

SECTION 03100 CONCRETE FORMING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes specifications for design, construction, and removal of formwork for the placement of cast-in-place concrete.

1.02 REFERENCE STANDARDS

- A. American Concrete Institute (ACI):
 - 1. 301 Specifications for Structural Concrete for Buildings
 - 2. 347 Guide to Formwork for Concrete
- B. American Plywood Association (APA)
 - 1. PS1-95 U.S. Product Standard for Construction and Industrial Plywood
- C. American Railway Engineering and Maintenance-of-Way Association (AREMA):
 - 1. Manual for Railway Engineering (Manual)
- D. State of California, Department of Transportation, Standard Specifications, (Caltrans):
 - 1. Section 51, Concrete Structures

1.03 SYSTEM DESCRIPTION

- A. The work of this Section shall be performed in accordance with the following provisions:
 - 1. AREMA Manual, Section 1.8, "Forms," of Section 8, "Concrete Structures and Foundations"
 - 2. Caltrans Standard Specifications, Section 51-1.05, "Forms"
 - 3. ACI 347

1.04 SUBMITTALS

- A. Formwork Shop Drawings: Submit drawings that indicate the following:
 - 1. Forming system and method of erection with associated details, including bracing as required to ensure stability of formwork.
 - 2. Design calculations for the forming system.

3. Concrete placement rates and ambient temperature requirements at time of concrete placement.
 4. Locations of all joints in concrete, including construction joints, expansion joints, isolation joints, cold joints, and contraction joints, in plan and elevation views.
 5. Locations and sizes of inserts, embedments, conduits, openings, recesses, chamfers, reveals, rustications, blockouts, pipes, ducts and other attached products.
 6. Form tie locations and patterns at exposed cast-in-place concrete.
 7. Beam intersections and other conditions where concrete casting by vertical drop may be restricted.
 8. Method and schedule for removing forms and shoring.
 9. Method for detecting formwork movement during concrete placement.
 10. Coordinate with the requirements specified in Section 03300, Cast-In-Place Concrete.
- B. Product Data: Provide manufacturers' data and installation requirements on form materials, form coatings, form ties, and other accessories.
- C. Samples: Submit form material with submittal of shop drawings, 12 inches by 12 inches or larger in size, for formed concrete which will be exposed in the finished work to the public view.

1.05 QUALITY ASSURANCE

- A. The design of the formwork will be done under the supervision of a civil engineer registered in the State of California.

PART 2 - PRODUCTS

2.01 WOOD FORM MATERIALS

- A. Provide form materials in accordance with the requirements of APA PS-1, including the following products:
1. B-B Plyform: Class I, EXT-APA, sanded, APA trade marked.
 2. B-C Plyform: Class I, EXT-APA , APA trade marked.
 3. High Density Overlay (HDO) Plyform: A-A, 60-60, Class I, EXT-APA trade marked.
 4. Thickness: As required to maintain surface smoothness without deflection, but not thinner than 5/8 inch.

- B Lumber:
1. Boards: Use dressed side of lumber for surface in contact with the concrete and use dressed or tongue-and-groove edges.
 2. Framing Lumber: Structural grade, dressed or rough.

2.02 PREFABRICATED FORMS

- A. Preformed Steel Forms: At Contractor's option, preformed steel forms may be used. Forms shall be structurally adequate, matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces. Provide surfaces which will not impart corrosion residue to concrete.

2.03 FORMWORK ACCESSORIES

- A. Plugged Cone Form Ties: Rod type, with ends or end fastener which can be removed without spalling the concrete and which leave a hole equal in depth to the required reinforcement clearance. Form ties shall be of a design in which the hole left by the removed end or end fastener is easily filled to match the surface of the hardened concrete. Provide removable cones 1-1/4 inches in diameter by 1-1/2 inches deep.
- B. Form Release Agent: Commercial formulation, silicone-free form-release agent, designed for use on all types of forms, which will not bond with, stain, nor adversely affect concrete surfaces, and which will not impair subsequent treatment of concrete surfaces requiring bond or adhesion nor impede wetting of surfaces which will be cured with water, steam, or curing compounds. Form release agent for use on steel forms shall be non-staining and rust-preventive.
- C. Chamfer Strips: 3/4 inch by 3/4 inch triangular fillets milled from clear, straight-grain pine, surfaced each side or extruded vinyl type with or without nailing flange.
- D. Miscellaneous Joint Strips: Preformed strips for reveals, rustication and similar joints fabricated of wood, metal, or plastic.
- E. Dovetail Anchor Slot: Galvanized steel, 22 gage thick, release tape sealed slots, anchors for securing to concrete formwork.
- F. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place during concrete placement.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify locations, lines, and levels before proceeding with formwork. Ensure that dimensions agree with shop drawings.

3.02 EARTH FORMS

- A. Hand trim sides and bottom of earth forms. Establish and maintain necessary benchmarks, lines, or controls throughout construction. Remove loose soil prior to placing concrete.

3.03 INSTALLATION

- A. Erect formwork, shoring and bracing to achieve design requirements and to maintain allowable tolerances in accordance with the requirements of ACI 301.
- B. Formwork of foundations shall not interfere with underground utilities, such as fiber optic cables, and railroad track operational clearances.
- C. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to over-stressing by construction loads.
- D. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping, and permit removal of remaining principal shores.
- E. Kerf wood inserts for forming keyways, reglets, and recesses in a manner that will prevent swelling and ensure ease of removal.
- F. Align joints and make watertight. Keep form joints to a minimum.
- G. Support joints with extra studs or girts and in a manner that will ensure true, square intersections.
- H. Provide chamfer strips on external corners of all concrete pours. Accurately shape and surface chamfer strips in a manner which will produce uniformly straight lines and edge joints and which will prevent mortar runs. Extend terminal edges to limits, and miter chamfer strips at changes in direction.
- I. Construct molding shapes, recesses and projections with smooth finish materials and install in forms with sealed joints.
- J. Provide camber in formwork as required to compensate for deflections caused by weight and pressures of fresh concrete and construction loads.
- K. Provide construction openings in forms where required for concrete pour pockets, vibrator access holes and inspection openings to aid in proper placement and consolidation of concrete and close up openings during placement of concrete as applicable.
- L. Provide inspection and cleanout openings in forms at bottom of walls and columns and elsewhere as required. Do not close cleanouts until inspected and accepted just before placing concrete.
- M. Drill air escape holes in bottom members of blockouts.
- N. Ensure that formed stair risers within stair run are equal.

- O. Edge Forms and Screeds for Slabs: Set edge forms or bulkheads and intermediate screeds for slabs to obtain required elevations and contours in the finished slab surface. Support screeds substantially without penetrating waterproof membranes and vapor barriers.
- P. Construction Joints:
 - 1. Locate joints as indicated. Support forms for joints in concrete so as to rigidly maintain their positions during placement, vibration, and curing of concrete. Install keys in all joints.
 - 2. Locate and install construction joints, for which locations are not indicated, so as not to impair strength and appearance of the structure and in accordance with approved Shop Drawings
 - 3. Position joints perpendicular to longitudinal axis of pier, beam, or slab as the case may be.
 - 4. Locate joints in walls, vertically as indicated; at top of footing; at top of slabs on grade; at bottom of door openings; and at underside of the deepest beam or girder framing into wall; or as required to conform to indicated details.
 - 5. Provide keyways as indicated in construction joints in walls and slabs, and between walls and footings, unless otherwise indicated. Place construction joints perpendicular to the main reinforcement. Continue reinforcement across construction joints.
- Q. Load Supports: Loads for construction of roof slab and suspended floor slabs shall be carried down to on-grade base slabs. These loads shall not be carried by intermediate slabs at any time. Formwork loads shall be carried only by structural elements which are supported directly by footings.

3.04 FORM RELEASE AGENT

- A. Apply form release agent on formwork in accordance with manufacturer's recommendations, prior to placement of reinforcing steel, anchoring devices, and embedded items. Do not allow excess form release agent material to accumulate in the forms or to come into contact with surfaces which are required to be bonded to fresh concrete such as concrete reinforcement and embedded items.
- B. Protect steel forms from rust with form release agent or otherwise protect against rusting.
- C. Apply release agent to bolts and rods that are to be removed or that are to be free to move.

3.05 INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Provide formed openings for items to be embedded in or passing through

formwork.

- B. Locate and set in place items that will be cast directly into concrete.
- C. Coordinate with related work of other Sections in forming and placing openings, slots, recesses, chases, sleeves, bolts, anchors, ties, inserts, and similar embedded items.
- D. Install accessories in accordance with manufacturer's instructions, straight, level, and plumb. Secure items to prevent disturbance during concrete placement.
- E. Provide temporary ports or openings in formwork to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.
- F. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.06 FORM CLEANING

- A. Clean and remove foreign matter within forms as erection of formwork proceeds.
- B. Clean debris from formed cavities prior to placing concrete.
- C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.

3.07 FORM STRIPPING

- A. Do not remove forms or bracing until concrete members have sufficient strength to safely support their own weight and all superimposed loads.
- B. Leave forms in place for at least 3 days, unless results of tests show that 70 percent of specified strength has been achieved. At times of low temperature or other adverse weather conditions, increase the required time to 5 days.
- C. Do not remove or release falsework and forms supporting concrete girders, beams, joists, slabs, walls, or other members subject to bending stress in less than 14 days after the concrete has been placed. In any case, do not remove falsework and forms supporting the members until the concrete has attained at least 70 percent of the indicated design compressive strength on test results of laboratory cured cylinders. Do not load such members until the concrete has attained its 28-day compressive strength.
- D. Loosen forms carefully, and remove without hammering or prying against finished concrete surfaces.
- E. Protect concrete surface from damage. Store removed forms for re-use, as appropriate, and remove damaged forms from the site and dispose of.
- F. As soon as the forms have been stripped and the concrete surfaces exposed, commence finishing and repairs such as removal of fins and other projections,

filling recesses left by the removal of form ties, and repair surface defects as specified in Section 03170, Concrete Finishing. Clean exposed concrete surfaces and adjoining work stained by leakage of concrete.

3.08 RE-USE OF FORMS

- A. Forms that are in good condition and have been cleaned, repaired, and resealed as required to achieve concrete of the specified quality and texture may be reused if approved by the Engineer. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable. Remove such material from the site. Renew form release coating as specified for new formwork.
- B. Do not reuse wood formwork more than four times for concrete surfaces exposed to view.
- C. Align and secure joints in a manner that will preclude offsets. Do not patch formwork unless accepted by the Engineer, in which case, patch holes and defects in forms with materials and methods that will not be reflected in the concrete.

3.09 FIELD QUALITY CONTROL

- A. Inspect erected formwork, shoring, and bracing to ensure that the work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and items are secure.
- B. While placing concrete, provide quality control to assure that formwork and related supports have not been displaced, that loss of cement paste through joints is prevented and that completed work will be within specified tolerances.
- C. During removal, verify that architectural features meet the form and texture requirements of the samples approved by the Engineer.
- D. Check movement using methods, such as plumb lines, tell tales and survey equipment, as approved by the Engineer, to detect movement of formwork during concrete placement.

END OF SECTION

SECTION 03150 CONCRETE ACCESSORIES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes specifications for accessories for concrete structures.

1.02 REFERENCE STANDARDS

- A. American Railway Engineering and Maintenance-of Way Association (AREMA):
 - 1. Manual for Railway Engineering (AREMA Manual)
- B. State of California, Department of Transportation, Standard Specifications (Caltrans):
 - 1. Section 51 Concrete Structures
 - 2. Section 68 Subsurface Drains
 - 3. Section 75 Miscellaneous Metals
 - 4. Section 95 Epoxy

1.03 SUBMITTALS

- A. Submit product data and manufacturer's instructions for elastomeric bearing pads, waterstops, mortar, epoxies, and other items.

