

SECTION 03300ACAST-IN-PLACE CONCRETEPART 1 - GENERAL1.1 SECTION INCLUDES

- A. Cast-In-Place Concrete
- B. Formwork
- C. Concrete reinforcement and accessories
- D. Modifications and/or Repairs to concrete
- E. Concrete curing
- F. Concrete finishing
- G. Concrete repairs
- H. Concrete testing
- I. Non-Shrink Grout

1.2 RELATED SECTIONS

- A. Section 01340 - Submittals
- B. Section 01400 - Quality Control
- C. Section 04200 - Unit Masonry
- D. Section 07150 - Dampproofing
- E. Section 07900 - Joint Sealers
- F. Division 15 - Pipes
- G. Section 15092 - Pipe Sleeves and Seals
- H. Section 15094 - Pipe Hangers and Supports
- I. Section 16050 - Basic Materials and Methods

1.3 REFERENCES

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| A. | ACI 211.1-91 | Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete |
| B. | ACI 301-99 | Standard Specifications for Structural Concrete |
| C. | ACI 302.1R-96 | Guide for Concrete Floor and Slab Construction |
| D. | ACI 304.2R-96 | Placing Concrete by Pumping Methods |
| E. | ACI 305R-99 | Hot Weather Concreting |
| F. | ACI 306R-88 | Cold Weather Concreting |
| G. | ACI 308R-01 | Guide to Curing Concrete |
| H. | ACI 308.1-98 | Standard Specification for Curing Concrete |
| I. | ACI 309R-96 | Guide for Consolidation of Concrete |
| J. | ACI 318-02 | Building Code Requirements for Structural Concrete and Commentary |
| K. | ACI 347R-01 | Guide to Formwork for Concrete |
| L. | ACI 350/350R-01 | Code Requirements for Environmental Engineering Concrete Structures and Commentary |
| M. | ASTM A82-01 | Specification for Steel Wire, Plain, for Concrete Reinforcement |

- N. ASTM A185-01 Specification for Steel Welded Wire Fabric, Plain for Concrete Reinforcement
- O. ASTM A615/A615M-01b Specification for Deformed and Plain Billet - Steel Bars for Concrete Reinforcement
- P. ASTM C31/C31M-00e1 Standard Practice for Making and Curing Concrete Test Specimens in the Field
- Q. ASTM C33-99a Specification for Concrete Aggregates
- R. ASTM C39/C39M-01 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
- S. ASTM C42/C42M-99 Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
- T. ASTM C94/C94M-00e2 Specification for Ready Mixed Concrete
- U. ASTM C150-02a Specification for Portland Cement
- V. ASTM C172-99 Practice for Sampling Freshly Mixed Concrete
- W. ASTM C231-97e1 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
- X. ASTM C260-01 Specification for Air Entraining Admixtures for Concrete
- Y. ASTM C309R-96 Guide for Consolidation of Concrete
- Z. ASTM C494/C494M-99aq1 Specification for Chemical Admixtures for Concrete
- AA. ASTM C1107 Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
- BB. ASTM E 329-02 Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction
- CC. ASTM F1554 Standard Specifications for Anchor Bolts, Steel, 36, SS and 105-KSI yield strength
- DD. Concrete Reinforcing Steel Institute - Manual of Standard Practice
- EE. Concrete Reinforcing Steel Institute - Placing Reinforcing Bars

1.4 QUALITY ASSURANCE

- A. Perform work in accordance with ACI 301, ACI 318 and ACI 350R as modified here-in.
- B. Maintain copies of ACI 301, ACI 318, and ACI 350R on site.

1.5 SUBMITTALS

- A. Submit layout drawings showing the location and extent of all joint waterstops, the type and size of all waterstops to be used and splice locations for each joint. Submit these layout drawings for review prior to the submittal of the reinforcing shop drawings and the start of concrete work.
- B. Submit shop drawings for concrete reinforcement prior to fabrication, showing bar bends, details and placement.
- C. Submit Concrete Mix designs including past field performance test results.
- D. Submit sieve analysis and soundness tests for fine and coarse aggregates taken within the last three (3) months.
- E. Submit Cement Manufacturer's Certificates of conformance with ASTM C150 taken during the last 3 months.

