

SECTION 03 30 53
(SHORT-FORM) CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies cast-in-place structural concrete and material and mixes for other concrete.

1.2 RELATED WORK

- A. Concrete roads, walks, and similar exterior site work: Section 32 05 23, CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS.

1.3 TOLERANCES

- A. ACI 117.
- B. Slab Finishes: ACI 117, F-number method in accordance with ASTM E1155.

1.4 REGULATORY REQUIREMENTS

- A. ACI SP-66 - ACI Detailing Manual.
- B. ACI 318 - Building Code Requirements for Reinforced Concrete.

1.5 SUSTAINABILITY REQUIREMENTS

- A. Materials in this section may contribute towards contract compliance with sustainability requirements.
- B. Blended Cement: It is the intent of this specification to reduce CO2 emissions and other environmentally detrimental effects resulting from the production of Portland cement by requiring that all concrete mixes, in aggregate, utilize blended cement mixes to displace Portland cement typically included in conventional construction. Provide the following submittals:
 - 1. Copies of concrete design mixes for all installed concrete.
 - 2. Copies of typical regional baseline concrete design mixes for all compressive strengths used on the Project.
 - 3. Quantities in cubic yards of each installed concrete mix.
- C. Biobased Material: For products designated by the USDA's BioPreferred® program, provide products that meet or exceed USDA recommendations for biobased content, subject to the products compliance with performance requirements in this Section. For more information regarding the product categories covered by the BioPreferred® program, visit <http://www.biopreferred.gov>.

1.6 REGULATORY REQUIREMENTS FOR RECYCLED CONTENT

- A. Products and Materials with Post-Consumer Content and Recovered Materials Content:

1. Contractor is obligated by contract to satisfy Federal mandates for procurement of products and materials meeting recommendations for post-consumer content and recovered materials content; the list of designated product categories with recommendations has been compiled by the EPA - refer to
<http://www.epa.gov/wastes/conserve/tools/cpg/products/>.
2. Materials or products specified by this section may be obligated to satisfy this Federal mandate and Comprehensive Procurement Guidelines program.
3. The EPA website also provides tools such as a Product Supplier Directory search engine and product resource guides.

1.7 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Concrete Mix Design.
- C. Shop Drawings:
 1. Submit Steel Reinforcement Shop Drawings and Product Data to include all information necessary for fabrication and placement of reinforcement.
 2. Indicate grades of reinforcing steel.
 3. Clearly indicate the splice length for every size and type of bar used.
 4. Indicate the type, size and location of all accessories required for the proper assembly, placement and support of the reinforcement.
 5. Provide layout drawings of all floor slabs and formed concrete indicating control and expansion joints.
- D. Manufacturer's Certificates: Air-entraining admixture, chemical admixtures, curing compounds.

1.8 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by the basic designation only. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
- B. American Concrete Institute (ACI):

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| 117-10 | Tolerances for Concrete Construction and Materials and Commentary |
| 211.1-91 (R2009) | Selecting Proportions for Normal, Heavyweight, and Mass Concrete |

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|---|--|
| 301-10 | Structural Concrete |
| 305R-10 | Guide to Hot Weather Concreting |
| 306R-10 | Guide to Cold Weather Concreting |
| SP-66-04 | ACI Detailing Manual |
| 318/318M-11 | Building Code Requirements for Structural Concrete and Commentary |
| 347R-04 | Guide to Formwork for Concrete |
| C. American Society for Testing and Materials (ASTM): | |
| A185/A185M-07 | Steel Welded Wire Reinforcement, Plain, for Concrete |
| A615/A615M-12 | Deformed and Plain Carbon Steel Bars for Concrete Reinforcement |
| C31/C31M-12 | Making and Curing Concrete Test Specimens in the Field |
| C33/C33M-13 | Concrete Aggregates |
| C39/C39M-12a | Compressive Strength of Cylindrical Concrete Specimens |
| C94/C94M-13 | Ready Mixed Concrete |
| C143/C143M-12 | Slump of Hydraulic Cement Concrete |
| C150/C150M-12 | Portland Cement |
| C171-07 | Sheet Materials for Curing Concrete |
| C172/C172M-10 | Sampling Freshly Mixed Concrete |
| C173/C173M-12 | Air Content of Freshly Mixed Concrete by the Volumetric Method |
| C192/C192M-12a | Making and Curing Concrete Test Specimens in the Laboratory |
| C231/C231M-10 | Air Content of Freshly Mixed Concrete by the Pressure Method |
| C260/C260M-10a | Air-Entraining Admixtures for Concrete |
| C494/C494M-13 | Chemical Admixtures for Concrete |
| C618-12a | Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete |
| D1751-04 (R2008) | Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) |
| E1155-96 (2008) | Determining FF Floor Flatness and FL Floor Levelness Numbers |

PART 2 - PRODUCTS**2.1 FORMS**

- A. Wood, plywood, metal, or other materials, approved by COR, of grade or type suitable to obtain
- B. Form releasing agents to be commercial formulations that will not bond with, stain or adversely affect concrete surfaces. Agents must not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds. If special form liners are to be used, follow the recommendation of the form coating manufacturer. Submit manufacturer's recommendation on method and rate of application of form releasing agents.

