

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

**PART 1 - GENERAL****1.1 DESCRIPTION:**

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

**1.2 RELATED WORK:**

- A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. 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 SUBMITTALS:**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Concrete Mix Design.
- C. Shop Drawings: Reinforcing steel: Complete shop drawings.
- D. Manufacturer's Certificates: Air-entraining admixture, chemical admixtures, curing compounds.

**1.6 APPLICABLE PUBLICATIONS:**

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Concrete Institute (ACI):
  - 117R-06.....Tolerances for Concrete Construction and Materials
  - 211.1-91(R2002).....Proportions for Normal, Heavyweight, and Mass Concrete
  - 211.2-98(R2004).....Proportions for Structural Lightweight Concrete
  - 301-05.....Specification for Structural Concrete
  - 305R-06.....Hot Weather Concreting
  - 306R-2002.....Cold Weather Concreting

SP-66-04 .....ACI Detailing Manual  
 318/318R-05.....Building Code Requirements for Reinforced  
   Concrete  
 347R-04.....Guide to Formwork for Concrete  
 C. American Society for Testing And Materials (ASTM):  
 A185-07.....Steel Welded Wire, Fabric, Plain for Concrete  
   Reinforcement  
 A615/A615M-08.....Deformed and Plain Billet-Steel Bars for  
   Concrete Reinforcement  
 A996/A996M-06.....Standard Specification for Rail-Steel and Axle-  
   Steel Deformed Bars for Concrete Reinforcement  
 C31/C31M-08.....Making and Curing Concrete Test Specimens in  
   the Field  
 C33-07.....Concrete Aggregates  
 C39/C39M-05.....Compressive Strength of Cylindrical Concrete  
   Specimens  
 C94/C94M-07.....Ready-Mixed Concrete  
 C143/C143M-05.....Standard Test Method for Slump of Hydraulic  
   Cement Concrete  
 C150-07.....Portland Cement  
 C171-07.....Sheet Material for Curing Concrete  
 C172-07.....Sampling Freshly Mixed Concrete  
 C173-07.Air Content of Freshly Mixed Concrete by the Volumetric Method  
 C192/C192M-07.....Making and Curing Concrete Test Specimens in  
   the Laboratory  
 C231-08.....Air Content of Freshly Mixed Concrete by the  
   Pressure Method  
 C260-06.....Air-Entraining Admixtures for Concrete  
 C494/C494M-08.....Chemical Admixtures for Concrete  
 C618-08.....Coal Fly Ash and Raw or Calcined Natural  
   Pozzolan for Use in Concrete  
 D1751-04.Preformed Expansion Joint Fillers for Concrete Paving and  
   Structural Construction (Non-extruding and  
   Resilient Bituminous Types)  
 D4397-02.....Polyethylene Sheeting for Construction,  
   Industrial and Agricultural Applications  
 E1155-96(2008).....Determining  $F_F$  Floor Flatness and  $F_L$  Floor  
   Levelness Numbers

**PART 2 - PRODUCTS****2.1 FORMS:**

Wood, plywood, metal, or other materials, approved by Resident Engineer, of grade or type suitable to obtain type of finish specified.

**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. Coarse aggregate for applied topping and metal pan stair fill shall be Size 7.
- 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 D4397, 0.25 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.
- M. Abrasive Aggregates: Aluminum oxide grains or emery grits.
- N. Liquid Densifier/Sealer: 100 percent active colorless aqueous silicate solution.
- O. Grout, Non-Shrinking: Premixed ferrous or non-ferrous, mixed and applied in accordance with manufacturer's recommendations. Grout shall show no settlement or vertical drying shrinkage at 3 days or thereafter based on initial measurement made at time of placement, and produce a compressive strength of at least 18mpa (2500 psi) at 3 days and 35mpa (5000 psi) at 28 days.

**2.3 CONCRETE MIXES:**

- A. Design of concrete mixes using materials specified shall be the responsibility of the Contractor as set forth under Option C of ASTM C94.
- B. Compressive strength at 28 days shall be not less than 25mpa 3000 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 <sup>3</sup> (lbs/c. yd)	Max. Water Cement Ratio	Min. Cement kg/m <sup>3</sup> (lbs/c. yd)	Max. Water Cement Ratio
25 (3000) <sup>1,3</sup>	280 (470)	0.55	290 (490)	0.50
25 (3000) <sup>1,2</sup>	300 (520)	0.55	310 (520)	0.50

1. If trial mixes are used, the proposed mix design shall 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 shall achieve a compressive strength 9.7 MPa (1400 psi) in excess of f'c.
2. This mix design is to be provided at slabs on grade. Course aggregate shall be well graded and shall contain sizes up to and including 1 ½ inch.
3. This mix design is to be provided at all locations other than slabs on grade. Course aggregate shall be well graded and shall contain sizes up to and including 1 inch.