1.04 DELIVERABLES

- A. Certificates of Compliance: Submit certificates of compliance for joint seals and elastomeric bearing pads.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Concrete Anchorage Devices, Bolts and Inserts: Conform to the provisions of Caltrans Standard Specifications, Section 75, Miscellaneous Metal.
- B. Expansion Joints, Joint Fillers and Sealers: Conform to the provisions in Caltrans Standard Specifications, Section 51, and AREMA Manual, Chapter 8. See Section 07250, Joint Sealants, for additional requirements.
- C. Elastomeric Bearing Pads: Elastomeric bearing pads for railroad bridges shall conform to the details shown on the Contract Drawings and the requirements of AREMA Manual, Chapter 15, and the following additional requirements:

1. Elastomeric bearing pads shall be plain pads as specified in Caltrans Standard Specifications, Section 51, unless otherwise indicated, with a thickness as dimensioned on the Contract Drawings.
 2. Provide holes as shown on the Contract Drawings for pads located at girder anchor rods.
- D. Waterstops: Conform to the provisions in Caltrans Standard Specifications, Section 51-1.14, Waterstops.
- E. Mortar: Conform to the provisions in Caltrans Standard Specifications, Section 51-1.135, Mortar.
- F. Drain Pipe: Conforming to the provisions for pipe for edge drains and edge drain outlets in Caltrans Standard Specifications, Section 68-3, Edge Drains.
- G. Embedded Junction Boxes and Conduit: Refer to Division 16, Electrical.
- H. Embedded Drains, Drain Pipes, Reducers, and Fittings: Refer to Section 02630, Storm Drainage System
- I. Gel-Type Epoxy: Delta AS23-18 A&B gel-type epoxy or Engineer approved equal.
- J. Epoxy binder: Conforming to the provisions in Caltrans Standard Specifications, Sections 95-1, General, and 95-2.01, Binder (Adhesive), Epoxy Resin Base.

2.02 MORTAR AND GROUT MIXES

- A. Gel-Type Epoxy Sand Mortar: Mix mortar consisting of equal parts by volume of gel-type epoxy and dry silica sand in accordance with manufacturer's instructions,
- B. Epoxy Grout: One part epoxy binder to three parts dry silica sand (fine aggregate), by volume.
- C. Grout for baseplates and bedplates: Refer to Section 03300, Cast-In-Place Concrete.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Coordinate installation of accessories with Section 03300, Cast-in-Place Concrete, and related concrete sections.
- B. Elastomeric Bearing Pads:
1. Bond pads to abutment seats and pier caps with epoxy.
 2. Clean top and bottom surface of bearing pads with methyl ethyl ketone to remove all traces of mold release agents. When mating surfaces are

clean and dry, apply gel-type epoxy to a 5 mil thickness on the bridge seat and the bottom side of the bearing pad and then set pad and hold in the proper location on the bridge seat until the epoxy takes its initial set.

3. Just before setting beams, spread gel-type epoxy sand mortar on top of bearing pads to a thickness of approximately 1/4 inch to obtain uniform bearing. Scrape excess mortar from around bearing pads after beams are set.
- C. Waterstops: Install waterstops as specified in Caltrans Standard Specifications, Section 51-1.14, Waterstops, and waterstop manufacturer's written instructions.
- D. Epoxy Grout: Apply where indicated on the Contract Drawings. Use in accordance with manufacturer's instructions.
1. Follow manufacturer instructions regarding maximum pot life. In the event of high air temperatures, the time shall be shortened so that placement of the grout occurs while the material is still sufficiently liquid to adhere.

END OF SECTION

SECTION 03160 COLORED CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes requirements for integrally colored concrete.

1.02 GENERAL

- A. Provisions herein augment requirements specified under Sections 03300, Cast-in-Place Concrete, and 03350, Concrete Finishing, to add provisions specific to integrally colored concrete.

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM International):
 - 1. C309 Liquid Membrane-Forming Compounds for Curing Concrete
 - 2. C979 Pigments for Integrally Colored Concrete

1.04 SUBMITTALS

- A. Submit product data and manufacturer's instructions for:
 - 1. Color additives
 - 2. Curing compounds
- B. Samples for Color Verification:
 - 1. Submit 8 inch by 10 inch by 2 inch samples (or comparable size approved by the Engineer) of specified colors indicating color additive number(s) and required dosage rate(s).
- C. Concrete Mix Designs: Submit under Section 03300, Cast-in-Place Concrete.

1.05 QUALITY ASSURANCE

- A. Maintain consistency in workmanship throughout colored concrete work.
- B. Installer Qualifications: Colored concrete work shall be performed by firm with five years experience with work of similar scope and quality.
- C. Colored Concrete Mock-Up:
 - 1. Provide full-scale mock-up for the Engineer's approval. Construct at least one month before observation and review to allow concrete to cure.

2. At location selected by the Engineer, place and finish 4 foot by 4 foot area for each concrete color and finish. Demonstrate methods of obtaining consistent visual appearance, including each forming and finishing condition required on Project using materials, workmanship, joint treatment, form ties, curing method, sealants, joint sealants, and patching techniques to be used throughout Project at color concrete.
3. Include specified concrete coverings, sealers, etc. as part of the mock-up if requested by the Engineer.
4. Retain samples of cements, sands, aggregates, and color additives used in mock-up for comparison with materials used in remaining Work. Make available to the Engineer upon request.
5. Accepted mock-up areas will be the visual standard for work of Section.
6. Remove when no longer required for comparison with finished work.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Color Additives: Comply with manufacturer's instructions. Deliver color additives in original, unopened packaging. Store in dry conditions.

1.07 PROJECT CONDITIONS

- A. Colored Concrete Environmental Requirements:
 1. Schedule placing to minimize exposure to wind and hot sun before curing materials are applied.
 2. Avoid placing concrete if rain, or frost is forecast within 24 hours. Protect fresh concrete from moisture and freezing.
- B. Schedule delivery of concrete to provide consistent mix times from batching until discharge.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Cement, Water, and Other Admixtures: Refer to Section 03300, Cast-in-Place Concrete. Obtain each material, including cement and aggregates, from same source throughout color concrete work.
- B. Cement: Cement shall be grey or white, as specified in the Contract Documents and as required to match samples available with the Engineer.
- C. Integral Color Concrete Pigment: Conforming to ASTM C979, resistant to lime and other alkali, resistant to sunlight, and inorganic, and containing no carbon black. Provide ready-to-use, integral color material. Integral color material shall be Chromix additive by L.M. Scofield Company, or Davis Colors, or Engineer approved equal. Color additives shall contain pure, concentrated mineral

pigments specially processed for mixing into concrete.

1. Colors: To match samples available with the Engineer, utilizing cement, aggregates, and pigmented additive specified in the Contract Documents.
- D. Curing Compound for Colored Concrete: Curing compound shall comply with ASTM C309 and be approved by color additive manufacturer for use with colored concrete. Provide W-1000 Clear Cure & Seal, manufactured by David Colors, or Engineer approved equal.
- E. Form Facing Materials: Refer to Section 03100, Concrete Forming, for general requirements.
 1. For formed colored concrete surfaces, provide non-porous surface such as steel, plastic, or high-density overlaid plywood with watertight joint seals to prevent leakage.
- F. Sealants for Colored Concrete: Joint sealants shall be type specified in Section 07250, Joint Sealants. Provide in color to match colored concrete.

2.02 CONCRETE MIX DESIGNS

- A. Concrete mix design shall conform to the requirements specified in Section 03300, Cast-in-Place Concrete, and the following additional requirements:
 1. Match the sample available with the Engineer, utilizing the cement, aggregates, and pigmented additive specified in the Contract Documents.
 2. Use of admixtures, in addition to pigmented additive itself, shall be subject to the written approval of the color additive manufacturer.
 3. Dosage rate of color additive shall not exceed 10 percent of weight of cementitious materials in mix.
- B. Maintain water content and control slump to maintain constant color.
- C. Color Additives: Mix in accordance with manufacturer's instructions. Mix until color additives are uniformly dispersed throughout and disintegrating bags, if used, have disintegrated.
- D. Patching Mix: If any patching is permitted, mix according to pigmented additive manufacturer's written instructions. Refer to Section 03170, Concrete Finishing, for additional requirements for patching.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to Sections 03300, Cast-in-Place Concrete, and 03170, Concrete Finishing, for general requirements for finishing and curing concrete.

- B. Finishing and Curing of Colored Concrete:
1. Finish in accordance with color additive manufacturer's written instructions and Section 03170, Concrete Finishing.
 2. Colored Concrete: Cure in accordance with color additive manufacturer's recommendations. Apply curing compound in accordance with curing compound manufacturer's instructions. Apply curing compound at consistent time for each pour to maintain color consistency.

END OF SECTION

SECTION 03170 CONCRETE FINISHING

PART 1 – GENERAL

1.01 DESCRIPTION

- A. Section includes specifications for the finishing and curing of formed and unformed concrete surfaces, including the repair of surface defects.

1.02 REFERENCE STANDARDS

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. M182 Burlap Cloth Made from Jute or Kenaf and Cotton Mats
- B. American Concrete Institute (ACI):
 - 1. 117 Specification for Tolerances for Concrete Construction and Materials
 - 2. 301 Specifications for Structural Concrete
 - 3. 308 Guide to Curing Concrete
 - 4. 503.4 Specification for Repairing Concrete with Epoxy Mortars
- C. American Society for Testing and Materials (ASTM International):
 - 1. C33 Specification for Concrete Aggregates
 - 2. C150 Specification for Portland Cement
 - 3. C171 Specifications for Sheet Materials for Curing Concrete
 - 4. C309 Specification for Liquid Membrane-Forming Compounds for Curing Concrete
 - 5. C881 Specification for Epoxy-Resin-Base Bonding Systems for Concrete

1.03. SYSTEM DESCRIPTION

- A. Finishes of formed concrete surfaces shall conform to applicable requirements of ACI 301.
- B. Finishes for slabs and flatwork shall conform to applicable requirements of ACI 301.
- C. Special architectural finishes for formed concrete surfaces shall conform to applicable requirements of ACI 301.

1.04. SUBMITTALS

- A. Product Data: Submit manufacturers' product data for manufactured products.
- B. Samples: Review by the Engineer will be for color and texture only. Approved samples will become the Engineer's control samples.
 - 1. Submit samples at least 12 inches by 12 inches in size of each type of sand blast finish, indicating materials and methods used to produce the sand blast finishes.
 - 2. Submit samples of seeded aggregate where washed aggregate finish is indicated.

1.05. QUALITY ASSURANCE

- A. Requirements of Regulatory Agencies: Comply with air pollution regulations of governing authorities for sandblasting activities and operations.
- B. Site Mock-Ups:
 - 1. Exposed Finishes: Provide site mock-ups, at least 3 feet by 4 feet in size, of finishes of formed surfaces in exposed locations and of exposed slab finishes for the Engineer's approval.
 - 2. Architectural Concrete: Provide site mock-ups of architectural concrete, at least 8 feet by 10 feet in size, showing finish texture and pattern of exposed formed concrete surfaces for Engineer's approval.
 - 3. Include specified concrete coverings, hardeners, sealers, etc. as part of the mock-up if requested by the Engineer.
 - 4. Provide the number of mock-up panels required necessary to obtain the Engineer's approval of pattern, texture, and color of panel.
 - 5. Maintain approved mock-ups and use as the standard for the aesthetic quality of the surface finish for work represented by mock-ups. Remove mock-ups when permitted by the Engineer.
 - 6. refer to Section 03160, Colored Concrete, for additional mock-up requirements for integrally colored concrete.

