

**SECTION 03300**  
**CAST-IN-PLACE CONCRETE**

1.0 **GENERAL**

1.1 **Section Includes**

- A. Formwork.
- B. Reinforcement.
- C. Mix Design.
- D. Placement Procedures.
- E. Finishes.

1.2 **References**

- A. AASHTO M182 – “Burlap Cloth Made from Jute or Kenaf.”
- B. ACI 117R – "Commentary on Standard Specifications for Tolerances for Concrete Construction and Materials.”
- C. ACI 222R - "Corrosion of Metals in Concrete."
- D. ACI 228.1R - "In-Place Methods to Estimate Concrete Strength."
- E. ACI 301 – “Standard Specification for Structural Concrete.”
- F. ACI 302.1R – “Guide for Concrete Floor and Slab Construction.”
- G. ACI 304 – “Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete.”
- H. ACI 305R – “Hot Weather Concreting.”
- I. ACI 306.1 – "Standard Specification for Cold Weather Concreting.”
- J. ACI 308 - "Standard Practice for Curing Concrete."
- K. ACI 309 – “Guide for Consolidation of Concrete”
- L. ACI 311.1R - "ACI Manual of Concrete Inspection (SP-2)."
- M. ACI 311.4R - "Guide for Concrete Inspection."
- N. ACI 311.5R - "Guide for Specifying Batch Plant Inspection and Field Testing of Ready-Mixed Concrete."
- O. ACI 318R – “Commentary to Building Code Requirements for Structural Concrete.”

- P. ACI 347R – “Guide to Formwork for Concrete.”
- Q. ACI SP-15 – “Field Reference Manual.”
- R. ACI SP-66 – “Detailing Manual.”
- S. ASTM A82 – “Standard Specification for Steel Wire, Plain, for Concrete Reinforcement”
- T. ASTM A185 – “Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.”
- U. ASTM A496 – “Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.”
- V. ASTM A497 – “Standard Specification for Welded Deformed Steel Wire Fabric for Concrete Reinforcement.”
- W. ASTM A615 – “Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.”
- X. ASTM A706 – “Standard Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement.”
- Y. ASTM C31 - "Standard Practice for Making and Curing Concrete Test Specimens in the Field."
- Z. ASTM C33 – “Concrete Aggregates.”
- AA. ASTM C39 – “Standard Test Method for Compressive Strength of Concrete.”
- BB. ASTM C42 – “Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.”
- CC. ASTM C94 – “Standard Specification for Ready-Mixed Concrete.”
- DD. ASTM C143 – “Standard Test Method for Slump of Portland Cement Concrete.”
- EE. ASTM C150 – “Standard Specification for Portland Cement.”
- FF. ASTM C171 – “Standard Specification for Sheet Materials for Curing Concrete.”
- GG. ASTM C172 – “Standard Practice for Sampling Freshly Mixed Concrete.”
- HH. ASTM C231 – “Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.”
- II. ASTM C260 – “Standard Specification for Air-Entraining Admixtures for Concrete.”
- JJ. ASTM C330 – “Standard Specification for Lightweight Aggregates for Structural Concrete.”

- KK. ASTM C441 - "Test Method for Effectiveness of Mineral Admixtures or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction."
- LL. ASTM C618 – “Standard Specification for Coal Fly Ash and Raw or Calcinated Natural Pozzolan for Use as a Mineral Admixture in Concrete.”
- MM. ASTM D698 - "Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort [12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>).]"
- NN. ASTM D1557 - "Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort [56,000 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>).]"
- OO. ASTM D1752 – “Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.”
- PP. CRSI MSP-1 – “Manual of Standard Practice.”
- QQ. Portland Cement Association (PCA) - "PCA Design and Control of Concrete Mixtures, 13th edition."
- RR. Wire Reinforcement Institute (WRI) - "WRI Manual of Standard Practice."

### 1.3

#### **Submittals**

- A. Submit the following information to the Construction Administrator for review and approval:
  1. Concrete Mix Proportions: Submit sources, proportions and testing data for all constituent materials, water-cement (w/c) ratio, and mixture characteristics for all designs of Portland Cement Concrete. The design mix shall be stamped and signed by a California Registered Civil Engineer. Submittal shall include copies of all trial mix reports, and the proportions of all materials used shall conform to the approved mix design.
  2. Concrete Admixtures: Submit specification sheets and a statement of suitability provided by manufacturer for all admixtures used in the concrete mix design.
  3. Portland Cement Concrete Test Reports: Submit copies of laboratory trial batch test reports or field-test data.
  4. Bond Breakers and Form Release Agents: Submit certificate of compliance with NSF 61 for all bond breakers and form release agents to be used on concrete surfaces exposed to drinking water.
  5. Shop Drawings for Reinforcement: Submit shop drawings, designed and stamped by a California Registered Civil Engineer, for fabrication, bending, and placement of concrete reinforcement. Comply with the most recent edition of ACI SP-66, “ACI Detailing Manual”, showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of concrete reinforcement. Include special reinforcement required for

openings through concrete structures. Include mill tags identifying mill and the melt or heat number for the reinforcing steel.