- F. Submit sample concrete mix delivery slip.
- G. Submit product data for concrete curing, sealing and hardening compounds.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

- A. Plywood: APA, B-B Plyform Class I exterior.
- B. Lumber: Southern pine, No. 2 grade or equal.
- C. Steel: Minimum 16 ga. sheet, well matched, tight fitting, stiffened to resist loads without excess deflection.
- D. Form Liner: Plywood conforming to PS-1, Grade B-B exterior (concrete form) not less than 1/4 inch thick.
- E. Form Ties: Factory fabricated assembly providing at least 1.5 inch break back dimension with at least a 1 inch diameter conical wood or plastic cones to leave a uniform hole for patching. Single rod ties require a tightly fitted waterstop washer at the mid point. Multi rod ties do not require washers.
- F. Form release agent: non-staining colorless, compatible with finishes. CRETE-LEASE 727 Release Agent by Cresset Chemical Co., Super-X Emulsive by A.H. Harris & Sons, Inc. or equal.
- G. Conform to ACI 301 and ACI 347

2.2 REINFORCING STEEL

- A. Bars: ASTM A615 Grade 60; deformed new materials.
- B. Welded wire fabric: ASTM A185
- C. Tie wire: ASTM A82, annealed.
- D. Bolsters, chairs and supports: plastic coated, stainless steel, or epoxy coated.
- E. Conform to CRSI Code of Standard Practice-Fabrication.

2.3 CAST-IN-PLACE CONCRETE

- A. Concrete Materials
 - 1. Portland cement: ASTM C150; Type II. Tricalcium Aluminate (C₃A) content in cement less than 8%.
 - 2. Aggregates:
 - a. Fine aggregate shall consist of washed inert natural sand conforming to the requirements of ASTM Specification C-33.
 - b. Coarse aggregate shall consist of a well graded crushed stone or a washed gravel conforming to the requirements of ASTM Specification C-33.
 - 3. Water: potable from municipal water supply or equal.
 - 4. Admixtures: All from one common manufacturer.
- B. Admixtures
 - 1. Low Range Water Reducer: Pozzolith 122-N by Master Builders; WRDA with HYCOL by Grace Construction Products Division; or equal meeting ASTM C494 Type A
 - 2. High Range Water Reducer (superplasticiser): Rheobuild 1000 by Master Builders; Daracem 100 by W.R. Grace; or equal meeting ASTM C494 Type F.

3. Air entraining agent: Micro-Air by Master Builders, DAREX 11 AEA by Grace Construction Products; or equal meeting ASTM C260.
4. Non-corrosive non-chloride accelerator: Pozzutec 20 by Master Builders; or equal meeting ASTM C494 type C or E.
5. Not permitted: Calcium chloride, thiocyanates or admixtures containing more than 0.05% chloride ions.

C. Concrete

1. Concrete Class
 - a. Reinforced concrete sections: Class A
 - b. Concrete fill: Class B
2. Concrete proportioning shall conform to ACI 318, Chapter 5 except as modified below:

Class	Minimum Compressive Strength (f_c)	Coarse Aggregate Size	% Air $\pm(1.5\%)$	Min.- Max. Slump	Min.- Max. Cem.Fac.	Max. W/C	High Range Water Reducer
A	4000 PSI	No. 67 (¾")	6	1-3	564-620	0.42	Yes
B	3000 PSI	No. 8 (3/8")	6	2-5	517-564	0.50	No

3. The maximum slump as indicated in the above table will be as measured at the batch plant.
4. Pumped Concrete: Conform to Chapter 4 - ACI 304.2
5. High range water reducer shall be added on site to obtain 4" - 8" slump.
6. No water shall to be added on site.
7. Concrete shall be furnished from one source during the project.

D. Selection of Concrete Proportions

1. The Concrete producer shall select the concrete mix proportions on the basis of past field performance or the use of trial mixes in accordance with ACI 318 Sections 5.2, 5.3 and 5.4.

