 302.1R, Tables 8.1 and 8.2 Slab on Ground Flatness/Levelness Construction Guide, for recommended concrete placing and finishing methods.

3.03 INSTALLATION

- A. Conveying and Placing:

1. Concrete shall be placed only under direct observation of the IOR. Do not place concrete outside of regular working hours, unless the IOR has been notified at least 48 hours in advance.
2. Concrete shall be conveyed from mixer to location of final placement by methods that will prevent separation or loss of materials.
3. Concrete shall be placed as nearly as practicable to its final position to avoid segregation due to re-handling or flowing. No concrete that has partially hydrated or has been contaminated by foreign materials shall be placed, nor shall re-tempered concrete or concrete which has been remixed after initial set be placed.
4. Concrete shall be placed as a continuous operation until placing of panel or section is completed.
5. Concrete shall be thoroughly consolidated by suitable means during placement, and shall be thoroughly worked around reinforcement and embedded fixtures and into corners of forms.
6. Where conditions make consolidation difficult or where reinforcement is congested, batches of mortar containing same proportions of cement, sand, and water as provided in the concrete, shall first be deposited in the forms to a depth of at least one inch.

B. Hot Weather:

1. Concrete to be placed during hot weather shall comply with the requirements of ACI 318, Section 5.13.
2. Maintain concrete temperatures indicated in Table 2.1.5 of ACI 305R to prevent the evaporation rate from exceeding 0.2 pound of water per square feet of exposed concrete per hour.
3. Cool concrete using methods indicated in ACI 305R Appendix B.
4. Place and cure concrete as specified in ACI 305R Chapter 4.

D. Compaction and Screeding:

1. Tamp freshly placed concrete with a heavy tamper until at least 3/8 inch of mortar is brought to surface. Concrete shall then be tamped with a light tamper and screeded with a heavy straightedge until depressions and irregularities are eliminated, and surface is true to finish grades or elevations. Remove excess water and debris.
2. Where slabs are to receive separate cement finish or mortar setting bed, continued tamping to raise mortar to surface is not performed. Laitance shall be removed by brushing with a stiff brush or by light sandblasting to expose clean top surface of coarse aggregate.

- E. Floating and Troweling:
1. When concrete has hydrated sufficiently, it shall be floated to a compact and smooth surface. After floating, wait until concrete has reached proper consistency before troweling. Top surfaces shall receive at least 2 troweling operations with steel hand trowel. Prior to and during final troweling, apply a fine mist of water frequently with an atomizing type fog sprayer. Omit troweling for slabs to receive a separate cement finish.
 2. For interior finish slabs, final troweling shall provide a hard, impervious, and non-slip surfaces, free from defects and blemishes. Finished surface shall be within tolerances indicated in Article 3.02. Avoid burnishing. Do not add cement or sand to absorb excess moisture.
- F. Curing:
1. Length of time, temperature and moisture conditions for curing concrete shall be in accordance with ACI 318, Section 5.11.
 2. If weather is hot or surface has dried out, spray surface of concrete slabs and paving with fine mist of water, starting not later than 2 hours after final troweling and continuing until sunset. Surface of finish shall be kept continuously wet until curing medium has been installed.
 4. Immediately after finishing, monolithic floor slabs shall be covered with curing paper. Paper shall be lapped 4 inches at joints and sealed with waterproof sealer. Edges shall be cemented to finish. Repair or replace paper damaged during construction operations.

3.05 FINISHING

- A. Abrasive: Interior exposed concrete floors in shop buildings shall receive an abrasive finish.
- B. Floor Hardener: Exposed interior concrete floors throughout shall be treated with floor hardener.
1. Protect adjacent surfaces. Clean surfaces to receive treatment in accordance with manufacturer's instructions, ensuring that all stains, oil, grease, form release agents, laitance, dust and dirt are removed prior to application.
 2. Apply hardener in accordance with manufacturer's instructions as soon as concrete is firm enough to work on after final troweling.
- C. Cement Grout and Dry-Pack Concrete: Cement grout shall be mixed at the Project site and shall be composed of one volume of Portland cement and 2-1/2 volumes of fine aggregate. Materials shall be mixed dry with sufficient water added to make mixture flow under its own weight. When grout is used as a dry pack concrete, add sufficient water to provide a stiff mixture, which can be molded into a sphere.