6. Concrete Formwork: Submit formwork design stamped and signed by a California Registered Civil Engineer.
  7. Related Materials: Submit specification sheets for all related materials used for concrete work including, but not limited to, evaporation reducer, fibrous reinforcement, joint filler, bonding agents, structural repair and patching mortar, and curing compounds.
  8. Samples of Materials: As requested by the Construction Administrator, submit samples of materials listed above, including names, sources, and descriptions.
  9. Favorable Weather Conditions: Prior to placement of concrete, the Contractor shall submit to the Construction Administrator a favorable local weather report which depicts no imminent rain or showers during the pour and initial setting, unless the Contractor can provide adequate protection against rain water to the satisfaction and approval of the Construction Administrator.
- B. A pre-placement conference shall be held a minimum of seven (7) days prior to first concrete placement. Attendees shall include representatives of the Construction Administrator, Contractor, Place and Finish Subcontractors, and any other necessary persons dealing with the concrete portion of the project, as determined by the Construction Administrator. Agenda shall include, but not be limited to the following topics: concrete placement, consolidation, finishing, testing, and curing procedures.

#### 1.4

#### **Quality Assurance**

- A. Perform Work in accordance with all referenced codes, specifications, and standards, except as modified herein.
- B. Contractor shall have available in the field office and be familiar with a copy of the ACI Field Reference Manual SP-15. This field reference manual is a compilation of selected ACI and ASTM references listed in ACI 301. A foreman experienced in work being done shall be on the job at all times.
- C. All laboratory trial batch test reports and/or field-test data for the concrete materials and development of the concrete mixtures shall be the responsibility of the Contractor, and shall be subject to the review and approval by the Construction Administrator.
- D. The design of concrete mixtures, and the shop drawings for concrete formwork reinforcement shall be the responsibility of the Contractor, and shall be subject to review and approval by the Construction Administrator.
- E. All testing and inspection services required for the placement of concrete will be provided by the District. Cost of such work, except as specifically stated otherwise, will be paid for by the District. Methods of tests will comply in detail with the latest applicable ASTM Test Methods.

1.5

**Delivery and Storage**

- A. Store and protect all materials on the jobsite in accordance with the manufacturer's recommendations.
- B. Reinforcing steel shall be stored in such a manner as to prevent the accumulation of rust, scale, or other deleterious substances on the surface. Reinforcing steel shall be transported, unloaded, and stored in such a manner as to prevent yielding of the steel due to bending or kinking.

2.0

**PRODUCTS**

2.1

**Form Materials**

- A. Forms for Exposed Finish Concrete: Plywood (Class I, B-B EXT – APA, or equal), metal, plastic, tempered concrete form-grade hardboard, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practical sizes to minimize number of joints and to conform to joint system shown on Drawings.
- B. Forms for Unexposed Finish Concrete: Plywood (Class I, B-B EXT – APA, or equal), lumber, metal, or other acceptable material. Provide lumber dressed on at least two (2) edges and one (1) side for tight fit.
- C. Form Coatings: Provide commercial formulation form-coating compounds with a maximum Volatile Organic Compounds (VOC) of 250 mg/L that will not bond with, stain, nor adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- D. Form Accessories: Factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent form deflection and to prevent spalling concrete upon removal. Wire ties shall not be permitted. Provide units that will leave no metal closer than 1-1/2 inches (38 mm.) to exposed surface. Provide ties that will leave holes no larger than 1 inch (25 mm.) diameter in concrete surface, with regular shape. Form ties, or any part thereof, for concrete in contact with drinking water shall be non-organic and leave no residue on the concrete surface.

2.2

**Reinforcing Materials**

- A. Reinforcing Bars: Shall be deformed, except spirals may be plain. Reinforcement shall be grades as shown on the Drawing and conform to one of the following:
  - a) ASTM A615, Grade 60, deformed;
  - b) ASTM A706.Reinforcing steel shall be new material, free from rust or scale, or any defects affecting its usefulness.
- B. Steel Wire: Plain wire shall conform to ASTM A82, plain, cold-drawn steel. Deformed wire shall conform to ASTM A496.
- C. Supports for Reinforcement: Use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars in place. Use wire-bar-type supports complying with CRSI MSP-1.

1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
  2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs that are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).
- D. Welded Wire Fabric Reinforcement: Plain welded wire fabric shall conform to ASTM A185. Deformed welded wire fabric shall conform to ASTM A497. Fabric may be used in place of reinforcing bars only for curbs and slabs on grade, not part of the structural foundation system, if approved by the Construction Administrator, provided the fabric has a cross-sectional area per linear foot not less than that of the reinforcing bars. Fabric shall be provided in flat sheet form.
- E. Tie Wire: Wire shall be 16 gauge or heavier, black annealed.