2.4 ACCESSORIES

- A. Joint filler and slab perimeters: J-Joint polyethylene foam with tear off strip for sealant or approved equal; joint filler to be slab thickness in depth less 0.5 inch for sealant.
- B. Surface applied waterstops: Waterstop-RX by Colloid Environmental Company RX 102 - 3/8" x ¾" for concrete 8" thick or less, RX 101 - ¾" x 1" for concrete over 8 inches thick; or Swellseal Plus by de neef America.
- C. Structural inserts: of type and size shown on the drawings; Richmond Screw Anchor or Heckman Building Products, Hohman and Barnard, Dayton Sure-Grip or equal.
- D. Bond Breaker: Thompson's Water Seal or equal, or form oil.
- E. Concrete Anchorage Fasteners:
 1. Expansion Anchors - Stainless steel AISI Type 316. Kwik-Bolt by Hilti Fastening Systems or Tru Bolt by Ramset Fastening System or equivalent.
 2. Anchor Rods - ASTM F1554 Grade 55.

3. Adhesive Anchors. Non-expanding chemical type, 6" minimum projection and nut; Parabond Capsule Anchor by Molly Fastener or HVA Adhesive Anchor by Hilti Fastening Systems or equivalent.

2.5 NON-SHRINK GROUT

- A. Conform to ASTM C1107.
- B. Install in accordance with manufacturer's recommendations, using appropriate grout for intended use.

2.6 LIQUID CURING COMPOUND MATERIALS

- A. Curing and Sealing Compound; ASTM C309 Type 1 Class B. Super Kurseal by A.H. Harris & Sons, Inc. Emulsion Kurseal 309 by A.H. Harris & Sons, Inc. or equivalent.
- B. Dissipating Resin Curing Compound: ASTM C309 type 1; Film must break down in two to four weeks. Kurez-DR by Euclid Chemical Company, Emulsion Super KonKure 309 clear by A.H. Harris & Sons, Inc., or equivalent.
- C. Curing/Hardening Compound: Sodium Silicate Type. EucoSil by Euclid Chemical Company, Super KurHard 309 by A.H. Harris & Sons, Inc., or equivalent.

2.7 FINISHING MATERIALS

- A. Slab Sealer: Siloxane based 96% chloride ion screen, Euco-Guard-100 by Euclid Chemical or equal.
- B. Bonding Admixture: Latex, non-rewettable type SBR Latex or Flex-con by Euclid Chemical, Daraweld C by W.R. Grace or equivalent.
- C. Patching Mortar: 1 part of a mixture of white and grey portland cement to 2.5 parts of damp loose sand. Cement type to match substrate.

2.8 REPAIR MATERIALS

- A. Epoxy Adhesive: Water Based epoxy resin/portland cement building agent Armatec 110 by Sika Corporation or equivalent.
- B. Repair Mortar: polymer improved, cementitious, 2 component, trowel grade mortar equal to Concrete Coat by Euclid Chemical; Sikatop 122 by Sika Corp. or equivalent.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Conform to ACI 301 and ACI 347
- B. Erect plumb and straight. Maintain rigid. Brace sufficiently.
- C. Allow no concrete leakage. Provide continuous, straight, smooth exposed surfaces.
- D. Treat forms with form release agent. Protect reinforcing from contact with form release agent.
- E. Earth forms not permitted.
- F. Chamfer all exposed outside corners and edges 0.75 inch unless otherwise noted.
- G. Clean out inside of forms of all foreign materials prior to concrete placement.

H. Maintain forms and shores supporting the cast concrete for the time periods indicated:

1. Walls and Vertical Surfaces *36 Hours

* These periods represent cumulative number of days or hours during which the temperature of the air surrounding the concrete is above 50°F and the concrete has been damp and no loss of moisture has occurred.

I. Form pressures increase with the use of concrete with High Range Water Reducers. Design forms accordingly.

J. All concrete formwork, including reinforcing steel and embedment items, shall have a temperature greater than or equal to 35°F at the time of concrete placement.

