

**SECTION 03 30 00
CAST-IN-PLACE CONCRETE**

PART 1 - GENERAL

1.1 SECTION INCLUDES:

- A. Cast-in-place structural concrete.
- B. Grouting under base plates.

1.2 RELATED REQUIREMENTS:

- A. Section 03 20 00 - Concrete Reinforcing.
- B. Section 05 12 00 - Structural Steel Framing

1.3 REFERENCE STANDARDS (EDITIONS ADOPTED BY CURRENT GOVERNING CALIFORNIA BUILDING CODE):

- A. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials; American Concrete Institute International.
- B. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; American Concrete Institute International.
- C. ACI 301 - Specifications for Structural Concrete for Buildings; American Concrete Institute International.
- D. ACI 302.1R - Guide for Concrete Floor and Slab Construction; American Concrete Institute International.
- E. ACI 306.1 - Cold Weather Concreting; American Concrete Institute International.
- F. ACI 308R - Guide to Curing Concrete; American Concrete Institute International.
- G. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; American Concrete Institute International.
- H. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field
- I. ASTM C33 - Standard Specification for Concrete Aggregates.
- J. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- K. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
- L. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
- M. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.

- N. ASTM C150 - Standard Specification for Portland Cement.
- O. ASTM C157 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
- P. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete.
- Q. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
- R. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
- S. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- T. ASTM C330 - Standard Specification for Lightweight Aggregates for Structural Concrete.
- U. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
- V. ASTM C567 - Standard Test Method for Determining Density of Structural Lightweight Concrete
- W. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
- X. ASTM C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
- Y. ASTM C 979 - Standard Specification for Pigments for Integrally Colored Concrete.
- Z. ASTM C1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.
- AA. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
- AB. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete.
- AC. ASTM C1218 - Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
- AD. ASTM C1602 - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
- AE. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- AF. ASTM E154 - Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs.
- AG. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
- AH. ASTM E1155 - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers.

- AI. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
- AJ. COE CRD-C513 - COE Specifications for Rubber Waterstops; Corps of Engineers.

1.4 SUBMITTALS:

- A. See Section 01 30 00 - Shop Drawings, Product Data and Samples, for submittal procedures.
- B. Product Data
 - 1. Manufacturer's catalog sheets including instructions for use and description of application shall be provided on each of the following materials:
 - a. Epoxies
 - b. Grout
 - c. Admixtures
 - d. Curing Compounds
 - e. Chemical Hardener
 - f. Adhesive Anchoring System
- C. Mix Designs
 - 1. Mix designs shall be submitted for each class of concrete on the job and shall show names and brands of all materials, proportions, slump, strength, gradation of coarse and fine aggregates, and location to be used on job. Field test records or test data that is used to establish the average compressive strength of the mixture shall be submitted.
- D. Concrete Placement Schedule: The Contractor shall submit a concrete placement schedule which shall show all proposed construction joint locations, limits of each placement sequence, order of placement and type of joint proposed at each joint location.
- E. Samples: Submit to testing agency of Owner's choice sample of materials as specified and as otherwise required by Architect, including names, sources and descriptions. Select samples to fairly represent average quality and grading of aggregates proposed for the work.
- F. Certificates of Compliance
 - 1. The Contractor shall provide Certificate of Compliance for each type of aggregate, cementitious material and admixture to be used in each class of concrete or a Certificate of Compliance for each class of concrete.
 - 2. Certificates of Compliance for cementitious materials shall include type, manufacturing location, shipping location; for aggregates: type, pit or quarry location, producers' name, grading, specific gravities and certification evidence not more than 90 days old; for admixtures: type, brand name, producer, manufacturer's technical data sheet, and certification data; and for water: source

of supply that are used in each class of concrete and shall be signed by the concrete supplier certifying that each material item complies with, or exceeds the specified requirements. Certificates of Compliance shall be furnished 60 days in advance of any concrete pours.

