

**SECTION 03 11 13**  
**CONCRETE FORMWORK**

**PART 1 - GENERAL**

**1.1 SCOPE**

- A. Requirements of the General Conditions Supplementary General Conditions and Division 1 apply to work of this Section.
- B. Furnish all labor, materials, services, equipment and appliances required to perform all work to complete the Contract, including, but not limited to, these major items:
  - 1. Design and construction of all building and site formwork.
  - 2. Placing in forms all anchor bolts, inserts, sleeves, accessories, waterstops, etc., embedded in concrete as indicated or required herein.
- C. Submit any conflict between provisions of the various Contract Documents to the Architect for resolution prior to commencement of work.

**1.2 RELATED WORK IN OTHER SECTIONS**

- A. Section 03 20 00: Concrete Reinforcement
- B. Section 03 30 00: Concrete and Concrete Finishes
- C. Section 03 36 00: Post Tensioned Concrete

**1.3 REFERENCE STANDARDS**

- A. California Building Code (CBC), 2010 Edition Chapter 19.
- B. Standard Specifications for Public Works Construction (PWS) and supplements, and City amendments thereto.
- C. American Concrete Institute (ACI).
  - ACI 117-06 "Standard Tolerances for Concrete Construction and Materials".
  - ACI 318-05 "Building Code Requirements for Structural Concrete".
  - ACI 347-04 "Guide to Formwork for Concrete".
  - ACI 224 & 302.1 for Slip Dowel References
- D. American Plywood Association (APA)
- E. U.S. Department of Commerce, PS1-95 or latest edition, Product Standard for Construction and Industrial Plywood
- F. West Coast Lumber Inspection Bureau (WCLIB).
- G. Western Wood Products Association (WWPA).

- H. International Conference of Building Officials (ICBO) - See ICC
- I. International Code Council (ICC)
- J. The Engineered Wood Association (APA)

#### 1.4 SUBMITTALS

- A. Provide manufacturers' product data sheets for all materials proposed for use.
- B. Submit shop drawings for architectural concrete and all other site concrete formwork/ falsework for review. Include dimensioned locations and types of inserts, sleeves and blockouts.
- C. Submit form and shoring removal record.

#### 1.5 REQUIREMENTS

- A. Design of formwork, embedded pipes, construction joints, removal of forms, shores and reshoring shall conform to the requirements of CBC Section 1906 and ACI 318-05, Chapter 6.
- B. Indicate where sleeves are required through concrete beam and/or girder locations for review and approval by the Architect.

#### 1.6 QUALITY ASSURANCE

- A. Accomplish shoring and reshoring design, falsework, sequence, erection and removal so that construction loads do not exceed design loads. Submit procedures, details and calculations signed and approved by a Civil Engineer Registered in the State of California for review prior to erecting formwork.
- B. The Contractor shall be responsible for the adequacy of all work. Above specifications are only minimum standards. Adequate and safe support, bracing, shoring, reshoring, and stabilizing of all concrete forms is the sole responsibility of the Contractor. Adhere to all requirements of the Division of Public Safety and Occupational Safety and Health of California.
- C. Contractor shall be responsible for the accuracy of all formwork so that the end result of formed surfaces produces surface finishes conforming to an "as cast" Class A finish at the walls and a Class B finish at the deck bottoms as defined by ACI 117, and as follows:
  - 1. Chamfered corners
  - 2. Wall surfaces smooth free of fins and projections.
  - 3. Exterior wall surfaces shall be sacked per 03 30 00, 3.8 to achieve uniform smooth finish.
  - 4. Form all soffit/slab edges above grade exposed to the exterior with a continuous uniform drip 4" from edge.

- D. Construction loads that impose loads exceeding the basic designed load of the structures end use (of superimposed dead load plus specified live load) shall not be supported on unshored portions of the structure, whether newly constructed or fully completed.
- E. Intent:
  - 1. Concrete edges shall be sharp and undamaged.
  - 2. No form joints will be permitted between reveal strips shown on the drawings.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Lumber for Formwork: WCLIB or WWPA, Douglas Fir "Construction" grade or better.
- B. Lumber for Rough Carpentry, Douglas Fir "Standard" grade.
- C. Plywood Forms: New, reused or reconditioned forms are permitted, upon Architect's concurrence. Fir plywood with phenolic resin-impregnated cellulose fiber bonded on face in contact with concrete, with back and all edges sealed. 5-ply, 3/4-inch thick minimum, medium (MDO) or high (HDO) density overlay finish, moisture resistant, APA "Plywood", except any thickness may be used when used as a liner for board formwork. Provide smooth overlay finished plywood forms for all exposed concrete surfaces, except where otherwise specified for beams and girders.
  - 1. Medium Density Overlay Plywood (MDO) - (soffit deck forms only): "B" face, "C" back, "C" inner plies, 100 percent Douglas Fir, exterior glue. Overlay 64#/MSF phenolic impregnated paper with 35 percent resin content and meet Structural 1 Specification for U.S. Product Standard PS 1-83.
  - 2. High Density Overlay Plywood (HDO)(wall, column, beam, girder): "B" face, "C" back, "C" inner plies, 100 percent Douglas Fir, exterior glue. Overlay: 100/30 HDO consisting of minimum of 1 layer of 64#/MSF MDO phenolic paper overlaid with 1 layer of HDO 100#/MSF phenolic paper on the face and 1 layer of 30#/MSF HDO phenolic paper on back and meet Structural 1 Specification per U.S. Product Standard PS 1-83.
  - 3. Coated Form Plywood (HDPE): Plastic overlaid plywood factory coated with a form coating and release agent is acceptable in lieu of the HDO plywood specified above. Product as manufactured by Sylvan Industries Inc. 'Dura-Pour', or equal.
- D. Forms for PT Beams: Only steel or aluminum forms shall be used or high density plywood.
- E. Forms for Transfer Girders: Steel, aluminum or HDO plywood as defined above may be used.

