

SECTION 03 31 00 - CAST-IN-PLACE STRUCTURAL CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Cast-in place structural concrete including footers, foundations, and other non-slab applications.
2. Formwork
3. Reinforcement

B. Refer to the following sections for concrete slab work:

1. Division 03 Section "Cast-In-Place Concrete Slabs" for Non-polished, non colored cast-in place concrete slabs-on-grade and non-polished, non-colored concrete topping on metal deck formwork.

C. Refer to Division 03 Section "Cast-In-Place Concrete Slab Cutting and Patching" for cutting and patching of existing cast-in-place.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each concrete mixture, provide proportion mixes by either laboratory trial batch or field experience method, complying with ACI 301. Include all admixtures to be used in the concrete. Include field test data from at least 10 tests or a three-point curve generated using trial mixtures.

C. Shop Drawings: For steel reinforcement.

D. Material Test Reports: From a qualified testing agency, indicating and interpreting test results for compliance of the materials, and admixtures with requirements indicated, for all materials utilized in the concrete.

1. Submit reports from tests required by section 1.6 of ACI 301-05 to structural engineer, architect, owner, contractor, concrete supplier, and building official.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

- B. **Installer Qualifications:** An experienced installer who has completed standard concrete work similar in material, design and extent to that indicated for this project on a minimum of three similar projects, and whose work has resulted in construction with a record of successful in-service performance.
- C. **ACI Publications:** Comply with the latest edition of the following unless modified by requirements in the Contract Documents:
 - 1. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
 - 2. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5.
 - 3. ACI 305R, "Hot Weather Concreting; American Concrete Institute International."
 - 4. ACI 306R, "Cold Weather Concreting; American Concrete Institute International."
 - 5. ACI 318, "Building Code Requirements for Structural Concrete."
 - 6. ACI 347 "Recommended Practice for Concrete Formwork."
 - 7. ACI 403 "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete."
- D. **Source Limitations:** Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.

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. **Form-Release Agent:** Commercially formulated form-release agent with a maximum of 350 mg/l volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- C. **Form Ties:** Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

2.2 STEEL REINFORCEMENT

- A. **Reinforcing Bars:** ASTM A 615/A 615M, Grade 60, deformed.
- B. **Plain-Steel Welded Wire Reinforcement:** ASTM A 185, plain, #42, fabricated from as-drawn steel wire into flat sheets.
- 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. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C 150, Type I or II.
- B. Normal-Weight Aggregates: ASTM C 33, graded.
- C. Fly Ash: ASTM C618, type F or C. When used, fly ash-to-total cementitious ratio shall be 15 percent minimum to 25 percent maximum.
- D. Ground Granulated Blast Furnace Slag: ASTM C989. Total ground granulated blast furnace slag-to-total cementitious ratio shall not exceed 30 percent maximum.
- E. Water: ASTM C 94/C 94M and potable.
- F. Air-Entraining Admixture: ASTM C 260.
- G. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- H. Chloride Content Of Concrete: Limit total chloride ion content to amount indicated in Table 4.2.2.6 of ACI 301-99. Admixtures containing chloride are not permitted in reinforced concrete or concrete containing metals.

2.4 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

2.5 CONCRETE MIXTURES

- 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.
- B. Proportion normal-weight concrete mixture as follows:
 - 1. Spread Footings:
 - a. Minimum Compressive Strength: 3000 psi.
 - b. Maximum Water-Cementitious Materials Ratio: 0.55.

- c. Aggregate: Normal weight.
- d. Slump Limit:
 - 1) Standard: 4 inches, plus or minus 1 inch.
 - 2) With Mid-Range Water Reducer: 6-inches, plus or minus 1-inch.

2.6 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, 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 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork according to ACI 301 to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
 - 1. Clean and adjust forms prior to concrete placement. Apply form release agents.
 - 2. Provide openings in formwork to accommodate work of other trades.
 - 3. Retighten forms during and after concrete placement if required to eliminate mortar leaks.

