

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

PART 1 - GENERAL 2

 1.1 REFERENCE STANDARDS..... 2

 1.2 COORDINATION 3

 1.3 SUBMITTALS 3

 1.4 CLOSEOUT SUBMITTALS..... 3

 1.5 QUALITY ASSURANCE 4

 1.6 AMBIENT CONDITIONS 4

PART 2 - PRODUCTS 4

 2.1 MATERIALS..... 4

 2.2 CONCRETE MIX..... 6

 2.3 CONCRETE FORMING MATERIALS 7

PART 3 - EXECUTION 7

 3.1 INSPECTION 7

 3.2 PREPARATION 8

 3.3 FORMWORK CONSTRUCTION 8

 3.4 BATCHING AND MIXING 9

 3.5 INSTALLATION 10

 3.6 CONSOLIDATION 11

 3.7 CURING AND PROTECTION..... 11

 3.8 FIELD QUALITY CONTROL..... 11

 3.9 ATTACHMENTS..... 13

SECTION 033000
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

A. American Concrete Institute:

1. ACI 301 - Specifications for Structural Concrete.
2. ACI 305R - Guide to Hot Weather Concreting.
3. ACI 306.1 - Standard Specification for Cold Weather Concreting.
4. ACI 308.1 - Specification for Curing Concrete.
5. ACI 318 – Building Code Requirements for Structural Concrete
6. ACI 347 – Guide to Formwork for Concrete.
7. ACI 605 – Recommended Practice for Hot Weather Concreting.
8. ACI 613 – Recommended Practice for Cold Weather Concreting.
9. ACI 614 - Recommended Practice for Measuring, Mixing and Placing Concrete.
10. ACI SP-15: Field Reference Manual.

B. American Plywood Association (APA) Grading Rules

C. Western Wood Products Association (WWPA) Grading Rules

D. Southern Pine Inspection Bureau (SPIB) Grading Rules

E. ASTM International:

1. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the field.
2. ASTM C33 - Standard Specification for Concrete Aggregates.
3. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
4. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
5. ASTM C143 - Standard Test Method for Slump of Portland-Cement Concrete.

6. ASTM C150 - Standard Specification for Portland-Cement.
7. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
8. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
9. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
10. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.

1.2 COORDINATION

- A. Section 013000 - Administrative Requirements: Requirements for coordination.

1.3 SUBMITTALS

- A. Submit the following information in accordance with Section 013300.
 1. Plant Qualification: Submit satisfactory evidence indicating compliance with specified qualification requirements.
 2. Materials: Submit satisfactory evidence indicating materials to be used including cement, aggregates and admixtures meet the specified requirements.
- B. Design Data:
 1. Submit a concrete mix design for each type and class of concrete.
 2. Submit separate mix designs if admixtures are required for following:
 - a. Hot and cold weather concrete Work.
 - b. Air entrained concrete Work.
 3. Identify mix ingredients and proportions, including admixtures.
 4. Identify chloride content of admixtures and whether or not chlorides were added during manufacture.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer Instructions: Submit installation procedures and interfacing required with adjacent Work.
- E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.4 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.

- B. Project Record Documents: Record actual locations of embedded utilities and components concealed from view in finished construction.

1.5 QUALITY ASSURANCE

- A. Perform Work according to ACI 301.
- B. Comply with ACI 305R when pouring concrete during hot weather.
- C. Comply with ACI 306.1 when pouring concrete during cold weather.
- D. Acquire cement and aggregate from one source for Work.

1.6 AMBIENT CONDITIONS

- A. Section 015000 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.
- B. Maintain concrete temperature after installation between 50°F and 80°F for a minimum of seven (7) days. Concrete installed and cured during ambient conditions outside the specified range, may require additives or other considerations. The Contractor shall notify the Engineer and the Owner in the event that concrete will be installed during such conditions along with proposed considerations.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cement:
 - 1. Domestic Portland cement conforming to the requirements of ASTM C150, Type I, Type II or Type III, natural color, domestic manufacture.
 - 2. Use only one brand of cement in any individual structure unless approved by the engineer. Cement which has become damaged, partially set, lumpy or caked shall not be used, the entire contents of the sack or container which contains such cement shall be discarded. Do not use salvaged or reclaimed cement.
- B. Normal Weight Aggregates:
 - 1. ASTM C33. Coarse Aggregates shall be size No. 67, ¾-inch to No. 4 or No 57, 1-inch to No. 4, as shown on the drawings, unless otherwise directed by the Engineer. Use size No. 8 for filling cells of masonry units.
- C. Water:
 - 1. Comply with ACI 318.