- F. Tube Forms: Provide paper or fiber tubes of laminated plies, metal, fiberglass-reinforced plastic, standard wall type that leave no marks in formed concrete. Products to be fabricated with a water resistant adhesive and wax impregnated exterior for weather and moisture protection. Provide one-piece lengths for full height required, when applicable. Provide units with sufficient wall thickness to resist wet concrete loads without deformation. Sonoco "Seamless Sonotubes", or equal.
- G. Tempered Hardboard: Conform to F.S. LLL-H-35.
- H. Form Ties: Adjustable prefabricated rod, flat band, wire, internally threaded disconnecting, removable or snap-off type. Use a working strength of not less than 3,000 lbs. (13.3 KN), when fully assembled.

Provide external holding devices to support form loads. "Burke Snap" or "Concrete Tie Stay-Form" or equal.

1. Form ties for exposed concrete surfaces shall be manufactured to allow a positive break-back of no less than 1-1/2 inch inside concrete surfaces. Ties shall be equipped with a plastic cone of not less than 5/8-inch diameter and 1 inch long which will completely cover hole and prevent leakage of mortar.
  2. Form ties for unexposed surfaces shall be bolt rods or other devices, adjustable in length and free of lugs, cones, washers or other features which would leave a hole not larger than 7/8 inch in diameter, or depressions back of exposed surface of concrete. Ties shall be of such construction that, when forms are removed there will be no metal remaining within 1-1/2 inch of finished surface of concrete.
  3. Form ties fabricated on project site and wire ties are not acceptable.
- I. Corner Chamfers: 3/4-inch corner chamfer strip solid lumber, plastic or PVC.
  - J. Compressible Filler: Where indicated on structural drawings provide a Styrofoam or closed cell polystyrene foam. Install at locations and required thickness as indicated.
  - K. Through Joints (Typical Non-Metallic Expansion at grade): Preformed expansion joint fillers of type, size and thickness required or noted on Drawings. Materials shall be of such character as not to be deformed or broken by ordinary handling when exposed to atmospheric conditions. Pieces of the joint filler which have been damaged shall be rejected.
    1. Fiber expansion joint fillers conforming to ASTM D1751.
    2. Flexible isomeric polymer foam expansion joint filler, ASTM D1752 Modified, vinyl and polyethylene foams are acceptable. "Ceramar" by W.R. Meadows or equal, joint filler and back-up material for use in either horizontal or vertical applications. Approved for joints in sidewalks, driveways and slabs on grade.
    3. Expansion joints to be W .R. Meadows "Sealtight" control joints or equal.
    4. Sealant materials in accordance with Section 07 92 00, Sealants and Caulking.

- L. Reglets: 22 gauge galvanized steel for concealed locations and stainless steel for exposed locations, by "Fry Reglets Corp.", "Pittcom", or equal.
- M. Form Coating Materials:
  - 1. Form coating shall be applied to steel, aluminum and wood forms and plastic or urethane formliners. Form coating shall be formulated with a rust inhibitor for use on steel forms and a wood preservative for use on wood forms.
  - 2. Form coating shall be commercially formulated, VOC compliant, chemically reactive and will not bond with or stain concrete surfaces. Form coating must not leave any residue on the concrete surface nor adversely affect the bond or performance of curing compounds, paints, waterproofing, sealers, or any other subsequent treatments that are to be applied to the concrete surface. The form coating must not contain any diesel distillates, waxes, silicones or carcinogens.
  - 3. Acceptable Products (or approved equal):
    - "Atlas Release" by Atlas Tech Products
    - "Clean Strip J-2 Gold VOC" by Dayton Superior Chemicals
    - "Crete-Lease 727 VOC" by Cresset Chemical Co., Inc.
- N. Waterstops: To be used where indicated on the drawings and as required to completely seal all cold joints below grade. Refer to the joint between the foundation retaining wall and grade slab around entire perimeter. Provide waterstop as manufactured by Adeka Ultra Seal MC-2010M or approved equal.

## PART 3 - EXECUTION

### 3.1 QUALITY OF WORK

- A. Design and Engineering: Formwork construction and removal shall be the responsibility of the Contractor. Formwork tolerances shall conform to ACI 117.
  - 1. Necessary forms, centering, shores and molds shall be built to conform to shapes, lines and dimensions of various members of concrete construction, as shown or scheduled on the drawings.
  - 2. Concrete members shall be adequately shored to safely support loads and lateral pressures outlined in ACI 347 without distortion, excessive deflection or other damage.
  - 3. Design forms in accordance with the recommendations of the American Concrete Institute for rate of placement, lateral pressure, temperature of concrete and height of pour and erected with all members adequate in strength, spaced to sustain the concrete loads without deflection.
  - 4. Refer to Section 03 30 00 for concrete finish requirements.
  - 5. Design shoring sufficient to support construction dead and live loads.
  - 6. Design wall forming consistent with wall dimensions and maximum expected rate of pouring.
  - 7. Check forms before and during placement of concrete and make corrections as work proceeds.