### 2.3 **Concrete Accessories**

- A. Waterstops: Waterstops shall be manufactured from virgin polyvinyl chloride plastic compound that does not contain any scrap or reclaimed material. The waterstop shall have a minimum tensile strength of 2000 psi (13.8 MPa), and shall conform to CRD-C-572.
1. Construction and Shrinkage Control Joints: Waterstop shall be 6 inch (150 mm.) by 3/8 inch (9.4 mm.) ribbed type. Waterstop shall be Style 679 by Greenstreak Inc., St. Louis, MO; Style R 6-38 by Vinylex Corp., Knoxville, TN; or equal.
  2. Expansion Joints: Waterstop shall be 9 inch (225 mm.) by 3/8 inch (9.4 mm.) ribbed type with 1 inch (25 mm.) outside diameter center bulb. Waterstop shall be Style 735 by Greenstreak Inc., St. Louis, MO; Style RB 9-38H by Vinylex Corp., Knoxville, TN; or equal.
  3. Waterstop Material Between New and Existing Canal Liner at MP 8.65: Waterstop shall be a hydrophilic rubber joint sealant De Neet Swellseal 2010; Adeka Ultraseal MC-2010; Sikawell S; or equal.
- B. Sealant: Refer to Section 07900, **Sealant and Caulking**, of the specifications.

### 2.4 **Concrete Materials**

- A. Portland Cement: Shall conform to ASTM C150, Type II, unless otherwise specified in Paragraph 2.5. Use same type, brand and source throughout the project.
- B. Normal Weight Aggregates: Shall conform to ASTM C33 except as modified herein. Provide aggregates from a single source throughout project.
1. Local aggregates not complying with ASTM C33 but that special tests or actual service have shown to produce concrete of adequate strength and durability may be used when acceptable to the Construction Administrator.

2. The maximum size coarse aggregate shall not exceed: a) 2 inches (50 mm.) for plain concrete; b) 1 inch (25 mm.) for a reinforced section 10 inches (250 mm.) or greater in thickness with a clear distance between reinforcement at least 2-1/4 inches (56 mm.); c) 3/4 inch (19 mm.) for reinforced sections less than 10 inches (250 mm.) in thickness.
  3. Fine aggregates shall have a pH value between 5.5 and 8.5.
- C. Water: Clean and free from injurious amounts of oils, acid, alkali, organic matter, or other deleterious substances.

- D. Admixtures: When specified in the concrete mix design, admixtures shall be used in accordance with the manufacturer's specifications. All admixtures shall be added at the batch plant, unless otherwise specified by the Construction Administrator.
- E. Fibermesh: 100% virgin polypropylene fibrillated fibers manufactured for concrete reinforcing to provide greater control of cracking.

## 2.5

### Concrete Mix Design

- A. Class A Concrete: Class A concrete shall be used for fence posts and concrete paving. Class A concrete shall meet the following requirements, unless otherwise specified on the Project Drawings or approved by the Construction Administrator:
  - 1. Coarse Aggregate: Shall consist of well-graded crushed stone or washed gravel conforming to the requirements of ASTM C33, Class 57 (Nominal size: 1 inch [25 mm.] to No. 4 sieve) or Class 467 (Nominal size: 1-1/2 inch [37.5 mm.] to No. 4 sieve). Refer to Paragraph 2.4.B.2 for additional coarse aggregate size restrictions.
  - 2. Slump: Concrete slump at the point of delivery shall not be greater than 4 inches +/- 1 inch (100 mm. +/- 25 mm.). If a field applied admixture is to be used that will increase the slump of concrete, the slump must be measured first and shall comply with the abovementioned requirements prior to the addition of the admixture to the concrete, (refer to Paragraph 2.4.E regarding restrictions to use of admixtures). Concrete shall be of such consistency that it can be readily worked into the corners and angles of the forms, and around the reinforcement, inserts, and castings without permitting materials to segregate or free water to collect on the surface, with consideration given to the methods of placing and compacting.
  - 3. Compressive Strength: The minimum 28-day compressive strength of the concrete shall be 2,500 psi (17.2 MPa). Testing of concrete shall be in accordance with ASTM C39.
  - 4. Water Cement (W/C) ratio shall be 0.45 maximum on a weight basis. The water-cement ration of the approved mix design shall be rigorously maintained.
- B. Class B Concrete: Class B concrete shall be used for the Markley Canyon apron, minor concrete at MP26.3 and canal lining at MP 8.65, if used in place of shotcrete. Class B concrete shall meet the following requirements, unless otherwise specified on the Project Drawings or approved by the Construction Administrator:
  - 1. Coarse Aggregate: Shall consist of well-graded crushed stone or washed gravel conforming to the requirements of ASTM C33, Class 67 (Nominal size: 3/4 inch [19 mm.] to No. 4 sieve). Refer to Paragraph 2.4.B.2 for additional coarse aggregate size restrictions.
  - 2. Slump: Concrete slump at the point of delivery shall not be greater than 3 inches +/- 1 inch (75 mm. +/- 25 mm.). If a field applied admixture is to



be used that will increase the slump of concrete, the slump must be measured first and shall comply with the abovementioned requirements prior to the addition of the admixture to the concrete, (refer to Paragraph 2.4.E regarding restrictions to use of admixtures). Concrete shall be of such consistency that it can be readily worked into the corners and angles of the forms, and around the reinforcement, inserts, and castings without permitting materials to segregate or free water to collect on the surface, with consideration given to the methods of placing and compacting.