2. Potable quality, clean and free from injurious amounts of deleterious materials.

D. Admixtures:

1. Air Entrainment: Comply with ASTM C260.
2. Water Reducing & Retarding Admixture
 - a. Concrete without Superplasticizer:
 - b. Water Reducing Admixtures: ASTM C494 Type A, equal to Eucon WR-75 by the Euclid Company, pozzolith 200 N by Master Builders, Plastocrete 161 by Sika Chemical Corporation, and containing no calcium chloride.
 - c. Water Reducing and Retarding Admixtures: ASTM C494 Type D, equal to Eucon Retarder-75 by the Euclid Company, Pozzolith 100 XR by Master Builders, Plastiment by Sika Chemical Corporation, and containing no calcium chloride.
 - d. Accelerating Admixtures: ASTM C494 Type C or E, equal to Accelguard 80 by the Euclid Company, Darex Set Accelerator by W.R. Grace, and containing no calcium chloride. The admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory (of at least a year's duration) using an acceptable accelerated corrosion-test method such as one using electrical potential measures.
3. Concrete with Superplasticizer:
 - a. Water Reducing, High Range Admixtures: ASTM C494, Type F or G, equal Eucon 37 by the Euclid Company, Rheobild 716 by Master Builders, Daracem 100 by W.R. Grace, Sikament by Sika Chemical Corporation, and consisting of a second-generation admixture, free of chlorides and alkalis (except for those attributable to water) composed of a synthesized sulfonate complex polymer, enabling the concrete to maintain its rehoploastic state in excess of two hours.
 - b. Manufacturer's Job Site Representation: Provide the services of a competent field representative from the manufacturer of each of the admixtures selected for use, to provide at the job site, advice and consultation on the use of the admixture materials, including the effect of the concrete in place, including recommending maximum discharge time for superplasticizer method and procedure to induce superplasticizer into mixer, quantities of admixtures to be used is variations are required because of temperature/humidity, wind or other environmental considerations, and to be available on short notice at any time requested by the Owner, Contractor or concrete producer.
4. Prohibited Admixture: Calcium chloride, thiocyanates, or admixtures containing more than 0.05% chloride ions are not permitted.

2.2 CONCRETE MIX

- A. Concrete supplier to furnish concrete to specific minimum water/cement ratio in accordance with ACI 301.
- B. Mix Design: conform to ACI 318, Section 5.3. Submit data on consecutive tests and standard deviation based upon use of supplied mix design for a minimum of 10 projects.
- C. Concrete Classes Definitions: shall conform to the following table for areas of use:

Concrete Use	Compressive Strength, PSI	Concrete Class
Structural	4,000	Structural
Foundation Slabs	4,000	Structural
Concrete Paving	4,000	A
Thrust Blocks	3,000	A
Deadman	3,000	A
Concrete Collars	3,000	A
Flow-able Fill	650	C

Note: For structural concrete, refer to sheets S1.1 and S1.2 for additional specific requirements.

- D. Contractor shall submit a mix design for each class of concrete a providing:
 - 1. Course Aggregate Size
 - 2. Minimum Cement Factor (lbs/cy)
 - 3. Max Water/Cement ratio (lbs/lb)
 - 4. Lower/Upper Slump Acceptance Limit
 - 5. Lower/Upper Entrained Air Acceptance Limits in percent. (Lower limit waived when air entrained in concrete is not required).
 - 6. Minimum Compressive Strength at 28 days (psi)
- E. Performance and Design Criteria:
 - 1. See plan details.
- F. Admixtures:
 - 1. Include admixture types and quantities indicated in concrete mix designs only if approved by Engineer.
 - 2. Cold Weather:
 - a. Use accelerating admixtures in cold weather.
 - b. Use of admixtures will not relax cold-weather placement requirements.
 - 3. Hot Weather: Use set-retarding admixtures.
- G. Average Compressive Strength Reduction: ACI 318.

- H. Ready-Mixed Concrete: Mix and deliver concrete according to ASTM C94.
- I. Site-Mixed Concrete: Mix concrete according to ACI 318.