PART 2 - PRODUCTS

2.01 REPAIR AND FINISHING MATERIALS

- A. Portland Cement: ASTM C150, Type I or II, of same brand as used in the work. Furnish white Portland cement where required to produce color matching color of surrounding concrete.

- B. Aggregate:
 - 1. For Bonding Grout: ASTM C33, washed clean sand passing a No. 30 sieve.
 - 2. For Patching Mortar: ASTM C33, washed clean, graded fine aggregate of suitable size for areas to be repaired. Clean coarse aggregate up to Size No. 8 may be added for repair of larger pockets and voids.
 - 3. For Washed Aggregate Finish: Washed clean, match approved sample.
- C. Commercial Patching Mortar: A structural repair mortar may be furnished if appropriate for the use and approved by the Engineer.
- D. Epoxy Patching Mortar: As specified in ACI 503.4 for Epoxy Mortar.
- E. Epoxy Adhesive: ASTM C881, Type II or Type V, epoxy-based bonding agent.
- F. Color Hardener: As specified in the Contract Documents.

2.02 REPAIR MIXES

- A. Bonding Grout: 1 part Portland cement to 1 part No. 30 mesh sand, mixed to the consistency of a thick cream.
- B. Patching Mortar: Make the patching mortar of the same materials and of approximately the same proportions as used for the concrete, except omit the coarse aggregate. Use not more than 1 part Portland cement to 2-1/2 parts sand by damp loose volume, and substitute white Portland cement for a portion of the regular gray Portland cement to produce patching mix matching the surrounding concrete in color when dry. Determine the proportion of white Portland cement by trial mixes and test areas, prior to repair of actual defective areas.

2.03 CURING MATERIALS

- A. Damp Curing Materials: Non-staining.
 - 1. Waterproof Sheet Materials: ASTM C171, waterproof paper with white paper face, polyethylene film pigmented white, or white burlap-polyethylene sheeting.
 - 2. Burlap: AASHTO M182, of class or weight suitable for the use and location. Do not use burlap where concrete is exposed to direct sunlight.
- B. Curing Compound: ASTM C309, liquid membrane-forming curing compound, Type I, Class A or B, as appropriate for the use or location.
 - 1. Where concrete surfaces will receive architectural finishes, such as resilient floor coverings, paint, or membrane waterproofing, membrane-forming curing compound shall not leave a coating or residue which will impair bond of adhesives, paints, and coatings with concrete.

- C. Curing Compound for Colored Concrete: For concrete colored with color hardener, use curing compound recommended by the manufacturer of the color-hardener material. For integrally colored concrete, refer to Section 03160, Colored Concrete, for curing compound.

PART 3 - EXECUTION

3.01 REPAIR OF SURFACE DEFECTS

- A. Repair Standards: Repair of surface defects shall conform to applicable requirements of ACI 301. When using epoxy mortar, conform to applicable requirements of ACI 503.4.
- B. Surface Defects:
 - 1. Begin repair of surface defects immediately after form removal. For repair with epoxy mortar, concrete shall be dry.
 - 2. Surface defects are defined to include: form-tie holes, air voids and pockets, bug holes with a nominal diameter or depth greater than 1/4-inch, honeycombed areas, rock pockets, visible construction joints, fins and burrs.
 - 3. Repair of surface defects shall be tightly bonded and shall result in concrete surfaces of uniform color and texture, matching adjacent surfaces, and free of shrinkage cracks.
- C. Repair Work:
 - 1. Remove honeycombed and other defective concrete down to sound concrete. Saw-cut the edges perpendicular to the surface or slightly undercut. Feather-edges will not be permitted. Dampen the area to be patched and an area at least 6 inches wide surrounding it to prevent absorption of water from the patching mortar.
 - 2. Where rock pockets or similar defects or voids expose steel reinforcement, cutout to solid surface behind the reinforcing steel to provide suitable key-lock for patching mortar. Envelop exposed reinforcing bar with patching mortar.
 - 3. Bond patching mortar to concrete with bonding grout or epoxy adhesive. Brush bonding grout well onto the concrete. Bond commercial patching mortar to concrete in accordance with the manufacturer's instructions.
 - 4. After surface water has evaporated from the area to be patched, brush the bond coat well into the surface. When the bond coat begins to lose the water sheen, apply the patching mortar. Compact the mortar into place and strike off so as to leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, leave the patch undisturbed for at least 1 hour before being finally finished. Keep the patched area damp for 7 days.

5. Neatly finish patched surfaces to match adjacent surrounding surface texture of concrete. Grind or fill surfaces to produce level and plumb, true planes.
6. For walls exposed in the finish work, form tie holes shall be patched and finished flush with adjacent surface. For holes passing entirely through walls, use a plunger type injection gun or other suitable device shall be used to completely fill the holes.
7. In order to patch honeycombed areas or rock pockets which are too large and unsatisfactory for mortar patching, cut out to solid surface, key, and pack solid with matching concrete to produce firm bond and flush surface. Patching shall match texture of adjacent surfaces where exposed in the finished work.
8. Remove repair work in exposed locations which does not match the texture and color of surrounding adjacent surfaces or which was not well performed and perform again until the repair work conforms to specified requirements.
9. Remove fines and loose materials from surfaces to receive membrane waterproofing , and patch voids and cracks flush with adjacent surfaces.
10. Cure completed repairs as specified herein under Curing.

3.02 FINISHING OF FORMED SURFACES

- A. Unexposed Surfaces:
 1. Concrete which will not be exposed in the completed structure shall be any form finish as specified in Section 03100, Concrete Forming, and ACI 301 for rough form finish.
 2. Concrete to receive membrane waterproofing shall receive a "smooth form finish" in accordance with ACI 301.
- B. Exposed Surfaces: Unless indicated otherwise, concrete which will be exposed in the completed structure shall receive the following finishes as indicated:
 1. Smooth Form Finish: Conform to ACI 301
 2. Smooth Rubbed Finish: Conform to ACI 301
 3. Grout Cleaned Finish: Conform to ACI 301
 4. Unspecified Finish: When finish is not indicated, provide "smooth form finish" as specified above.

- C. Sand Blast Finish:
1. Blasting Operations and Requirements:
 - a. Apply sandblasted finish to exposed concrete surfaces where indicated.
 - b. Perform sand blasting at least 72 hours after placement of concrete. Coordinate with formwork construction, concrete placement schedule, and formwork removal to ensure that surfaces to be blast finished are blasted at the same age for uniform results.
 - c. Determine type of nozzle, nozzle pressure, and blasting techniques required to match the Engineer's control samples.
 - d. Abrasive blast corners and edge of patterns carefully, using back-up boards, to maintain uniform corner or edge line.
 2. Depths of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surface to match the Engineer's control samples as follows:
 - a. Brush Sand Blast Finish: Remove cement matrix to expose face of fine aggregate; no reveal.
 - b. Light Sand Blast Finish: Expose fine aggregate with occasional exposure of coarse aggregate; maximum 1/16-inch reveal.
 - c. Medium Sand Blast Finish: Generally expose coarse aggregate; 3/16-inch to 1/4-inch reveal.
 3. Surface Continuity: Perform sand blast finishing in as continuous an operation as possible, utilizing the same work crew to maintain continuity of finish on each surface or area of work. Maintain patterns of variances in depths of cuts as indicated.
 4. Construction Joints: Use technique approved by the Engineer to achieve uniform treatment of construction joints.
 5. Protection and Repair:
 - a. Protect adjacent materials and finishes from dust, dirt, and other surface or physical damage during abrasive blast finishing operations. Provide protection as required and remove from site at completion of the work.
 - b. Repair or replace other work damaged by finishing operations.
 6. Clean-up: Maintain control of concrete chips, dust, and debris in each area of the work. Clean up and remove such material at the completion of each day of operation. Prevent migration of airborne materials by use of tarpaulins, wind breaks, and similar containing devices.

3.03 SLABS AND FLATWORK

- A. Placement and Finishing Standards: Place, consolidate, and finish slabs and flatwork in accordance with applicable requirements of ACI 301. Coordinate with Section 03300, Cast-In-Place Concrete, as applicable.
- B. Placement:
 - 1. Place slabs and flatwork and finish monolithically. Strike off and screed slabs to true, plane surfaces at required elevations, and thoroughly compact concrete with vibrators, floats, and tampers to force coarse aggregate below the surface. Finish slab within four hours of concrete placement.
 - 2. Whether indicated or not, in areas where drains occur, slope finished slab to drains. Slope shall be a minimum of 1/8-inch per foot unless otherwise indicated.
- C. Slab Finishes: Unless indicated otherwise, slabs and flatwork shall receive the following finishes as indicated:
 - 1. Scratched Finish: Conform to ACI 301. Provide "scratched finish" for slab substrates to receive cementitious toppings or finishes, such as terrazzo or mortar setting bed for ceramic tile.
 - 2. Floated Finish: Conform to ACI 301. Provide "floated finish" for track slabs and mud slabs and for slabs and flatwork to receive roofing and membrane waterproofing.
 - 3. Troweled Finish: Conform to ACI 301. Provide "troweled finish" for interior slabs and flatwork to be exposed in the completed structure, for slabs to receive resilient floor coverings, and for flatwork to receive elastomeric bearing pads.
 - 4. Broom Finish: Conform to ACI 301. Exact texture and coarseness of the broom finish shall match the approved site mock-up. Provide fine or medium-coarse "broom finish" as indicated for exterior sidewalks and paving, garage floors (other than parking garages), exterior ramps, equipment and transformer pads, and subway invert slab.
 - 5. Unspecified Finish: When finish is not indicated or specified, provide finishes as specified in ACI 301.
 - 6. Washed Aggregate Finish: Evenly distribute seeded aggregate over a floated finish. Tamp surface to bring fines to surface completely covering seeded aggregate. Apply troweled finish. Apply surface retarder according to manufacturer's instructions and recommendations. Wash surfaces with water and finish with stiff bristle brush until seeded aggregate is uniformly exposed.

7. Swirl Pattern Finish: After basic floating operations have been completed, hand float slabs using wood float to produce a continuous swirl patterned surface, free from porous spots, irregularities, depressions, and small pockets or rough spots such as may be caused by accidentally disturbing particles of coarse aggregate embedded near the surface. Use natural arm circular motion to produce rows of approximately 1-foot radius swirl pattern covering approximately half of the preceding row with each successive row. Provide swirl pattern finish for parking garage floors.
- D. Surface Tolerances and Finishes: Refer to Tolerances specified herein.
1. Flat Tolerance: Slabs and flatwork with "troweled finish" and with "nonslip finish."
 2. Straightedge Tolerance: Slabs and flatwork with fine "broom finish" or medium-coarse "broom finish."
 3. Bullfloated Tolerance: Slabs and flatwork with "scratched finish," with "floated finish," and with coarse "broom finish."
- E. Joints:
1. Construction, expansion, isolation, and contraction joints shall be located as indicated. Construction joints shall act as contraction joints. Where additional contraction joints are required to prevent shrinkage cracks, saw-cut such joints. All joints shall be straight and true to line.
 2. Mark-off lines or edges at formed construction and expansion joints shall be finished with 1/4-inch radius curved edging tool, neat and true to line, uniform throughout.