3. When Certificates of Compliance cannot be provided, the Contractor shall hire a professional testing laboratory to verify compliance of each type of material to be used in each Class of Concrete. The cost of testing shall be paid for by the Contractor.
4. The Contractor shall provide a certificate of compliance for the vapor retarder/barrier material. When a Certificate of Compliance cannot be provided, laboratory test reports shall be provided. The cost of testing shall be paid for by the Contractor.
5. Certificates of Compliance for vapor retarder/barrier shall include the name, and description of the product and shall state that the product complies with ASTM E1745 and ASTM E154.

G. Weight and Batch Tags:

1. The special inspector shall be provided with a weight and batch tag upon delivery of each load of concrete.

1.5 QUALITY ASSURANCE:

- A. Comply with the provisions of the current governing CBC, ACI 301, and ASTM C94 except where more stringent requirements are shown or specified.

B. Sampling, Testing and Inspection:

1. General:

- a. If the Owner's agent, through oversight or otherwise, has accepted material or work which is defective or contrary to specifications, this material or work, regardless of state of completion, may be rejected.
- b. Testing agencies shall meet the requirements of ASTM C1077. Testing agencies shall be accepted by the Architect/Engineer before performing any work.

2. Contractor:

- a. The Contractor shall cooperate with and notify Owner's agent at least 24 hours in advance of inspection required and shall provide samples and facilities for inspection without extra charge.
- b. The Contractor shall provide and maintain adequate facilities on the project site for safe storage and initial curing of concrete test specimens as required by ASTM C31 for the sole use of the testing agency.
- c. Each mix design shall be verified by trial batch tests or field test records and certified to by a principal of a testing agency who is a registered Civil Engineer in the State of California and submitted to the Architect/Engineer for review. Agency field test records, in order to be

acceptable, must satisfy the requirement of ACI 318 section 5.3 otherwise trial mixture meeting the requirements of ACI 318 section 5.3 shall be made. The Contractor shall submit data on qualifications of proposed testing agency for acceptance and hire the accepted testing agency to provide trial mixture test data for each type of concrete on the job.

- d. Prior to placing any concrete, a trial batch of each Class of concrete shall be prepared using the design mix proposed for the project. From the trial batch, specimens for determining the "Drying Shrinkage" shall be prepared by the Owner's agent. The average drying shrinkage of the test specimens after 21 days of drying shall not exceed 0.036%.

1.6 SEQUENCING AND SCHEDULING:

- A. Obtain information and instructions from other trades and suppliers in ample time to schedule and coordinate the installation of items furnished by them to be embedded in concrete so provision for their work can be made without delaying the project.
- B. Perform any coring and infill of cored holes that were required by failed test results from test panels, failure or delay in complying with these requirements, at no cost to Owner.

PART 2 - PRODUCTS

2.1 REINFORCEMENT:

- A. Comply with requirements of Section 03 20 00 Concrete Reinforcing.

2.2 CEMENTITIOUS MATERIALS:

- A. Cement: ASTM C 150, Type II portland type.
- B. Fly Ash: ASTM C618, Class C.
 - 1. Fly ash may substitute for portland cement up to a maximum of 25% of total cementitious materials by weight (fly ash, if used, must substitute for 15% of the total cementitious materials by weight, minimum).
 - a. Substitutions that combine fly ash and ground granulated blast-furnace slag are limited to a combined total of 50% of the total cementitious material by weight with fly ash no more than 25% of the total cementitious materials by weight.
 - b. Reduce slag and fly ash substitution rates by at least 50% for cold weather concreting as defined in ACI 306.1.
- C. Ground-granulated Blast-furnace Slag: ASTM C989 grades 100 or 120
 - 1. Ground-granulated Blast-furnace Slag may substitute for portland cement up to a maximum of 50% of the total cementitious material by weight.
- D. Use cementitious materials that are of the same brand and type and from the same plant of manufacture as the cementitious materials used in the concrete represented by the submitted field test records or used in the trial mixtures.

