

SECTION 03300 - 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 1 Specifications Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Concrete for composite floor construction.
- B. Floors and slabs on grade.
- C. Concrete reinforcement.
- D. Joint devices associated with concrete work.

1.3 RELATED REQUIREMENTS

- A. Section 03100 - Concrete Forms and Accessories: Forms and accessories for formwork.
- B. Section 03200 - Concrete Reinforcement.

1.4 REFERENCE STANDARDS

- A. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; American Concrete Institute International; 1991 (Reapproved 2002).
- B. ACI 301 - Specifications for Structural Concrete for Buildings; American Concrete Institute International; 2005.
- C. ACI 302.1R - Guide for Concrete Floor and Slab Construction; American Concrete Institute International; 2004 (errata 2007).
- D. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International; 2000.
- E. ACI 305R - Hot Weather Concreting; American Concrete Institute International; 1999.
- F. ACI 306R - Cold Weather Concreting; American Concrete Institute International; 1988 (Reapproved 2002).
- G. ACI 308R - Guide to Curing Concrete; American Concrete Institute International; 2001 (Reapproved 2008).
- H. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; American Concrete Institute International; 2008.
- I. ASTM A 185/A 185M - Standard Specification for Steel Welded Wire

- Reinforcement, Plain, for Concrete; 2007.
- J. ASTM A 497/A 497M - Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete; 2007.
 - K. ASTM C 33 - Standard Specification for Concrete Aggregates; 2007.
 - L. ASTM C 39/C 39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2005.
 - M. ASTM C 94/C 94M - Standard Specification for Ready-Mixed Concrete; 2007.
 - N. ASTM C 143/C 143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2008.
 - O. ASTM C 150 - Standard Specification for Portland Cement; 2007.
 - P. ASTM C 260 - Standard Specification for Air-Entraining Admixtures for Concrete; 2006.
 - Q. ASTM C 494/C 494M - Standard Specification for Chemical Admixtures for Concrete; 2008a.
 - R. ASTM C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2008a.
 - S. ASTM C 685/C 685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing; 2007.
 - T. ASTM C 881/C 881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 2002.
 - U. ASTM C 1059 - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete; 1999 (Reapproved 2008).
 - V. ASTM C 1107/C 1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2008.
 - W. ASTM D 994 - Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type); 1998 (Reapproved 2003).
 - X. ASTM D 1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types); 2004 (Reapproved 2008).
 - Y. ASTM E 1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2009.
 - Z. COE CRD-C 572 - Corps of Engineers Specifications for Polyvinylchloride Waterstop; Corps of Engineers; 1974.

1.5 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Mix Design: Submit mix design for each type of concrete proposed.

- C. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements.
- D. Samples: Submit samples of underslab vapor retarder to be used.

1.6 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 301 and ACI 318.
- B. Follow recommendations of ACI 305R when concreting during hot weather.
- C. Follow recommendations of ACI 306R when concreting during cold weather.

PART 2 PRODUCTS

2.1 FORMWORK

- A. Comply with requirements of Section 03100.

2.2 REINFORCEMENT

- A. Comply with requirements of Section 03200.

2.3 CONCRETE MATERIALS

- A. Cement: ASTM C 150, Type I - Normal portland type.
 - 1. Acquire all cement for entire project from same source.
- B. Fine and Coarse Aggregates: ASTM C 33.
- C. Fly Ash: ASTM C 618, Class C or F.
- D. Water: Clean and not detrimental to concrete.

2.4 CHEMICAL ADMIXTURES

- A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.
- B. High Range Water Reducing and Retarding Admixture: ASTM C 494/C 494M Type G.
- C. High Range Water Reducing Admixture: ASTM C 494/C 494M Type F.
- D. Water Reducing and Accelerating Admixture: ASTM C 494/C 494M Type E.
- E. Water Reducing and Retarding Admixture: ASTM C 494/C 494M Type D.
- F. Accelerating Admixture: ASTM C 494/C 494M Type C.
- G. Retarding Admixture: ASTM C 494/C 494M Type B.
- H. Water Reducing Admixture: ASTM C 494/C 494M Type A.

