

**SECTION 03 30 53
CAST-IN-PLACE CONCRETE**

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections " General Conditions of the Construction Contract ", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

- A. Section Includes:
 - 1. Cast-in-place structural concrete.
 - 2. Slab on grade infill.
 - 3. Footings.
 - 4. Equipment pads.
 - 5. Preparation of existing surfaces to receive concrete.
 - 6. Preparation of existing surface to received concrete topping.

1.3 RELATED WORK

- A. Section 01 45 29, TESTING LABORATORY SERVICES: Materials Testing and Inspection During Construction.
- B. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS
- C. Section 32 05 23, CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS: Stairs, Walks, Pads, and Similar Exterior Site Work.

1.4 APPLICABLE PUBLICATIONS

- A. Comply with references to extent specified in this Section.
- B. American Concrete Institute (ACI):
 - 117-10(R2015)..... Specification for Tolerances for Concrete Construction and Materials and Commentary
 - 211.1-91(R2009)..... Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
 - 301/301M-16..... Specifications for Structural Concrete.
 - 305.1-14 Hot Weather Concreting.
 - 306.1-90(R2002)..... Cold Weather Concreting.
 - 318/318M-19..... Building Code Requirements for Structural Concrete and Commentary
 - 347R-14 - Guide to Formwork for Concrete.
 - SP-66-04-..... ACI Detailing Manual.

C. ASTM International(ASTM):

A615/A615M-20	Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement
A1064/A1064M-18a	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
C33/C33M-18.....	Standard Specification for Concrete Aggregates.
C39/C39M-20.....	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
C94/C94M-20.....	Standard Specification for Ready-Mixed Concrete.
C150/C150M-20.....	Standard Specification for Portland Cement.
C171-16	Standard Specification for Sheet Materials for Curing Concrete.
C192/C192M-19.....	Standard practice for Making and Curing Concrete Test Specimens in the Laboratory.
C260/C260M-10a(2016)	Standard Specification for Air-Entraining Admixtures for Concrete.
C494/C494M-19.....	Standard Specification for Chemical Admixtures for Concrete.
C881/C881M-20	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
D1751-18	Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
E1155-20	Determining FF Floor Flatness and FL Floor Levelness Numbers.
E1745-17	Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

D. International Concrete Repair Institute:

310.2R-2013	Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.
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1.5 SUBMITTALS

- A. Submittal Procedures: Refer to Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. All items indicated below are required submittals requiring Design Professional review and approval.
- B. Submittal Drawings:
 - 1. Submit large scale drawings of reinforcing steel, including all reinforcing bend diagrams, and reinforcing details, to the Design Professional for review and approval.
- C. Manufacturer's Literature and Data:
 - 1. Concrete Mix Design.

2. Air-entraining admixture, chemical admixtures, and curing compounds.
 3. Indicate manufacturer's recommendation for each application.
- D. Sustainable Construction Submittals:
1. Recycled Content: Identify post-consumer and pre-consumer recycled content percentage by weight.
- E. Certificates: Certify products comply with specifications.
1. Each ready-mix concrete batch was delivered to site.

1.6 DELIVERY

- A. Deliver each ready-mixed concrete batch with mix certification in duplicate according to ASTM International(ASTM) C94.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I.
- B. Pozzolans:
1. Fly Ash: ASTM International(ASTM) C618, Class C or F including supplementary optional physical requirements. Pozzolans shall not exceed 25 percent of total cementitious materials by weight.
- C. Coarse Aggregate: ASTM International(ASTM) C33/C33M.
1. Size 467 for footings and walls over 300 mm (12 inches) thick.
 2. Size 7 for coarse aggregate for applied topping and metal pan stair fill.
 3. Size 67 for other applications.
- D. Fine Aggregate: ASTM International(ASTM) C33.
- E. Mixing Water: Fresh, clean, and potable.
- F. Air-Entraining Admixture: ASTM International(ASTM) C260.
- G. Chemical Admixtures: ASTM International(ASTM) C494.
- H. Vapor Barrier: ASTM International(ASTM) E1745, Class A with a minimum puncture resistance of 2200 g (3000 pounds); minimum 0.38 mm (15 mil) thick.
- I. Reinforcing Steel: ASTM International(ASTM) A615 Grade 60, deformed.
- J. Forms: Wood, plywood, metal, or other materials, approved by Design Professional, of grade or type suitable to obtain type of finish specified.
1. Plywood: Exterior grade, free of defects and patches on contact surface.
 2. Lumber: Sound, grade-marked, S4S stress graded softwood.
 3. Form coating: As recommended by Contractor.
- K. Welded Wire Fabric: ASTM International(ASTM) A1064, deformed; Grade 65; sized as indicated.
- L. Expansion Joint Filler: ASTM International(ASTM) D1751.
- M. Sheet Materials for Curing Concrete: ASTM International(ASTM) C171.
- N. Abrasive Aggregates: Aluminum oxide grains or emery grits.
- O. Liquid Densifier/Sealer: 100 percent active colorless aqueous silicate solution.