- E. Color Additives: ASTM C979, synthetic or natural mineral-oxide pigments or liquid coloring admixtures, temperature stable and nonfading.
- F. Fiber Reinforcement: Synthetic Fiber; fibrillated polypropylene fibers designed for use in concrete, complying with ASTM C1116, Type III, 1/2 inch to 1-1/2 inch in length.

2.3 AGGREGATES:

- A. Aggregates for hardrock concrete shall conform to ASTM C33.
- B. Lightweight Aggregate: ASTM C330.
- C. Aggregates used for entire project shall be obtained from the same sources and have the same size ranges as the aggregates used in the concrete represented by submitted historical data or used in trial mixtures.

2.4 WATER:

- A. Mixing Water for concrete shall be clean and free from deleterious amounts of acids, alkalis or organic materials.

2.5 CHEMICAL ADMIXTURES:

- A. Do not use chemicals that contain calcium chloride or will result in total soluble chloride ions in hardened concrete at ages from 28 to 42 days contributed from water, aggregates, cementitious materials, and admixtures in excess of 0.30 percent by weight of cement for reinforced concrete and 0.06 percent by weight of cement for prestressed concrete. Measure water-soluble chloride-ion content in accordance with ASTM C1218. Admixtures containing chloride salts shall not be used where concrete is poured on top of the metal deck. Calcium chloride or any admixture containing chloride ions shall not be used in drilled piers.
- B. Air Entrainment Admixture: ASTM C260.
 - 1. Acceptable Products subjected to compliance with requirements:
 - a. Sika Aer; Sika Corporation.
 - b. MB-VR or MB-AE; Master Builders.
 - c. Darex AEA; W.R. Grace.
- C. High Range Water Reducing and Retarding Admixture: ASTM C 494 Type G.
- D. High Range Water Reducing Admixture (Super Plasticizer): ASTM C494 Type F.
 - 1. Acceptable Products subjected to compliance with requirements:
 - a. WRDA19; W.R. Grace..
 - b. Sikament; Sika Chemical Corporation..

- c. Pozzolith 400; Master Builders..
- E. Water Reducing and Retarding Admixture: ASTM C494 Type D.
 - 1. Acceptable Products subjected to compliance with requirements:
 - a. Pozzolith 300-R; Master Builders.
 - b. Daratard; W.R. Grace.
 - c. Plastiment; Sika Chemical Corporation.
- F. Water Reducing Admixture: ASTM C494 Type A.
 - 1. Acceptable Products subjected to compliance with requirements:
 - a. Eucon WR-75; Euclid Chemical Company.
 - b. Pozzolith 344; Master Builders.
 - c. Plastocrete 160; Sika Chemical Corporation.
- G. Admixtures used in concrete shall be the same as those used in the concrete represented by the submitted field test records or used in the trial mixtures.

2.6 ACCESSORY MATERIALS:

- A. Non-Shrink Grout:
 - 1. ASTM C1107 Grade B or C, pre-mixed, high strength, Metallic or non-metallic flowable grout, which does not shrink as it cures. Water-soluble chloride ion content of grout less than 0.06 percent chloride ion by weight of cement when tested in accordance with ATM C1218.
 - a. Minimum Compressive Strength at 7 Days: 5000 psi.
- B. Post-installed anchoring systems:
 - 1. Adhesive anchoring system
 - a. Adhesive anchoring system shall be HILTI-HY 150 MAX-SD (ESR-3013) or approved equal with a current ICC/IAPMO evaluation report.
 - 2. Expansion anchors and screw anchors
 - a. Expansion anchors shall be HILTI KWIK BOLT TZ (ESR-1917) or approved equal with a current ICC/IAPMO evaluation report.
 - 3. Inserts
 - a. HILTI HIS-N Inserts (ESR-2322): ASTM A193 Grade B7 cap bolts and ASTM A194 nut, galvanized per ASTM A153 Class C or D.
 - b. HILTI HIS-RN Inserts (ESR-2322): ASTM A193 Grade B8M stainless

steel bolts and ASTM F594 nut. Nuts shall be the same alloy group as the bolt.