3.04 TOLERANCES

- A. Formed Surfaces: Conform with applicable requirements of ACI 117.
1. Where elastomeric bearing pads are indicated, the level plane upon which bearing pads are placed shall not vary more than 1/16-inch from a 10-foot straightedge placed in any direction across the area and the area shall extend a minimum of 1 inch beyond the limits of the pads.
 2. Bearing surfaces of girders on a slope or girders with a camber shall be finished on a horizontal/level plane so that loads are uniformly distributed over the entire surface of the elastomeric bearing pads.
 3. The finished plane shall not vary more than 1/8-inch from the elevation indicated.
- B. Slabs and Flatwork: Conform to applicable classification requirements of ACI 117, as follows:

1. Very Flat Tolerance: True plane with maximum variation of 1/8-inch in 10 feet when measured with a 10-foot straightedge placed anywhere on the slab in any direction.
2. Flat Tolerance: True plane with maximum variation of 3/16-inch in 10 feet when measured with a 10-foot straightedge placed anywhere on the slab in any direction.
3. Straightedge Tolerance: True plane with maximum variation of 5/16-inch in 10 feet when measured with a 10-foot straightedge placed anywhere on the slab in any direction.
4. Bullfloated Tolerance: True plane with maximum variation of 1/2 inch in 10 feet when measured with a 10-foot straightedge placed anywhere on the slab in any direction.

3.05 CURING

- A. Curing Standards: Cure concrete in accordance with applicable requirements of ACI 301 and ACI 308, except that the duration of the curing period shall be ten days. Curing of concrete shall also conform to Section 03300, Cast in Place Concrete.
- B. Curing Requirements:
 1. Cure concrete with waterproof sheet materials, damp burlap, or curing compounds.
 2. Do not use curing compounds on surfaces when their use may be detrimental to bonding of concrete, mortar, membrane waterproofing, caulking and sealants, adhesives, plaster, paint, or the specified surface finish or coating.
 3. Cure color-hardener finished slabs and flatwork as recommended by the color-hardener material manufacturer.
 4. Cure integrally colored concrete as specified in Section 03160, Colored Concrete, and as specified herein.
 5. At the expiration of the curing period, clean concrete surfaces of all curing media.
- C. Damp Curing:
 1. Vertical surfaces shall be cured by keeping the forms wet at all times and by leaving the forms in place as long as possible as specified in Section 03100, Concrete Forming. After removal of forms, concrete shall be kept continuously damp by fog spraying or otherwise washing down the concrete in an accepted manner until ten days after placing. Protect exposed surfaces by covering with sheet materials or burlap kept continuously moist.

2. Horizontal surfaces shall be cured and protected by covering the finished surfaces with waterproof sheet materials or damp burlap, left in place for a minimum of ten days and kept continuously moist.
 3. Fog spray freshly placed slabs until finishing operations commence. Allow no slabs to become dry until finishing operations are complete.
- D. Curing Compound: Non-structural concrete, such as slabs-on-grade, may be cured by membrane curing compound in lieu of wet curing specified above. Apply curing compound in accordance with applicable requirements of ACI 308 and manufacturer's instructions. Apply without delay on newly finished surface. Protect integrity of membrane and touch up damaged spots immediately.

3.06 PROTECTION

- A. Protect exposed concrete surfaces, including flatwork, as required to prevent damage from impact or strains.
- B. Protect fresh concrete from drying winds, rain, damage, or soiling.
- C. Refer to Section 03300, Cast-In-Place Concrete, for additional requirements.
- D. Prevent contamination of planting areas during washing of washed aggregate finish.

END OF SECTION

SECTION 03200 CONCRETE REINFORCING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes specifications for concrete reinforcing.

1.02 REFERENCE STANDARDS

- A. American Concrete Institute (ACI):
 - 1. 301 Specifications for Structural Concrete for Buildings.
 - 2. 315 Details and Detailing of Concrete Reinforcement.
- B. ASTM International (ASTM):
 - 1. A82 Specification for Steel Wire, Plain, for Concrete Reinforcement
 - 2. A185 Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
 - 3. A497 Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
 - 4. A706 Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement
 - 5. A767 Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
 - 6. A775 Specification for Epoxy-Coated Reinforcing Steel Bars
 - 7. A884 Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement
 - 8. C1107 Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
 - 9. D3963 Specification for Epoxy-Coated Reinforcing Steel
- C. American Welding Society (AWS):
 - 1. D1.4 Structural Welding Code – Reinforcing Steel
 - 2. QC1 Specification for AWS Certification of Welding Inspectors
- D. Concrete Research Standards Institute (CRSI):
 - 1. Manual of Standard Practice

2. Placing Reinforcing Bars
- E. State of California, Department of Transportation, Standard Specifications (Caltrans):
1. Section 52 Reinforcement
 2. Section 83 Railings and Barriers
 3. Section 90 Portland Cement Concrete
- F. State of California, Department of Transportation, Test Methods (Caltrans):
1. 417 Soils and Water for Sulfate Content
 2. 422 Testing Soils and Water for Chloride Content

1.03 SUBMITTALS

- A. Reinforcing Steel Shop Drawings: Indicate sizes, spacing, bending and cutting schedules, splices and laps, supporting and spacing devices, and quantities. Coordinate drawings to prevent reinforcing steel from interfering with the placement of embedded items.
- B. Mill Test Reports: Submit certified mill test reports (tensile and bending) for each heat or melt of steel showing physical and chemical analyses before delivery of reinforcing material to the job site.
- C. Certificates of Compliance: Submit in accordance with Caltrans Standard Specifications Section 52-1.04, Inspection. For galvanized reinforcing bars, submit certificates of compliance with ASTM A 767.
- D. Submit manufacturer's product data and installation instructions for proprietary mechanical coupler systems when such splicing methods are permitted.
- E. When galvanized or epoxy-coated reinforcing bars are indicated, furnish two 12-inch long samples and two additional samples bent to minimum radius of the rebar from each lot shipped to the work site.
- F. Qualifications of welding operators, welding processes, and procedures. For welders, furnish welding certificates or affidavits attesting to the welders' qualifications to perform the indicated welding in accordance with applicable requirements of AWS D1.4.

1.04 DELIVERABLES

- A. Submit copies of inspection and test reports for welding as required in this Section.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with the requirements of applicable building codes, CRSI Manual of Standard Practice, and CRSI Placing Reinforcing Bars.
- B. Perform work in accordance with the requirements of ACI 301 and ACI 315.
- C. Qualifications of Welding Inspector: Welds to be inspected by the Contractor shall be inspected and certified by a Contractor-employed AWS Certified Welding Inspector (CWI), certified in accordance with AWS QC 1.
- D. Qualification of Personnel Performing Nondestructive Testing: Personnel performing nondestructive testing, who are Contractor-employed, shall be qualified and certified in accordance with SNT-TC-1A. Only persons certified for NDT Level I and working under a NDT Level II person or persons certified for NDT Level II may perform nondestructive testing.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Ship and store reinforcement with bars of the same size and shape fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing the same designations as shown on the submitted placing drawings.
- B. Store reinforcement off the ground, protect from moisture, and keep free from dirt, oil, or other contaminants. Steel, which cannot be properly identified, will be rejected and shall be immediately removed from the work site.
- C. Handle and store galvanized and epoxy-coated reinforcement in a manner which will prevent damage to the coatings. For epoxy-coated reinforcement, comply with the requirements of ASTM D 3963.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Reinforcing Steel Bars: ASTM A706
- B. Reinforcing Steel Wire: ASTM A 82, cold drawn
- C. Welded Steel Wire Fabric – Plain Wire: ASTM A 185, uncoated finish
- D. Welded Steel Wire Fabric – Deformed Wire: ASTM A 497, uncoated finish
- E. Welded Steel Wire Fabric – Epoxy-Coated: ASTM A 884
- F. Epoxy-coated Reinforcing Bars: ASTM A 706 epoxy-coated in accordance with ASTM A 775 and ASTM D 3963. Coating material shall conform to ASTM A 775 and ASTM D 3963, Annex 1, green in color. Bars shall be cut and bent cold before applying coating material.
- G. Galvanized Reinforcing Bars: ASTM A 706 galvanized in accordance with ASTM A 767, Class I coating. Bars shall be cut and bent cold before galvanizing.

- H. Mechanical Splice Coupler: Provide bar splicing connections produced by threaded reinforcing bar ends and threaded coupler, or by sleeves hydraulically pressed or forged onto butt-ended reinforcing bars. Mechanical splice couplers shall be capable of being installed in the clear space indicated and to provide the required clearances. The strength of the splice in tension and compression shall be a minimum of 125 percent of the yield strength of the connected reinforcing bars.
- I. Welding Electrodes: E90 meeting the requirements of AWS D1.4.

2.02 ACCESSORIES

- A. Steel Tie Wire: No. 16 gage or heavier, black or galvanized, soft or commercial grade steel tie wire. For galvanized reinforcement, provide zinc-coated wire. For epoxy-coated reinforcement, provide nylon-, epoxy-, or plastic-coated wire.
- B. Chairs, bolsters, bar supports, and spacers:
 - 1. Metal, plastic tipped, in accordance with the requirements of CRSI Manual of Standard Practice for reinforced concrete construction.
 - 2. Sized and shaped for strength and support of reinforcement during installation and placement of concrete.
 - 3. For galvanized reinforcement, provide all galvanized accessories.
 - 4. For epoxy-coated reinforcement, provide accessories which are nylon-, epoxy-, or plastic-coated.

2.03 GROUT

- A. Bonding Material for Bonding Dowels: As specified in Caltrans Standard Specifications, Section 83-2.02D(1).
- B. Non-Shrink Grout: Grout shall be a premixed package blend of Portland cement, graded silica sand, and water reducing, plasticizing and time release expansion agents, which conforms to ASTM C1107, Grade B, and provides a minimum 5000 psi compressive strength at 28 days. Mix grout in accordance with the manufacturer's recommendations. Water shall comply with the provisions in Caltrans Standard Specifications, Section 90-2.03, Water.
 - 1. Admixtures shall not contain more than 0.05 percent soluble chlorides when tested in conformance with California Test 422 nor more than 0.25 percent soluble sulfates, as SO_4 , when tested in conformance with California Test 417.

2.04 FABRICATION

- A. Fabricate in accordance with the requirements of ACI 315.

- B. Locate splices not indicated on the Contract Drawings at point of minimum stress.
- C. Repair of Damaged Coatings:
 - 1. Epoxy: Repair in accordance with the provisions in Caltrans Standard Specifications, Section 52, Reinforcement.
 - 2. Galvanized: Repair as specified in ACI 301, ASTM A 767, ASTM A 775, ASTM A 884, and ASTM D 3963, as applicable.
- D. Welding:
 - 1. Welding of reinforcement, where indicated and approved, including preparation of bars, shall conform with applicable requirements of AWS D1.4.
 - 2. Clean bars of oil, grease, dirt, and other foreign matter and flame-dry before welding. Preheat bars welding in accordance with AWS D1.4, Chapter 5.
 - 3. Butt Welded Splices: Use full penetration butt welds in accordance with the provisions in Caltrans Standard Specifications, Section 52, Reinforcement, unless another weld splice type is indicated or approved.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Before placing concrete, clean reinforcement of foreign particles, including mortar, oil, grease, dirt, loose mill scale, rust and any other coating that will prevent or reduce bond.
- B. Place in position, support, and secure reinforcement to prevent displacement during concrete placement. Do not deviate from alignment or spacing as shown on the Contract Drawings.

3.02 CLEANING, BENDING, PLACING, AND SPLICES

- A. Perform work in accordance with the provisions in Caltrans Standard Specifications, Section 52, Reinforcement, and as specified herein.
- B. Perform installation of mechanical coupler and tightening for joint assembly in accordance with the coupler manufacturer's installation instructions and recommendations.

3.03 DRILLING AND BONDING DOWELS

- A. Drilling and bonding dowels shall conform to the details shown on the Contract Drawings, the provisions in Caltrans Standard Specifications, Section 83-2.02D(1), and as specified herein.

