

## **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**