2.7 CURING MATERIALS:

- A. Curing Compound, Naturally Dissipating: Clear, water-based, liquid membrane-forming compound, that dissipates within 3 to 5 weeks; complying with ASTM C309.
- B. Curing and Sealing Compound, Low Gloss: Liquid, membrane-forming, clear, non-yellowing acrylic; complying with ASTM C 1315 Type 1 Class A.
- C. Curing and Sealing Compound, High Gloss: Liquid, membrane-forming, clear, non-yellowing acrylic; complying with ASTM C 1315 Type 1 Class A.
- D. Moisture-Retaining Sheet: ASTM C171.

2.8 CONCRETE MIX DESIGN:

- A. Admixtures: Where admixtures are used they shall be added as recommended in ACI 211.1 for normal weight concrete and at rates recommended by manufacturer. Admixtures are subject to the engineer's review.
- B. Normal Weight Concrete Mix Requirements:
 - 1. Shall be made with aggregates for hardrock concrete.
 - 2. Minimum Compressive Strength, f'c, when tested in accordance with ASTM C39 at 28 days: As scheduled below.
 - 3. Minimum Cementitious Material Content:
 - a. For concrete used in floors and slab-on-grades, cementitious material content shall not be less than indicated in following table:

Nominal maximum size of aggregate, in	Minimum cementitious material content, sacks
1-1/2	5
1	5.5
3/4	6
1/2	6.5

- 4. Maximum Water-Cement Ratio: As scheduled below. Significant volume of liquid admixtures should be considered as part of the mixing water.
- 5. Maximum Aggregate Size: Nominal maximum size of coarse aggregate shall not exceed three-fourths of the minimum clear spacing between reinforcing bars, one-fifth of the narrowest dimension between sides of forms, or one-third of the thickness of slabs or toppings.

Concrete Class	Minimum 28-day Compressive Strength f'c	Maximum Water/Cementitious Material Ratio	
		Non-Air Entrained	Air Entrained
Class A	3000 psi	0.55	0.55

- C. Structural Lightweight Concrete Mix Requirements:

1. Shall be made with light weight aggregates conforming to ASTM C330.
 2. Minimum Compressive Strength, f'c, when tested in accordance with ASTM C330 at 28 days: As scheduled above.
 3. Minimum Cementitious Material Content: Same as normal weight concrete.
 4. Maximum Water-Cement Ratio: As scheduled above. Significant volume of liquid admixtures should be considered as part of the mixing water.
 5. Maximum Aggregate Size: Same as normal weight concrete but not greater than 3/4 inch.
 6. Maximum dry unit weight: 120 lb per cubic foot as determined by ASTM C567.
- D. Concrete Mix Designs: The following table presents a schedule of classes of concrete, maximum aggregate, maximum slump and air content for each type of concrete, which shall be as follows:

Concrete Element	Class of Concrete	Max. Size Aggregate	Max./Min Slump (inch) at point of discharge
Equipment Pads	A	3/4	4/1

- E. Determine the slump by ASTM C143. Slump shall not exceed 3" for any concrete placement where top of surface slopes more than 2%. When use of a Type I or II plasticizing admixture conforming to ASTM C1017 or when a Type F or G high-range water-reducing admixture conforming to ASTM C494 is permitted to increase the slump of concrete, concrete shall have a slump of 2 to 4 in. before the admixture is added and a maximum slump of 8 in. at the point of delivery after the admixture is added unless otherwise specified.
- F. Add an air entraining agent to the concrete to provide specified amounts of entrained air per table below unless noted otherwise. Measure air content at the point of delivery in accordance with ASTM C173. Tolerance is plus/minus 1.5%. For specified compressive strengths above 5000 psi, the air contents indicated in the following table may be reduced by 1%.