- B. Construction: Use/reuse clean, sound, approved form material, coated with specified materials only, no petroleum products. Provide backing on all plywood joints.
1. Contact form materials for all concrete shall be MDO/HDO plywood as specified, metal or fiberglass which give uniform surface, free from excessive variations and irregularities. Reuse of any form material to be contingent upon condition after stripping in ability to produce required finishes. Clean, repair and reseal forms before reuse.
  2. Tie, clamp and brace all forms against all possible spreading, bulging shifting, or other movement. Make tight to prevent leakage of mortar. Use metal form ties and spreaders, designed to hold the forms securely and uniformly to required dimensions and without any off-sets in joints and shall be true to line. Use only ties with break-backs that remove 1-1/2 inch or more from surfaces. Assemble in a manner that permits forms for walls, columns and beam sides to be stripped without disturbing the soffits or shoring of beams and/or girders.
  3. Camber structural members as specified on the Structural Drawings.
  4. Fabricate deck formwork so that joints are true and level for elevation and alignment. Do not over drive nails or screws which dimple surface.
  5. All perimeter soffits/slab edges above grade exposed to the exterior shall have a continuous, uniform, drip line, 4-inches from edge or as detailed on the Drawings.

### 3.2 PREPARATION OF FORM SURFACES

- A. Form surfaces must be clean, dry and free of contaminants. Clean form surfaces to remove all dirt, rust, any concrete build-up and existing form oils from forms prior to each use.
- B. Prior to each use, forms shall be coated with form release coating in accordance with manufacturer's written instructions.
- C. Prior to coating new wood forms, apply two heavy coats of waterproofing protection to edges for waterproofing protection.
- D. Do not allow excess form release coating to accumulate on forms or come in contact with existing concrete surfaces against which fresh concrete will be placed.
- E. Do not apply form release coating to reinforcing steel. Do not apply to surfaces that form construction joints.
- F. Coat PVC "Snaptie Cone", or equal, form plugs for easy removal without causing damage to edges during form stripping.

### 3.3 FORM ERECTION

- A. Construct forms to exact shapes, sizes, lines, and dimensions required to obtain level, plumb, and straight surfaces. Provide openings, offsets, keys, reglets, anchorages, recesses, moldings, chamfers, blocking, screeds, drips, bulkheads, and all other required features. Make forms easily removable without hammering or prying against concrete. Space forms apart with metal spreaders.

Construct forms to accurate alignment, location and grades, and provide against sagging, leakage of concrete mortar, or displacement occurring during and/or after placing of concrete. Coordinate installation of inserts, embeds and anchors in forms according to Shop Drawings and requirements for work of other sections.

- B. Place form ties equidistant from panel edges and equally spaced symmetrically, accurately in line horizontally and vertically for precise pattern, in the panel field. Snap ties left in the concrete shall be a minimum of 1-1/2-inches back from the concrete surface. Tie system shall not leak. Grease tie bolts with a silicone grease to facilitate removal without spalling of the concrete. Remove ties with a special tool recommended by the manufacturer. Fill and patch all form ties to match surrounding concrete.
- C. Seat shoring on solid bearing. Design and place shoring so that loads from successive parts of the structure will be transmitted directly through the false-work without creating bending or shearing stresses in the concrete. Construct shoring so that it can be taken down without vibration to the structure.
- D. Earth forms may be used for footings and below grade concrete, provided such banks stand firm with no evidence of sloughing which may dilute the concrete, if approved by Architect. Footings and other sections shall be increased in width to obtain required minimum 3-inch clear coverage to reinforcing at all surfaces.
- E. Complete form construction, tying and shoring prior to pouring concrete. Wet all forms and allow time to expand. Install outlets, anchors, embeds, inserts, dowels, sleeves and other necessary work of other sections prior to pouring. Forms shall be free of all corrosion, wood chips, shavings, tie wires and other debris. Notify Engineer 48 hours in advance of concrete placement to allow for review of forms and reinforcing steel placement. Engineer 's review will in no way relieve the Contractor of its responsibility for the safety of the forms and shoring.
- F. Chamfers or Bevels: Provide 3/4-inch x 3/4-inch chamfers on all exposed external form corners of beams, girders, spandrels, walls, columns, pilasters and slabs to relieve angles, unless otherwise indicated. Form concealed concrete corners and angles square unless otherwise indicated on Drawings.
- G. Reglets and Rebates: Form required reglets and rebates to receive frames, flashing, and other equipment. Obtain required dimensions, details, and precise positions for work to be installed under other sections.
- H. Recesses, Drips, Reveals and Openings In Concrete: Install as shown on the Drawings and as acceptable by the Architect. Provide smooth milled solid lumber or preformed rubber or plastic shapes of types shown.
- I. Nailing Blocks, Bucks and Backing: Install in forms accurately as required and as shown on detail drawings.
- J. Set in forms anchor bolts, anchor slots, hangers, embeds, inserts and reglets for securing masonry, miscellaneous metal, sleeves for embedding in or passing through plumbing pipes, mechanical, electrical, carpentry or other work.

- K. Screeds over Vapor Barrier: Use weighted pad or cradle type screeds and do not drive stakes through the vapor barrier.

