

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Provide cast-in-place concrete work as indicated on the Drawings and specified herein. Work includes the following:
 - 1. Cast-in-place concrete footings, floors, slabs on grade, supported slabs, columns, and beams.
 - 2. Formwork.
 - 3. Reinforcement.
 - 4. Control, expansion, and contraction joint devices associated with cast-in-place concrete work, including joint sealants.
 - 5. Equipment pads.

1.3 REFERENCES

- A. ACI 211.1: Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
- B. ACI 301: Structural Concrete for Buildings.
- C. ACI 302: Guide for Concrete Floor and Slab Construction.
- D. ACI 304: Recommend Practice for Measuring, Mixing, Transporting and Placing Concrete.
- E. ACI 305R: Hot Weather Concreting.
- F. ACI 306R: Cold Weather Concreting.
- G. ACI 308: Standard Practice for Curing Concrete.
- H. ACI 318: Building Code Requirements for Structural Concrete.
- I. ASTM C33: Concrete Aggregates.
- J. ASTM C39: Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- K. ASTM C94: Ready-Mixed Concrete.

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- L. ASTM C150: Portland Cement.
- M. ASTM C260: Air Entraining Admixtures for Concrete.
- N. ASTM C494: Test Method for Chemical Admixtures for Concrete.
- O. ASTM C618: Fly Ash and Raw or Calcinated Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
- P. ASTM D994: Preformed Expansion Joint Filler for Concrete (Bituminous Type).
- Q. ASTM D1190: Concrete Joint Sealer, Hot-Poured Elastic Type.
- R. ASTM D1751: Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
- S. ASTM E 1693: Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
- T. ASCE 7-05: Minimum Design Loads for Buildings and other Structures.

1.4 SUBMITTALS

- A. Product Data: Provide data on joint devices, attachment accessories, admixtures, curing compound, and sealers. Include manufacturers' installation instructions.
- B. Design Mixtures: For each concrete mixture, submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Field quality-control test reports.
- D. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement.
- E. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.
- F. Closeout Submittals: Accurately record actual locations of embedded utilities and components that are concealed from view.

1.5 DESIGN REQUIREMENTS

- A. Design in conformance with ACI 318 and ACI 301.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 301 and ACI 117.
- B. Mix and deliver ready mixed concrete in accordance with ASTM C94.
- C. Maintain one copy of each document on site.
- D. Acquire cement and aggregate from same source for all work.
- E. Conform to ACI 305R when concreting during hot weather.
- F. Conform to ACI 306R when concreting during cold weather.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

2.2 STEEL REINFORCEMENT

- A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
- B. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
 - 1. Epoxy-Coated Reinforcing Bars: ASTM A 775, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.
- C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice.

2.3 CONCRETE MATERIALS

- A. Cement: ASTM C150, Type I - Normal, Portland type.
- B. Fine and Coarse Aggregates: ASTM C33.

- C. Water: Clean, not detrimental to concrete, potable, in accordance with ASTM C 94.

2.4 ADMIXTURES

- A. Air Entrainment: ASTM C260.
- B. Chemical Admixtures: ASTM C494, and as follows:
 - 1. Water Reducing - Type A.
 - 2. Retarding - Type B.
 - 3. Accelerating - Type C.
 - 4. Water Reducing and Retarding - Type D.
 - 5. Water Reducing and Accelerating - Type E.
 - 6. Water Reducing, High Range - Type F.
 - 7. Water Reducing, High Range and Retarding - Type G.
- C. Fly Ash: ASTM C618, Class F.

2.5 VAPOR RETARDERS

- A. Vapor Retarders, General: Provide one of the vapor retarders specified herein. Include manufacturer's recommended adhesive or pressure-sensitive tape.
- B. Products: Provide one of the following:
 - 1. "ProGuard Vapor Barrier 16 Mil"; Proguard, Inc. 16 mil thickness. Virgin resin-based polyolefin membrane; three layer cross-laminated construction.
 - 2. "Stego Wrap Vapor Barrier"; Stego Industries, Inc. 15 mil thickness. Virgin resin-based polyolefin membrane; multi-layer construction.
 - 3. "Perminator"; W. R. Meadows, Inc. 15 mil thickness. Resin-based polyolefin membrane.

2.6 ACCESSORIES

- A. Bonding Agent Types:
 - 1. Polymer resin emulsion.
 - 2. Polyvinyl acetate.
 - 3. Latex emulsion.
- B. Polymer resin emulsion, Polyvinyl Acetate, Latex emulsion, two component modified epoxy resin,

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- C. Non-Shrink Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days.

2.7 JOINT DEVICES AND FILLER MATERIALS

- A. Joint Filler: ASTM D1751; Asphalt impregnated fiberboard or felt; resiliency recovery of 95 percent if not compressed more than 50 percent of original thickness.
- B. Construction Joint Devices: Integral galvanized steel; formed to tongue and groove profile, with removable top strip exposing sealant trough, ribbed steel spikes with tongue to fit top screed edge.
- C. Sealant and Primer: Type, as specified in Section 07 92 00 "Joint Sealants".

2.8 CONCRETE MIX

- A. Mix concrete in accordance with ACI 304. Deliver concrete in accordance with ASTM C94.
- B. Select proportions for normal weight concrete in accordance with ACI 301 Method 3.
- C. Use accelerating admixtures in cold weather only when approved by Architect and Engineer. Use of admixtures will not relax cold weather placement requirements.
- D. Use set retarding admixtures during hot weather only when approved by Architect and Engineer.
- E. Add air-entraining agent to normal weight concrete mix for work exposed to exterior.

2.8 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 - 1. Fly Ash: 20 percent, maximum.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.