- B. If reinforcement is encountered during drilling, before the specified depth is attained, notify the Engineer. Unless the Engineer approves coring through the reinforcement, the hole will be rejected. If hole is rejected, drill a new hole, in which reinforcement is not encountered, adjacent to the rejected hole to the depth shown on the Contract Drawings. Grout rejected hole.
- C. Dowels shall conform to the provisions for reinforcing steel bars specified herein.

3.04 DRILLING AND GROUTING DOWELS

- A. Drilling and grouting concrete shall consist of drilling through reinforced concrete bridge members, placing reinforcement and filling holes with non-shrink grout, and shall conform to the details shown on the Contract Drawings, the provisions in Caltrans Standard Specifications, Section 83-2.02D(1), and as specified herein.
- B. If reinforcement is encountered during drilling, before the specified depth is attained, notify Engineer. Unless the Engineer approves coring through the reinforcement, the hole will be rejected. If hole is rejected, drill new hole, in which reinforcement is not encountered, adjacent to the rejected hole to the depth shown on the Contract Drawings. Grout rejected hole.
- C. Dowels shall conform to the provisions for reinforcing steel bars specified herein.
- D. Clean concrete areas to be in contact with grout of all loose or foreign material that would in any way prevent bond between the concrete surfaces, flush flushed with water, and allow to dry to a surface dry condition immediately prior to grouting.
- E. After placement of reinforcement, seal ends of the drilled hole containing the reinforcement, with one vent tube and one injection feed tube. Place tubes in the hole in a manner which will allow the air to vent and the hole to be completely filled with grout. Achieve sufficient pressure to ensure that the hole is free of voids. Pump grout through the holes and continually waste grout until no visible slugs or other visible evidence of water or air are ejected and the efflux time of ejected grout is not less than 11 seconds.
- F. Prevent grout from falling into any waterway and on public traffic, from flowing across shoulders or lanes occupied by public traffic, and from flowing into gutters or other drainage facilities.

3.05 FIELD QUALITY CONTROL

- A. Inspection and testing of welds shall be performed by an approved Inspection and Testing Agency retained by the Contractor:
 - 1. Visually inspect reinforcing bar welds.
 - 2. Tension tests of welded butt joints shall be performed on sample welds produced by the Contractor in accordance with ASTM E8.
 - 3. Non destructive tests of installed welded butt joints shall be performed in accordance with ASTM E165.

4. Inspections and tests shall be performed in accordance with the applicable requirements of AWS D1.4, Chapters 6 and 7.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes specifications for cast-in-place Portland cement concrete including mix designs, delivering, and placing.

1.02 REFERENCE STANDARDS

- A. American Concrete Institute (ACI):
 - 1. 211.1 Selecting Proportions for Normal, Heavyweight and Mass Concrete
 - 2. 301 Specifications for Structural Concrete for Buildings
 - 3. 302.1R Guide for Concrete Floor and Slab Construction
 - 4. 304R Guide for Measuring, Mixing, Transporting and Placing Concrete
 - 5. 305R Hot Weather Concreting
 - 6. 306.1 Cold Weather Concreting
 - 7. 308 Standard Practice for Curing Concrete
 - 8. 318 Building Code Requirements for Reinforced Concrete
- B. American Society of Testing and Materials (ASTM International):
 - 1. C31 Making and Curing Concrete Test Specimens in the Field
 - 2. C33 Concrete Aggregates
 - 3. C39 Compressive Strength of Cylindrical Concrete Specimens
 - 4. C94 Ready-Mixed Concrete
 - 5. C109 Test Method for Compressive Strengths of Hydraulic Cement Mortars
 - 6. C138 Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
 - 7. C143 Test Method for Slump of Portland Cement Concrete
 - 8. C150 Portland Cement

9. C 171 Sheet Materials for Curing Concrete
 10. C173 Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
 11. C231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
 12. C260 Air-Entraining Admixtures for Concrete
 13. C494 Chemical Admixtures for Concrete
 14. C579 Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing and Polymer Concretes
 15. C618 Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
 16. C827 Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
 17. C928 Packaged, Dry, Rigid-Hardening Cementitious Materials for Concrete Repairs
 18. C1017 Chemical Admixtures for Use in Producing Flowing Concrete.
 19. C1107 Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrinkable)
 20. C1059 Latex Agents for Bonding Fresh To Hardened Concrete
 21. C1116 Fiber-Reinforced Concrete and Shotcrete
 22. D1751 Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
 23. E329 Agencies Engaged in Construction Inspection and/or Testing.
- C. State of California, Department of Transportation, Standard Specifications, (Caltrans):
1. Section 51, Concrete Structures
- D. U.S. Army Corps of Engineers, Concrete Research Division (CRD):
1. C621 Nonshrink Grout

1.03 SUBMITTALS

- A. Concrete Mix Designs: Submit mix designs for each class of concrete. Indicate locations to be used. Include names and brands of materials, proportions,

slump, strength, gradation of aggregates. Include laboratory test reports of trial strength and shrinkage tests.

- B. Product Data: Submit manufacturer's product data for proposed products, including epoxy adhesive, grout, and concrete admixtures.
- C. Shop Drawings:
 - 1. Submit drawings that indicate the locations of all joints in concrete, including construction joints, expansion joints, isolation joints, and contraction joints. Coordinate with the requirements specified in Section 03100, Concrete Forming.
 - 2. Submit drawings that indicate concrete placement schedule, method, sequence, location, and boundaries. Include each type and class of concrete, and quantity in cubic yards.
 - 3. Submit drawings that detail the type, size, and location of all pipes, conduit, embeds, blockouts, and recesses for all vertical and horizontal concrete construction.
 - 4. Reproductions of contract drawings are unacceptable.
- D. Submit for the Engineer's approval the name, address, and telephone number of the laboratory, agency, mill, or ready-mix plant which the Contractor intends to engage to design the concrete mixes.

1.04 DELIVERABLES

- A. Certificates of Compliance: For each shipment of materials, submit evidence of compliance with Specification requirements for cement, aggregate, and admixtures.
- B. Batch Tickets: Submit a delivery ticket with each batch of concrete delivered to the site in accordance with the requirements of ASTM C94.
- C. Records and Reports: Report the location in the finished work of each mix design, and the start and completion times of placement of each batch of concrete placed for each date concrete is placed.

1.05 QUALITY ASSURANCE

- A. Qualifications of Mix Design Source: Obtain mix designs, including recommended amounts of admixture and water to be used in the mixes, from a qualified independent testing laboratory or agency, or from a mill or ready-mix plant, properly equipped to design concrete mixes. The laboratory, agency, mill, or ready-mix plant shall meet applicable requirements of ASTM E329.
- B. Comply with ACI 304R.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Concrete Materials:
1. Portland Cement: Conforming to ASTM C150 Type I or II
 2. Air-entraining admixture: Conforming to ASTM C260
 3. Fine aggregate: Conforming to ASTM C33
 4. Coarse aggregate: Conforming to ASTM C33
 5. Water: Potable, clear and free of injurious amounts of oil, acid, alkali, salts, organic matter, and any other substances that may be deleterious to concrete or steel.
 6. Corrosion inhibitor: Equivalent in quality and performance to one of the following:
 - a. DCI by Grace Concrete Products
 - b. Rheocrete 222 by Master Builders, Inc.
- B. Optional Concrete Admixtures and Cementitious Materials: At Contractor's option and with Engineer's acceptance, include accepted concrete admixtures and cementitious materials in the mix to improve the water-cement ratio or water-cementitious ratio or workability of the concrete, providing strengths specified and other desirable characteristics of the concrete can be achieved and maintained. Obtain Engineer's acceptance of proposed admixtures prior to use. Indicate admixtures in design mix. Add admixtures at batch plant and add in solution form, except as otherwise approved.
1. Chemical Admixtures, Water-Reducing: ASTM C494, Type A
 2. Pozzolanic Admixtures: ASTM C618, Class N or F
 3. Fly Ash: ASTM C618, Class F, with a maximum of 25 percent retained on the No. 325 mesh sieve and a loss on ignition of 1.0 percent maximum.
 4. Pigments for integrally colored concrete: Refer to Section 03160, Colored Concrete.
 5. Chemical Admixtures, Plasticizing: ASTM C1017, or ASTM C494 Type F or Type G, high-range water-reducing admixtures.
 6. Prohibited Admixtures: Admixtures containing chlorides or sulfides are not acceptable.

- C. Grout:
 - 1. Cementitious Grout: Provide a prepackaged, nonshrink, nonmetallic, noncorrosive cement-based grout conforming to the following requirements:
 - a. ASTM C1107, Grade B or C, as appropriate for the condition or use. Grout shall be manufactured specifically for use in supporting heavy loads and shall have a minimum compressive strength of 7,500 psi at 28 days.
 - b. Shrinkage at 28 days: No shrinkage before hardening (0.00 shrinkage when tested in accordance with ASTM C827); no shrinkage after hardening (0.00 shrinkage when tested in accordance with CRD-C621.)
 - 2. Epoxy Grout: Provide a nonshrink, nonmetallic, noncorrosive epoxy grout conforming to the following requirements:
 - a. Gout shall be a 3-component epoxy resin system (two liquid epoxy components and one inert aggregate filler component) manufactured specifically for use in supporting heavy loads. The minimum compressive strength shall be 10,000 psi at seven days when tested in accordance with ASTM C579.
 - b. Shrinkage at 28 days: None (0.00 shrinkage when tested in accordance with ASTM C827 modified procedure) with a minimum bearing area (EBA) of 95 percent coverage of the tested base plate.
 - 3. Cementitious Grout for Repairs to Concrete Pavements and Structures: Provide a prepackaged, nonshrink, nonmetallic, noncorrosive cement-based grout conforming to the following requirements:
 - a. ASTM C928. Compressive strength of 5000 psi minimum in 28 days, conforming to ASTM C109.
 - b. Rapid-hardening when mixed with water, forming a permanent bond. Initial set shall be in 30 minutes.
- D. Expansion Joint Filler: Pre-molded asphalt impregnated felt conforming to ASTM D1751, 1/2-inch unless otherwise indicated on the Contract Drawings.
- E. Polypropylene Fibers:
 - 1. Fibrillated Polypropylene Fibers: 100 percent virgin polypropylene, MD Graded, containing no reprocessed olefin materials, and specifically manufactured for use as concrete secondary reinforcement, and to protect concrete from stresses which cause cracking initially after placement.

2. Monofilament Polypropylene Fibers: 100 percent virgin polypropylene, MD Graded, containing no reprocessed olefin materials, and specifically manufactured to protect concrete from stresses which cause cracking initially after placement.
 3. The physical characteristics of the polypropylene fibers shall be as follows:
 - a. 1/2 inch or 3/4 inch polypropylene fibers, maximum 3 denier, complying with ASTM C1116, Type III.
 - b. Not less than 50 million individual fibers per pound.
 4. Supply fibers in cellulose fiber bags which disintegrate and disperse fibers during mixing. Other packaging and dispensing means may be acceptable.
- F. Bonding Agent: ASTM C1059 for bonding fresh to hardened concrete.
- G. Curing Materials: Refer to Section 03170, Concrete Finishing.
- H. Expanded Polystyrene: As specified in the Caltrans Standard Specifications, Section 51-1.12D.