### 3.4 EMBEDDED PIPING AND ROUGH HARDWARE

- A. Coordinate work of all sections to obtain dimensions and other required information to accurately install required openings for the passage of pipes, conduits, j-boxes, ducts or other inserts in the concrete. The interrelated work shall be located and placed as part of the scope of this work to conform to the criteria established below.
- B. Conduits or Pipes:
  - 1. Locate so as not to reduce strength of concrete. In no case place pipes, other than approved conduits, in a slab 7 inch thick or less. Conduit up to 1-1/2-inches nominal diameter, but not more than 1/4 slab thickness, buried in a concrete slab must be embedded in the central one-third thickness of the slab. Do not place below the bottom reinforcing steel or over top reinforcing steel. In no case may conduits displace reinforcing, do not stack layers of conduit. Conduits shall be placed parallel with rebar and shall be independently supported. Submit layouts to the Architect/Structural Engineer for approval.
  - 2. Conduits may be embedded in walls only if the outside diameter does not exceed 2 inches, are spaced no closer than 6 diameters on centers, and are located no closer than 100 inches to either end of wall and do not impair the strength of the structure.
- C. Sleeves: Pipe sleeves may pass vertically through slabs or horizontally through walls if not exposed to rusting or other deterioration. Provide galvanized steel or PVC sleeves of diameter large enough to pass any hub or coupling on pipe, including but not limited to any insulation. Sleeve sizes shall conform to applicable code requirements for clearance. Submit proposed sizes and locations to Engineer for review prior to fabrication.
- D. Miscellaneous Hardware: Hardware shall have an approval by ICBO/ICC Research Report which shall be submitted to the Engineer and Inspector.

### 3.5 FORMWORK TOLERANCES

- A. Deflection: Limit deflection of forming surfaces from concrete pressure to L/400 maximum.
- B. Finish Lines: Position formwork to maintain hardened concrete finish lines within following permissible deviations.
  - 1. Variation from plumb:

In 10' - 0"	1/4 inch
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  - 2. Variation from Level or Grades Indicated

In 10' - 0"	1/4 inch
In any bay or 20' - 0"	3/8 inch



- |    |                            |                   |
|----|----------------------------|-------------------|
| 3. | Cross-Sectional Dimensions |                   |
|    | Minus                      | 1/4 inch          |
|    | Plus                       | 1/2 inch          |
| 4. | Irregularity               |                   |
|    | Gradual                    | 3/16 inch maximum |
|    | Abrupt Offsets             | 3/16 inch maximum |
- C. Building Lines: Variation of linear building lines from established position in plan and related position of walls:
- |                              |          |
|------------------------------|----------|
| In any bay, 20' - 0" maximum | 1/2 inch |
|------------------------------|----------|

### 3.6 WATERSTOP INSTALLATION

- A. Remove dust, dirt loose particles or any other materials which might cause areas of poor adhesion. Apply minimum of one coat of primer if required as recommended by the manufacturer. Apply waterstop the same day as the primer.
- B. Press waterstop firmly and continuously in place over the (primed) substrate. Press and butt ends together to ensure no separation or air pockets. Place in maximum practical lengths. Square cut ends to fit splices together without overlaps.
- C. Where achieving adhesion is difficult, mechanically fasten (if not required), starting 1-inch from the end of the coil and proceeding every 10-inches on center. Remove release papers (if applicable) immediately prior to second pour.
- D. Do not allow waterstop to become wet prior to casting into concrete.

### 3.7 FORM REMOVAL

- A. Remove forms in compliance with ACI 301 and ACI 347 and in a manner to ensure safety of workers and of structure.
- B. Exercise care in removing formwork to prevent damage to concrete. Surfaces shall not be marred, gouged or otherwise damaged. Do not pry against exposed concrete surfaces when removing the forms. Corners shall be true and unbroken.
- C. Coordinate timing of form removal with curing requirements for concrete with architectural finishes. Strip entire surface without break to ensure uniform curing.
- D. Remove forms for poured-in-place concrete only when concrete has developed sufficient strength to safely sustain its own weight and the superimposed loads. After concrete is placed, allow the following minimum time period before the removal of forms unless approved by the Architect. Comply with CBC Section 1906.2
1. Forms for non-prestressed/postensioned members may be removed when concrete has reached 80 percent design strength or 3000 psi minimum, when sufficient to enable them to carry their dead loads and anticipated construction loads. Immediately reshore all horizontal members unless approved otherwise by the Engineer.
  2. Forms for post-tensioned members may be removed after satisfactory completion of stressing operations. Immediately reshore to elements capable of safe resistance.

3. Where the structure as a whole is adequately supported on shores, the removable wall and column vertical forms may be removed after the concrete is sufficiently strong not to be injured and liquid curing compound is applied to all exposed surfaces.
4. Reshore immediately after stripping to distribute construction loads to elements capable of safe resistance.
5. Remove formwork in a manner such that members are not subjected to stress reversal.

### 3.7 REUSE

Clean form materials of loose materials with compressed air and wipe with wet rags to make suitable for reuse before erection. Form material will be unacceptable for reuse, if in the opinion of the Architect, required finished surface cannot be achieved.

### 3.8 FIELD QUALITY CONTROL

Inspection: Obtain inspection and approval of forms before placing structural concrete.

END OF SECTION

**SECTION 03 20 00**  
**REINFORCING STEEL**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

- A. Requirements of the General Conditions, Supplementary General Conditions and Division I apply to work of this Section.
- B. Furnish all labor, materials, services, equipment and appliances required to perform all work to complete the Contract, including but not limited to these major items:
  - 1. Mild steel reinforcing for poured-in-place concrete work
  - 2. Heavy duty adhesive/injection/epoxy anchoring systems
  - 3. Provide dowels for movement joints between interior slab on-grade and exterior flatwork

**1.2 RELATED WORK IN OTHER SECTIONS**

- A. Division 1
- B. Section 03 30 00: Concrete and Concrete Finishes
- C. Section 03 36 00: Post Tensioned Concrete
- D. Section 04 22 00: Concrete Unit Masonry

**1.3 CONDITIONS**

The "General Notes" on the structural drawings are part of these specifications.