3.2 REINFORCEMENT

A. Conform to the CRSI Code of Standard Practice - Field Erection for surface condition, bending, spacing and placement tolerance.

B. Splicing reinforcement: conform to ACI 318; welded wire fabric to be lapped 1½ courses or 12 inches; tie fabric at 24 inches on center maximum spacing.

C. Provide bar supports: on grade use concrete brick; elsewhere use manufactured wire supports.

D. Do not bend reinforcing partially embedded in the concrete.

3.3 EMBEDDED ITEMS

A. Coordinate installation of embedded items.

B. Pipes or Conduits for embedment within a slab, wall or beam, other than those merely passing through, shall satisfy the following:

1. Shall not be larger in outside diameter than one-third (1/3) the thickness of the slab, wall or beam.

2. Shall not be spaced closer than 3 diameters on center.

3. Shall not impair significantly the strength of the concrete.

3.4 WATERSTOPS

A. Nail surface applied waterstops to concrete at 12 inches on center. Protect from contact with water.

3.5 PLACING CONCRETE

A. Notify Engineer 24 hours minimum prior to each placement.

B. Place no concrete on frozen ground.

C. Place concrete within 90 minutes of batching.

D. Freefall: 4 feet maximum.

E. Do not place partially hardened concrete.

F. Consolidate concrete by vibrating. Conform to ACI 309.

G. Conform to ACI 306R for cold weather concreting.

H. Conform to ACI 305R for Hot Weather Concreting. Temperature of concrete placed shall not exceed 90°F.

- I. Provide concrete Delivery Slip prepared at batch plant with each truck load of concrete showing ticket number, date, truck number, mix strength, maximum stone size, weight of coarse aggregate, weight of fine aggregate, cement weight, volume of concrete, gallons of water added at plant, time water added at plant, quantities of all admixtures used and gallons of water withheld at the plant.
- J. Thoroughly moisten subgrade materials prior to placing slabs on grade.
- K. Thoroughly clean the surface of the concrete at construction and control joints and remove laitance prior to placing adjoining concrete. Do not place concrete against the hardened side of a joint for at least 48 hours.

3.6 ADDITIONAL CONCRETE TESTS

- A. Independent Testing Laboratory shall provide additional testing of in-place concrete as directed by Engineer due to non-compliance or considered substandard. Additional tests may consist of non-destructive testing, cores drilled from the area in question or load tests. Costs of additional testing will be paid by Owner. The cost of the additional testing will be determined by Engineer and Owner will invoice Contractor for that cost. If unpaid after 60 days, the invoice amount will be deducted from the Contract Price.
- B. When the concrete strength is substandard as defined in Specification 03300 Section 3.12 paragraph A, concrete core specimens shall be obtained and tested from the affected area.
 - 1. Three (3) cores shall be taken for each sample in which the strength requirements were not met. The drilled cores shall be obtained and tested in conformance with ASTM C 42 "Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete."

3.7 FINISHING SLABS AND FLATWORK

- A. Screed to bring concrete surface to proper contour and elevation.
- B. Highway straightedge, bull float or darby float the concrete surface immediately after screening.
- C. Allow bleed water to evaporate or remove.
- D. (STF) Steel Troweled Finish: Float the surface with magnesium or cast aluminum float or with a power finishing machine. Steel trowel surface immediately after floating to produce smooth surface. Steel trowel again after concrete has hardened enough so that mortar does not adhere to trowel edge. Ringing sound should be apparent when performing second troweling due to tilted, compacting motion.
- E. (WFF) Wood Float Finish: allow concrete to stiffen; float surface twice or more to a uniform sandy texture.
- F. (LBF) Light Broom Finish: wood float finish as in E above; while plastic draw a soft-bristled broom, over the concrete in long even strokes with downward pressure. Broom transverse to traffic or at right angles to the slope of the slab.
- G. Finish to receive concrete fill: do not bull float; remove water scum, laitance and loose aggregate from surface after concrete has started to harden with stiff bristle brush to partially expose coarse aggregate. Clean surface with brooms, water jets or air jets. Maintain wet for 12 hours immediately before placing fill concrete. As

fill concrete is placed and just ahead of placement, broom in grout paint to the damp concrete surface. Do not allow grout paint to set prior to placement of concrete fill.

