

**SECTION 033000 - CAST-IN-PLACE CONCRETE**

**PART 1 - GENERAL**

1.1 Description of Work

- A. This Section specifies cast-in-place concrete, including products/submittals, formwork, reinforcement, joints, mix design, placement, finishes, curing and quality control.
- B. See Section 02741, Hot-Mix Asphalt Paving (General comments) for parking design and installation standards.

1.2 Standards

- A. International Building Code (IBC) 2000.
- B. International Existing Building Code 2003.
- C. ACI 117, 211.1, 301, 302.1, 305R, 306R, 315, and 318-02.
- D. CRSI 93, "Manual of Standard Practice" for placing reinforcement.
- E. Added WVU design requirements (maintenance concerns):
  - 1. Sidewalk preferred width is 5', no less than 4'.
  - 2. Limit the number of steps in exterior design.
  - 3. Provide ADA accessibility unless otherwise approved by the owner.
  - 4. Provide logical, recognizable and visible circulation patterns.
  - 5. Provide surface textures that are easily treatable and maintainable.
  - 6. Design should consider the use of fiber reinforcement in non-structural exterior slabs and sidewalks.
  - 7. In exterior slab/walk applications where reinforcement is required, consider use of epoxy coated or fiberglass reinforcement.

1.3 Submittals

- A. Product Data: For each type of manufactured material and product indicated.
  - 1. Design mixes for each concrete mix.
  - 2. Admixtures.
  - 3. Expansion joint fillers.
  - 4. Waterstops.

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- B. Steel Reinforcement Shop Drawings.
- C. On request by Designer, submit manufacturer's and/or supplier's, and/or installer's affidavit that material or product provided complies with Contract Documents.

### 1.4 DELIVERY AND STORAGE

- 1. Material deliveries and storage areas to be approved by Owner.
- 2. Material storage to comply with manufacturer's recommendations.

## PART 2 - PRODUCTS

### 2.1 Form Materials

- A. Conform to Section 1906 of IBC and ACI 318, Chapter 6.
- B. Prior to concrete being poured, the following items shall be met:
  - 1. Forms and formwork shall conform to shop drawings and be subject to the approval of the Designer and Owner 24 hours prior to concrete being poured.
  - 2. All debris shall be removed.
  - 3. All forms shall be clean and oiled with an approved form-release agent each time they are used.
- C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 1/2 by 1/2 inch minimum shall be installed at locations directed by Designer.
- D. Falsework to be designed by a Registered Engineer and approved by the Designer.

### 2.2 Steel Reinforcement

- A. Comply with ACI 318, Section 3.5.
- B. Reinforcing Bars: ASTM A 615, Grade 60.
- C. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

### 2.3 Reinforcement Accessories

- A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:
  - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected or CRSI Class 2 stainless-steel bar supports.

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- B. Joint Dowel Bars: Plain-steel bars, ASTM A 615, Grade 60.

### 2.4 Concrete Materials

- A. Cement: ACI 318, Section 3.2 normally required. Others must be pre-approved.
- B. Aggregates: Comply with ACI 318, Section 3.3 and ASTM C33, uniformly graded.
- C. Water: ACI 318, Section 3.4, potable and complying with ASTM C 94 and ACI 318, Section 3.4.

### 2.5 Admixtures

- A. General: ACI 318, Section 3.6. Subject to approval by the design professional.
- B. Do not use admixtures containing calcium chloride.
- C. Air-Entraining Admixture: ASTM C 260.
- D. Water-Reducing Admixture: ASTM C 494.

### 2.6 Fiber Reinforcement

- A. Exterior concrete slabs shall be engineered for secondary reinforcement and crack control.
- B. Synthetic Fiber: Fibrillated fibers engineered and designed for use in concrete, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long. Acceptable products/manufacturers are: "Fibermesh", Fibermesh, Inc., "Forta CR", Forta Corporation, and "Grace Fibers", W.R. Grace and Company.

### 2.7 Vapor Retarders

- A. Vapor Retarder: Section 1911, IBC, 6-mil polyethylene,

### 2.8 Floor and Slab Treatments

- A. Chemical Hardener: as approved by Designer.