**1.4 REFERENCE STANDARDS**

- A. American Concrete Institute (ACI):
  - ACI 301 Specifications for Structural Concrete for Buildings
  - ACI 315 Details and Detailing of Concrete Reinforcement
  - ACI 318 Building Code Requirements for Reinforced Concrete
- B. American Welding Society (AWS) - AWS D1.4
- C. American National Standards Institute/American Welding Society (ANSI/AWS):
  - ANSI/AWS D1.1
- D. Concrete Reinforcing Steel Institute (CRSI):
  - CRSI - MSP-1, Manual of Standard Practice
- E. American Society of Testing and Materials (ASTM)
- F. International Code Council (ICC)
- G. California Building Code (CBC) 2010, Chapter 19

## 1.5 SUBMITTALS

- A. Shop Drawings:
1. Submit shop drawings of reinforcement, related accessories, and embeds with reinforcement, as required for fabrication and placement.
  2. Produce sufficient diagrams, notes etc., to show plan layout, plans of combined footings, elevations of walls, shear wall chord details, deck plans, bar placement, bending diagrams, bar schedules, bar sizes, bar grades, stirrup placement and spacing, offsets, splicing, lapping of bars and proposed welding. Include layout dimensions, size and location of splices including dowel bar splice with size and location of accessories.
  3. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures"
  4. Shop drawings are not to be generated from reproductions of contract document drawings.
  5. Obtain the review of the Architect for construction joint locations. Coordinate with reinforcing and tendon supplier/placer before submittal of shop drawings.
  6. Review of shop drawings shall not be deemed acceptance of any proposed changes or deviations to contract documents that are not specifically flagged and indicated.
- B. Mill Certificates:
1. Reinforcing steel shall be identified as being purchased direct from a United States mill. Provide a purchase order and manufacturers approved / certified test data sheets. Steel supplier shall furnish steel producer's certified reports of mill analysis with carbon equivalent and tensile and bend test results.
  2. Reinforcing steel from dealers stock not clearly identified as being purchased direct from a United States mill, shall have tension and bending tests performed, on three separate samples for each heat number, size of bar in every 10 tons of each type of steel, tested as specified in the appropriate ASTM specification. Contractor shall furnish materials for testing and pay for such tests from either the Owner's project testing laboratory or Contractor selected other as approved by the Architect.
  3. Submit in accordance with CBC 1704.4 and 1708.3.
- C. Welding Certificates: Provide AWS D1.4 certificates for all field welders and/or shop welders of certified fabrication shops performing work on this Contract.
- D. Product Data: Provide manufacturers data sheets and current ICC ES reports for the mechanical / adhesive-anchoring systems proposed. Usage shall only be permitted where specifically approved by the Architect or Structural Engineer.
- E. Weld Tests (As Applicable): Submit results of nondestructive radiographic or ultrasonic testing performed by the Owners testing laboratory at the Contractors expense for retesting corrected welds that are found to be initially defective.

## 1.6 QUALITY ASSURANCE

- A. Source Quality Control: Deliver bars in bundles as delivered from the mill, identified to heat number, mill analysis and test reports and tagged with identification certificate. Unidentified steel is not to be used for this project unless Contractor obtains samples of materials, pays for quality testing indicated above and submits test data reports to the Architect for review and approval prior to site delivery.
- B. Inspection: Inspector from Owner's testing laboratory shall inspect placement of reinforcing steel for conformance with contract documents prior to delivery of concrete.
- C. Welding Qualifications: Employ welders qualified in accordance with CBC Standard 19-1, Section 1903.10 and AWS D1.4 certified. Shop welding shall be by a fabricator approved by the building official in accordance with Section 1704.2.2, prior to start of fabrication. Owner's project inspector shall continuously inspect field welding.

## 1.7 REQUIREMENTS

- A. Conform to the requirements of CBC Section 1907 regarding details of reinforcement for hooks, bend diameters, bending, surface conditions, placement, spacing, etc.
- B. Reinforce all concrete whether specifically indicated or not. Provide framing and reinforcement for conditions not specifically shown or detailed in a manner consistent with other similar details.
- C. Post-installed mechanical / adhesive anchoring systems are not to be used unless specifically approved by the Architect or Structural Engineer. Fasteners are not to be used before the concrete substrate has obtained the minimum 28-day compressive design strength. Selection of fastener or system is to be based on ICC approved values of the proposed fasteners and its intended usage. No anchorage of any type shall be shot or drilled in the post-tensioned slab after concrete is placed where damage or contact may occur to the post-tensioned tendons. It is the responsibility of the general contractor to coordinate the locations of all such anchorages.