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1. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete and concrete with a water-cementitious materials ratio below 0.50.

2.9 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Footings: Proportion normal-weight concrete mixture as follows

1. Minimum Compressive Strength: 3000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.50.
3. Slump Limit: 4 inches, plus or minus 1 inch.

B. Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 3000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.50.
3. Slump Limit: 4 inches, plus or minus 1 inch.
4. Air Content: Do not allow air content of troweled finished floors to exceed 3percent.

C. Elevated Slabs: Proportion normal-weight concrete mixture as follows

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.50.
3. Slump Limit: 4 inches, plus or minus 1 inch.
4. Air Content: Do not allow air content of troweled finished floors to exceed 3-percent.

D. Columns and Beams: Proportion normal-weight concrete mixture as follows

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.50.
3. Slump Limit: 4 inches, plus or minus 1 inch.

2.10 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.

- D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
- E. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

2.11 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

2.12 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and furnish batch ticket information.
 - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify requirements for concrete cover over reinforcement.
- B. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete.

3.2 PREPARATION

- A. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent in accordance with manufacturer's written instructions.
- B. Coordinate the placement of joint devices with erection of concrete formwork and placement of form accessories.
- C. Remove all foreign matter and water from forms or structural excavations.

3.3 FORMWORK

- A. Conform to ACI 347.

- B. Foundations shall be formed. Earth forms not allowed.
- C. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- D. Do not chamfer exterior corners and edges of permanently exposed concrete.

3.4 PLACING CONCRETE

- A. Place concrete in accordance with ACI 301.
- B. Notify Architect and Engineer minimum 24 hours prior to commencement of operations.
- C. Ensure reinforcement, inserts, embedded parts, formed expansion and contraction joints are not disturbed during concrete placement.
 - 1. Install vapor retarder under interior slabs on grade. Lap joints minimum six inches and seal watertight by taping edges and ends with manufacturer's recommended tape. Adhesion areas free from dust, dirt, and moisture to allow maximum adhesion of tape.
- D. Repair vapor barrier damaged during placement of concrete reinforcing. Repair with vapor barrier material; lay over damaged areas minimum six inches and seal watertight. Place, protect, and repair in accordance with ASTM E 1643 and manufacturer's printed instructions.
- E. Separate slabs on grade from vertical surfaces with joint filler.
- F. Place joint filler in floor slab pattern placement sequence. Secure to resist movement by wet concrete.
- G. Extend joint filler from bottom of slab to within 1/4 inch of finished slab surface. Conform to Section 07 92 00 "Joint Sealants" for finish joint sealer requirements.
- H. Install joint devices in accordance with manufacturer's written instructions.
- I. Install construction joint devices in coordination with floor slab pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.
- J. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- K. Place concrete continuously between predetermined expansion, control, and construction joints.
- L. Do not interrupt successive placement; do not permit cold joints to occur.

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- M. Saw cut joints within 24 hours after placing. Use 3/16 inch thick blade, cut into 1/4 depth of slab thickness.
- N. Screed floors and slabs on grade level, maintaining surface flatness of maximum 1/8 inch in 10 feet.

3.5 CONCRETE FINISHING

- A. Provide formed concrete surfaces to be left exposed.
- B. Finish concrete floor surfaces as indicated on Drawings.

3.6 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete Work.
- B. Curbs: Provide monolithic finish to curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

3.7 CONCRETE PROTECTION AND CURING

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305R for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2-lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing by one or a combination of the following methods:

- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces, by one or a combination of the following methods:
1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 2. Moisture Retaining Cover Curing: Cover concrete surfaces with moisture retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer recommends for use with floor coverings.
 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated on the finish schedule (shown on the drawings and noted as "sealed concrete"), exterior walkway suspended slabs, and stairs in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.8 FIELD QUALITY CONTROL

- A. The Owner shall employ a testing laboratory to perform tests and to submit test reports, except as designated otherwise. The testing laboratory and its employees shall be qualified in accordance with ASTM E 329, and the inspection and testing activities shall be in accordance with ASTM E 329. Contractor shall coordinate all tests.
- B. Provide free access to Work and cooperate with appointed firm.

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- C. Tests of cement and aggregates may be performed to ensure conformance with specified requirements.
- D. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed, except modified for slump to comply with ASTM C 94.
 - 1. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated on the finish schedule.
 - 2. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mix exceeding 5 cubic yards, plus one set or each additional 50 cubic yards or less.
 - 3. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 - 4. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - 5. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 - 6. Compression Test Specimens: ASTM C 31.
- E. Cast and laboratory cure four standard cylinder specimens for each composite sample.
- F. One additional test cylinder shall be taken during cold weather concreting, cured on the job site under the same conditions as the concrete it represents.
- G. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at 7 days, one set of two specimens at 28 days, and retain one specimen in reserve for later testing if required.
- H. A compressive strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
- I. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- J. Test results shall be reported in writing to Architect and Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- K. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect and Engineer but will not be used as sole basis for approval or rejection of concrete.

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- L. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect and Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Architect and Engineer.
- M. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- N. Correct deficiencies in the Work that test reports and inspections indicate does not comply with the Contract Documents.
- O. Measure floor and slab flatness and levelness according to ASTM E 1155 within 24 hours of finishing.

3.9 PATCHING

- A. Allow Architect and Engineer to inspect concrete surfaces immediately upon removal of forms.
- B. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Architect and Engineer upon discovery.
- C. Patch imperfections in accordance with ACI 301.

3.10 DEFECTIVE CONCRETE

- A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
- B. Architect and Engineer shall determine the repair or replacement of defective concrete.

END OF SECTION 03 30 00