Nominal maximum aggregate size, in	Air content, percent	
	Class F1	Classes F2 and F3
3/8	7.5	6
1/2	7	5.5
3/4	6	5
1	6	4.5
1-1/2	5.5	4.5

2.9 MIXING:

- A. Use ready-mixing concrete complying with ASTM C94 and with the requirements of Contract Documents. Mix for a period of not less than ten (10) minutes; at least three (3) minutes of mixing period shall be immediately prior to discharging at the job.
- B. CLSM shall be placed in the work within 3 hours after introduction of the cement to the aggregates.

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Verify lines, levels, and dimensions before proceeding with work of this section.

3.2 PREPARATION:

- A. Vapor retarder/barrier Installation Requirement: Install vapor retarder/barrier under interior slabs on grade where required by Contract Drawings in accordance with manufacturer's instruction and ASTM E1643.

3.3 WEATHER REQUIREMENTS:

- A. Reinforcement, forms and ground which concrete will contact shall be completely free of frost.
- B. When the average of the highest and lowest temperature during the period from midnight to midnight is expected to drop below 40° F for more than three successive days, deliver concrete to meet the following minimum temperatures immediately after placement:
 - 1. 55° F for sections less than 12 in. in the least dimension;
 - 2. 50° F for sections 12 to 36 in. in the least dimension;
 - 3. 45° F for sections 36 to 72 in. in the least dimension; and
 - 4. 40° F for sections greater than 72 in. in the least dimension.

The temperature of concrete as placed shall not exceed these values by more than 20° F. These minimum requirements may be terminated when temperatures above 50° F occur during more than half of any 24 h duration.

- C. The temperature of concrete as placed shall not exceed 90° F. When temperature of steel reinforcement, Embedments, or forms is greater than 120° F, fog steel reinforcement, Embedments, and forms with water immediately before placing concrete. Remove standing water before placing concrete.
- D. Do not begin to place or continue to place concrete while rain, sleet, or snow is falling unless adequate protection is provided and, when required, acceptance of protection is obtained. Do not allow rain water to increase mixing water or to damage the surface of the concrete.

3.4 CONVEYING AND PLACING CONCRETE:

- A. All concrete shall be mixed, delivered and discharged in accordance with the requirements of ASTM C94. All concrete shall be placed, finished and cured and all other pertinent construction practices shall be in accordance with the requirements of ACI 301.
- B. Notify Architect not less than 48 hours prior to commencement of placement operations.
- C. Before placing, clean mixing and conveying equipment, clean forms and space to be occupied by concrete and wet forms. Remove ground water until completion of work.