### 2.9 Curing Materials

- A. Sealers: Saltgard-NY by ProSoco or equal (Forsoc, Preco, Meadows) or Linseed oil/Mineral spirit mixture as approved by Designer or Owner.

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- B. Membrane Curing Compound: ASTM C309, Type 1 (must be compatible with later applications).
- C. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9-oz./sq. yd. dry.
- D. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

### 2.10 Related Materials

- A. Joint-Filler Strips: Asphalt-impregnated fiber (ASTM D 994), asphalt-saturated cellulose fiber (ASTM D 1751), or cork or self-expanding cork (ASTM D 1752), isomeric polymer foam or polyethylene foam.
- B. Epoxy Joint Filler: Two-component, semi-rigid, 100 percent solids epoxy resins with a Shore A hardness of 80 per ASTM D 2240 or Sika-flex self-leveling sealant.
- C. Bonding Agent: ASTM C 1059, Type II, non-redisersible, acrylic emulsion or styrene butadiene.
- D. Waterstop: Serrated split type with center bulb, extruded vinyl made only from virgin raw materials, highly resistant to alkalis, acids, oxygen, ozone, and waterborne chemicals, installed per manufacturer's recommendations. Acceptable manufacturers: Sealtight Products, Vinylex Corporation, and Vulcan Metal Products, Inc.

### 2.11 Concrete Mixes

Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases.

- A. Footings and Foundation Walls: Proportion normal-weight concrete mix as follows:
  - 1. Minimum Compressive Strength (28 Days): 3000 psi (4000psi when exposed to freezing).
  - 2. Maximum Slump: 4 inches.
- B. Slab-on-Grade and exposed walls: Proportion normal-weight concrete mix as follows:
  - 1. Minimum Compressive Strength (28 Days): 4000 psi.
  - 2. Maximum Slump: 4 ½ inches.
- C. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
  - 1. Fly Ash: 25 percent.
- D. Maximum Water-Cementitious Materials Ratio: 0.45.

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- E. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content as follows within a tolerance of plus 1 or minus 1.5 percent, unless otherwise indicated:
  - 1. Air Content: 5.5 percent for 1-1/2-inch nominal maximum aggregate size.
  - 2. Air Content: 6 percent for 1-inch nominal maximum aggregate size.
  - 3. Air Content: 6-7 percent for 3/4-inch nominal maximum aggregate size.
- F. Do not use air-entrained concrete for trowel-finished interior floors.
- G. Admixtures: Use admixtures according to manufacturer's written instructions.
  - 1. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
  - 2. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required being watertight, and concrete with a water-cementitious materials ratio below 0.50.

### 2.12 Fabricating Reinforcement

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

### 2.13 Concrete Mixing

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and ASTM C 1116, and furnish batch ticket information.
  - 1. When air temperature is between 85 and 90 degrees F reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 degrees F, reduce mixing and delivery time to 60 minutes.

## PART 3 - EXECUTION

### 3.1 Formwork, Embedded Pipes, and Construction Joints

- A. Use typical Masterspec information.

### 3.2 Embedded Items

- A. Install anchor bolts, accurately located, to elevations required

### 3.3 Removing and Reusing Forms

- A. Use typical Masterspec information.

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### 3.4 Vapor Retarders

- A. Vapor Retarder: Install vapor retarder per section 1911 of IBC 2000.
- B. Granular Fill: Cover vapor retarder with granular fill, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch or minus 3/4 inch.

### 3.5 Steel Reinforcement

- A. Details of reinforcement: Comply with IBC Section 1907 and ACI 318, Chapter 7.

### 3.6 Joints

- A. Contraction Joints in Slabs-on-Grade: Follow IBC 2000 and ACI 318, sectioning concrete into uniform areas (maximum 225 S.F.). Construct contraction joints for a depth equal to at least one-fourth of concrete thickness.
- B. Isolation Joints in Slabs-on-Grade: terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealant, specified in Division 7 Section "Joint Sealants," are indicated.
- C. Dowel Joints: Install dowelled joints in expansion joints for exterior slabs and sidewalks. Use dowel sleeves or lubricate one-half of dowel length to prevent concrete bonding to one side of joint.