3.06 EXPANSION AND CONSTRUCTION JOINTS

- A. Construction Joints: Details and proposed location of construction joints shall be as indicated on the Drawings, located to least impair strength of structure, in accordance with the following:
 - 1. Thoroughly clean contact surface by sand blasting entire surface not earlier than 5 days after initial placement.
 - 2. A mix containing same proportion of sand and cement provided in concrete plus a maximum of 50 percent of coarse aggregate shall be placed to a depth of at least one inch on horizontal joints. Vertical joints shall be wetted and coated with a neat cement grout immediately before placing of new concrete.
 - 3. Should contact surface become coated with earth, sawdust, or deleterious material of any kind after being cleaned, entire surface shall be re-cleaned before applying mix.
- B. Tooled Joints: Slabs, walks and paving shall be marked into areas as indicated with markings made with a V-grooving tool. Marks shall be round-edged, free from burrs or obstructions, with clean cut angles and shall be straight and true.

3.07 TESTING

- A. Molded Cylinder Tests:
 - 1. IOR or testing lab personnel will prepare cylinders and perform slump tests. Samples for concrete strength shall be taken in accordance to ASTM C172. Each cylinder shall be dated, given a number, point in structure from which sample was obtained, mix design number, mix design strength and result of accompanying slump test noted.
 - 2. Separate tests of molded concrete cylinders obtained at same place and time shall be made at age of 3 days, 7 days, and 28 days. A strength test shall be the average of the compressive strength of 2 cylinders, obtained from the same sample of concrete and tested at 28 days or at test age designated for determination of f_c .
 - 3. Test cylinders shall be prepared at the Project site and stored in testing laboratory in accordance with ASTM C31, and tested in accordance with ASTM C39.
- B. Core Test: At request of the Architect, cores of hardened concrete shall be cut from portions of hydrated structures for testing, in accordance with CBC and ASTM C42.
 - 1. Provide 4 inch diameter cores at representative places throughout the structure as designated by the Architect.
 - 2. In general, provide sufficient cores to represent concrete placed with at least one core for each 4,000 square feet of building area, and at least 3 cores total for each Project.

3. Where cores have been removed, fill voids with drypack, and patch the finish to match the adjacent existing surfaces.
- C. Concrete Consistency: Measure consistency according to ASTM C143. Test twice each day or partial day's run of the mixer.
 - D. Adjustment of Mix: If the strength of any grade of concrete for any portion of Work, as indicated by molded test cylinders, falls below minimum 28 days compressive strength specified or indicated, adjust mix design for remaining portion of construction so that resulting concrete meets minimum strength requirements.
 - E. Air Content Testing: Measure in accordance to ASTM C173 or ASTM C231, for each composite sample taken in accordance to ASTM C172.
 - F. Defective Concrete:
 1. Should strength of any grade of concrete, for any portion of Work indicated by tests of molded cylinders and core tests, fall below minimum 28 days strength specified or indicated, concrete will be deemed defective Work and shall be replaced or adequately strengthened in a manner acceptable to the Architect and DSA.
 2. Concrete Work that is not formed as indicated, is not true within 1/250 of span, not true to intended alignment, not plumb or level where so intended, not true to intended grades and levels, contains sawdust shavings, wood or embedded debris, or does not fully conform to Contract provisions, shall be deemed to be defective Work and shall be removed and replaced.
 - G. Concrete for Equipment Pads Work: Unless otherwise indicated, strength shall have a minimum $f'c = 3,000$ psi. Exposed concrete shall be provided with a hand trowel finish with radius edges. Calcium chloride shall not be furnished in any concrete mix provided for the installation of underground electrical conduits. For concrete encasement of more than one conduit, furnish 3/4 inch maximum aggregate.
- 3.08 CLEAN UP
- A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.
- 3.09 PROTECTION
- A. Protect the Work of this section until Substantial Completion.

END OF SECTION