- D. Place no concrete in any unit of work until all formwork has been completely constructed, all reinforcements secured in place, all items to be built into concrete are in place, form ties at construction joints tightened and all preparation have been checked by the Inspector. A placing record shall be kept on the site of the time and date of placing the concrete in each portion of the structure until the completion of the structure and shall be open to the Inspector.
- E. Slabs and beams shall not be subjected to occupant or storage loads exceeding 20 psf until specified strength is reached (28 days minimum).
- F. Concrete shall be placed so that a uniform appearance of surfaces will be obtained. The concrete will be free of all rock pockets, honeycombs and voids.
- G. The subgrade must be moist when the concrete is placed for floor slab to prevent excessive loss of water from the concrete mix.
- H. Pumping of concrete may require admixtures to increase slump beyond the maximum slump listed. Admixtures are subject to the engineer's review.
- I. Carry on concreting, once started, as a continuous operation until the section of approved size and shape is completed. Make pour cut-offs of approved detail and location.
- J. Handle concrete as rapidly as practicable from mixer to place of deposit by methods which prevent separation or loss of ingredients. Deposit as nearly as practicable in final position to avoid rehandling or flowing. Do not drop concrete freely where reinforcing bars will cause segregation, impact the soil face of excavations nor drop freely more than eight feet. Use hoppers, chutes or trunks of varying length so that the free unconfined fall of concrete shall not exceed eight feet. Deposit to maintain a plastic surface approximately horizontal. In walls, deposit in horizontal layers not over eighteen inches deep. In pouring columns, walls or thin sections of considerable heights, use openings in forms, elephant trunks, tremies or other approved devices which permit concrete to be placed without segregation or accumulation of hardened concrete on forms or metal reinforcement above the level of the concrete. Install so concrete will be dropped vertically.
- K. Consolidating: All concrete shall be placed with mechanical vibration unless noted otherwise. Employ as many vibrators and tampers as necessary to secure the desired results. Minimum: one per each 20 cubic yards of concrete placed per hour. Eliminate the following practices: Pushing of concrete with vibrator; external vibration of forms; allowing vibrator to vibrate against reinforcing steel where steel projects into green concrete; allowing vibrator to vibrate contact faces of forms. Vibrators shall function at a minimum frequency of 3600 cycles per minute when submerged in concrete. Supplement vibration by forking and spading along the surfaces of the forms and between reinforcing whenever flow is restricted. Drilled piers shall be vibrated only to a depth of 3 times the pier diameter measured from the top of pier.
- L. Tremie Method: Tremie is a special procedure for placing concrete underwater. Tremie concrete shall be placed by pump or a gravity feed pipe. If a gravity feed pipe is used it shall be 8" minimum diameter and shall be affixed with a shutoff device at the bottom that will allow filling of the pipe with concrete without allowing water to enter. Pumping pipe shall be 4" minimum diameter. The trunk of the pump or gravity pipe shall be placed at the bottom of drilled pier prior to placing any concrete. The pump trunk or gravity pipe shall be removed slowly as the drilled pier is filled insuring that the end of pump trunk or gravity pipe is embedded in concrete a minimum of 5 foot.

3.5 CONSTRUCTION JOINTS:

- A. Location and details of construction joints shall be as indicated on drawings, specified, or as approved by the Engineer. Locate so as not to impair the strength of the structure.
- B. Sandblast all construction joints using coarse sand or waterblast to clean and roughen entire surface of joint to 1/4 inch amplitude at all construction joints unless noted otherwise, exposing coarse aggregate solidly embedded in mortar matrix uniformly. Clean forms and reinforcing of drippings. Clear away debris by compressed air.

3.6 CONCRETE FINISHING:

- A. Finishing Formed Surfaces: Finish per Architect specifications and requirements of ACI 301.
 - 1. If the type of finish is not specified by Architect, use grout-cleaned finish for permanently exposed formed surfaces except foundation surfaces and smooth-rubbed finish for exposed foundation surfaces.
- B. Finishing Unformed Surfaces: Finish per Architect specifications and requirements of ACI 301. Start finishing after bleeding of concrete is finished. The presence of bleed water is detected visually but when concrete surface is getting dry fast and rate of evaporation is so high, place a clear plastic sheet over a section of the concrete to block evaporation and to allow observation of bleeding.

3.7 CURING AND PROTECTION:

- A. Comply with requirements of ACI 301. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at above 50° F for the period of time necessary for hydration of cement and hardening of concrete.
 - 1. Normal concrete: At least the first 7 days after placement.
 - 2. High early strength concrete: At least the first 3 days after placement.
- C. Curing methods shall comply with ACI 308R.
- D. Curing compounds conforming to ASTM C309 or ASTM C1315 shall be applied in accordance with the recommendations of the manufacturer and shall not be used on any surface against which additional concrete or other cementitious finishing materials are to be bonded, where epoxy flooring is called for, where concrete topping is to receive waterproofing membrane, where not recommended by integral color maker, nor on surfaces where such curing is prohibited by the project specifications.
- E. Unformed concrete surfaces: Start curing as soon as the bleed water sheen has disappeared and before surface is dry.
 - 1. Initial Curing: If surface drying starts before initial set of concrete, keep concrete continuously moist up to final set of concrete by fog spray. Time of initial set is also known as the vibration limit where concrete can not be properly consolidated after reaching initial set. Before initial set, the concrete is not stiff enough to support the weight of a finisher or finishing machine. Water from fogging should be removed or allowed to evaporate before finishing.