## 1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver reinforcing materials in bundles marked with fabricator's tags indicating heat, bar size and length. Maintain organized access after bundles are broken for identification by the Owners inspector.
- B. Store and handle materials to prevent damage or contamination by accumulation of dirt, mud, rust, grease, paint or other bond-breaking coatings.
- C. Deliver and store welding electrodes in accordance with AWS D1.4.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Reinforcing Steel: Provide clean, new stock conforming to ASTM designations as shown. Bars larger than 1/4" in diameter shall be deformed. Location of types and grades shall be as indicated on Drawings. Ultimate tensile stress of Grade 60 steel shall not be less than 80 ksi.
1. Non-welded Bars: ASTM A615 Grade 60 unless otherwise noted.
  2. Welded Bars: ASTM A706 with maximum of 0.55% carbon equivalent.
  3. Reinforcement Resisting Earthquake:
    - a. Longitudinal reinforcing steel in frame members and frame grade beams shall comply with low alloy A706, 60ksi.
- B. Tie Wire: Annealed black 16 gage steel minimum conforming to ASTM A82 and Fed Spec QQ-W-461.
- C. Fabricated Bar Mats: Deformed steel bar mats, ASTM A184 using ASTM A615 Grade 60 steel bars.
- D. Welded Wire Mesh (Fabric) Welded wire mesh shall be clean, free from oil and rust. Wire size and gage as shown. Smooth wire shall be Grade 60 (60ksi) minimum yield strength conforming to ASTM A185 and deformed wire conforming to Grade 80 per ASTM A497.
- E. Welding Electrodes: Comply with AWS D1.4, Table 5.1 for low-hydrogen electrodes E80XX series.
- F. Mechanical Splice / Coupler Systems: Mechanical connections of splices of deformed bars in tension shall be in conformance with ACI 318 12.14.3.6 and 21.2.6 Type 2 splice with fasteners developing 125% of the yield stress of the bar, and 100 percent of the specified tensile strength. Provide Lenton, HRC, or other ICC approved equal.
- Threaded or transition couplers with plastic internal coupler end protector with O-Ring may be used only where indicated. Welded mechanical splices are not permitted without written approval of the Architect/Structural Engineer and approved inspection by the Owners inspector.
- G. Post-Installed Mechanical / Adhesive Fastener Systems: Provide ICC approved mechanical fasteners, such as sleeve anchors, kwik-bolt expansion anchors, drive/impact anchors, etc. or adhesive, injection and epoxy chemical anchoring systems as manufactured by Hilti, Covert Operations Inc., ITW Ramset/Red Head, Simpson Strong Tie Company Inc. or approved equal. Each mechanical or chemical fastening system to be evaluated by the Engineer on a case by case basis, based on application, ultimate load, shear and tension values. Post-installed anchors will not be permitted in post-tensioned concrete.

## 2.2 TESTING OF MATERIALS

- A. Owners testing laboratory will test and inspect all materials specified as required by CBC 1704.4, 1708.3, and 1903.
- B. Reinforcing steel must be sampled and tested for compliance with ASTM requirements at the place of distribution prior to shipment. Place of distribution shall mean the mill for non-fabricated (straight) bars and fabrication shop for bent bars. Owners testing laboratory will make one tensile test and one bending test from specimens of each 10 tons or fraction thereof from each heat number, size, type or grade of reinforcing steel when taken from bundles as delivered from the mill properly identified with tag and certificates. Owner's laboratory shall submit their independent test data results accompanied by the certified mill analysis data.
- C. Samples shall be taken by the Owners testing laboratory representative consisting of not fewer than 2 pieces each 18" long of each heat number, size and kind of reinforcing steel as obtained and prepared for testing by the Contractor.
- D. Owners laboratory shall perform testing of welds as required per Article 3.04.F.

## 2.3 FABRICATION

- A. Do not start fabrication of reinforcing steel before steels been sampled / tested by the Owners laboratory nor before Contractor furnished shop drawings, have been reviewed.
- B. Shop fabricate reinforcing steel bar using equipment that is capable of accurately bending steel bars in strict accordance with the details of the reviewed shop drawings and contract documents.
  - 1. Field bending and fabrication of rebar shapes and sizes shall be limited to ASTM A615, Grade 40 steel; No. 4 size bars or smaller. Do not field bend ASTM A615 Grade 60 steel unless approved in writing by the Architect or Structural Engineer.
- C. Accurately form bars and assemblies to the indicated sizes, shapes, details, lengths, spacing and other dimensions indicated on the Drawings.
  - 1. Fabricate reinforcing bars and assemblies to fabrication tolerances complying with the CRSI Manual.
  - 2. In case of fabricating errors, do not straighten or re-bend reinforcement in a manner that will weaken or injure the material. Heating of reinforcement for bending will not be allowed.
  - 3. Do not flame cut rebar of any kind without the express acceptance of the Architect.
  - 4. Do not weld or field bend ASTM A615 Grade 60 steel unless approved by the Architect or Structural Engineer.

- D. Reinforcement with any of the following defects will be rejected:
  - 1. Bar lengths, depths and/or bends exceeding the specified fabrication tolerances;
  - 2. Bends or kinks not indicated in the contract documents or reviewed shop drawings;
  - 3. Bars with reduced cross section due to excessive rusting or other cause.
  
- E. Marking and Shipment of Reinforcement: Bundle fabricated reinforcement and tag with suitable identification from the fabricators shop as to content, placement location or other related detail, and additionally with the original mill tag identifying the mill analysis & heat number to facilitate sorting, transporting to and storing at the project site.
  - 1. Deliver, handle and store in such a way as to not cause physical damage to the material or fabricated assemblies.
  - 2. Keep sufficient supply of tested, approved and fabricated and non-fabricated stock reinforcement on site to avoid delays in the work.

## PART 3 - EXECUTION

### 3.1 SURFACE CONDITIONS

Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work.

### 3.2 INSTALLATION

- A. Comply with the specified reference standards for required methods and procedures for placement of reinforcement, clearance requirements and the use of supports, except as may be modified herein. In cases of conflict the most stringent shall govern.
  
- B. Clean reinforcement to remove loose rust and mill scale, earth and other materials that may reduce or destroy the cohesive bond with concrete.
  