3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
- B. Bar Reinforcement
 - 1. Position reinforcement accurately per plan before concrete is placed. Secure against displacement with 16 gage annealed wire or suitable clips. Place reinforcing in accordance with ACI 301.

2. Reinforcement, at time concrete is placed, shall be free of mud, oil, release agents, or other materials that may adversely affect or reduce bond.
3. Where concrete surface will be exposed to weather in finished structure where rust would impair architectural finishes, portions of accessories in contact with formwork shall be stainless steel or plastic.
4. Lap splice reinforcing bars as follows unless noted otherwise:
 - a. Horizontal bars with more than 12-inches of concrete below: 62 bar diameters
 - b. Horizontal bars with less than 12-inches of concrete below, and all other bars: 50 bar diameters
5. Securely anchor reinforcing steel before conduit, piping and other items are placed. Do not displace reinforcing without prior review of Owner's Representative.

3.4 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
 1. Locate and install construction, isolation and control joints as indicated or required. Give special attention to reentrant corners.

3.5 CONCRETE PLACEMENT, GENERAL

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
 1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 2. Do not add water at the job site unless approved by the Owner's Representative.
 - a. If concrete arrives at the point of delivery with a slump below that which will result in the specified slump at the point of placement and is unsuitable for placing at that slump, the slump may be adjusted once only to the required value by adding water up to the amount allowed in the accepted mixture proportions. Addition of water shall be in accordance with ASTM C94. Do not exceed the specified water-cementitious material ratio or slump in the approved mix design. Do not add water to concrete delivered in equipment not acceptable for mixing. After plasticizing or water reducing admixtures are added to the concrete at the site to achieve flowable concrete, do not add water to the concrete. Measure slump (and air content of air entrained concrete), after slump adjustment, to verify compliance with specified requirements.
- C. Cold-Weather Placement: Comply with ACI 306R and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

D. Hot-Weather Placement: Comply with ACI 305R and as follows:

1. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.6 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Cure concrete according to ACI 308.1.

3.7 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Owner's Representative. Remove and replace concrete that cannot be repaired and patched to Owner's Representative approval.

3.8 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports. Field testing to be performed by an ACI certified concrete field testing technician grade I (or equivalent).
- B. Contractor's Responsibilities
 1. Notify Owner's Representative in advance of concrete placement to allow sufficient time to prepare for required testing.
 2. Assist Owner's Representative in securing field specimens.
 3. Provide and maintain for sole use of Owner's testing laboratory, facilities for safe storage and proper curing of concrete test cylinders at Project site as required by ASTM C31 and acceptable to Owner's testing laboratory.
- C. Inspections:
 1. Steel reinforcement placement.
 2. Headed bolts and studs.
 3. Verification of use of required design mixture.
 4. Concrete placement, including conveying and depositing.

5. Curing procedures and maintenance of curing temperature.
6. Verification of concrete strength before removal of shores and forms from beams and slabs.

D. Testing and Inspecting:

1. Testing Services: Tests shall be performed according to ACI 301.
2. Sampling: ASTM C-172.
3. Slump: ASTM C-143, one (1) test at discharge point for each day's pour for each type of concrete. Conduct additional tests when concrete consistency appears to have changed.
 - a. Measure slump prior to the addition of admixtures and after the addition of admixtures.
4. Air Content: ASTM C-173 or C-231, one for each set of compressive strength specimens.
5. Compression Test Specimen: ASTM C-31, one set of four standard cylinders for each compressive strength test, unless directed otherwise.
6. Concrete Temperature: ASTM C-1064
7. Compressive Strength: ASTM C-39, minimum testing is one set per day for each mix placed for each 50 cubic yards or fraction thereof; one specimen tested at 7 days, two specimens tested at 28 days and one retained for later testing if required.
8. Moisture vapor emission testing shall be conducted as required by the Owner's Representative.

E. Additional Tests: Owner's 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 Owner's Representative. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Owner's Representative.

1. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

F. Correct deficiencies in the Work that test reports and inspections indicate does not comply with the Contract Documents

G. Owner's Representative shall make final acceptance and approval of concrete work.

END OF SECTION 03 31 00