- H. Tolerances for trowel finished floors: ACI 302 class BX. 5/16 inch maximum deviation from 10 foot long straightedge placed anywhere on the surface.

3.8 FINISHING VERTICAL SURFACES

- A. (RFF) Rough Form Finish: Repair structural defects only and patch tie holes. Fins exceeding 1/4 in. in height to be removed by grinding and/or rubbing.
- B. (SFF) Smooth Form Finish: The concrete surface shall be of uniform color, texture and free of all irregularities. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to the minimum. Material with raised grain, torn surfaces, worn edges, patches, dents, or other defects which will impair the texture of the concrete surface shall not be used. Remove fins flush by grinding and/or rubbing. Repair surface and structural defects as specified in this section.
- C. Curbs: Provide monolithic finish to curbs by stripping forms while concrete is still green and steel-toweling surfaces to a hard, dense finish with corners, intersections, and terminations chamfered.

3.9 CURING

- A. Curing: Curing shall begin immediately following the initial set of concrete or after slab surface finishing has been completed and shall continue after form removal per Section 03300, 3.1.L. All concrete shall be cured to attain strength and durability by one of the following methods for a minimum of seven days after placement regardless of the ambient air temperature: See Schedule of Finishes and Curing Requirements - Section 03346, [3.9.]
1. Ponding or continuous sprinkling. Intermittent wetting and drying is not an acceptable curing method.
 2. Application of concrete curing compounds. If applying slab sealing compounds, use dissipating resin curing compound. Allow dissipating resin curing compound to chemically break-down, and remove residuals and other foreign material, prior to applying slab sealing compound.
- B. Moisture loss from surfaces placed against wooden or metal forms exposed to heating by the sun shall be minimized by keeping the forms wet until they can be safely removed. After form removal, the concrete shall be cured by one of the methods described above, for the balance of time remaining as specified above.
- C. Schedule of Finishes and Curing Requirements:
1. Provide finishes on concrete surfaces according to the following schedule:

<u>Location</u>	<u>Finish</u>	<u>Curing Requirements</u>
Exterior Exposed Walls to 6" below grade	SFF	Moist cure or apply two coats dissipating curing compound
Exterior unexposed walls	RFF	Moist cure or apply two coats curing and sealing compound.

Exterior slabs-on-grade	LBF	Moist cure and apply two coats of slab sealer
Slabs (not coated)	STF	Apply two coats of curing/hardening compound.
Equipment Pads	WFF	
Stairs, Exterior platforms sidewalks and drives	LBF	Moist cure and apply two coats of slab sealer

- NOTE:
1. Coordinate compatibility of curing compounds with dampproofing compounds.
 2. When two (2) coats of materials are required as indicated above, second coat shall be applied perpendicular to the first coat.

D. Cold Weather:

1. Conform to ACI 306R
2. Maintain concrete temperature between 50°F and 70°F for a minimum of seven days after placement, enclose and heat, insulate as required.
3. Reapply curing compounds every two days during heating period.
4. The maximum allowable temperature drop of the concrete surfaces during the first 24 hours after the end of the curing period shall not exceed 5°F in any 1 hour and shall not exceed a total of a 40°F drop in the first 24 hours.

- E. Hot Weather: Conform to ACI 305R Concrete temperature shall not be greater than 90°F. Protect from loss of slump, flash set, plastic cracking and rapid evaporation of water.

3.10 JOINTS

- A. Provide joints only where shown on the drawings or as otherwise approved after written request.