3. Air-Entraining Admixture: Shall conform to ASTM C260 and shall be MICRO AIR by Master Builders, Inc., or equal. The maximum amount of entrained air measured at discharge from the truck shall be: 1) 3.0 percent (3.0%) maximum for finished slabs; b) 3.5 to 5.0 percent (3.5% to 5.0%) for all other uses. Air content shall be measured in accordance with ASTM C231.
4. Pozzolans: At the Contractor's option, pozzolans may be used in the concrete mix design to replace cement. Pozzolan for cement replacement shall conform to ASTM C618 Class N or Class F (fly ash).
5. Compressive Strength (Concrete at MP 26.9 and Concrete Canal Lining): The minimum 28-day compressive strength of the concrete shall be 3,000 psi (20.7 MPa), as determined by testing of samples taken from the transportation unit at point of discharge. Testing of concrete shall be in accordance with ASTM C39.
6. Compressive Strength (Apron, Grade Beam and Drilled Piers at Markley Canyon): The minimum 28-day compressive strength of the concrete shall be 4,500 psi (31.0 MPa), as determined by testing of samples taken from the transportation unit at point of discharge. Testing of concrete shall be in accordance with ASTM C39.
7. Cement Content: The minimum cement content shall be 500 pounds per cubic yard (lb./yd.<sup>3</sup>) of concrete. (450 pounds per cubic yard [lb./yd.<sup>3</sup>] minimum with the additional of pozzolans.)
8. Water Content: The water-cement (w/c) ratio of the approved mix design shall be rigorously maintained.
9. Fibermesh: Provide minimum 1.5 pounds of fibermesh per cubic yard.

## 2.6 **Related Materials**

- A. Evaporation Reducer: Shall be CONFILM by Master Builders, Inc., ProFilm 19 by Pro Mix Technologies, or equal; a spray applied product that reduces the rate of surface moisture evaporation under hot, dry and/or windy conditions. Product shall be used to minimize plastic shrinkage cracking and shall not affect the cement hydration process.
- B. Epoxy Bonding Agent: Shall be 100 percent (100%) solids, two component epoxy bonding compound for bonding new concrete to existing concrete. The color of the components shall be of contrasting color so when mixed according to manufacturer recommendations shall produce a third color. The epoxy bonding

agent shall be CONCRETSIVE Liquid LPL by Master Builders, Inc., A-H Poly-Epoxy Bonding #100 by Anti Hydro International, Inc., or equal.

- C. Structural Repair Mortar: Shall be a shrinkage compensated, rheoplastic, one-component, cementitious based, hand or low velocity spray applied material suited for repairing distressed horizontal, vertical or overhead concrete. Material shall be EMACO S Series by Master Builders, Inc., CR-60 Super Bond Repair Cember by Lone Star Epoxies, Inc., or equal.
- D. Patching Mortar: Shall be a single-component, polymer modified cementitious based mortar suited for patching and/or resurfacing of distressed horizontal, vertical or overhead concrete. Material shall be EMACO R Series by Master Builders, Inc., Sika MonoTop 611 by Sika Corporation, or equal.
- E. Absorptive Cover: Shall be burlap cloth made from jute or kenaf, weighing approximately 9 ounces per square yd (oz./yd.<sup>2</sup>), complying with AASHTO M182, Class 2. When used, absorptive cover shall be covered with specified Moisture-Retaining Cover.
- F. Moisture-Retaining Cover: Shall be one of the following, complying with ASTM C171.
  - 1. Waterproof paper.
  - 2. Polyethylene film.
  - 3. Polyethylene-coated burlap.
- G. Water Content: The water-cement (w/c) ratio of the approved mix design shall be rigorously maintained.

2.7 **Production of Concrete**

- A. Ready Mixed Concrete: Shall comply with requirements of ASTM C94, except as modified herein.
  - 1. Plant equipment and facilities shall conform to the "Checklist for Certification of Ready Mixed Concrete Production Facilities" of the National Ready Mixed Concrete Association.
  - 2. Add ingredients at the batch plant during the mixing time with the weights recorded on the delivery ticket. This includes all cementitious materials, aggregates, water, admixtures, and fibers.

3.0 **EXECUTION**

3.1 **General**

- A. Mix, place, consolidate, finish and cure concrete in accordance with the requirements of ACI 301.