2.02 MIX CRITERIA

- A. Ready-mix concrete shall conform to ASTM C94, Option B. Proportions shall conform to ACI 211.1, except as modified below.
- B. Concrete shall comply with ACI 301 and ACI 318, as applicable. Ensure that mix designs will produce concrete suited for proper placement and finishing.
- C. Concrete mix:
 1. Compressive strength: 4,000 psi minimum at 28 days, unless otherwise indicated on the Contract Drawings.
 2. Entrained air content: 3 to 4 percent, except as indicated in the following:
 - a. 2 to 4 percent for concrete with a 28 day compressive strength of 5000 psi or greater.
 - b. 3 percent maximum for concrete used for cast-in-place concrete station platforms ramps, and stairs.
 3. Corrosion inhibitor added in accordance with the manufacturer's instructions; 2 gallons DCI or 1 gallon Rheocrete 222 per cubic yard of concrete, minimum.
 4. Include polypropylene fibers in concrete mix of the type shown and where indicated in the Contract Documents. For uniform distribution,

mix in truck for a minimum of 20 minutes after fiber addition. Add fibers at the batch plant to ensure proper mixing. Use the following dosages:

- a. Typical: One pound per cubic yard of concrete unless greater dosage is recommended by the fiber manufacturer.
 - b. Bus Access Lanes and Bus Stop Pads: One and one half pounds per cubic yard.
5. Design concrete mix for pumping to meet requirements specified herein except that mix may be richer in lubricating components in order to allow proper pumping, subject to the Engineer's approval.
- D. Each trial mix shall be developed by an independent testing laboratory in accordance with the requirements of ACI 318 and ACI 301. Quality control relating to mix design shall be provided by the Contractor.

2.03 SOURCE QUALITY CONTROL

- A. The Engineer will perform testing concrete ingredients at their source of supply using an Owner-hired independent testing laboratory.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Inspect forms, earth bearing surfaces, reinforcement, and embedded items, and obtain the Engineer's written approval before placing concrete.
- B. Verify that substrates are in suitable condition to receive the work of this Section. Correct unsuitable conditions prior to proceeding.
- C. Earth bottoms or bearing surfaces for footings and slabs shall be dampened but not saturated or muddied just prior to placing concrete.

3.02 PLACEMENT

- A. Convey and place concrete in compliance with the applicable requirements of ACI 301, ACI 302.1R, ACI 304R, and ACI 318.
- B. Place no concrete until reinforcing is fastened in place and forms are complete. Place no concrete before work that is to be embedded has been correctly set and secured. Do not disturb reinforcing or other materials that have been set in place.
- C. Conform to the requirements of ACI 318. Remove debris, mud and water from surfaces to receive concrete. Clean surfaces of forms and embedded items of all mortar, grout and deleterious materials before placing concrete. Place concrete in dry formwork and prevent water from entering or lying in formwork where concrete is being placed or is setting.

- D. Place concrete immediately after mixing. Do not use concrete after it has begun to stiffen. Do not retemper concrete by adding water in the field. If chuting is used, prevent segregation. Concrete at time of placing shall have 4 inches slump maximum, unless otherwise specified or approved with mix design, and temperature of 50 to 90 degrees F. Concrete with temperature exceeding 90°F at time of placement will be rejected and shall be removed from the job site.
- E. Minimum Concrete Cover (Unless otherwise indicated on the Contract Drawings):
 - 1. Concrete deposited against ground: 3 inches
 - 2. Formed surfaces exposed to weather: 2 inches
 - 3. Slab-on-grade with one layer of reinforcement: Centered
- F. Conform to ACI 305R and 306.1 for placement of concrete in hot and cold weather, respectively.
- G. Transfer concrete from mixer to point of placement as rapidly as practical preventing formation of cold joints. Use equipment and methods that permit rapid placing of concrete of the required consistency and prevent segregation.
 - 1. Convey concrete with conveyors, pipes, chutes, or spouts to a point not more than 3 feet from its final position.
 - 2. Do not change material proportions or consistency of the concrete to accommodate mixing and placing.
 - 3. Use no pipes, chutes or other equipment made of aluminum.
- H. Regulate air entrainment and slump within specified limits.
- I. Deposit concrete vertically in forms as nearly as practical in its final position, in approximately horizontal layers.
- J. Pumping: Concrete may be placed by pumping where approved by the Engineer.
 - 1. Use equipment for pumping of such size and design as to ensure a practically continuous flow of concrete at the delivery end without separation of materials. Pump shall be piston or squeeze pressure type. Pipeline shall be steel pipe or heavy duty flexible hose. Inside diameter of the pipe shall be at least three times the maximum size of the coarse aggregate. Distance to be pumped shall not exceed the limits recommended by pump manufacturer. Supply concrete continuously to the pump. When pumping is completed, eject the concrete remaining in the pipeline without contaminating the concrete in place. After each operation, thoroughly clean equipment. Waste flushing water outside the forms in compliance with storm water pollution prevention requirements specified in Section 01560, Temporary Controls.
 - 2. Do not pump concrete through aluminum pipes.

- 3. Provide full-time inspection of all pumping operations by a recognized testing laboratory approved by the Engineer.
- K. Avoid formation of laitance and accumulation of excessive water on surface of concrete as it is deposited. Remove accumulated water before placing additional concrete.

3.03 CONSTRUCTION JOINTS

- A. Construction joints will be permitted only where indicated or approved by the Engineer.
- B. Make construction joints straight and as inconspicuous as possible, and in exact vertical and horizontal alignment with the structure, as the case may be.
- C. Locate joints which are not indicated so that the strength of the structure is not impaired and where shown on approved shop drawings.
- D. Provide and prepare construction joints and install waterstops in accordance with the applicable requirements of ACI 301 and ACI 304R, and as specified in Section 03100, Concrete Forming.
- E. Use approved key, at least 1-1/2 inches in depth, at joints unless otherwise indicated or approved by the Engineer.
- F. Thoroughly clean the surface of the concrete at construction joints and remove laitance, loose or defective concrete, coatings, sand, sealing compound and other foreign material. Prepare surfaces of joints by sandblasting or other approved methods to remove laitance and expose aggregate uniformly.
- G. Immediately before new concrete is placed, wet the joint surfaces and remove standing water. To allow for shrinkage, do not place new concrete against the hardened concrete side of a construction joint for a minimum of 72 hours.
- H. Ensure that reinforcement is continuous across construction joints.
- I. Where bonding of the joint is required, provide bonding agent.
- J. Retighten forms and dampen concrete surfaces before concrete placing is continued.
- K. Allow at least 72 hours to elapse before continuing concrete placement at a construction joint. Approval for accelerating the minimum time elapsing between adjacent placements will be based on tests and methods which confirm that a minimum moisture loss at a relatively constant temperature will be maintained for the period as necessary to control the heat of hydration and hardening of concrete, and to prevent shrinkage and thermal cracking.

3.04 CONSOLIDATION AND FINISHING

- A. Thoroughly work concrete into all corners and around all embedded items and into corners and shapes of formwork, leaving no excessive voids in the concrete or honeycombed surfaces.
- B. Consolidate concrete with a mechanical vibrator of type and size acceptable to the Engineer. Vibrators shall be operated in such a manner as to reach all concrete areas, but minimize the amount of contact with reinforcing steel and formwork.
- C. All concrete shall be fully consolidated within 15 minutes of placement.
- D. Obtain a uniform surface by floating as necessary. Concrete surface shall be within 1/4 inch laterally and 1/8 inch vertically from specified line and grade, except where stricter tolerances are indicated.
- E. Apply a uniform broomed finish to the concrete surface unless indicated otherwise. Broom marks shall not exceed 1/8 inch in depth.
- F. Tool all edges with a 2-inch wide, 1/4-inch radius rounded edger.
- G. Refer to Section 03170, Concrete Finishing, for additional finishing requirements.

3.05 CURING AND PROTECTION

- A. Curing of concrete shall conform to applicable requirements of ACI 301 and ACI 308, except that the curing duration shall be a minimum period of ten days. Curing with earth, sand, sawdust, straw, and hay will not be permitted.
- B. Keep concrete in a moist condition from the time it is placed until it has cured for at least ten days. Keep forms damp and cool until removal of forms.
- C. Immediately upon removal of forms, exposed concrete surfaces shall be kept moist by applying an approved curing compound or by covering with damp curing materials as specified in Section 03170, Concrete Finishing.
- D. Do not permit concrete to dry during the curing period because of finishing operations.
- E. Protect fresh concrete from hot sun, drying winds, rain, damage, or soiling. Fog spray freshly placed slabs after bleed water dissipates and after finishing operations commence. Allow no slabs to become dry at any time until finishing operations are complete.
- F. Finishing and curing of slabs are specified in Section 03170, Concrete Finishing.
- G. Protect concrete from injurious action of the elements and defacement of any kind. Protect exposed concrete corners from traffic or use which will damage them in any way.

- H. Protect concrete during the curing period from mechanical and physical stresses which may be caused by heavy equipment movement, subjecting the concrete to load stress, load shock, or excessive vibration.
- I. Fog Spray: Keep the entire surface of concrete damp by applying water with a nozzle that so atomizes the flow that a mist and not a spray is formed, until the surface of the concrete is covered with a curing medium. The moisture from the nozzle shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface.
- J. Maintain a minimum temperature of 50 degrees F in the concrete for not less than 6 days for concrete subject to loads.

3.06 GROUT

- A. Surface Preparation:
 - 1. Concrete surfaces to receive grout shall be prepared by chipping, water blasting, or other accepted methods to remove defective concrete, laitance, dirt, oil, grease, and other foreign matter to achieve sound, clean concrete surfaces. Lightly roughen concrete for bond, but not to interfere with proper placement of grout.
 - 2. Cementitious Grout: Saturate concrete surfaces with clean water for 24 hours prior to grouting, and remove excess water immediately before grouting.
 - 3. Epoxy Grout: Apply only to a clean, dry, roughened, sound concrete surface.
- B. Mixing:
 - 1. Mix grout ingredients for both cementitious and epoxy grout in accordance with the respective manufacturer's mixing instructions and recommendations. Mix grout materials in proper mechanical mixers.
 - 2. Mix grout as close to work area as possible.
- C. Placing:
 - 1. Cementitious Grout:
 - a. Place in accordance with manufacturer's instructions.
 - b. Completely fill all spaces and cavities below the bottom of baseplates.
 - c. Provide forms where baseplates and bedplates do not confine grout.

- d. Where exposed to view, finish grout edges smooth. Taper edges at an angle of 60 degrees when measured from the horizontal, or as indicated on the Contract Drawings.
 - e. Protect against rapid moisture loss by covering with wet rags or polyethylene sheets.
 - f. Wet cure grout for seven days, minimum.
2. Epoxy Grout:
- a. Place in accordance with manufacturer's instructions.
 - b. Completely fill all spaces and cavities around dowels and anchors without voids.
 - c. Obtain manufacturer's field technical assistance as required to ensure proper placement.
 - d. Cure grout as recommended by the manufacturer.

3.07 FIELD QUALITY CONTROL

- A. The Engineer will perform field testing listed herein by use of an Owner-hired independent testing laboratory. The Engineer will determine test locations. Test results will be made available to the Contractor. Provide assistance to the testing laboratory in taking samples upon the Engineer's request.
- 1. At least one set of three cylinders made in accordance with ASTM C31 and cured under laboratory conditions for each day of placing concrete or grout.
 - 2. At least one slump testing in accordance with ASTM C143 and air content test in accordance with ASTM C138, C173, or C231 made for each day of placing concrete or grout.
 - 3. The three concrete cylinders will be broken after 28 days to determine the compressive strength of the concrete. Compressive strength will be tested in accordance with ASTM C39.
 - 4. The one grout cylinder will be broken after 7 days, and two grout cylinders will be broken after 28 days to determine the compressive strength of the grout. Compressive strength will be tested in accordance with ASTM C39.
- B. If the average compressive strength of any set of three concrete cylinders, or any set of two grout cylinders broken at 28 days, does not achieve the specified amount, the Engineer may require the Contractor to do one or more of the following, at the Contractor's expense:
- 1. Additional field testing by coring or impact hammer to determine if in-place compressive strength meets specified requirement. The Contractor shall repair all core holes as approved by the Engineer.