3.11 MODIFICATIONS OR REPAIRS TO EXISTING CONCRETE

- A. Field measurements shall be taken at the required structures to determine the quantity of concrete to be removed and/or repair and the amount of patching to be done.
- B. When removing materials or portions of existing structures and when making openings in existing structures, all precautions shall be taken and all necessary barriers and other protective devices shall be erected to prevent damage to the structures beyond the limits necessary for the new work, and to prevent damage to the structures or contents by falling or flying debris.
- C. Remove concrete to the depths shown or required. Roughen concrete surfaces by chipping, sandblasting or scarifying.
- D. Surfaces must be clean and sound. Surfaces may be dry, damp, or wet, but free of standing water. Remove dust, laitance, grease, curing compounds, impregnations,

waxes, foreign particles, and disintegrated materials by mechanical abrasion methods such as sandblasting.

- E. Exposed reinforcement shall be cleaned by wire brushing and where shown the reinforcement shall be cut or bent. Additional reinforcement shall be provided as shown on the Drawings.

3.12 CORING OF HOLES

- A. Core drill holes where shown.
- B. Coring shall be performed with a non-impact rotary tool with diamond core drills, size shall be suitable for pipe conduit, sleeves or mechanical seals to be installed. All equipment shall conform to OSHA standards. Protect all existing equipment, utilities and critical areas against water or other damage caused by the drilling operation.
- C. No structural members shall be cut without any exceptions taken by the Engineer.

3.13 TOLERANCES

- A. Maximum allowable deviations from dimensions, elevations, slopes and position shall conform to ACI 117. Tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel, dowels, or embedded items.

3.14 FAILURE TO MEET STRENGTH REQUIREMENTS

- A. The strength of the concrete in place will be considered substandard if any one of the following results occur:
 - 1. The arithmetic average of 28-day cylinder tests for any three (3) consecutive test results are less than the specified strength ($f'c$).
 - 2. More than 10 percent of the 28-day cylinder tests have strengths less than the specified strength ($f'c$).
 - 3. An individual compressive strength test result falls below the specified strength ($f'c$) by more than 500 psi.
- B. Concrete which fails to meet the strength requirements as outlined above will be reviewed by the Engineer. The Engineer will determine whether the substandard concrete will be accepted, rejected or additional tests performed.
- C. When Substandard concrete as defined in Parts A.1 and A.2 occurs, the Engineer will require corrective measures to be taken immediately in order to increase the average of subsequent strength tests. When substandard concrete as defined in part A.3 occurs, non-destructive testing shall be performed on the substandard concrete. The testing shall be performed by an independent firm elected by the Engineer and paid for by the contractor at no additional cost to the Owner.

3.15 DEFECTIVE CONCRETE

- A. Defective concrete is defined as concrete in place which does not conform to strength, shapes, alignments, appearances and/or elevation as shown on the drawings and/or presents faulty surface areas.
- B. Reinforcing steel size, quantity, strength, position, or arrangement at variance with the Drawings will be considered defective.

- C. Concrete which differs from the required dimensions or locations in such a manner as to reduce the strength will be considered defective.
- D. Concrete surfaces not finished or cured in accordance with this Section shall be classified as defective concrete.
- E. Formed surfaces larger or smaller than dimensional tolerances specified in this Division may be rejected. If the Engineer permits the Contractor to correct the error, such correction shall be as directed and in such a manner as to maintain the strength, function and appearance of the structure.
- F. Concrete members cast in the wrong location may be rejected and shall be removed at no additional cost to the Owner if the strength, appearance or function of the structure is adversely affected.
- G. Inaccurately formed surfaces exposed to view may be rejected and shall be repaired or removed and replaced at no additional cost to the Owner.
- H. Concrete exposed to view with defects which adversely affect the appearance of the specified finish shall be repaired. If, in the opinion of the Engineer, the defects cannot be repaired, the concrete may be accepted or rejected in accordance with the decision of the Engineer.

3.16 PROTECTION

- A. Protect concrete from high and low temperatures for seven days.
- B. Protect against vibration until concrete has attained 33% of its 28-day strength.
- C. Protect against premature loads until the 28-day strength has been attained.
- D. Concrete structures shall be covered, insulated and heated as required to prevent frost penetration beneath the structures until acceptance by the Owner.

END OF SECTION