3.2 **Forms**

- A. General: Design, erect, support, brace, and maintain formwork to safely and adequately support vertical and lateral, static and dynamic loads that might be applied until concrete structure can support such loads. Design of formwork shall meet the requirements of all applicable building codes, and shall be prepared

and stamped by a California Registered Civil Engineer. Formwork shall be designed to support pressure resulting from placement and consolidation of concrete. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Design of all formwork shall be the responsibility of the Contractor.

- B. Design: Formwork shall be designed in accordance with ACI 347. Special consideration shall be taken to allow for conveying of concrete in the forms.
- C. Tolerances: Formwork construction tolerances shall comply with ACI 117.
- D. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blockings, screeds, bulkheads, anchorages and inserts, and other features as required in work or on Project Drawings. Use selected materials to obtain required finishes. Formwork shall be tight with backup provided at joints to prevent loss of mortar. Formwork for architectural concrete shall be watertight.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Place form ties so ends can be removed with a minimum of spalling. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only.
- F. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- G. Chamfer exposed corners and edges as shown on Project Drawings, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints. Provide 3/4 inch (19 mm.) chamfer strips in the corners of formwork for permanently exposed surfaces.
- H. Provisions for Other Trades: Coordinate with other trades to provide openings in concrete formwork as required. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.
- I. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Retighten forms and bracing before concrete placement as required to prevent mortar leaks and maintain proper alignment. Surfaces of the formwork and embedded materials shall be clean before concrete is placed. Formwork shall be clear of standing water before concrete is placed.
- J. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to obtain required elevations and contours in finished surfaces. Provide and secure forms to support screed strips that accommodate strike-off templates or compacting-type screeds. Camber formwork as shown on Project Drawings or as required to compensate for anticipated deflections in formwork due to loading of plastic concrete. Screeds shall be set to like camber.



### 3.3

#### **Placing Reinforcement**

- A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports and as herein specified.
- B. Clean reinforcement of loose rust and mill scale, earth, ice and other materials that may reduce or destroy bond with concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by the Construction Administrator. Provide the minimum cover as indicated on the drawings and in conformance with ACI 318.
- D. Place, support and fasten reinforcement as shown on the Project Drawings. Do not exceed the placing tolerances specified in ACI 117 before the placement of concrete. Placing tolerances shall not reduce the cover requirements except as specified in ACI 117. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- E. All reinforcement shall be bent cold. No preheating is allowed. Field bending or straightening of reinforcing steel is not permitted.
- F. Splicing: Splices of tensile reinforcement at points of maximum stress is not allowed. Unless otherwise shown on drawings, all splices shall be a minimum of Class B splices per ACI 318. Only lap splices shall be allowed, and stagger all splices between adjacent bars unless otherwise shown on the drawings.

### 3.4

#### **Joints**

- A. Construction Joints: Locate and install construction joints as shown on the Contract Drawings, or at 15'-0" on center spacing.
  - 1. Provide keyways as indicated on Project Drawings. Unless otherwise shown, longitudinal keyways shall be at least 1-1/2 inches (37.5 mm) deep in construction joints in walls, and between walls and footings. The set surface shall have an average roughened surface of full amplitude of approximately 1/4 inch (6 mm.), clean and free of laitance.
  - 2. If load transfer between existing concrete surface and new concrete placement will not be accomplished by keyway, load transfer dowels or other approved mechanical load transfer device, use bonding agent as specified in Paragraph 2.6.C on existing concrete surfaces that will be joined with fresh concrete. Follow manufacturer's directions on mixing and timing of placement.
- B. Isolation Joints in Slabs on Grade: Construct isolation joints in slabs on grade at points of contact between slabs on grade and vertical surfaces, such as column pedestals, foundation walls, shear walls, grade beams and elsewhere as shown on the Project Drawings.
- C. Control Joints in Slabs on Grade: Construct control joints in slabs on grade in accordance with ACI 302.1 and Project Drawings.

1. Sawed control joints shall be made as soon as the concrete has hardened sufficiently to prevent dislodgment of aggregates. Saw a continuous slot to a depth of one-fourth the thickness of the slab, but not less than 1 inch (25 mm.). Complete sawing within twelve (12) hours of placement. Control joints shall be filled with epoxy joint filler as specified in Paragraph 2.6.B, in accordance with manufacturer's recommendations.
  2. If joint pattern is not shown on Project Drawings, distance between control joints shall not exceed thirty-six (36) times the slab thickness for slabs less than or equal to 5 inches (125 mm.) thick; thirty (30) times the slab thickness for slabs greater than 5 inches (125 mm.) thick but less than or equal to 8 inches (200 mm.); and twenty-four (24) times the slab thickness for slabs greater than eight 8 inches (200 mm.) thick. Joints shall be located to conform to bay spacing wherever possible (at column centerlines, half bays, and third bays). The ratio of the length to width of any panel shall not exceed 1.5 to 1.0. Length to width ratio shall not apply to sidewalks and curbs.
- D. Expansion and Contraction Joints: Expansion and contraction joints shall be filled with preformed sponge rubber expansion joint filler as specified in Paragraph 2.3.B. Joint filler shall be firmly bonded to the previously poured joint face with a suitable adhesive, and the new concrete shall be poured directly against the joint filler.
- E. Waterstops: Provide waterstops as specified in Paragraph 2.3.A in construction, contraction, and/or expansion joints as shown on the Project Drawings. Install waterstops to form continuous diaphragm in each joint. The lengths of pre-molded waterstop shall be selected to minimize the number of joints. Make provisions to support and protect exposed waterstops during progress of work. Field-fabricate joints in waterstops in accordance with manufacturer's printed instructions.