- C. Position, support and secure reinforcement against displacement by formwork, construction and concrete placing operations. Locate and support reinforcing by plastic supports, runners, bolsters, spacers and hangers.
  
- D. Place reinforcement as indicated to obtain the minimum concrete coverage required for corrosion protection of the steel.
  
- E. Accurately place reinforcement and securely tie in precise position with specified annealed steel tie wire at points where bars cross, and in such a way to hold against displacement during concrete placement.
  - 1. Tie stirrups to bars at both top and bottom.
  - 2. Tie all accessories.
  - 3. Twisted ends of tie wires are to be directed inward away from exposed concrete surfaces.



- F. Do not place reinforcing bars more than 6" beyond last leg of any continuous bar support.
- G. Do not use placed and supported reinforcement as a base runway for concrete conveying equipment or similar construction loads.
- H. Floor System Reinforcement: Do not place deck reinforcing steel until the concrete in walls and columns below has been placed, deck forms are inspected, cleaned, placed and shored, form release compound applied and projecting reinforcing steel tie bars have been thoroughly cleaned. Construction schedule shall not eliminate any of these sequential operations.

### 3.3 SPLICES

- A. Provide reinforcement splices indicated on the structural contract drawings by placing bars, lapping ends and tying tightly with specified wire.

Comply with code requirements and in conformance with ACI 318 reference standard for minimum lap of all spliced bars, mechanically coupled or welded compression splices. Do not splice bars, except as specifically indicated on contract documents and as specifically approved by the Architect, Structural Engineer and Owners inspector.

- B. Lap as indicated or required by code and reference standards to develop the full strength of bars. Do not make splices at points of maximum stress that have not been indicated or specifically approved by the Structural Engineer.
- C. Mechanical tension splices where specifically detailed on the contract drawings and specifically approved by the Architect in strict conformance with manufacturer requirements using Cadweld (C-Series), Dayton Bar-Grip, Erico, Lenton, or approved equal.
- D. Extend reinforcing bars and dowels required to receive and engage subsequent work as indicated on the contract drawings or specifically approved to the length to develop the strength of the bar. Place extending dowels and bars in the forms and secure against displacement during concrete placement.
- E. Thoroughly clean steel bars and dowels that extend through construction joints in walls of all adhering cured concrete paste before continuing with the placement of fresh concrete.

### 3.4 WELDING

- A. Provide welded or mechanical tension splices of reinforcing steel only where specifically detailed on the contract drawings and reviewed shop drawings or specifically approved by the Architect and the Owner's inspector. No cutting, burning or welding of tendons or rebar in the field is permitted without the specific approval of the Architect before executing any such activity. Prepare ends of bars in compliance with AWS D 1.4.

- B. Perform welding only where indicated or specifically approved by using a pre-qualified process in accordance with AWS D1.4 and CBC Section 1704.3, using the specified low-hydrogen electrodes. Employ only experienced welding operators certified for the types of welds specified. Pre-qualification of welds shall be in accordance with CBC. Preheat bars before welding. Protect joints from drafts during the cooling process; accelerated cooling is prohibited. Do not tack weld bars and leave that connection as the means of final attachment.
- C. Clean metal surfaces to be welded of all oil, grease, dirt, loose scale and foreign material. Clean welds each time electrode is changed and chip burned edges before placing welds. Flame dry before welding.
- D. When wire brushed the completed welds must exhibit a uniform section that is smooth welded metal with feathered edges. Weld shall be without undercuts or overlays, free from porosity and clinkers and in good fusion and penetration into the base metal. Cut out welds or parts of welds found defective with chisel and replace with proper welding. Reinforcing bars to be welded (ASTM A706) shall have a maximum of 0.55 carbon equivalent. Carbon equivalent for each bar shall be known from the mill certificates prior to welding such that preheat and inter-pass temperatures may be determined.
- E. Weld using full penetration butt welds by the electric-arc method. Weld per the structural drawings. Exercise care to assure that no reduction of the cross sectional area of the steel reinforcement occurs.
- F. Owner's testing laboratory will perform nondestructive radiographic or ultrasonic testing on 25% of all welds. If any weld fails, the laboratory will test all remaining welds at the Contractors expense. Contractor shall correct defective welds and request retesting by the Owners laboratory with services billed directly to the Contractor. Submit results of the welding retests to the Owner.

### 3.5 WIRE MESH REINFORCEMENT – Pan Filled Stair Pans and Landings - Only

- A. Roll out straight and cut to required size in longest lengths practical and lay reasonably flat in place.
  - 1. Lap minimum two full mesh wire spaces at outermost sides and ends (1 foot minimum).
  - 2. Staggering ends when using rolled stock.
  - 3. When using sheet stock, offset laps of adjoining widths to prevent continuous laps in either direction.
  - 4. Securely wire together and to other reinforcement at frequent intervals.
- B. Support to prevent displacement by workers during pour and to carry the reinforcement. Locate mesh in center of slab or as shown on the contract drawings. Wire mesh to be used only as indicated.

### 3.6 SETTING MISCELLANEOUS ITEMS

- A. Allow for the setting of miscellaneous items of reinforcing steel as specified in "Cast-in-Place Concrete"
- B. Reinforce openings in the floors and walls required by work of other sections.
- C. Provide dowels, etc. the sizes and shapes as indicated or as required.
- D. Provide accessories to maintain vertical wall bars in place during pouring. Single curtain vertical bars shall be secured within 1/4 inch of the specified location. Support spacing of vertical bars shall not exceed 100 bar diameters.
- E. Support slab reinforcing at maximum 42". Support top reinforcement at the face of supporting walls, columns, beams and capitals.
- F. Tie all splices and accessories.