2. Final Curing: Begin immediately after finishing. If finishing is completed but concrete has not reached final set, keep concrete continuously moist by fog spray, a liquid-applied evaporation reducer spray, or liquid membrane-forming curing compound spray. Water from fogging should be removed or allowed to evaporate before finishing. After final set of concrete, curing shall be accomplished by one of the following materials or method:
 - a. Ponding, continuous fogging, or continuous sprinkling;
 - b. Application of a curing compound.
 - c. Application of mats or fabric kept continuously wet.
 - d. Application of moisture-retaining sheet conforming to ASTM C171.
 - e. Other moisture-retaining covering as reviewed by Architect.
- F. Formed concrete surfaces: Steel forms and all wood forms in contact with the concrete shall be kept wet until they are removed. After formwork removal cure concrete by one of the method in final curing.
- G. Remove protection in such a manner that the maximum decrease in temperature measured at the surface of the concrete in a 24 hr period shall not exceed the following:
 1. 50° F for sections less than 12 in. in the least dimension;
 2. 40° F for sections from 12 to 36 in. in the least dimension;
 3. 30° F for sections 36 to 72 in. in the least dimension; or
 4. 20° F for sections greater than 72 in. in the least dimension.
- H. Measure concrete temperature using a method acceptable to the Architect/Engineer, and record the concrete temperature. When the surface temperature of the concrete is within 20° F of the ambient or surrounding temperature, protection measures may be removed.

3.8 PATCHING AND CLEANING:

- A. After forms are removed, remove projecting fins, form ties, nails, etc. not necessary for the work or cut back one inch from the surface. Joint marks and fins in exposed work shall be smoothed off and cleaned as directed by the Architect.
- B. Repair defects in concrete work as directed by the Engineer and per ACI 301. Chip voids and stone pockets to a depth of one inch or more as required to remove all unsound material. Voids, surface irregularities, chipped areas, etc., shall be filled by patching, gunite or rubbing, as directed by the Architect/Engineer. Repaired surfaces shall duplicate appearance of unpatched work.
- C. Clean exposed concrete surfaces and adjoining work stained by leakage of concrete to approval of Architect.

3.9 CLEANUP:

- A. Clean up all concrete and cement work on completion of this portion of the work, except protective coatings or building papers shall remain until floors have completely cured or

until interior partitions are to be installed.

3.10 GROUTING:

- A. Column base plates: The grout shall be mixed and placed in strict accordance with manufacturer's instructions. Care shall be taken in the grouting to ensure that there are no voids or air pockets, and that there is full bearing between the base plates and the grout.
- B. Bearing plates and channels: The space between plates and channels bearing against masonry or concrete shall be filled with grout when required by the Engineer. The grout shall be mixed and placed in strict accordance with manufacturer's instructions. Care shall be taken in the grouting to ensure that there are no voids or air pockets, and that there is full bearing between the bearing plates and channels and the grout.