### 3.5 Installation of Embedded Items

- A. General: Set and build into Work anchorage devices and other embedded items required for other work as shown on Project Drawings.
- B. Equipment Anchor Bolts: Set anchor bolts for machines and equipment to templates at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.

### 3.6 Preparation of Formed Surfaces

- A. General: Coat contact surfaces of forms with a nonresidual, low-VOC, form release agent as specified in Paragraph 2.1.F before reinforcement is placed.
- B. Do not allow excess form release agent to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.
- C. Coat steel forms with a non-staining, rust-preventative material. Rust-stained steel formwork is not acceptable.

### 3.7

#### **Concrete Placement**

- A. Inspection: Complete formwork installation, reinforcing steel placement, and items to be embedded or cast in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Prior to placement of concrete, the Construction Administrator shall inspect the work, and no placement shall occur unless approval is received from the Construction Administrator.
- B. General: Comply with ACI 304 and ASTM C94 except as modified herein. Concrete in each integral part shall be placed continuously. Contractor shall not commence with Work of any part unless the facilities and forces on hand are sufficient to complete the placing and finishing of work.
- C. When a truck or mixer or agitator is used for transporting concrete to the delivery point, discharge shall be completed within one and one-half (1<sup>1/2</sup>) hours, or before 250 revolutions of the drum or blades, whichever comes first, after the introduction of the cement to the aggregates. Under conditions contributing to quick stiffening for the concrete, or when the temperature of the concrete is 85° F., or above, a time less than one and one-half (1<sup>1/2</sup>) hours may be required.
- D. When non-agitating hauling equipment is used for transporting concrete to the delivery point, discharge shall be completed within one (1) hour after the addition of the cement to the aggregates. Under conditions contributing to quick stiffening for the concrete, or when the temperature of the concrete is 85° F. or above, the time between the introduction of cement to the aggregates and discharge shall not exceed forty-five (45) minutes.
- E. Each load of ready-mixed concrete delivered at the jobsite shall be accompanied by a ticket showing volume of concrete, the concrete mix identification number, and the total amount of water added to the load. The ticket shall also show the time of day at which the materials were batched and for transit-mixed concrete, the reading of the revolution counter at the time the truck mixer is charged. The Contractor shall be responsible for collecting and delivering all concrete tickets to the Construction Administrator the day of the pour.
- F. No additional water shall be incorporated into the concrete during the hauling or after arrival to the delivery point, unless requested by the Contractor and authorized by the Construction Administrator. If the Construction Administrator authorizes additional water to be incorporated into the concrete, the Contractor has the sole responsibility to verify that the specified maximum water-cement (w/c) ratio or slump will not be exceeded.
- G. The slump of the concrete shall be measured prior to placement of the concrete in the forms and prior to addition of any field applied admixtures. Refer to Paragraph 2.5 for the maximum allowable slump. Also refer to Paragraph 2.4.E for restrictions to using of admixtures.
- H. Placing Concrete in Forms: Deposit concrete continuously or in layers so that no concrete will be placed on concrete that has hardened sufficiently to cause the formation of seams or other planes of weakness. The maximum free fall of concrete shall be 3 feet (900 mm.) and the maximum lift thickness shall be 18 inches (450 mm.). If a section cannot be placed continuously, provide construction joints as herein specified or as shown on the Project Drawings.



Deposit concrete to avoid segregation at its final location. Place concrete with square ends and level tops.