2.3 CONCRETE FORMING MATERIALS

- A. Lumber for unexposed finished work: No. 2 Southern Yellow Pine or equal.
- B. Plywood for unexposed concrete: C-C EXT-APA, BB Form Ply.
- C. Metal or Plastic Forms: Smooth, undented, clean steel or new plastic forms may be used, with Architect's approval, to achieve rubbed finish.
- D. Earth Forms: Forms for foundations may be cut into earth, provided that earth is dry, stable, level, and sound.
- E. Form Ties:
 - 1. For architectural finishes: Break-back type with 5/8-inch removable vinyl sleeve.
 - 2. For all other conditions: Ties with 1½-inch break back.
- F. Form-Release Agent: Type required which will not stain or cause surface imperfections in architectural finishes. Use same brand form-release agent for all forms.
- G. Form Sealant:
 - 1. Acceptable products:
 - a. General Electric/Silicone Products Dept., SCS-1200.
 - b. Dow Chemical Co., #790.
 - c. Or approved equal.
 - 2. Type: One-part silicone.
 - 3. Color: Clear.
 - 4. Primer: Sealant manufacturer's recommended product.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Contractor shall submit a plan for control joints and expansion joints for review and approval by the Owner and Engineer a minimum of two weeks prior to placing concrete pavement.
- B. Preconstruction Meeting: Prior to beginning any concrete placement, Contractor shall schedule meeting with the Owner, Architect, Engineer, Testing Agency, concrete supplier, concrete placing and finishing foreman, and other affected sub-contractors. Placing procedures, acceptable tolerances and finishes, testing, curing, and protection will be discussed. The Contractor shall be responsible for keeping meeting minutes and distributing to attending parties.
- C. Verify requirements for concrete cover over reinforcement.

- D. Verify that anchors, seats, plates, reinforcement, and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with placing concrete.

3.2 PREPARATION

- A. Preparations before Placing: Place no concrete until the approval of the Engineer has been received. Ensure that forms are thoroughly clean and reinforcing and all other items required to be set in concrete have been placed and thoroughly secured. Notify Engineer 24 hours before concrete is placed.
- B. Previously Placed Concrete:
 - 1. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent.
 - 2. Remove laitance, coatings, and unsound materials.
- C. Remove debris and ice from formwork, reinforcement, and concrete substrates.
- D. Remove water from areas receiving concrete before concrete is placed.

3.3 FORMWORK CONSTRUCTION

- A. General
 - 1. Construct formwork to lines and elevations indicated in accordance with approved permanent structure layout drawings and provisions of ACI 301, ACI 318, and ACI 347, latest edition.
 - 2. Contractor shall assume sole responsibility for design and construction of concrete formwork capable of supporting construction loads, and for maintaining plastic concrete to planes, dimensions, and surfaces shown, within specified tolerances. Care shall be taken in the design to account for uplift, unbalanced, and vibratory loads and their effect upon the vertical and lateral stability of formwork. Design shall maintain joints tight and true.
 - 3. Construct forms for removal without hammering or prying against concrete.
 - 4. Clean forms of dirt, debris, concrete, and foreign matter before each use. Examine forms prior to each reuse and replace units lacking strength, tightness, or visual appearance.
 - 5. Apply form-release agent to forms in accordance with manufacturer's printed instructions prior to placement of reinforcement. Application rate shall be constant to prevent concrete discoloration. Remove excess material immediately.

3.4 BATCHING AND MIXING

- A. All central plant and rolling stock equipment and methods shall conform to ACI 304, ASTM C94, and the latest Truck Mixer and Agitator Standards of the Truck Mixer Manufacturers' Bureau of National Ready-Mixed Concrete Association, except where more stringent requirements are specified.
- B. With each load of concrete, the concrete producer shall furnish a numbered delivery ticket showing Contractor, concrete plant identification, name and location of project, date and time batched, truck number, number of cubic yards in load, specified strength, slump, mix design number and quantity of ingredients (including water) added at the batch plant. Mix ticket shall be delivered to the Engineer.
- C. Start mixing time after all ingredients are in the mixer. Minimum mixing shall be 70 revolutions at mixing speed if charged to maximum capacity, or 50 revolutions at mixing speed if charged to less than maximum capacity. Discharge mixture within one hour of initial mixing.
- D. When concrete is delivered in a truck mixer or agitator, do not water add water after the initial introduction of mixing water for the batch, except when on arrival at project site the concrete slump is less than specified, or as allowed herein for hot-weather concreting. Inject additional water into the mixer to bring slump within required limits. Turn the drum or blades an additional 30 revolutions or more at mixing speed until the concrete is within the proper slump limits.
- E. Complete concrete discharge within 1-1/2 hours, or before the drum has completed 300 revolutions whichever comes first after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates.
- F. Deliver concrete at a rate that will assure prompt discharge upon truck arrival. Do not place concrete that has been discharged from mixer truck for longer than 30 minutes.
- G. Reject truck mixers with unacceptable batches of concrete. Dispose of concrete legally offsite and clean mixer prior to refilling. The Testing Agency shall perform slump and mix tests on new delivery of previously rejected mixers.
- H. The re-tempering of concrete or mortar which has partially hardened, that is, mixing with or without additional cement, aggregate, or water, will not be permitted.
- I. Attention is called to the importance of dispatching trucks from the batching plant so that they shall arrive at the site of the work just before the concrete is required, thus avoiding excessive mixing of concrete while waiting or delays in placing successive layers of concrete in the forms.
- J. Cold Weather Concreting:
 - 1. Take cold weather precautions when temperature on job site is below 40 degrees F., in accordance with ACI 306R. Add accelerators, if used, at the concrete producer's plant in accordance with approved mix design.
 - 2. Heat water, aggregates, or both to maintain the concrete temperature at the time of delivery at not less than 55 degrees F. Provide tarps, heaters, insulated forms, or other