2.5 ACCESSORY MATERIALS

- A. Underslab Vapor Retarder (Slab on Grade):

1. Vapor retarder shall have an ASTM E-96 water vapor permeance not to exceed 0.002 perms when tested in accordance with ASTM E 1745 Class A, minimum 15 mils thick in accordance with ACI 302, 1R-04. Products: Stego Wrap (15 mil) by Stego Industries, Reef Griffolyn "15 mil green" by Reef Industries, Strata Barrier 16 mil by Strata Systems, Inc., or "15 mil Perminator" by W. R. Meadows.
- B. Non-Shrink Grout: ASTM C 1107/C 1107M; 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. Curing Materials: Comply with requirements of Section 03390.

2.6 BONDING AND JOINTING PRODUCTS

- A. Latex Bonding Agent: Non-dispersible acrylic latex, complying with ASTM C 1059 Type II.
- B. Epoxy Bonding System: Complying with ASTM C 881/C 881M and of Type required for specific application.
- C. Waterstops: PVC, complying with COE CRD-C 572.
 1. Configuration: As indicated on the drawings.
 2. Size: As indicated on the drawings.
- D. Reglets: Formed steel sheet, galvanized, with temporary filler to prevent concrete intrusion during placement.
 1. Size: As indicated on drawings.
- E. Joint Filler: Nonextruding, resilient asphalt impregnated fiberboard or felt, complying with ASTM D 1751, 1/4 inch thick and 4 inches deep; tongue and groove profile.
- F. Joint Filler: Compressible asphalt mastic with felt facers, complying with ASTM D 994, 1/4 inch thick and 4 inches deep.
- G. Slab Construction Joint Devices: Combination keyed joint form and screed, galvanized steel, with minimum 1 inch diameter holes for conduit or rebars to pass through at 6 inches on center; ribbed steel stakes for setting.

2.7 CONCRETE MIX DESIGN

- A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.
- B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
 1. For trial mixtures method, employ independent testing agency acceptable to Architect/Structural Engineer of Record for preparing and reporting proposed mix designs.
- C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.
- D. Normal Weight Concrete:

1. Compressive Strength, when tested in accordance with ASTM C 39/C 39M at 28 days: 3000 psi.
 - a. Fly Ash Content: Maximum 20 percent of cementitious materials by weight.
 - b. Cement Content: Minimum 470 lb per cubic yard.
 - c. Maximum Slump: 5 inches.
 - 1) Slump shall be increased to 8 inches for drilled footings by means of chemical admixtures.
 - d. Maximum Aggregate Size:
 - 1) SUSPENDED STRUCTURES
 - (a) Unless detailed otherwise on plans maximum aggregate size shall be as follows:
 - (1) Beams and slabs, 3/4".
 - (2) Columns, 3/4".
 - (3) Concrete joists and slabs, 3/4".
 - (4) Slabs and Metal Deck, 3/4".
 - (5) Spread or spot footings, 1-1/2".
 - (6) Drilled Piers, 1-1/2".
 - 2) SLAB AND BEAMS ON FILL
 - (a) Unless detailed otherwise on plans maximum aggregate size shall be as follows:
 - (1) Beams and slabs, 1".
 - (2) Tilt-Wall Panels, 3/4".
 2. Compressive Strength, when tested in accordance with ASTM C 39/C 39M at 28 days: 4,000 psi.
 - a. Fly Ash Content: Maximum 20 percent of cementitious materials by weight.
 - b. Cement Content: Minimum 517 lb per cubic yard.
 - c. Maximum Slump: 5 inches.
 - 1) Slump shall be increased to 8 inches for drilled footings by means of chemical admixtures.
 - d. Maximum Aggregate Size: ___ inch
 - 1) SUSPENDED STRUCTURES
 - (a) Unless detailed otherwise on plans maximum aggregate size shall be as follows:
 - (1) Beams and slabs, 3/4".
 - (2) Columns, 3/4".
 - (3) Concrete joists and slabs, 3/4".
 - (4) Spread or spot footings, 1-1/2".
 - (5) Drilled Piers, 1-1/2".
 - 2) SLAB AND BEAMS ON FILL
 - (a) Unless detailed otherwise on plans maximum aggregate size shall be as follows:
 - (1) Beams and slabs, 1".
 - (2) Tilt-Wall Panels, 3/4".
 3. Compressive Strength, when tested in accordance with ASTM C 39/C 39M at 28 days: 5000 psi.
 - a. Fly Ash Content: Maximum 20 percent of cementitious materials by weight.
 - b. Cement Content: Minimum 564 lb per cubic yard.
 - c. Maximum Slump: 5 inches.

