

## SECTION 03110

### CONCRETE FORMWORK

#### PART 1 - GENERAL

##### 1.01 SCOPE

This Specification section prescribes materials and methods to be used in fabricating, erecting, and removing forms for cast-in-place concrete. The CONTRACTOR shall furnish all form design, forms, shoring, ties, form coating, and materials and all labor, equipment, and other items necessary or convenient to the CONTRACTOR for the fabrication, erection, and removal of formwork.

##### 1.02 GENERAL

- A. Forms shall be fabricated, erected, and removed as specified herein and shall be of a type, size, shape, quality and strength to produce hardened concrete having the shape, lines and dimensions indicated on the drawings. The forms shall be true to line and grade in accordance with the tolerances as specified in "Cast-In-Place Concrete" and shall be mortar tight and sufficiently rigid to resist deflection during concrete placement. The surfaces of forms shall be smooth and free from irregularities, dents, sags, and holes that would deface the finished surfaces.
- B. The responsibility for correctly assessing and analyzing the erection stresses induced upon the structure, its elements and supporting foundations during construction will be the total obligation of the CONTRACTOR. Since the ENGINEER does not dictate or determine the CONTRACTOR'S sequence of operations of construction, the ENGINEER cannot determine erection stresses and therefore assumes no responsibility or obligation to do so. The CONTRACTOR must employ or otherwise provide for adequate professional structural engineering supervision to determine erection stresses and notify the ENGINEER of the results of the study.
- C. The responsibility for adequate formwork design for construction of cast-in-place, reinforced concrete will be the total obligation of the CONTRACTOR. The CONTRACTOR shall employ competent professional engineering services to design formwork and supervise the erection of all formwork needed for the job.
- D. Except as modified herein, form design, fabrication, and erection shall conform to the requirements of ACI 347 and ACI 318 and shall be acceptable to the ENGINEER. Design criteria for plywood shall conform to APA Form V345.
- E. Formwork shall comply with the requirements of ANSI A10.9 and OSHA Construction Standards, Part 1926, "Subpart Q, Concrete, Concrete Forms, and Shoring."

### 1.03 SUBMITTALS

- A. When requested by the ENGINEER, the CONTRACTOR shall submit to the ENGINEER for review shop drawings and design calculations for formwork the CONTRACTOR intends to use in constructing the work. The CONTRACTOR shall furnish said shop drawings and design calculations at no additional cost to the OWNER.
- B. Prior to beginning concreting operations, the CONTRACTOR shall submit to the ENGINEER for approval engineering data and manufacturer's literature on all form ties, spreaders, bar supports, form coatings, and prefabricated steel forms intended for use in the work.

### 1.04 STORAGE

All form materials and accessories shall be stored above ground on framework or blocking and shall be covered with a suitable waterproof covering providing adequate air circulation and ventilation.

## PART 2 - PRODUCTS

### 2.01 FORMS

- A. Forms for surfaces which will be exposed to view when construction is completed shall be prefabricated plywood panel forms, job-built plywood forms, or forms that are lined with plywood or fiberboard.
- B. Plywood or lined forms will not be required for surfaces which are normally submerged or not ordinarily exposed to view, such as the insides of manholes or wetwells. Other types of forms, such as steel or unlined wooden forms, may be used for surfaces which are not restricted to plywood or lined forms, and may be used as backing for form linings. Forms are required above all extended footings.
- C. Forms for cast-in-place concrete shall conform with the following requirement:

- |                              |                                                                                            |
|------------------------------|--------------------------------------------------------------------------------------------|
| 1. Prefabricated Steel Forms | Simplex "Industrial Steel Frame Forms", Symons "Steel Ply", Universal "Uniform", or equal. |
| 2. Plywood                   | Product Standard PSI, waterproof resin-bonded, exterior type Douglas Fir.                  |
| a. Normal                    | Face adjacent to concrete Grade B or better                                                |
| b. Architectural             | Face adjacent to concrete Grade B or better with plastic overlay.                          |

3. Lumber                                              Straight, dressed all sides, uniform thickness, and free from knots, offsets, holes, dents, and other surface defects.
  4. Fiberboard                                        Federal Specification LLL-B-810, Type IX, tempered, waterproof, screenback, concrete form hardboard.
  5. Chamfer Strips                                 Clear white pine, surface against concrete planed.
- C. Reuse of job-built plywood forms shall be permitted only when specifically approved by the ENGINEER. Plywood shall be furnished and placed in 48-inch widths and in uniform lengths of not less than 96 inches, except where the dimension of the member is less. Where plywood is attached directly to studs or joists, the panels shall be not less than 5/8 inch thick. Studs shall be provided sufficiently sized and spaced to prevent bulging of the plywood sheeting.
- D. Where earth is too unstable to serve as a form for sides of footings and foundations, the sides against the earth may be formed with 3/4 inch thick No. 2C Yellow Pine with tight butt joints, securely braced to hold a straight line.