- 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 shall conform with the following table:

**TABLE I - TOTAL AIR CONTENT  
FOR VARIOUS SIZES OF COARSE AGGREGATES (NORMAL CONCRETE)**

Nominal Maximum Size of Coarse Aggregate	Total Air Content Percentage by Volume
10 mm (3/8 in)	6 to 10
13 mm (1/2 in)	5 to 9
19 mm (3/4 in)	4 to 8
25 mm (1 in)	3 1/2 to 6 1/2
40 mm (1 1/2 in)	3 to 6

#### **2.4 BATCHING & MIXING:**

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

1. Job-Mixed: Concrete mixed at job site shall be mixed in a batch mixer in manner specified for stationary mixers in ASTM C94.
2. Ready-Mixed: Ready-mixed concrete 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 shall furnish, in duplicate, certification as required by ASTM C94.

#### **2.5 REPAIR MATERIALS:**

A. Bonding Agent: Multi-component, solvent-free, moisture-tolerant epoxy-modified cementitious product formulated as a bonding agent and anti-corrosion coating.

1. Bond Strength:

- a. Plastic Concrete to Hardened Concrete: Wet on Wet: 2800 psi min., 14 days moist cure, per ASTM C 882.
- b. Steel Reinforcement to Concrete: 625 psi min., pullout test.

B. Repair Mortar: Silica fume polymer-modified Portland cement mortar intended for use as a patching mortar at thicknesses of 1/2" and greater, freeze-thaw resistant, compatible with coefficient of thermal expansion of concrete.

1. Flowable Mortar:

- a. Bond Strength: 2200 psi at 28 days, per ASTM C 882 modified.
- b. Flexural Strength: 720 psi min at 28 days, per ASTM C 293.
- c. Splitting Tensile Strength: 500 psi min. at 28 days, per ASTM C 496.
- d. Compressive Strength: 3000 psi at 1 day, 6500 psi at 28 days, per ASTM C 109.

- C. Penetrating Crack Sealer: Two-component 100% solids epoxy crack penetrating sealer; conforming to ASTM C 881.

### **PART 3 - EXECUTION**

#### **3.1 FORMWORK:**

- A. Installation to conform to ACI 347. Sufficiently tight to hold concrete without leakage, sufficiently braced to withstand vibration of concrete, and to carry, without appreciable deflection, 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 and required to be in their final position at time concrete is placed shall be properly located, accurately positioned and built into construction, and maintained securely in place.
- D. Construction Tolerances:
1. Contractor is responsible for setting and maintaining concrete formwork to assure erection of completed work within tolerances specified to accommodate installation or other rough and finish materials. Remedial work necessary for correcting excessive tolerances is the responsibility of the Contractor. Erected work that exceeds specified tolerance limits shall be remedied or removed and replaced, at no additional cost to the Government.
  2. 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:**

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 VAPOR BARRIER:**

Except where membrane waterproofing is required, place interior concrete slabs on a continuous vapor barrier.

- A. Lap joints 150 mm (6 inches) and seal with a compatible pressure-sensitive tape.
- B. Patch punctures and tears.

**3.4 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 Resident Engineer before placing concrete. Provide screeds at required elevations for concrete slabs.
- B. When placing new concrete on or against existing concrete which has set, prepare existing concrete as indicated on drawings.
- 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. Vibration shall be carried on 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 shall not be permitted without written approval from COR.

**3.5 PROTECTION AND CURING:**

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 shall be subject to approval by Resident Engineer.

**3.6 FORM REMOVAL:**

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.

**3.7 SURFACE PREPARATION:**

Immediately after forms have been removed and work has been examined and approved by Resident Engineer, remove loose materials, 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.

**3.8 EXISTING CONCRETE SURFACE PREPARATION**

- A. Remove delaminated concrete and remove additional concrete as required to provide minimum required thickness of repair material.
- B. Edge Preparation: Make a minimum 1/2" deep saw-cut along perimeter of repair areas. Make cut at right angle to surface. Avoid feather edges. Geometric configurations or repair patches shall be kept as simple as possible.
- C. After removals and edge conditioning are complete, remove bond inhibiting materials (dirt, concrete slurry, loosely bonded aggregates) by abrasive blasting or high pressure water-blasting with or without abrasive. Check the surfaces after cleaning to insure that surface is free from additional loose aggregate, or that additional de-laminations are not present.
- D. If hydro demolition is used, cement and particulate slurry must be removed from the prepared surfaces before slurry hardens.

**3.9 APPLYING REPAIR MORTAR**

- A. General: Perform repairs using flowable mortar or non-sag mortar as appropriate to conditions at each location.
- B. Forms:
  - 1. Support, brace, and maintain forms as required to support loads that might be applied. Construct formwork so concrete repair patch is of correct size, shape, and alignment.
  - 2. Construct forms of one piece and to obtain accurate alignment, location, grades, and plumb work in finished repair.
  - 3. Fabricate forms for easy removal without hammering or prying against concrete surfaces.



4. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive repair mortar. Remove chips, wood, sawdust, dirt or other debris just before concrete is placed. Tighten forms and bracing before repair mortar placement to prevent mortar leaks and maintain alignment.