- 1) Slump shall be increased to 8 inches for drilled footings by means of chemical admixtures.
- d. Maximum Aggregate Size:
 - 1) SUSPENDED STRUCTURES
 - (a) Unless detailed otherwise on plans maximum aggregate size shall be as follows:
 - (1) Beams and slabs, 3/4".
 - (2) Columns, 3/4".
 - (3) Concrete joists and slabs, 3/4".
 - (4) Spread or spot footings, 1-1/2".
 - (5) Drilled Piers, 1-1/2".
 - 2) SLAB AND BEAMS ON FILL
 - (a) Unless detailed otherwise on plans maximum aggregate size shall be as follows:
 - (1) Beams and slabs, 1".
 - (2) Tilt-Wall Panels, 3/4".

2.8 MIXING

- A. On Project Site: Mix in drum type batch mixer, complying with ASTM C 685. Mix each batch not less than 1-1/2 minutes and not more than 5 minutes.
- B. Transit Mixers: Comply with ASTM C 94/C 94M.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 CONSTRUCTION JOINTS

- A. Provide in monolithic concrete framing so that not more than 400 cubic yards is placed in one day and no side dimension of the section being concreted is greater than 150 feet. Larger areas shall be approved by the Engineer.
- B. Locate so as not to impair the strength of the structure, and coordinate the location and details with the Architect/Engineer. Location shall generally be near the middle of the spans of slabs and beams with wood or steel-formed soffits. When soffits are formed with cardboard cartons, locate construction joint on centerline of pier.
- C. Provisions shall be made for transfer of shear and other forces through the joint. Generally this shall consist of forming horizontal keyways at mid-depth, 1-1/2" deep X 1/3 of beam or slab depth and allowing all reinforcing to continue through the joint. Add extra reinforcing if so directed by Engineer.
- D. Follow procedure for "Bonding new concrete to old", as described herein.

3.3 PREPARATION

- A. Formwork: 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. Verify that forms are clean and free of rust before applying release agent.
- C. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.
- D. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.
 - 1. Use epoxy bonding system for bonding to damp surfaces, for structural load-bearing applications, and where curing under humid conditions is required.
 - 2. Use latex bonding agent only for non-load-bearing applications.
- E. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.
- F. Interior Slabs on Grade: Install vapor retarder under interior slabs on grade. Lap joints minimum 6 inches. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.

3.4 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 welded wire reinforcement 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.

3.5 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304R.
- B. Place concrete for floor slabs in accordance with ACI 302.1R.
- C. Notify Architect/Structural Engineer of Record not less than 24 hours prior to commencement of placement operations.
- D. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.
- E. Repair underslab vapor retarder damaged during placement of concrete reinforcing. Repair with vapor retarder material; lap over damaged areas minimum 6 inches and seal watertight.
- F. Separate slabs on grade from vertical surfaces with joint filler.