### 3.7 Concrete Placement

- A. Before placing concrete, owner to be notified a minimum of 24 hours in advance of any concrete placement.
- B. The subgrade shall be moistened in advance on concrete placement, but shall not be muddy or excessively wet.
- C. Before placing concrete, water may be added at Project site, subject to limitations of ACI 301.
  - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mix.
- D. Deposit concrete continuously or in 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 specified. Install concrete to avoid segregation.
- E. Height limitation, 60 inches for dropping concrete in forms.

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- F. Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints.
  - 1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.
  - 2. Do not use vibrators to transport concrete inside forms. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer.
  - 3. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
  
- G. Cold-Weather Placement: Comply with IBC 2000 and ACI 306.1 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 air temperature has fallen to or is expected to fall below 40 deg F uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
  - 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 mix designs.
  
- H. Hot-Weather Placement: Place concrete according to recommendations in IBC 2000 and ACI 305R and as follows, when hot-weather conditions exist:
  - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement.

### 3.8 Finishing Formed Surfaces

- A. Rough-Formed Finish: Remove fins and other projections exceeding ACI 347R limits for class of surface specified.
- B. Smooth-Formed Finish: Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch in height.
- C. Rubbed Finish: Apply the following to smooth-formed finished concrete:
  - 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

### 3.9 Finishing Floors and Slabs

- A. General: Comply with recommendations in ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. A guide for final finishing is the time at

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which the water sheen (from bleedwater) has disappeared from the surface. Cracking (superficial surface hairline cracking) should be prevented by using stiffer mixes, timely troweling and immediate curing. Surface scaling should be prevented by using proper air entrainment, slump, mixing and curing procedures as well as limited use of deicers.

- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
1. Apply scratch finish to surfaces indicated and to surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
1. Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- D. Trowel Finish: After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
1. Apply a trowel finish to surfaces to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system
  2. Finish surfaces to the following tolerances, measured within 24 hours according to ASTM E 1155/E 1155M for a randomly trafficked floor surface: Select floor flatness values and levelness values required for Project or revise values to suit type of floor. ACI 302.1R suggests first subparagraph values below be used for carpeted slabs; second and third, for thin floor coverings; and fourth, for very flat floors for high-speed forklifts, air pallets, and ice and roller rinks.
    - a. Specified overall values of flatness, F(F) 25; and levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and levelness, F(L) 15.
  3. Finish and measure surface so gap at any point between concrete surface and an unlevelled freestanding 10-foot long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed the following:
    - a. 1/8 inch
- E. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.



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- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
  - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

3.10 Concrete Protection 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 with recommendations in ACI 305R for hot-weather protection during curing. Curing procedures shall be compatible with subsequent floor coverings.

3.11 Concrete Surface Repairs

- A. Defective Concrete: Repair and patch defective areas when approved by the Architect. Remove and replace concrete that cannot be repaired and patched to Owner's approval.
- B. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discoloration that cannot be removed by cleaning.
- C. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

3.12 Field Quality Control

- A. Testing Agency: The Owner will engage a qualified independent testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
  - 1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mix exceeding 5 cu. yd., but less than 25 cu. yd. plus one set for each additional 50 cu. yd. or fraction thereof. Initial samples shall be taken after 1/4 cubic yard has been discharged. Subsequent samples shall be taken as specified herein or as specified by the Owner. If tests indicate the concrete is unacceptable, the unacceptable concrete shall be removed.
  - 2. 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 mix. Perform additional tests when concrete consistency appears to change.
  - 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for

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- each composite sample, but not less than one test for each day's pour of each concrete mix.
4. Concrete Temperature: ASTM C 1064, one test hourly when air temperature is 40 degrees F and below and when 80 degrees F and above, and one test for each composite sample.
  5. Compressive-Strength Tests: ASTM C 39. Cast and field cure a minimum of one set of three standard cylinder specimens for each composite sample.
    - a. Test one field-cured specimen at 7 days and two at 28 days.
    - b. A 28-day compressive strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.
- C. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
- D. Strength of each concrete mix 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.
- E. Test results shall be reported in writing to Owner, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain the following information: 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 mix proportions and materials, compressive breaking strength, and type of break for both 7-and 28-day tests.
- F. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Owner but will not be used as sole basis for approval or rejection of concrete.
- G. 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 Owner. 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 Owner.

END OF SECTION 033000