- P. Grout, Non-Shrinking: Premixed ferrous or non-ferrous. Grout to show no settlement or vertical drying shrinkage at 3 days. Compressive strength for grout, at least 18 MPa (2500 psi) at 3 days and 35 MPa (5000 psi) at 28 days.

2.2 ACCESSORIES

- A. Bonding Agent: ASTM International (ASTM) C 1059, Type II.
- B. Structural Adhesive: ASTM International (ASTM) C881, 2-component material suitable for use on dry or damp surfaces. Provide material Type, Grade, and Class to suit Project requirements.
- C. Water Stops: Rubber base with self-healing properties. Expanding clay based products not acceptable.
- D. Weeps: Geotextile type as recommended by Contractor and approved by the Design Professional.

2.3 CONCRETE MIXES

- A. Design concrete mixes according to ASTM International (ASTM) C94, Option C.
- B. Compressive strength at 28 days: minimum 4,000 psi.
- C. Submit mix design and results of compression tests to the Design Professional for evaluation. Identify all materials, including admixtures, making-up the concrete.
- D. Maximum Slump for Vibrated Concrete: 4 inches tested according to ASTM International (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/cu. m (lbs./cu. yd.)	Max. Water Cement Ratio	Min. Cement kg/cu. m (lbs./cu. yd.)	Max. Water Cement Ratio
35 (5000)1	375 (630)	0.45	385 (650)	0.40
30 (4000)1	325 (550)	0.55	340 (570)	0.50
25 (3000)1	280 (470)	0.65	290 (490)	0.55
25 (3000)1	300 (500)	See 4 Below	310 (520)	See 4 Below
Notes:				
1. If trial mixes are used, achieve a compressive strength 1200 psi in excess of f_c .				

- F. Air-entrainment as specified, and conform with the following for air content table:

TABLE II - TOTAL AIR CONTENT FOR VARIOUS SIZES OF COARSE AGGREGATES	
Nominal Maximum Size of Coarse Aggregate	Total Air Content, percent
10 mm (3/8 inches)	6 Moderate exposure; 7.5 severe exposure

TABLE II - TOTAL AIR CONTENT FOR VARIOUS SIZES OF COARSE AGGREGATES	
Nominal Maximum Size of Coarse Aggregate	Total Air Content, percent
13 mm (1/2 inches)	5.5 Moderate exposure; 7 severe exposure
19 mm (3/4 inches)	5 Moderate exposure; 6 severe exposure
25 mm (1 inches)	4.5 Moderate exposure; 6 severe exposure
40 mm (1 1/2 inches)	4.5 Moderate exposure; 5.5 severe exposure