means to maintain the temperature of deposited concrete at not less than 40 degrees F. for seven days after placement.

K. Hot Weather Concreting:

1. Take hot-weather precautions when temperature on the job site is above 75 degrees F. in accordance with ACI 305R1 Report, Hot Weather Concreting.
2. Add the water-reducing retarders, if used, at concrete producer's plant in accordance with approved mix designs. Where necessary, cool aggregates or use chilled water or both to maintain concrete temperatures as delivered to the job site below 90 degrees F. Reject any truck mixer in which concrete temperatures are above 90 degrees F.
3. In hot weather, up to 10% of design mix water may be added to truck mixers at the job site to replace water lost by evaporation. Mix for a minimum of 30 additional revolutions after adding water. Make slump test and cylinders for compression test specimens from each truck to which water has been added. These additional cylinders do not count in determining frequency of testing as defined in Concrete Testing section. The Contractor shall bear the cost for additional testing.

3.5 INSTALLATION

- A. Notify testing laboratory and Engineer minimum of 24 hours prior to commencement of concrete installation.
- B. Provide metal or metal lined chutes having a slope not exceeding one vertical to two horizontal and not less than one vertical to three horizontal. Use chutes more than 20-feet long and chutes not meeting the slope requirements only if they discharge into a hopper before distribution.
- C. Handle concrete from mixer to final deposit as rapidly as practical by methods preventing segregation or loss of ingredients. Distribute concrete by means equal to a steep-sided, bottom-drop concrete bucket. Do not allow concrete to free-fall over 4'-0". Use buckets with a capacity of not less than 1/2-cubic yard. Clean transporting and handling equipment at frequent intervals and flush with water before and after each day's run. Do not discharge water into concrete forms.
- D. Do not place concrete in forms after initial set has occurred. Do not place concrete while temperature or other environmental conditions or facility limitations prevent proper finishing and curing.
- E. Deposit concrete as near final position as possible to avoid re-handling. Place concrete in forms in uniform horizontal layers 1'-6" to 2'-0" in depth, avoiding vertical joints or inclined planes. Do not permit concrete to pile up in forms permitting escape of mortar, or preventing flow of the concrete. Deposit concrete continuously. Vibrate for thorough consolidation to insure a dense, homogeneous mass without voids or pockets. Do not spade concrete at surfaces to receive architectural finishes.
- F. Transport and place pumped concrete in accordance with ACI 304 requirements. Brace formwork to handle effects of pump hammer. Employ aggregates of controlled water content

for pumped concrete. Do not use aluminum pipes for transporting concrete. Equipment used to transport concrete shall be compatible with concrete reinforcement and desired finishes.

3.6 CONSOLIDATION

- A. Use vibrators for concrete consolidation. Place vibrators in concrete rapidly to penetrate into previous lift blending two layers and minimizing or eliminating entrapped air between concrete and form.
- B. Vibrator head shall not be allowed to come within 3 inches of form face.
- C. Use vibrators with steady, continuous motion in concrete mass and for long enough duration at each position in a pattern to permit maximum escape of air from concrete.
- D. Vibrators shall be 2-1/2 to 2-5/8-inches in diameter, with minimum frequency of 10,000 impulses per minute. Furnish number of vibrators as required to vibrate all concrete immediately upon placing. Maintain spare vibrators at project site in case of breakdown.