- I. Consolidate Concrete with Vibrators: All concrete shall be thoroughly consolidated by means of mechanical vibrators. Vibration shall be in accordance with ACI 309, minimum frequency of 8,000 vibrations per minute. Do not use vibrators to transport the concrete in the forms. Contractor shall provide adequate number of vibrators to consolidate concrete work within five (5) minutes after it is deposited.
- J. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of joints, until the placing of a panel or section is completed.
  - 1. Consolidate slab concrete during placing operations using a vibrator screed for slabs less than 6 inches (150 mm) thick. For 6 inches (150 mm) and greater thickness, use internal vibration. Keep the vibrator perpendicular to the surface of the concrete at all times.
  - 2. Bring slab surfaces to correct level with straightedge and strike off. Use bull floats or darbies to smooth surface, free of humps or hollows. Use of a "jitterbug" is not allowed. Do not disturb slab surfaces prior to beginning finishing operations.
  - 3. The evaporation rate of water from exposed surfaces of plastic concrete shall not exceed 0.20 lb./ft<sup>2</sup>/hr. Windbreaks, foggers, and/or the application of the surface applied evaporation reducer as specified in Paragraph 2.6.A shall be used to limit the evaporation rates as specified. The rate of evaporation chart in ACI 305R shall be used to determine the evaporation rate of water.
- K. Cold Weather: When cold weather conditions exist, place concrete in compliance with ACI 306.
- L. Hot Weather: When hot weather conditions exist, place concrete in compliance with ACI 305.
- M. Wet Weather: Do not begin to place concrete in the rain or under the threat of rain during the pour and initial set unless concrete is protected, per the approval of the Construction Administrator, against addition of extra water. Refer to Paragraph 1.3.A.9 for submittal of favorable local weather report prior to placement of concrete.

### 3.8 Finish of Formed Surfaces

- A. Rough Form Finish: Shall be used for formed concrete surfaces not exposed to view in the finished structure or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch (6 mm.) high rubbed down or chipped off.
- B. Smooth Form Finish: Shall be used for formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, corrosion control coating, veneer plaster, painting, or other similar

system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas as described in Paragraph 3.14.A.

- C. Related Unformed Surfaces: At tops of walls, horizontal offsets and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise shown on Project Drawings.

### 3.9

#### **Unformed Finishes**

- A. General: Use the following finishes as specified or as shown on Project Drawings.
- B. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or portland cement terrazzo; and as otherwise indicated. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Slab shall meet the conventional straightedge flatness tolerance requirements of ACI 117. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture. Do not overfinish concrete.
- C. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other final finish. Unless otherwise specified, slab shall meet the conventional straightedge flatness tolerance requirements of ACI 117. Grind smooth surface defects that would telegraph through applied floor covering system.
- D. Trowel and Fine Broom Finish: Apply trowel and fine broom finish to monolithic slab surfaces to be covered by thinset terrazzo, or ceramic or quarry tile, that is to be installed with thin-set mortar, apply trowel finish as specified, then immediately follow with slightly scarifying surface by fine brooming.
- E. Nonslip Broom Finish: Apply nonslip broom finish to exterior concrete subjected to foot or wheel traffic, steps, and ramps, and elsewhere as shown on Project Drawings. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Construction Administrator before application.

### 3.10

#### **Concrete Curing and Protection**

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Protect freshly placed concrete from rainfall or rainfall runoff. Protect concrete from rapid moisture loss before and during finishing operations with evaporation reducer specified in Paragraph 2.6.A or fog spray. Apply evaporation reducer in accordance with manufacturer's instructions after screeding and bull floating, but before power floating and troweling. Curing shall begin as soon as the finishing operation has been completed and the surface will not be damaged by the curing method. Curing shall be maintained for not less than seven (7) days unless otherwise specified by the Construction Administrator. Water used for curing shall be potable.
- B. Cure Time for Canal Lining Repair at MP 8.65: Curing shall proceed for a minimum of three days after concrete placement. The minimum three day compressive strength of the concrete shall be at least 50 percent of the 28-day compressive strength indicated in Part 2.5B, as measured by ASTM C39.



- C. Curing Methods: Perform curing of concrete by moist curing, by moisture-retaining cover curing, or combinations thereof, as herein specified.
1. Provide moisture curing by one of the following methods.
    - a. Keep concrete surface continuously wet by covering with water.
    - b. Use continuous water-fog spray.
    - c. Cover concrete surface with absorptive cover specified in Paragraph 2.6.F, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4 inches (100 mm.) lap over adjacent absorptive covers. Moisture retaining cover specified in Paragraph 2.6.G shall be placed over absorptive cover to prevent drying out.
  2. Provide moisture retaining cover curing as follows:
    - a. Cover concrete surfaces with moisture retaining cover specified in Paragraph 2.6.G placed in widest practical width with sides and ends lapped at least 3 inches (75 mm.) and sealed by waterproof tape or adhesive.
    - b. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
- D. Curing Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces for seven (7) days by moist curing with forms in place. If forms are removed prior to completion of specified seven (7) day period, continue curing by methods specified in Paragraph 3.10.B.
- E. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces, by application of specified curing methods in Paragraph 3.10.B.
- F. Shrinkage Control Joints: Allow a minimum 48-hour cure time for shrinkage control joints and seals.

### 3.11 Removal of Forms

- A. General: Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 degrees Fahrenheit (50°F [10°C]) for twenty-four (24) hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations as specified in Paragraph 3.10 are executed.
- B. Formwork supporting weight of concrete, such as beam soffits, joists, and other structural elements, shall not be removed prior to fourteen (14) days or until in-place concrete has attained at least 75 percent (75%) of design minimum 28-day compressive strength (f'c).