C. Preparation of Form Surfaces:

1. Coat contact surfaces of forms with a non-residual, form-coating compound.
2. Do not allow excess form-coating material to accumulate on forms or to come into contact with existing concrete surfaces against which repair mortar will be placed. Apply in compliance with manufacturer's instructions.

D. Repair Mortar Placement:

1. Apply bonding compound to prepared concrete and reinforcing steel surfaces. Apply in compliance with manufacturer's instructions at coverage rate recommended for performance as a bonding agent and as a corrosion inhibitor.
2. Deposit repair mortar continuously in a manner to avoid segregation at its final location and in accordance with manufacturer's instructions.

E. Finish of Formed Surfaces: Provide an as-cast concrete surface to match the existing cast in place concrete surface, with a minimum of seams. Repair and patch defective areas including fins and other projections completely removed and smoothed. Match approved field sample.

F. Curing and Protection: Protect freshly placed repair mortar from premature drying and excessive cold or hot temperatures.

### 3.10 PENETRATING CRACK SEALER APPLICATION

- A. Clean and prepare cracked concrete surfaces in accordance with sealer manufacturer's instructions. Concrete shall be clean, sound, and free of surface moisture. Remove dust, laitance, grease, oils, curing compounds, waxes, impregnations, foreign particles, coatings and disintegrated materials by mechanical means.
- B. Apply penetrating crack sealer to cracked concrete surfaces, in accordance with manufacturer's instructions.

### 3.8 FINISHES:

A. Vertical and Overhead Surface Finishes:

1. Unfinished Areas: Vertical and overhead concrete surfaces exposed in unfinished areas, above suspended ceilings in manholes, and other unfinished areas exposed or concealed will not require additional finishing.

2. Interior and Exterior Exposed Areas (to be painted): Fins, burrs and similar projections on surface shall be knocked off flush by mechanical means approved by Resident Engineer and rubbed lightly with a fine abrasive stone or hone. Use an ample amount of water during rubbing without working up a lather of mortar or changing texture of concrete.
3. Interior and Exterior Exposed Areas (finished): Finished areas, unless otherwise shown, shall be given a grout finish of uniform color and shall have a smooth finish treated as follows:
  - a. After concrete has hardened and laitance, fins and burrs have been removed, scrub concrete with wire brushes. Clean stained concrete surfaces by use of a hone or stone.
  - b. Apply grout composed of 1 part Portland cement and 1 part clean, fine sand (smaller than 600 micro-m (No. 30) sieve). Work grout into surface of concrete with cork floats or fiber brushes until all pits and honeycomb are filled.
  - c. After grout has hardened, but still plastic, remove surplus grout with a sponge rubber float and by rubbing with clean burlap.
  - d. In hot, dry weather use a fog spray to keep grout wet during setting period. Complete finish for any area in same day. Confine limits of finished areas to natural breaks in wall surface. Do not leave grout on concrete surface overnight.

B. Slab Finishes:

1. Scratch Finish: Slab surfaces to receive a bonded applied cementitious application shall all be thoroughly raked or wire broomed after partial setting (within 2 hours after placing) to roughen surface to insure 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: Ramps, stair treads, and platforms, both interior and exterior, equipment pads, and slabs to receive non-cementitious materials, except as specified, shall be screened and floated to a smooth dense finish. After first floating, while surface is still soft, surfaces shall be checked for alignment using a straightedge or template. 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. Steel Trowel Finish: Applied toppings, concrete surfaces to receive resilient floor covering or carpet, future floor roof and all monolithic concrete floor slabs exposed in finished work and for which no other finish is shown or specified shall be steel troweled. Final steel troweling to secure a smooth, dense surface shall be delayed as long as possible, generally when the surface can no longer be dented with finger. During final troweling, tilt steel trowel at a slight angle and exert heavy pressure on trowel to compact cement paste and form a dense, smooth surface. Finished surface shall be free of trowel marks, uniform in texture and appearance.
5. Broom Finish: Finish all exterior slabs, ramps, and stair treads with a bristle brush moistened with clear water after the surfaces have been floated.
6. Finished slab flatness (FF) and levelness (FL) values comply with the following minimum requirements:

Slab on grade & Shored suspended slabs		Unshored suspended slabs	
Specified overall value	F <sub>F</sub> 25/F <sub>L</sub> 20	Specified overall value	F <sub>F</sub> 25
Minimum local value	F <sub>F</sub> 17/F <sub>L</sub> 15	Minimum local value	F <sub>F</sub> 17

### 3.9 SURFACE TREATMENTS:

- A. Surface treatments shall be mixed and applied in accordance with manufacturer's printed instructions.
- B. Liquid Densifier/Sealer: Use on all exposed concrete floors and concrete floors to receive carpeting except those specified to receive non-slip finish.
- C. Non-Slip Finish: Except where safety nosing and tread coverings are shown, apply non-slip abrasive aggregate to treads and platforms of all concrete steps and stairs, and to surfaces of exterior concrete ramps and platforms. Aggregate shall be broadcast uniformly over concrete surface. Trowel concrete surface to smooth dense finish. After curing, rub the treated surface with abrasive brick and water sufficiently to slightly expose abrasive aggregate.

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