## 2.02 FORM TIES

Form ties shall be approved by the ENGINEER and shall be of the snap cone or she-bolt with cone type as manufactured by a recognized manufacturer of concrete forming accessories. Cones shall leave a hole or depression in the concrete no larger than 7/8 inch in diameter. Plain snap ties or flat bar ties, unless otherwise approved by the ENGINEER, shall not be used. Ties shall be of a type that will accurately tie, lock, and spread the forms. Tie spacing shall be designed to withstand concrete pressures without bulging, spreading, or lifting of the forms. The tie shall be of such a design that when forms are removed no metal shall be within 2 inches of any surface unless stainless steel ties are used, in which case no metal shall be within 1 inch of any surface. Permanently embedded portions of form ties which are not provided with threaded ends shall be constructed so that the removable ends are readily broken off without damage to the concrete.

## 2.03 FORM COATINGS

Where specified herein, forms shall be coated with a nonstaining form release agent prior to concrete placement. Form coatings shall be Industrial Lubricants "Nox-Crete Form Coating", L & M "Debond", Prater "Pro-Cote", Richmond "Rich Cote", or equal.

## PART 3 - EXECUTION

### 3.01 FABRICATION AND ERECTION

- A. Forms shall be substantial and sufficiently tight to prevent leakage of mortar. Forms shall be braced or tied to maintain the desired position, shape, and alignment during and after concrete placement. Walers, studs, internal ties, and other form supports shall be sized and spaced so that proper working stresses are not exceeded. Joints in forms shall be bolted tightly and shall bear on solid construction. Forms shall be constructed so they can be removed without hammering, wedging, or prying against the concrete. Form ties in exposed surfaces shall be uniformly spaced and aligned in horizontal and vertical rows. The forms shall produce finished surfaces that are free from off-sets, ridges, waves, and concave or convex areas.
- B. Forms to be reused shall be thoroughly cleaned and repaired. Split, frayed, delaminated, or otherwise damaged forms shall not be used.
- C. All form panels shall be placed in a neat, symmetrical pattern with horizontal joints level and continuous. The CONTRACTOR shall place special attention on mating forms to previously placed walls so as to minimize steps or rough transitions. Form panels shall be of the largest practical size to minimize joints and to improve rigidity.
- D. Beams and slabs supported by concrete columns shall be formed so the column forms may be removed without disturbing the supports for the beams or slabs.
- E. Wherever the top of a wall will be exposed to weathering, the forms on at least one side shall not extend above the top of the wall and shall be brought to true line and grade. At other locations forms for concrete which is to be finished to a specified elevation, slope, or contour, shall be brought to a true line and grade, or a wooden guide strip shall be provided at the proper location on the forms so that the top surface can be finished with a screed or template. At horizontal construction joints in walls the forms on one side shall not extend more than 2 feet above the joints.
- F. Temporary openings shall be provided at the bottom of column and wall forms and at other points where necessary to facilitate cleaning and inspection prior to concrete placement.
- G. Unless shown otherwise on the Drawings, all salient corners and edges of beams, columns, walls, slabs, and curbs shall be provided with a 3/4 inch by 3/4 inch chamfer formed by a wood or metal chamfer strip.
- H. Forms for exposed surfaces and all steel forms shall be coated with nonstaining form release agent which shall be applied just prior to placement of steel reinforcement. After coating, any surplus form release coating on the form surface shall be removed. Wood forms for unexposed surfaces may be thoroughly wetted with water in lieu of coating immediately before concrete placement, except in freezing weather form release coating shall be used.

- I. Should misalignment of forms or screeds, excessive deflection of forms, or displacement of reinforcement occur during concrete placement, immediate corrective measure shall be taken to insure acceptable lines and surface to required dimensions and cross sections.
- J. If any forms bulge or show excessive deflection, in the opinion of the ENGINEER, the concrete shall be removed and the forms rebuilt and strengthened.

### 3.02 FORM REMOVAL

- A. Forms shall not be removed or disturbed until the concrete has attained sufficient strength to safely support all dead and live loads. Shoring beneath beams or slabs shall be left in place and reinforced as necessary to carry any construction equipment or materials placed thereon.
- B. No forms shall be removed without the approval of the ENGINEER. In general and under normal conditions, the ENGINEER will approve removal of forms after the following time has elapsed:

ITEM	TIME AFTER PLACEMENT
Elevated Slabs and Beams	14 days
Columns	7 days
Walls	3 days
Other Concrete	2 days

- C. When ambient air temperatures during the curing period fall below 45 degrees F., form removal will take place based on job-cured test cylinder strength only.
- D. Care shall be taken in form removal to avoid surface gouging, corner or edge breakage, or other damage to the concrete. Immediately after form removal, any damaged or imperfect work shall be repaired as specified in "Cast-In-Place Concrete" of these Specifications.