- C. Formwork supporting retaining walls shall not be removed nor earth retaining walls backfilled prior to fourteen (14) days or until in-place concrete has attained at least 75 percent (75%) of design minimum 28-day compressive strength (f'c).
- D. Form-facing material may be removed four (4) days after placement only if shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports.

3.12

3.12

#### **Reuse of Forms**

- A. Clean and repair surfaces of forms to be reused in work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.
- B. When forms are extended for successive concrete placement, thoroughly clean surfaces and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use patched forms for exposed concrete surfaces except as acceptable to the Construction Administrator.

3.13

#### **Miscellaneous Concrete Items**

- A. Filling In: Fill in holes and openings left in concrete structures for passage of Work by other trades, unless otherwise shown or directed, after Work of other trades is in place. Mix, place, and cure concrete fill as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still fresh and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on Project Drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.

3.14

#### **Concrete Surface Repairs**

- A. Repair of Surface Defects: After removal of forms, repair and patch defective areas with patching mortar specified in Paragraph 2.6.E.
- B. Structural Repair of Honeycomb and Rock Pocket Areas: In honeycomb and rock pocket areas, saw cut area and remove material down to solid concrete. Saw cut edges shall be perpendicular to the concrete surface. Place structural repair mortar as specified in Paragraph 2.6.D in accordance with the manufacturer's recommendations. Protect and cure repair mortar as specified in Paragraph 3.10.

3.15

#### **Quality Control Testing During Construction**

- A. General: The District shall employ a testing laboratory to perform tests and to submit test reports. Testing laboratory shall furnish all equipment for taking samples and testing. Sampling and testing of concrete shall be performed by ACI certified Concrete Field Technicians Grade 1.

- B. Sampling Fresh Concrete: Shall conform to ASTM C172 and ASTM C94 except as modified herein. Sampling and testing for quality control during placement of concrete shall include the following, or as directed by the Construction Administrator.
1. Slump: ASTM C143; one test at point of discharge for each day's placement of each type/class of concrete. Additional tests shall be taken when concrete consistency seems to have changed and when compression test specimens are taken.
  2. Air Content: ASTM C231 pressure method for normal weight concrete; one (1) for each day's placement of each type/ class of concrete. Additional tests shall be taken when compressive test specimens are taken.
  3. Concrete and Ambient Temperature: Test hourly when air temperature is 40 degrees Fahrenheit (40°F [4°C]) and below, when 80 degrees Fahrenheit (80°F [27°C]) and above, and each time a set of compression test specimen are made.
  4. Compression Test Specimen: ASTM C31; one (1) set of ten (10) standard cylinders for compressive strength testing, unless otherwise directed by the Construction Administrator. Mold and store cylinders for laboratory-cured test specimens except when field-cure test specimens are required.
  5. Compressive Strength Tests: ASTM C39; one set as specified in Paragraph 3.15.B.4 for each day's pour exceeding 5 cubic yards (4 m<sup>3</sup>) plus additional sets for each 50 cubic yards (40 m<sup>3</sup>) more than the first 25 cubic yards (20 m<sup>3</sup>) of each concrete type/class placed in any one (1) day; three (3) specimen shall be tested at three (3) days, three (3) specimen shall be tested at seven (7) days, three (3) specimen shall be tested at twenty-eight (28) days, and one (1) specimen retained in reserve for later testing if required. When frequency of testing will provide fewer than five (5) strength tests for a given class of concrete, conduct testing from at least five (5) randomly selected batches or from each batch if fewer than five (5) are used.
  6. Test results will be reported in writing to Construction Administrator, Ready Mix Producer and Contractor within twenty-four (24) hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at twenty-eight (28) days, concrete mix proportions and materials, compressive strength, and type of break for three (3) day, seven (7) day and twenty-eight (28) day tests.
  7. Additional Tests: The testing service 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, as directed by the Construction Administrator. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42, or by other methods as directed by the Construction

Administrator. Contractor shall pay for such tests if unacceptable concrete is verified.

- C. Should the strengths shown by the test specimens made and tested in accordance with the above provisions fall below the values specified in Paragraph 2.5, the Construction Administrator shall have the right to require changes in proportions to apply on the remainder of the Work. Furthermore, the Construction Administrator shall have the right to require additional curing on those portions of the structure represented by the test specimens that failed. The cost of such additional curing is to be at the Contractor's expense. In the event that such additional curing does not give the required strength, as evidenced by core and/or load tests, the Construction Administrator shall have the right to require strengthening or replacement, at Contractor's cost, portions of the structure which fail to develop the required strength.
- D. Should the strength of test cylinders, at the seven (7) day break, fall below 60 percent (60%) of the required 28-day compressive strength, the concrete shall be rejected and shall be removed and replaced.

**\*\*\* END OF SECTION\*\*\***



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