3.7 CURING AND PROTECTION

- A. Cure concrete according to ACI 308.1.
- B. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- C. Maintain concrete with minimal moisture loss at relatively constant temperature for period as necessary for hydration of cement and hardening of concrete.
- D. Do not allow rainwater to increase the mixing water or to damage the surface finish.
- E. Protect concrete from construction overloads and do not apply design loads until the specified strength has been attained.
- F. Bonding: Before depositing new concrete on or against concrete that has set, thoroughly clean the surfaces of the set concrete to expose the coarse aggregate and to ensure they are free of laitance, coatings, foreign matter, and loose particles. Retighten forms. Dampen, but do not saturate hardened concrete of joints and then thoroughly cover with a coat of cement grout of similar proportions to the mortar in the concrete. Place the grout as thick as possible on the vertical surfaces and at least 1/2-inch thick on horizontal surfaces. Place the fresh concrete before the grout has attained its initial set.

3.8 FIELD QUALITY CONTROL

- A. Testing: Performed by testing laboratory according to ACI 318.
- B. Submit proposed mix design for each class of concrete to testing firm for review prior to commencement of Work.

C. Concrete Inspections:

1. Continuous Placement Inspection: Inspect for proper installation procedures.
2. Periodic Curing Inspection: Inspect for specified curing temperature and procedures.

D. Strength Test Samples:

1. One slump test shall be performed for each set of test cylinders taken and for each concrete mixer truck load delivered. When average ultimate 28-day strength of control cylinders in any set falls below the required ultimate strength or below proportional minimum 7-day strengths where proper relation between 7 and 28-day strengths have been established by tests, proportions, water content, or temperature conditions shall be changed to secure the required strength.
2. The contractor shall cooperate in the making of such tests to the extent of allowing free access to the work for the selection of samples, providing heated (when required) moist storage facilities for specimens, affording protection to the specimens against injury or loss through his operations, and furnishing material and labor required for the purpose of taking concrete cylinder samples, curing boxes and shipping boxes.
3. Air entrainment shall be measured by the testing laboratory at time of concrete deposit in accordance with ASTM C231.
4. Sampling Procedures: Comply with ASTM C172 Standard (laboratory) curing for test cylinders is normal practice. By ICC codes building officials may require field-cured test cylinders.
5. Cylinder Molding and Curing Procedures:
 - a. Comply with ASTM C31.
 - b. Cylinder Specimens: Field cured.
6. Sample concrete and make one set of four cylinders for every 50 cu. yd. or less of each class of concrete placed each day
7. If volume of concrete for a class of concrete would provide less than four sets of cylinders, take samples from four randomly selected batches, or from every batch if less than four batches are used.
8. Make one additional cylinder during cold weather concreting and field cure.

E. Field Testing:

1. Slump Test Method: Comply with ASTM C143.
2. Air Content Test Method: Comply with ASTM C231.
3. Temperature Test Method: Comply with ASTM C1064.
4. Compressive Strength Concrete:

- a. Measure slump and temperature for each sample.
- b. Measure air content in air-entrained concrete for each sample.

F. Cylinder Compressive Strength Testing:

1. Test Method: Comply with ASTM C39.
2. Test Acceptance: According to ACI 318.
3. Test one cylinder at seven (7) days.
4. Test two cylinders at twenty-eight (28) days.
5. Retain one cylinder for testing when requested by Engineer.
6. Dispose of remaining cylinders if testing is not required.

G. Patching:

1. Allow Engineer to inspect concrete surfaces immediately upon removal of forms.
2. Honeycombing or Embedded Debris in Concrete:
 - a. Not acceptable.
 - b. Notify Engineer upon discovery.
3. Patch imperfections as directed by Engineer according to ACI 301, ACI 318.

H. Defective Concrete:

1. Description: Concrete not conforming to required lines, details, dimensions, tolerances, or specified requirements.
2. Repair or replacement of defective concrete will be determined by Engineer.
3. Do not patch, fill, touch up, repair, or replace exposed concrete except upon express direction of Architect/Engineer for each individual area.
4. The requirements of these specifications are to be considered minimum with respect to the strength, placement, finishing and curing. The contractor shall extend the requirements of the Specifications as necessary to provide finished work free of defects. Defective work, including low strength, cracked concrete, surface irregularities, exceeding of tolerances, or any other defects which are caused by the Contractor's operations or construction methods shall be removed and replaced at no additional cost to the Owner.

3.9 ATTACHMENTS

A. Schedule - Concrete Types and Finishes:

1. Thrust block: 3,000 psi, 28-day concrete; form finish.
2. Concrete Paving: 4,000 psi, 28-day concrete.
3. Concrete Structures: 4,000 psi, 28-day concrete.

END OF SECTION 033000