2.4 BATCHING AND MIXING

- A. Store, batch, and mix materials according to ASTM C94.
 1. Job-Mixed: Batch mix concrete in stationary mixers as specified in ASTM International(ASTM) C94.
 2. Ready-Mixed Concrete: Comply with ASTM International(ASTM)C94, except use of non-agitating equipment for transporting concrete to Site is not acceptable.
 3. When aggregate producer's instructions deviate from specifications, submit proposed resolution for Design Professional's Representative consideration.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Installation: Conform to ACI 347. Construct forms to obtain concrete of the shapes, dimensions and profiles indicated, with tight joints.
- B. Design and construct forms to prevent bowing-out of forms between supports and to be removable without prying against or otherwise damaging fresh concrete.
- C. When patching formed concrete, seal form edges against existing surface to prevent leakage; set forms so that patch is flush with adjacent surfaces.
- D. Treating and Wetting: Treat or wet concrete contact surfaces:
 1. Coat plywood and lumber forms with non-staining form sealer.
 2. Wet wood forms thoroughly when they are not treated with a form release agent.
 3. Prevent water from accumulating and remaining within forms.
 4. Clean and coat removable metal forms with light form oil before reinforcement is placed.
 5. In hot weather, cool metal forms by thoroughly wetting with water just before placing concrete.
 6. Prevent water from accumulating and remaining within forms.
- E. Inserts, Sleeves, and Similar Items: Install flashing relets, masonry ties, anchors, inserts, wires, hangers, sleeves, boxes for floor hinges, and other cast-in items specified in other Sections. Place where indicated, square, flush, and secured to formwork.
- F. Construction Tolerances - General: Install and maintain concrete formwork to assure completion of work within specified tolerances.
- G. Adjust or replace completed work exceeding specified tolerances before placing concrete.

3.2 REINFORCEMENT

- A. Install concrete reinforcement according to ACI 318 and ACI SP-66.
- B. Support and securely tie reinforcing steel to prevent displacement during placing of concrete.
- C. Drilling for Dowels in Existing Concrete: Use sharp bits, drill hole slightly oversize, fill with epoxy grout, inset the dowel, and remove excess epoxy.

3.3 VAPOR BARRIER

- A. Except where membrane waterproofing is required, place interior concrete slabs on a continuous vapor barrier.
- B. Lap joints 150 mm (6 inches) and seal with a compatible pressure-sensitive tape.
- C. 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 from Design Professional's Representative before placing concrete.
- B. Install screeds at required elevations for concrete slabs.
- C. Roughen and clean free from laitance, foreign matter, and loose particles before placing new concrete on existing concrete.
 - 1. Blow-out areas with compressed air and immediately coat contact areas with adhesive in compliance with manufacturer's instructions.
- D. Place structural concrete according to ACI 301 and ACI 318.
- E. Convey concrete from mixer to final place of deposit by method that 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 for 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.
- F. 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. Continuously vibrate during placement of concrete.
- G. Hot Weather Concrete Placement: As recommended by ACI 305.1 to prevent adversely affecting properties and serviceability of hardened concrete.
- H. Cold Weather Concrete Placement: As recommended by ACI 306.1, to prevent freezing of thin sections less than 300 mm (12 inches) and to permit concrete to gain strength properly.
 - 1. Do not use calcium chloride without written approval from Design Professional's Representative.

3.5 TOLERANCES

- A. Slab on Grade Finish Tolerance: Comply with ACI 117, FF-number and FL-number method.
 - 1. Paragraph 4.8.3, Class A 1/8 inches for offset in form-work.
 - 2. Table R4.8.4, "Flat" 1/4 inch in 10 feet for slabs.

3.6 PROTECTION AND CURING

- A. Protect exposed surfaces of concrete from premature drying, wash by rain or running water, wind, mechanical damage, and excessive hot or cold temperatures.
- B. Curing Methods: Cure concrete with curing compound using wet method with sheets.
- C. Formed Concrete Curing: Wet the tops and exposed portions of formed concrete and keep moist until forms are removed.
 - 1. If forms are removed before 14 days after concrete is cast, install sheet curing materials as specified above.
- D. Concrete Flatwork Curing:
 - 1. Install sheet materials according to the manufacturer's instructions.
 - 2. When manufacturer's instructions deviate from specifications, submit proposed resolution for Design Professional's Representative consideration.

3.7 FORM REMOVAL

- A. Maintain forms in place until concrete is self-supporting, with construction operation loads.
- B. Remove fins, laitance, and loose material from concrete surfaces when forms are removed. Repair honeycombs, rock pockets, sand runs, spalls, or otherwise damaged surfaces by patching with the same mix as concrete minus the coarse aggregates.
- C. Finish to match adjacent surfaces.