2.2 MATERIALS

- A. Portland Cement: ASTM C150, Type I or II.
- B. Fly Ash: ASTM C618, Class C or F including supplementary optional requirements relating to reactive aggregates and alkalis, and loss on ignition (LOI) not to exceed 5 percent.
- C. Coarse Aggregate: ASTM C33, Size 67. Size 467 may be used for footings and walls over 300 mm (12 inches) thick. Provide Size 7 coarse aggregate for applied topping and metal pan stair fill.
- D. Fine Aggregate: ASTM C33.
- E. Mixing Water: Fresh, clean, and potable.
- F. Air-Entraining Admixture: ASTM C260.
- G. Chemical Admixtures: ASTM C494.
- H. Vapor Barrier: ASTM E1745, 0.38 mm (15 mil).
- I. Reinforcing Steel: ASTM A615 or ASTM A996, deformed. See structural drawings for grade.
- J. Welded Wire Fabric: ASTM A185.
- K. Expansion Joint Filler: ASTM D1751.
- L. Sheet Materials for Curing Concrete: ASTM C171.

2.3 CONCRETE MIXES

- A. Design of concrete mixes using materials specified as set forth under Option C of ASTM C94.
- B. Compressive strength at 28 days: Minimum 33 MPa, 4500 psi.
- C. Establish strength of concrete by testing prior to beginning concreting operation. Test consists of average of three cylinders made and cured in accordance with ASTM C192 and tested in accordance with ASTM C39.

D. Maximum slump for vibrated concrete is 100 mm (4 inches) tested in accordance with ASTM C143.

E. Cement and water factor (See Table I):

TABLE I - CEMENT AND WATER FACTORS FOR CONCRETE

| Concrete: Strength | Non-Air-Entrained | | Air-Entrained | |
|-------------------------------------|--|----------------------------|---|----------------------------|
| Min. 28 Day Comp. Str. MPa (psi) | Min. Cement kg/m ³ (lbs/c. yd) | Max. Water Cement Ratio | Min. Cement kg/m ³ (lbs/c. yd) | Max. Water Cement Ratio |
| 35 (5000) ^{1,3} | 375 (630) | 0.45 | 385 (650) | 0.40 |
| 30 (4000) ^{1,3} | 325 (550) | 0.55 | 340 (570) | 0.50 |
| 25 (3000) ^{1,3} | 280 (470) | 0.65 | 290 (490) | 0.55 |
| 25 (3000) ^{1,2} | 300 (500) | * | 310 (520) | * |

1. If trial mixes are used, the proposed mix design must achieve a compressive strength 8.3 MPa (1200 psi) in excess of f'c. For concrete strengths above 35 Mpa (5000 psi), the proposed mix design must achieve a compressive strength 9.7 MPa (1400 psi) in excess of f'c.

2. For concrete exposed to high sulfate content soils maximum water cement ratio is 0.44.

F. Air-entrainment is required for all exterior concrete and as required for Section 32 05 23, CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS.

Air content must conform with ACI 318 Table 4.4.1.

2.4 BATCHING AND MIXING

A. Store, batch, and mix materials as specified in ASTM C94.

1. Job-Mixed: Mix in a batch mixer in manner specified for stationary mixers in ASTM C94.

2. Ready-Mixed: Comply with ASTM C94, except use of non-agitating equipment for transporting concrete to the site will not be permitted. With each load of concrete delivered to project, ready-mixed concrete producer must furnish, in duplicate, certification as required by ASTM C94.

PART 3 - EXECUTION

3.1 FORMWORK

A. Installation conforms to ACI 347. Sufficiently tight to hold concrete without leakage, sufficiently braced to withstand vibration of concrete, and to carry, without appreciable deflection while remaining

within allowable construction tolerances, all dead and live loads to which they may be subjected.

B. Treating and Wetting: Treat or wet contact forms as follows:

1. Coat plywood and board forms with non-staining form sealer. In hot weather cool forms by wetting with cool water just before concrete is placed.
2. Clean and coat removable metal forms with light form oil before reinforcement is placed. In hot weather, cool metal forms by thoroughly wetting with water just before placing concrete.
3. Use sealer on reused plywood forms as specified for new material.

C. Inserts, sleeves, and similar items: Flashing reglets, masonry ties, anchors, inserts, wires, hangers, sleeves, boxes for floor hinges and other items specified as furnished under this and other sections of specifications are required to be in their final position at time concrete is placed - properly located, accurately positioned, built into construction, and maintained securely in place.