## SECTION 03240

### CONCRETE REINFORCEMENT

#### PART 1 - GENERAL

##### 1.01 SCOPE

This specification section describes steel reinforcement to be furnished and installed in cast-in-place concrete. The CONTRACTOR shall furnish all steel reinforcement, supports, and materials and all labor equipment, and other items necessary or convenient to the CONTRACTOR for the proper installation of the reinforcement.

##### 1.02 GENERAL

- A. Steel reinforcement shall be designed, detailed, fabricated and placed in conformance with all applicable requirements of ACI 315, ACI 318, and CRSI Manual of Standard Practice.
- B. No concrete shall be placed until all steel reinforcement to be covered has been inspected in place and approved by the ENGINEER.

##### 1.03 SUBMITTALS

- A. Prior to placing any steel reinforcement, the CONTRACTOR shall submit to the Engineer written evidence that the steel reinforcement has been tested and is in conformance with the material and mechanical requirements specified herein. Certified copies of mill tests may be considered evidence of compliance provided such tests are regularly conducted by the reinforcement supplier by experienced, competent personnel using adequate testing equipment. In case of doubt as to the adequacy or accuracy of the mill tests, the Engineer may require the Contractor to furnish, at no additional cost to the OWNER, test results from an independent testing laboratory acceptable to the ENGINEER on mill samples or delivered steel reinforcement. Mill or laboratory test results for verifying compliance with this specification section shall be provided for each 15 tons of steel reinforcement shipped. Results of laboratory or mill tests submitted to the ENGINEER shall be of tests conducted not earlier than 90 days prior to delivery.
- B. The cost of all sampling and testing of steel reinforcement necessary to furnish satisfactory evidence of compliance shall be borne by the CONTRACTOR and no separate payment will be made.
- C. Prior to fabrication and bending of steel reinforcement, the CONTRACTOR shall submit to the ENGINEER for review and approval complete shop drawings, bending diagrams, and schedules of all steel reinforcement to be incorporated in the work.
- D. The reinforcement shop drawings and bending diagrams shall show all dimensions, details, notes, location, size, length, and each bar mark, together

accessories and other materials belonging to the reinforcement for the concrete. Schedules shall show all information and be of the same general form as those on the Drawings. Concrete walls shall be detailed in elevation.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

#### A. REINFORCING BARS

Reinforcing bars shall be deformed billet-steel bars conforming to ASTM A 615. All bars #4 and larger shall be Grade 60. All bars #3 and smaller shall be Grade 40. All bars shall be shop fabricated and bent cold. Bars shall be free from defects and kinks and from bends not indicated on the Drawings or approved bending diagrams.

#### B. MESH REINFORCEMENT

Mesh reinforcement shall be electrically-welded, cold-drawn, mild-steel, plain wire fabric conforming to ASTM A 185. Wire shall be cold-drawn steel conforming to ASTM A 82.

#### C. SUPPORT CHAIRS

Reinforcement supports shall conform to Product Standard PS7 and CRSI Manual of Standard Practice, Class D or E.

Reinforcement support chairs shall be stainless steel or shall be plastic-tipped when used in walls and elevated slabs. Support chairs used in slabs on grade shall be stainless steel or shall be hot-dip galvanized after fabrication or plastic-tipped in such a manner as to provide a minimum 1-1/2 inches of protection from the subgrade. Nails shall not be used to support reinforcement.

#### D. TIE WIRE

Tie wire shall conform to Federal Specification QQ-W-461 and shall be of black annealed steel, 16-gauge minimum.

## PART 3 - EXECUTION

### 3.01 DELIVERY AND STORAGE

- A. Reinforcement shall be delivered to the job site carefully bundled and tagged for identification. Reinforcement shall be stored at least 12 inches above ground on timber mats or other supports acceptable to the ENGINEER. Contact between reinforcement and the ground shall not be permitted during storage. Reinforcement shall be supported so as not to bend or deflect excessively under its own weight.

### 3.02 SURFACE PREPARATION

Before placement, all reinforcement shall be thoroughly cleaned of oil, dirt, mill scale, rust scale, and other coatings that would tend to destroy or reduce bond. A thin coating of orange rust resulting from short exposure will not be considered objectionable; but any reinforcement having heavy rust scale or thick rust coating shall be thoroughly cleaned to the satisfaction of the ENGINEER or shall be ejected and removed from the job site. When there is a considerable delay between placement of reinforcement and placement of concrete, the reinforcement shall be reinspected prior to placement of concrete and re-cleaned if necessary.