3.8 FINISHES

- A. Vertical and Overhead Surface Finishes:
 - 1. Surfaces Concealed in Completed Construction: As-cast; no additional finishing required.
 - 2. Surfaces Exposed to View Scheduled for Paint Finish: Remove fins, burrs and similar projections by mechanical means approved by Design Professional's Representative flush with adjacent surface. Lightly rub with fine abrasive stone or hone. Use ample amount of water during rubbing without working up a lather of mortar or changing texture of concrete.
 - 3. Surfaces Exposed to View in Finished Areas: Grout finish, unless otherwise shown, for uniform color and smooth finish treated.
 - a. Remove laitance, fins, and burrs.
 - b. Scrub concrete with wire brushes. Clean stained concrete surfaces with hone or stone.
 - c. Apply grout composed of 1-part Portland cement and 1-part clean, fine sand (smaller than No. 30 sieve). Work grout into surface of concrete with cork floats or fiber brushes until pits and honeycomb are filled.
 - d. After grout has hardened, but is still plastic, remove surplus grout with sponge rubber float and by rubbing with clean burlap.
 - e. In hot, dry weather fog spray surfaces with water to keep grout wet during setting period. Complete finished areas 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. Allow bleed water to evaporate before surface is finished. Do not sprinkle dry cement on the surface to absorb water.
2. Scratch Finish: Rake or wire broom after partial setting slab surfaces to received bonded applied cementitious application, within 2 hours after placing, to roughen surface and provide permanent bond between base slab and applied cementitious materials.
3. Float Finish: Interior and exterior ramps, interior stair treads, and platforms, both equipment pads, and slabs to receive non-cementitious materials, except as specified.
 - a. Screen and float to smooth dense finish.
 - b. After first floating, while surface is still soft, check surfaces for alignment using straightedge or template. Correct high spots by cutting down with trowel or similar tool. Correct low spots by filling in with material same composition as floor finish. Remove any surface projections on floated finish by rubbing or dry grinding. Refloat slab to uniform sandy texture.
4. Steel Trowel Finish: Applied toppings, concrete surfaces to receive resilient floor covering or carpet, future floor roof and other monolithic concrete floor slabs exposed to view without other finish indicated or specified.
 - a. Delay final steel troweling to secure smooth, dense surface, usually when surface can no longer be dented by fingers. During final troweling, tilt steel trowel at slight angle and exert heavy pressure on trowel to compact cement paste and form dense, smooth surface.
 - b. Finished surface: Free from trowel marks. Uniform in texture and appearance.
5. Broom Finish: Finish exterior slabs, ramps, and stair treads with bristle brush moistened with clear water after surfaces have been floated.
6. Finished Slab Flatness (FF) and Levelness (FL):
 - a. Slab on Grade: Specified overall value FF 25/FL 20. Minimum local value FF 17/FL 15.
 - b. Test flatness and levelness according to ASTM E1155.

3.9 SURFACE TREATMENTS

- A. Mix and apply the following surface treatments according to manufacturer's instructions.
 1. When manufacturer's instructions deviate from specifications, submit proposed resolution for Design Professional's Representative consideration.
- B. Liquid Densifier/Sealer: Use for exposed concrete floors and concrete floors to receive carpeting except those specified to receive non-slip finish.
- C. Slip Resistant Finish:
 1. Except where safety nosing and tread coverings are shown, apply abrasive aggregate to treads and platforms of concrete steps and stairs, and to surfaces of exterior concrete ramps and platforms.
 - a. Broadcast aggregate uniformly over concrete surface. Trowel concrete surface to smooth dense finish. After curing, rub treated surface with abrasive brick and water sufficiently to slightly expose abrasive aggregate.

3.10 APPLIED TOPPING

- A. Install concrete topping with thickness and strength shown with only enough water to ensure stiff, workable, plastic mix.
- B. Continuously place applied topping until entire area is complete, struck off with straightedge, compact by rolling or tamping, float, and steel trowel to hard smooth finish.

3.11 RESURFACING

- A. Remove existing deteriorated surfaces to sound concrete by abrasive blasting or grinding. Achieve a surface profile of 2 to 4 according to ICRI 310.2R for the condition found at Site.

END OF SECTION