D. Construction Tolerances:

1. Set and maintain concrete formwork to assure erection of completed work within tolerances specified to accommodate installation or other rough and finish materials.
2. Properly brace the forms so the set concrete is correct within the allowable construction tolerances when the forms are removed.
3. Upon removal of the forms, the professional surveyor must survey the placed concrete and provide information to the COR where the work is not in conformance with the design drawings, within the allowable construction tolerances. The work cannot progress until the exposed concrete for the foundations are brought into compliance.
4. Remedial work necessary for correcting installations that is in excess of allowable tolerances are the responsibility of the Contractor.
5. Erected work that exceeds specified tolerance limits must be remedied or removed and replaced, at no additional cost to the Government.
6. Any remediation work is subject to approval of the COR in advance of the work.
7. Permissible surface irregularities for various classes of materials are defined as "finishes" in specification sections covering individual materials. They are to be distinguished from tolerances

specified which are applicable to surface irregularities of structural elements.

3.2 REINFORCEMENT

- A. Details of concrete reinforcement, unless otherwise shown, in accordance with ACI 318 and ACI SP-66. Support and securely tie reinforcing steel to prevent displacement during placing of concrete.

3.3 PLACING CONCRETE

- A. Remove water from excavations before concrete is placed. Remove hardened concrete, debris and other foreign materials from interior of forms, and from inside of mixing and conveying equipment. Obtain approval of COR before placing concrete. Provide screeds at required elevations for concrete slabs.
- B. Roughen and clean set concrete free from laitance, foreign matter, and loose particles, before placing new concrete on or against concrete which has set.
- C. Convey concrete from mixer to final place of deposit by method which will prevent segregation or loss of ingredients. Do not deposit in work concrete that has attained its initial set or has contained its water or cement more than 1 1/2 hours. Do not allow concrete to drop freely more than 1500 mm (5 feet) in unexposed work nor more than 900 mm (3 feet) in exposed work. Place and consolidate concrete in horizontal layers not exceeding 300 mm (12 inches) in thickness. Consolidate concrete by spading, rodding, and mechanical vibrator. Do not secure vibrator to forms or reinforcement. Provide vibration continuously with placing of concrete.
- D. Hot weather placing of concrete: Follow recommendations of ACI 305R to prevent problems in the manufacturing, placing, and curing of concrete that can adversely affect the properties and serviceability of the hardened concrete.
- E. Cold weather placing of concrete: Follow recommendations of ACI 306R, to prevent freezing of thin sections less than 300 mm (12 inches) and to permit concrete to gain strength properly, except that use of calcium chloride cannot be used without written approval from RE/COR.

3.4 PROTECTION AND CURING

- A. Protect exposed surfaces of concrete from premature drying, wash by rain or running water, wind, mechanical injury, and excessively hot or cold temperature. Curing method is subject to approval by COR.

3.5 FORM REMOVAL

- A. Forms remain in place until concrete has a sufficient strength to carry its own weight and loads supported. Removal of forms at any time is the Contractor's sole responsibility.

3.6 SURFACE PREPARATION

- A. Immediately remove loose materials, after forms have been removed and work has been examined and approved by COR, and patch all stone pockets, surface honeycomb, or similar deficiencies with cement mortar made with 1 part portland cement and 2 to 3 parts sand.
- B. For exposed surfaces of concrete for the columbarium and memorial walls and walls in their complexes, follow the procedures identified in Paragraph FINISHES for Exterior Exposed Areas (finished).

3.7 FINISHES

- A. Slab Finishes:
 - 1. Scratch Finish: Slab surfaces to receive a bonded applied cementitious application must be thoroughly raked or wire broomed after partial setting (within 2 hours after placing) to roughen surface and ensure a permanent bond between base slab and applied cementitious materials.
 - 2. Floating: Allow water brought to surface by float used for rough finishing to evaporate before surface is again floated or troweled. Do not sprinkle dry cement on surface to absorb water.
 - 3. Float Finish: Screen and float ramps, stair treads, and platforms, both interior and exterior, equipment pads, and slabs to receive non-cementitious materials, except as specified, to a smooth dense finish. Check for alignment using a straightedge or template after first floating and while surface is still soft. Correct high spots by cutting down with a trowel or similar tool and correct low spots by filling in with material of same composition as floor finish. Remove any surface projections on floated finish by rubbing or dry grinding. Refloat the slab to a uniform sandy texture.
 - 4. Broom Finish: Finish all exterior slabs, ramps, and stair treads with a bristle brush moistened with clear water after the surfaces have been floated.

5. Finished slab flatness (FF) and levelness (FL) values must comply with the following minimum requirements:

| Slab On Grade & Shored Suspended Slabs | | Unshored Suspended Slabs | |
|--|-------------------------------------|--------------------------|-------------------|
| Specified overall value | F _F 25/F _L 20 | Specified overall value | F _F 25 |
| Minimum local value | F _F 17/F _L 15 | Minimum local value | F _F 17 |

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