### 3.03 PLACEMENT

- A. Reinforcement shall be accurately positioned and tied at intersections with annealed wire or suitable clips approved by the ENGINEER. Reinforcement shall be supported by concrete or metal chairs, stays, spacers, hangers, or other supports acceptable to the ENGINEER.
- B. Reinforcing bars shall be fastened with wire ties at a minimum of three places per bar. Bars shall be tied at every intersection around the periphery of slabs. Wall steel shall be tied at every fourth intersection as a minimum.
- C. Reinforcement supports shall have sufficient strength and stability to maintain the reinforcement in place throughout placement and concreting operations. Supports and ties shall not be exposed at the face of the concrete nor shall they discolor the surface of the finished concrete.
- D. Movement of steel reinforcement in place during concreting operations shall be prevented. Any reinforcement which is displaced shall be accurately repositioned in the proper place before being completely covered.
- E. Dowels for successive work shall be securely fastened in correct position before placing concrete. The sticking of dowels after placing concrete shall not be permitted.
- F. Reinforcement which has been exposed for bonding with future work shall be protected from corrosion by heavy wrappings of burlap saturated with a bituminous material.
- G. No bar partially embedded in concrete shall be field-bent unless approved by the ENGINEER.

### 3.04 MINIMUM COVER AND CLEARANCE

The minimum concrete cover for the protection of embedded steel reinforcement shall be as follows:



A. Surfaces cast against crushed rock, sand, or earth:

All bar sizes                      3 inches

B. Surfaces exposed directly to water, backfill, or weather after form removal:

All bar sizes                      2 inches

C. Surfaces not exposed directly to water, backfill, or weather after form removal:

1. Elevated Slabs                      1 inch
2. Floors, Walkways, Pavement   1-1/2 inches
3. Walls
  - Less than 12 inches thick      1-1/2 inches
  - 12 inches or thicker            2 inches
4. Beams
  - Stirrups                              1-1/2 inches
  - Principal Reinforcement        2 inches

The minimum clearance between adjacent parallel bars shall not be less than the nominal diameter of the bars, not less than 1.5 times the maximum course aggregate size, and not less than 1 inch in beams, 1-1/2 inches in columns, and 2 inches in other locations.

### 3.05 TOLERANCES

A. Allowable tolerances for fabricating steel reinforcement shall be as follows:

ITEM	MAXIMUM TOLERANCE	
Sheared Length of Bars	+1"	-1"
Depth of Truss Bars	+0.0"	-1/2"
Outside Dimensions of Stirrups, ties, and Spirals	+1/2"	-1/2"
Location of Bends	+1"	-1"

B. Allowable tolerances for placing steel reinforcement shall be as follows:

ITEM	MAXIMUM TOLERANCE
Concrete Cover from Outside of Bar to Finished Surface	+1/4" -0.0"
Lateral Spacing of Bars in Plane of Reinforcement in Beams and Joists	+1/4" -0.0"
Lateral Spacing of Bars in Plane of Reinforcement in Slabs and Walls	+1" -1"
Spacing of Stirrups, Ties, and Spirals along Longitudinal Axis of Member	+1/2" -1/4"
Height of Bottom Bars in Slabs, Beams, and Joists	+1/4" -1/4"
Height of Top Bars in Slabs, Beams, and Joists	
Depth 8" and less	+1/4" -1/4"
Depth 9-24"	+1/2" -1/2"
Depth 25" and greater	+1" -1"

### 3.06 SPLICES

- A. Splices in reinforcement shall conform to the requirements of ACI-318, Chapter 7, Details of Reinforcement. Unless otherwise shown on the Drawings, all bars shall be lapped a minimum of 36 bar diameters where splicing is necessary and splices shall be staggered. Except where indicated on the Drawings, welding or tack welding of reinforcement shall not be permitted. Lapped connections shall be sufficient to transfer the full stress between the bars by bond and shear and to develop the full strength of the bars. In slabs and beams no splices shall be made at points of maximum positive or negative moment, and in no case shall adjacent bars be spliced at the same place.
- B. Although tolerances are allowed in the lateral spacing of parallel bars in the plane of reinforcement layers and in the spacing of stirrups, ties, and spirals along the longitudinal axis of a member, in no case shall the number of bars per layer of reinforcement provided in walls and slabs be less than the lateral dimension on the wall or slab in the plane of the reinforcement layer divided by the specified spacing, nor shall the number of stirrups, ties, or spirals provided along the longitudinal axis of a member in a given segment be less than the length of the segment divided by the specified spacing.

- C. Welded wire fabric reinforcement shall be lapped a minimum of 6 inches at joints and shall be wired securely. Mesh shall extend to within 2 inches of sides and ends of slabs. Lapped ends of welded wire fabric shall be offset to prevent continuous laps. Splices shall not be made midway between supporting beams or directly over beams of continuous structures.

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

**\*\*REST OF THIS PAGE LEFT BLANK INTENTIONALLY\*\***