2. Removal and replacement of work.
3. Other procedures determined by the Engineer.

END OF SECTION

SECTION 03400

PRECAST CONCRETE STRUCTURES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes specifications for precast concrete structures, including fabrication and erection.

1.02 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM International):
 - 1. A123 Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - 2. A153 Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - 3. C31 Making and Curing Concrete Test Specimens in the Field
 - 4. C39 Compressive Strength of Cylindrical Concrete Specimens
 - 5. C260 Specification for Air-Entraining Admixtures for Concrete
 - 6. C494 Specification for Chemical Admixtures for Concrete
 - 7. C618 Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
- B. American Welding Society (AWS):
 - 1. D1.1 Structural Welding Code – Steel
 - 2. D1.4 Structural Welding Code – Reinforcing Steel
- C. State of California, Department of Transportation (Caltrans), Standard Specifications:
 - 1. Section 51 Concrete Structures
- D. Precast/Prestressed Concrete Institute (PCI):
 - 1. MNL 116 Manual for Quality Control for Plants and Production of Structural Precast Concrete Products
 - 2. MNL 120 Design Handbook – Precast and Prestressed Concrete

1.03 SYSTEM DESCRIPTION

- A. Design precast components in accordance with PCI MNL 120.
- B. Fabricate and erect precast concrete units in accordance with PCI MNL-116, as indicated on the Contract Drawings and as specified herein.

1.04 SUBMITTALS

- A. Shop Drawings: Submit shop drawings prepared by an experienced professional detailer showing complete information for fabrication and installation of precast concrete units. Indicate unit dimensions and cross-section; fabrication tolerances; location, size, and type of reinforcement, including special reinforcement; and lifting devices necessary for handling and erection.
 - 1. Show layout, dimensions, and identification of each precast unit corresponding to sequence and procedure of installation.
 - 2. Indicate welded connections by AWS standard symbols. Detail inserts, connections, and joints, including accessories and construction at openings in precast units.
 - 3. Quantities, dimensions, and locations of sleeves, anchors, brackets, inserts, reglets, accessories, and methods of securing same in forms.
 - 4. Casting, consolidating, and finishing procedures.
 - 5. Include setting diagrams and instructions as required for installation.
- B. Submit concrete mix designs as specified under Section 03300, Cast-In-Place Concrete.
- C. Comply with the submittal requirements specified in Section 03200, Concrete Reinforcing, and Section 03300, Cast-In-Place Concrete.
- D. Product Data: Submit manufacturer's product data of manufactured products and accessories. Include manufacturer's detailed drawings and dimensions when applicable.
- E. Quality Assurance Submittals:
 - 1. Submit evidence of current plant certification under the PCI Plant Certification Program.
 - 2. Submit qualifications of fabricator including a list of three successfully completed precast jobs of similar type and size to the project. Include a detailed description of the fabricated structure, project name, location, general contractor, and engineer.
 - 3. For welders, furnish welding certificates or affidavits attesting to the welders' qualifications to perform the indicated and specified welding.

Welders shall be prequalified in accordance with AWS D1.1 or AWS D1.4, as applicable to the work

1.05 QUALIFICATIONS OF THE FABRICATOR

- A. Plant shall be PCI certified under the PCI Plant Certification Program or equivalent and regularly engaged in design and construction of structural precast concrete with a minimum of five (5) years experience. PCI Certification shall be in a product group and category appropriate to the work.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Transport, handle, and store precast units in a manner that will prevent damage to the units. Units shall be handled such that the points of the support and direction of the reactions with respect to the unit are approximately the same during transportation and storage as when the unit is in the final position.
- B. Store units in a manner that will prevent cracking, distortion, staining, or other damage. Units shall be stored above ground on skids or other supports to keep items free of dirt and other foreign debris.
- C. Units damaged by improper storage or handling shall be replaced or repaired to the satisfaction of the Engineer.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Precast concrete members shall conform to the provisions in Caltrans Standard Specifications, Section 51, "Concrete Structures", and as specified herein.
- B. Reinforcement: Comply with applicable requirements of Section 03200, Concrete Reinforcing.
- C. Concrete: Comply with the applicable requirements of Section 03300, Cast-In-Place Concrete, and the following:
 - 1. Flyash meeting the requirements of ASTM C618, Type C, may be used as a cement replacement only with the approval of the Engineer.
 - a. Type F may be used to modify potentially reactive aggregates
 - b. Flyash may replace up to 15 percent, by weight, of the cement
 - 2. Admixtures
 - a. All admixtures must be from the same manufacturer.
 - b. Air-entraining admixtures shall conform to ASTM C260 and shall be used to produce 6 to 8 percent entrained air in the concrete after all admixtures have been incorporated.
 - c. Water reducing admixtures meeting the requirements of ASTM

C494, Type A, may be used only with the approval of the Engineer.

d. Admixtures containing chlorides and sulfides are not acceptable.

2. Maximum total chloride ion content contributed from all ingredients of concrete including water, aggregates, cement, and admixtures measured as a weight percent of cement shall not exceed 0.06.

2.02 FABRICATION

- A. Field verify dimensions shown on the Contract Drawings prior to fabrication of any precast concrete structure. Notify the Engineer of any differences between field measurements and those shown on the Contract Drawings.
- B. The manufacture, quality, dimensional, and erection tolerances of all precast units shall be in accordance with PCI MNL 116.
- C. Forms shall be accurately constructed to produce units to dimension, shape, configuration, and profile indicated. When not otherwise indicated, construct forms to produce smooth concrete.
- D. Anchors, Lift Devices, and Accessories: Provide concrete inserts, reglets, anchors, brackets, and fasteners as indicated or required for fabrication and installation work. All items shall be zinc-coated or galvanized in accordance with ASTM A153 or ASTM A123, as applicable. Contractor shall select the lift devices, and shall be responsible for their performance and for any damage resulting from the use of faulty or inferior devices. Lift devices shall not be visible on exposed faces of precast members. Provide a minimum four for each unit.
- E. Concrete reinforcement, lifting reinforcement, and concrete inserts and anchorage devices shall be placed and secured against movement as required.
- F. Concrete shall be placed and consolidated to shape, configuration, and dimensions indicated.
- G. Identification: Identify each precast unit, in a semi-permanent manner, at the precasting yard with respect to the final location. Locate such identification and make it of such material as to withstand wear during shipping and damage from the elements for a period of not less than one year. Protect and preserve identification marks and restore any identification which becomes damaged or partially obliterated.
 - 1. The Engineer reserves the right to reject any unit, and require replacement, if the identification becomes obliterated.
- H. Repair or replace any unit which does not conform to the dimensions or structural standards shown on the Contract Drawings or specified herein, and which is not suitable for use as determined by the Engineer.

2.03 FABRICATION TOLERANCES

- A. Fabricate precast units conforming to the maximum dimensional tolerances listed in the PCI Standards for precast concrete structures. Units shall be stored in such a way as to permit the Inspector access to all sides at all times.

2.04 SOURCE QUALITY CONTROL

- A. The Engineer will perform an inspection of precast concrete structures during the fabrication process at the manufacturing plant.
- B. The Contractor-employed independent testing laboratory or agency shall perform such inspections and tests as required to verify compliance with these Specifications, including the following testing: Concrete shall be tested for compressive strength specified in Section 03300, Cast-in-Place Concrete. A set of seven cylinders shall be prepared for every ten precast units, or fraction thereof, cast in any one day. Two cylinders shall be tested at 3 days, two cylinders at 7 days, two cylinders at 28 days, and one cylinder shall be retained for further testing as may be required. Cylinders shall be prepared and moist cured in accordance with ASTM C31, and tested in accordance with ASTM C39.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Verify acceptability and location of supports to receive precast concrete structures. Examine all parts of the supporting structure and the conditions under which the precast units are to be erected and installed. Check bearing surfaces to determine that they are level and uniform.

3.02 INSTALLATION

- A. Perform excavation and backfill operations in accordance with Section 02300, Earthwork.
- B. Install precast concrete structures, including precast concrete field joints, in conformance with Caltrans Standard Specifications, Section 51-1.115, "Precast Members," as specified herein, and to the stages shown on the Contract Drawings.

END OF SECTION

SECTION 03450

PRECAST ARCHITECTURAL CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes specifications for precast architectural concrete items, including mini-high platforms.

1.02 REFERENCE STANDARDS

- A. American Concrete Institute (ACI):
 - 1. 318 Building Code Requirements for Reinforced Concrete
- B. American Society for Testing and Materials (ASTM International):
 - 1. A36 Specification for Carbon Structural Steel
 - 2. A82 Specification for Steel Wire, Plain, for Concrete Reinforcement
 - 3. A153 Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - 4. A185 Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
 - 5. A283 Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
 - 6. A307 Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
 - 7. A497 Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
 - 8. A615 Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
 - 9. A706 Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement
 - 10. A767 Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
 - 11. A775 Specification for Epoxy-Coated Steel Reinforcing Bars
 - 12. C33 Specification for Concrete Aggregates
 - 13. C39 Compressive Strength of Cylindrical Concrete Specimens

14. C150 Specification for Portland Cement
 15. C260 Specification for Air-Entraining Admixtures for Concrete
 16. C494 Specification for Chemical Admixtures for Concrete
 17. C642 Test Method for Density, Absorption, and Voids in Hardened Concrete
 18. C979 Specification for Pigments for Integrally Colored Concrete
- C. American Welding Society (AWS):
1. D1.1 Structural Welding Code - Steel
 2. D1.4 Structural Welding Code – Reinforcing Steel
 3. D1.6 Structural Welding Code – Stainless Steel
- D. Concrete Reinforcing Steel Institute (CRSI):
1. Manual of Standard Practice
- E. Precast/Prestressed Concrete Institute (PCI):
1. MNL 117 Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products
 2. MNL 120 Design Handbook – Precast and Prestressed Concrete

1.03 DESIGN REQUIREMENTS

- A. Precast concrete units shall be reinforced with new billet steel reinforcing bars, as necessary for safe handling, setting and structural stress, and the size of the reinforcing shall be specified with a minimum area of steel equal to one quarter of one percent of the cross section area. If the surfaces are to be exposed to the weather, the reinforcement shall be galvanized or epoxy coated when covered with less than 2 inches of material for bars larger than 5/8 inch and 1-1/2 inches for bars 5/8 inch or smaller. The material covering in all cases shall be at least twice the diameter of the bars. Very small non-structural pieces, such as 8 x 8 x 4 inch, may be made without reinforcing if approved by the Engineer.
- B. Reinforcing shall comply with CRSI Manual of Standard Practice.

1.04 SUBMITTALS

- A. Mix designs: Submit mix designs along with laboratory test reports, less than 6 months old, performed by a qualified testing agency using the same mix design as proposed for the work showing absorption and compressive strengths

meeting the requirements of these specifications. Include names and brands of materials, proportions, slump, strength, and gradation of aggregates.

- B. Shop Drawings: Submit shop drawings prepared by an experienced professional detailer showing complete information for fabrication and installation of precast concrete units. Indicate unit dimensions and cross-section; fabrication tolerances; location, size, and type of reinforcement, including special reinforcement; and lifting devices necessary for handling and erection.
 - 1. Show layout, dimensions, and identification of each precast unit corresponding to sequence and procedure of installation.
 - 2. Indicate welded connections by AWS standard symbols. Detail inserts, connections, and joints, including accessories and construction at openings in precast units.
 - 3. Show caulked joints, including expansion joints ("soft" type) and grouted joints ("rigid" type).
 - 4. Show location and details of anchorage devices to be embedded in other construction.
 - 5. Indicate the specified protective finishes for metal items including connectors.
 - 6. Include setting diagrams and instructions as required for installation.
- C. Samples: Minimum size 6 x 6 x 2 inches to illustrate the quality, color, and specified surface finish texture.
- D. Submit samples or catalog cuts of cast-in gaskets, anchors, and other attachments and accessories.
- E. Submit qualifications of fabricator including a list of five successfully completed precast jobs at least five years old. Include a detailed description of the fabricated item, project name, location, general contractor, and architect or engineer.