- G. Place joint filler in floor slab pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.
- H. Extend joint filler from bottom of slab to within 1/2 inch of finished slab surface. Conform to Section 07900 for finish joint sealer requirements.
- I. Install joint devices in accordance with manufacturer's instructions.
- J. Install construction joint devices in coordination with floor slab pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.
- K. Apply sealants in joint devices in accordance with Section 07900.
- L. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- M. Place concrete continuously between predetermined expansion, control, and construction joints.
- N. Do not interrupt successive placement; do not permit cold joints to occur.
- O. FLOOR FLATNESS AND LEVELNESS
 - 1. Flatness and levelness tolerances for floors shall conform to the requirements set forth in ACI 117, "Standard Tolerances for Concrete Construction and Materials", particularly section 4.5.6 and 4.5.7. Either of the following specifications is acceptable.
 - a. Face Floor Profile Numbers (F-Numbers):
 - 1) CONVENTIONAL, BULL-FLOATED; Flatness Ff = 15 Level FI = 13
 - 2) CONVENTIONAL STRAIGHTEDGED; Flatness Ff = 20 Level FI = 15
 - 3) FLAT; Flatness Ff = 30 Level FI = 20
 - 4) VERY FLAT; Flatness Ff = 50 Level FI = 30
 - b. 10-ft. Straightedge Method:
 - 1) CONVENTIONAL, BULL-FLOATED; 1/2 in.
 - 2) CONVENTIONAL, STRAIGHTEDGED; 5/16 in.
 - 3) FLAT; 3/16 in.
 - 4) VERY FLAT; 1/8 in.
 - 2. Unless noted otherwise, slab surfaces shall conform to the following criteria:
 - a. Offices, classrooms, corridors, etc: FLAT.
 - b. Warehouses, storerooms, equipment rooms: STRAIGHTEDGED.
 - c. Sidewalks, plazas, pavement: BULL-FLOATED.
 - d. Gymnasium Floors: VERY FLAT

3.6 CONCRETE FINISHING

- A. Repair surface defects, including tie holes, immediately after removing formwork.
- 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.
- D. Concrete Slabs: Finish to requirements of ACI 302.1R, and as follows:
 1. Surfaces to Receive Thick Floor Coverings: "Wood float" as described in ACI 302.1R; thick floor coverings include quarry tile, ceramic tile, and terrazzo with full bed setting system.
 2. Surfaces to Receive Thin Floor Coverings: "Steel trowel" as described in ACI 301.1R; thin floor coverings include carpeting, resilient flooring, seamless flooring, thin set quarry tile, and thin set ceramic tile.
 3. Other Surfaces to Be Left Exposed: "Steel trowel" as described in ACI 302.1R, minimizing burnish marks and other appearance defects.
 - a. Chemical Hardener: After slab has cured, apply water-diluted hardener in three coats per manufacturer's instructions, allowing 24 hours between coats.
- E. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains at 1:100 nominal.

3.7 CURING AND PROTECTION

- A. Comply with requirements of ACI 308R. 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.
 2. High early strength concrete: Not less than 4 days.
- C. Formed Surfaces: Cure by moist curing with forms in place for full curing period.
- D. Surfaces Not in Contact with Forms:
 1. Initial Curing: Start 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-saturated sand, water-fog spray, or saturated burlap.
 2. Final Curing: Begin after initial curing but before surface is dry.

3.8 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 of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
- D. Compressive Strength Tests: ASTM C 39/C 39M. For each test, mold and cure three concrete test cylinders. Obtain test samples for every 80 cu yd or less of each class of concrete placed.

- E. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
- F. Perform one slump test for each set of test cylinders taken, following procedures of ASTM C 143/C 143M.

3.9 DEFECTIVE CONCRETE

- A. Test Results: The testing agency shall report test results in writing to Architect/Structural Engineer of Record 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 Architect/Structural Engineer of Record . 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 Architect/Structural Engineer of Record for each individual area.

3.10 BELOW STRENGTH CONCRETE

- A. If the 28-day cylinder strengths fall below the specified strength, the concrete represented by such test cylinders shall be considered unacceptable and subject to removal. Consideration will be given to the acceptance of such concrete if it can be demonstrated to the satisfaction of the Engineer that the cylinder tests do not accurately represent the strength of the concrete in place, or that the structure is fully capable of carrying the loads for which it was designed. This data may be obtained by a series of non-destructive tests and core tests in accordance with ASTM C-42 of the concrete in place, and/or by load testing in accordance with applicable codes. All costs in connection with this additional testing and/or removal and replacement of defective concrete shall be paid by the Contractor.

END OF SECTION