3.11 POST INSTALLED ANCHORS:

- A. Installation of anchors and adhesive including drilling, cleaning of holes and torque shall be in accordance with the current ICC/IAPMO evaluation report. Post installed anchors shall be used only in applications permitted by the Evaluation Report. Anchors shall use washer sized to prevent crushing of the attached member at installation torque.
- B. Provide stainless steel anchors for exterior use or when expose to weather or in chemically corrosive environments. Provide galvanized carbon steel anchors at other locations unless noted otherwise on the Drawings.
- C. If reinforcement is encountered during drilling, abandon and shift the hole location to avoid the reinforcement. Provide a minimum of 2 anchor diameters or 1 inch, whichever is larger, of sound concrete between the anchor and the abandoned hole. Fill the abandoned hole with non-shrink grout. If the anchor or dowel may not be shifted as noted above, the Engineer will determine a new location.
- D. Adhesive Anchors:
 - 1. Insert the anchor or dowel in the hole with a twisting motion to the required embedment depth. Do not pump the anchor or dowel in and out of the hole.
 - 2. Wedge bars tight and centered in the hole with wooden wedges (golf tees) to hold it in place until the adhesive sets.
- E. Expansion Anchors:
 - 1. Install per the ICC/IAPMO report to the nominal embedment depth shown on the plans. Tightening of the anchor shall not reduce the embedment below that specified on the plans by more than eight threads. Projecting portions of the anchor shall not be cut off before inspection is complete.

3.12 FIELD QUALITY CONTROL

- A. Engineer Review: The Engineer shall inspect the surfaces between plates and channels, bearing on masonry and concrete to determine if grouting of space is necessary. If grouting of space is necessary, the Owner's agent shall inspect the grouting procedure.
- B. Acceptance of concrete strength:

1. Standard molded and cured strength specimens: Test results from standard molded and cured test cylinders shall be evaluated separately for each specified concrete mixture. For evaluation, each specified mixture shall be represented by at least five tests. The strength level of concrete will be considered satisfactory when the averages of all sets of three consecutive compressive strength test results molded and cured in accordance with the requirements of ASTM C31 equal or exceed f'_c and no individual strength test result falls below f'_c by more than 500 psi when f'_c is 5000 psi or less, or by more than $0.10f'_c$ when f'_c is more than 5000 psi.
2. Core tests: Where required by the Engineer, cores shall be obtained in accordance with ASTM C42. The location of cores shall be determined by the Engineer. If, before testing, cores show evidence of having been damaged subsequent to or during removal from the structure, replacement cores shall be taken. Strength level of concrete in the area represented by core tests will be considered adequate when the average compressive strength of the cores is equal to at least 85% of f'_c , and if no single core is less than 75% of the specified compressive strength f'_c .
- C. When the strength of field-cured cylinders is less than 85% of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing in-place concrete.
- D. Field Acceptance of concrete: Concrete within the specified limits of air-entrainment, slump and temperature shall not be used in the work.
- E. Additional Tests: The Owner's agent will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure or deficiencies in protection and curing has occurred, as directed by Engineer. Owner's agent may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42, or by other methods as directed. Contractor shall pay for such tests conducted, other additional testing as may be required, and cost of repairing areas of structure tested when unacceptable concrete is verified.

3.13 DEFECTIVE CONCRETE:

- A. General: Work considered to be defective may be ordered by the Architect/Engineer to be replaced in which case the Contractor shall remove the defective work at his expense. Work considered to be defective shall include, but not be limited to, the following:
 1. Concrete in which defective or inadequate reinforcing steel has been placed.
 2. Concrete in incorrectly formed, or not conforming to details and dimensions on the drawings or with the intent of these documents, or concrete the surfaces of which are out of plumb or level.
 3. Concrete below specified strength.
 4. Concrete not meeting the maximum allowable drying shrinkage requirements.
 5. Concrete containing wood, cloth, or other foreign matter, rock pockets, voids, honeycombs, cracks or cold joints not scheduled or indicated on the drawings.

3.14 CORRECTION OF DEFECTIVE WORK:

- A. The Contractor shall, at his expense, make all such corrections and alleviation measures as directed by the Engineer.
- B. Concrete work containing rock pockets, voids, honeycombs, cracks or cold joints not scheduled or indicated on the drawings, shall be chipped out until all unconsolidated material is removed.
- C. Secure approval of chipped-out areas before patching. Patch per ACI 301-latest governing edition.

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