1.05 QUALITY ASSURANCE

- A. Qualifications of Fabricator:
 - 1. Fabricator of precast concrete products shall be an active and approved participant in the PCI Plant Certification Program.
 - 2. Precast concrete work shall be produced in a plant or production facility by a fabricator who has been regularly and continuously engaged in the manufacture of architectural precast concrete product for a minimum of five (5) years.
- B. Applicable standards for inspection and quality control shall be PCI MNL 117 and PCI MNL 120.

- C. Precast units that are suspended from the structure or carry weight over openings shall be detailed under the supervision of a qualified professional engineer registered in the State of California if the structural design of the piece is not shown on the Contract Drawings.
- D. Installer of precast work shall have a minimum of 3 years successful experience in erection of architectural precast concrete units similar to units required for the Work.
- E. Welding shall conform to the requirements in AWS D1.1, AWS D1.4, and AWS D1.6, as applicable to the work.

1.06 DELIVERY, STORAGE, AND HANDLING.

- A. Store units at project site to prevent cracking, distortion, warping, staining, or other physical damage and so that markings are visible. Lift and support units only at designated lifting or supporting points as shown on approved shop drawings.

PART 2 – PRODUCTS

2.01 REINFORCEMENT

- A. Reinforcing Bars: ASTM A615, or ASTM A706, Grade 60, deformed. Reinforcing bars conforming to ASTM A706 shall be used when welding bars.
- B. Epoxy-Coated Reinforcing Bars: ASTM A775.
- C. Galvanized Reinforcing Bars: ASTM A767, Class II (2.0 oz. zinc psf), hot-dip galvanized after fabrication and bending.
- D. Steel Wire: ASTM A82, plain, cold-drawn, steel.
- E. Welded Wire Fabric: ASTM A185.
- F. Welded Deformed Steel Wire Fabric: ASTM A497.
- G. Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing.
 - 1. 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 I) or stainless steel protected (CRSI, Class 2).

2.02 CONCRETE MATERIALS

- A. Use only one brand, type, and source of supply for each type of cement, aggregates, pigments, and other materials affecting color throughout the work.

- B. Portland Cement: ASTM C150, Type I or Type III. White cement, gray cement, or a blend of white and gray cement may be used as long as the color is achieved as approved by the Engineer.
- C. Coarse Aggregate: ASTM C33; hard, durable, selected, and graded; free of material that causes staining or reacting with cement. Color shall be white. Darker aggregates may be used as long as the color is achieved as approved by the Engineer.
- D. Fine Aggregate: ASTM C33; hard, durable, selected, and graded; free of material that causes staining or reacting with cement. Color shall be white. Darker aggregates may be used as long as the color is achieved as approved by the Engineer.
- E. Pigments: ASTM C979; Inorganic, nonfading, resistant to lime and other alkalis, and containing no carbon black. Provide ready-to-use, pure, and concentrated pigment material specially processed for mixing into concrete. Pigments shall not to exceed 10 percent of the cement weight.
- F. Water: Drinkable, clean, and free of injurious amounts of oil, acid, alkali, salts, organic material, and any other substances that may be harmful to concrete or embedded steel.
- G. Air-Entraining Admixture: ASTM C260
- H. Water-Reducing, Retarding, or Accelerating Admixtures: ASTM C494, type as selected by fabricator. Admixtures containing chlorides and sulfides are not acceptable.

2.03 CONNECTION MATERIALS

- A. Steel Plates: Structural quality, hot-rolled carbon steel, ASTM A283, Grade C
- B. Steel Shapes: ASTM A36
- C. Stainless Steel Shapes: AISI Type 302/304
- D. Anchor Bolts: ASTM A307, low-carbon steel bolts, regular hexagon nuts and carbon steel washers
- E. Electrodes for Welding:
 - 1. Steel plates and shapes: E70 meeting the requirements of AWS D1.1, and as applicable to plates conforming to ASTM A283
 - 2. Reinforcing bars: E90 meeting the requirements of AWS D1.4
 - 3. Stainless steel: E70 meeting the requirements of AWS D1.6
- F. Cast-In Items: Provide reglets, slots, holes, inserts, and other accessories in units to receive dowels, reglets, flashings, anchors and other similar work as indicated.

- G. Anchorages: Provide loose steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other miscellaneous loose steel shapes, necessary for securing precast units to supporting and adjacent members.
- H. Finish of Steel Cast-In Items: Items exposed to weather shall be hot-dip galvanized after fabrication in accordance with ASTM A153. Items not exposed to weather shall be painted with one coat of rust-inhibitive primer. Threaded inserts cast into precast units shall be hot-dip galvanized, electrogalvanized, or cadmium plated.

2.04 MISCELLANEOUS MATERIALS

- A. Cast-In Items: Provide waterstops and similar accessories as indicated.

2.05 MIX DESIGN

- A. Prepare design mix for the type of concrete required. Unless otherwise noted, all architectural precast shall be the same color and of the same mix design.
- B. Obtain design mixes from an independent testing facility or qualified precast manufacturing plant personnel, at precast fabricator's option.
- C. Proportion mixes by either laboratory trial batch or field experience methods, using materials to be employed on the project for each type of concrete required, complying with ACI 318.
- D. Mix Properties: Standard-weight concrete consisting of specified Portland cement, aggregates, pigments, admixtures, and water to produce the following properties.
 - 1. Compressive Strength: 6000 psi minimum at 28 days. Tests shall be performed by a professional testing laboratory using 6" x 12" cylinders per ASTM C39.
 - 2. Total Air Content: Minimum 4 percent, maximum 7 percent
 - 3. Water Absorption: Not to exceed 5 percent by weight when tested per ASTM C642.
 - 4. Color: Except as otherwise indicated, integral custom colored mix to match a colored sample provided by the Engineer.
- E. Adjustment to Concrete Mixes: Mix design adjustments may be requested when characteristics of materials, job conditions, weather, test results, or other circumstances warrant. Submit laboratory test data for revised mix designs and strength results to the Engineer and obtain Engineer's acceptance before using in the work.
- F. Admixtures: Use air-entraining admixture in strict compliance with admixture manufacturer's directions. Other admixtures to increase cement dispersion or provide increased workability for low-slump concrete may be used subject to

Engineer's acceptance. Use amounts as recommended by admixture manufacturer for climatic conditions prevailing at time of casting. Adjust quantities of admixtures as required to maintain quality control.

2.06 FABRICATION

- A. General: Fabricate precast concrete units complying with manufacturing and testing procedures, quality control recommendations, and dimensional tolerances as described herein, unless otherwise indicated.
- B. Provide forms and, where required, form-facing materials of metal, plastic, wood, or other acceptable material that is nonreactive with concrete and will produce required finish surfaces per the approved sample. Accurately construct forms mortar-tight and of sufficient strength to withstand pressures due to concrete placing operations, and temperature changes. Maintain form work to provide completed precast concrete trim units of shapes, lines, and dimensions indicated, within specified fabrication tolerances.
- C. Dimensional Tolerances of Finished Units:
 - 1. Overall height and width measured at face adjacent to mold at time of casting: Plus or minus 1/8 inch.
 - 2. Angular deviation of plane of side mold: 1/32 inch per 3 inches depth or 1/16 inch total, whichever is greater.
 - 3. Out of square (difference in length of two diagonal measurements): 1/8 inch per 6 feet or 1/4 inch total, whichever is greater.
 - 4. Thickness: Minus 1/8 inch, plus 1/4 inch
 - 5. Tolerances of other dimensions not otherwise indicated: Numerically greater of plus or minus 1/16 inch per 10 feet, or plus or minus 1/8 inch.
 - 6. Other tolerances per PCI MNL-117
- D. Position Tolerance: For cast-in items measured from datum line locations as shown on approved shop drawings:
 - 1. Anchors and inserts: Within 3/8 inch of centerline location shown on shop drawings.
 - 2. Blockouts and reinforcements: Within 1/4 inch of position shown on shop drawings, where such positions have structural implications or affect concrete cover; otherwise within plus or minus 1/2 inch.
- E. Fabricate units straight, smooth, and true to size and shape, with exposed edges and corners formed or stoned to a minimum radius unless otherwise indicated.
 - 1. Precast trim units that are cracked, broken, spalled, stained, or exceeding the specified manufacturing tolerances will not be acceptable.

- F. Curing: Cure units in a warm, moist, totally enclosed curing room for a minimum of 20 hours.
- G. Surface Finish: Remove all surface cement paste by means of acid etching or lightly sandblasting to provide a smooth, dense, fine-grained texture with no streaks or blotches. Texture and quality of finish shall match approved sample when viewed in direct daylight at a 10 foot distance.
- H. Color: The color shall be match approved sample when viewed in direct daylight at a 10 foot distance. Color variation between pieces shall be minimal as determined by the Engineer.

2.07 SOURCE QUALITY CONTROL

- A. Testing: Test specimens shall be prepared by an ACI certified Grade 1 Field Testing Technician. Tests shall be performed by a certified testing laboratory hired by the Contractor. Keep test results on file for at least two years and submit to the Engineer upon request.
 - 1. Perform one set of 6 inches x 12 inches cylinder tests for every 500 cubic feet of concrete placed. Perform at least one set of cylinder tests for work that requires more than 25 cubic feet of concrete but less than 500 cubic feet.
 - 2. Perform one absorption test for every 500 cubic feet of concrete placed. Perform at least one absorption test for work that requires more than 25 cubic feet of concrete but less than 500 cubic feet.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. General: Deliver anchorage items to be embedded in other construction before start of such work.
- B. Do not install precast units until supporting concrete has attained minimum allowable design compressive strength.
- C. Do not install any precast units that have any defects that exceed the acceptable PCI MNL-117 tolerances for dimensions and color if installation would result in unsatisfactory performance or appearance as determined by the Engineer.
- D. Install precast concrete members plumb, level, and in alignment in accordance with PCI MNL-117 erection tolerances. Utilize fabricator provided templates. Provide temporary supports and bracing as required to maintain position, stability, and alignment as members are being permanently connected.
 - 1. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
- E. Accessories: Install clips, hangers, and other accessories required for erection of precast units to supporting members and backup materials.

- F. Anchor units in final position by bolting, welding, grouting, or as otherwise indicated on the Contract Documents. Remove temporary shims, wedges, and spacers as soon as possible after anchoring and grouting are completed.
 - 1. At bolted connections use lock washers or other acceptable means to prevent loosening of nuts.
 - 2. At welded connections apply rust-inhibitive coating on damaged areas, same as shop-applied material. Use galvanizing repair coating on galvanized surfaces.
- G. Before pointing and caulking, scrub face of precast with a fiber brush, using mild detergent and water and then thoroughly rinse with clean running water. Remove any mortar on the face of the precast. Do not use acids or prepared cleaners without the approval of the precast fabricator.

3.02 PROTECTION AND REPAIR

- A. Protect the precast units from discoloration and staining when washing down the surrounding masonry by covering the precast units with plastic sheeting and/or by thoroughly soaking them with clear water so they will not absorb any of the dirty washdown water that may run onto them. If dirty washdown water gets on the precast, hose it off immediately with clear water.
- B. Repair or replace chipped or damaged precast items to the satisfaction of the Engineer. Repair of chipped or damaged precast shall be done only by mechanics skilled in this class of work, with materials and instructions furnished by the fabricator.
- C. Replace chipped or damaged precast units that cannot be repaired.

END OF SECTION