### 3.7 CHANGES OF MILD STEEL REINFORCING

- A. Make no change of mild steel reinforcing or supports on shop drawings or field installation phases without the knowledge and review of the Architect and Owner. A letter request noting specific recommended changes must be submitted to Architect and Owner prior to preparation and issuance of shop drawings. Shop drawing review will not suffice as approval for any change in the absence of an itemized letter request.
- B. Reinforcing steel is shown in U.S. dimensions. If metric sized steel is supplied the equivalent poundage and effective area of steel must be provided, subject to Owner's and Architect's review and approval.

### 3.8 ANCHORING SYSTEMS

- A. Post-installed anchors will not be permitted in post-tensioned concrete. Submit all requests for use to the Architect for review prior to starting work.
- B. Adhesive / Injection / Epoxy Systems: Installation is to be as instructed by the manufacturer based on type of insert used.

### 3.9 FIELD QUALITY CONTROL

- A. The Owner will employ and pay a qualified independent testing laboratory to perform testing for field quality control and inspection. Retesting of materials failing to meet specified requirements shall be redone at Contractors expense. Inspector will perform the following:
  - 1. Perform visual inspection of reinforcement and support prior to concrete placement for size, type and quality of materials.

2. Observe placement of reinforcement including size, vertical location, horizontal spacing, correctness of bends, splices, clearance between bars and forms, firmness of installation and security of supports and ties immediately prior to concreting.
3. Observe placement of embedded items including size, vertical location, horizontal spacing and correctness of fabrication.
4. Inspection shall be to observe compliance with code requirements, contract documents, reviewed shop drawings and approved field orders, bulletins and change orders. Inspector shall not be responsible for Contractor coordination of items to be placed for subsequent work.

### 3.10 CLEANING

- A. Verify that forms have been cleaned and excess form release compounds have been removed prior to placing reinforcing.
- B. Reinforcing steel and anchoring systems are to be inspected and cleaned as required to remove objectionable rust, scale, dirt, debris or hardened concrete paste that may have been splattered from previous pour.
- C. Clean any spills, drips and excess materials of any nature at the completion of the work of this section.

### 3.11 PROTECTION

- A. Where post-installed mechanical / adhesive fastener systems are utilized with the specific approval of the Architect, installed anchor systems shall be protected so that anchoring adhesive can obtain its designed maximum cure and threaded rod or insert is not damaged prior to its intended use.
- B. Units damaged and not able to be used as originally intended shall be repaired or replaced, inspected and approved at no additional cost to the Owner.

END OF SECTION

## SECTION 03 30 00

### CAST-IN-PLACE CONCRETE

#### PART 1 - GENERAL

##### 1.1 SCOPE

- A. Requirements of the General Conditions Supplementary General Conditions and Division apply to work of this Section.
- B. Furnish all labor, materials, services, equipment and appliances required to perform all work to complete the Contract, including, but not limited to, these major items:
  - 1. Cast-in-place reinforced concrete
  - 2. Concrete finishing and curing
  - 3. Poured concrete stairs.
  - 4. Concrete fill of metal decking
  - 5. Grouting of post-tensioning anchors
  - 6. Equipment bases.
  - 7. Concrete encasement for pipes.
- C. Construction Means, Methods, Techniques, Sequences and Procedures
  - 1. The Contractor is solely responsible for, and has sole control over, construction means, methods, techniques, sequences and procedures, and for coordinating all portions of the Work under the Contract.
  - 2. Shoring, including shoring for structural foundations, structures, and trenching, that is required to complete the Work, is considered a method or technique and is the sole responsibility of the Contractor. If a regulatory agency requires a licensed engineer to design, approve or provide drawings for shoring, then it is the sole responsibility of the Contractor to contract with a qualified Engineer for shoring design services.
  - 3. Provide, as part of the Base Bid, all necessary construction means, methods, techniques, sequences and procedures, including shoring design, for coordinating and completing all portions of the Work.

##### 1.2 RELATED WORK IN OTHER SECTIONS

- A. Section 01 45 00: Testing and Inspection
- B. Section 03 11 13: Concrete Formwork
- C. Section 03 20 00: Reinforcing Steel
- D. Section 03 36 00: Post Tensioned Concrete
- E. Section 04 22 00: Concrete Unit Masonry
- F. Section 07 18 00: Elastomeric Deck Coatings
- G. Section 09 90 00: Painting

##### 1.3 CONDITIONS

The "General Notes" on the structural drawings are part of these specifications.

## 1.4 REFERENCE STANDARDS

- A. American Concrete Institute (ACI) – Latest Editions
  - ACI 117 "Specifications for Tolerances for Concrete Construction and Materials and Commentary".
  - ACI 301 "Specifications for Structural Concrete".
  - ACI 304 "Guide for Measuring, Mixing, Transporting and Placing Concrete".
  - ACI 305 "Hot Weather Concreting"
  - ACI 306 "Cold Weather Concreting".
  - ACI 311.1 "ACI Manual of Concrete Inspection".
  - ACI 311.4 "Guide for Concrete Inspection".
  - ACI 311.5 "Guide for Concrete Plant Inspection and Testing of Ready-Mixed Concrete".
  - ACI 318 "Building Code Requirements for Reinforced Concrete".
- B. American Society for Testing and Materials (ASTM).
- C. Comply with California Building Code (CBC) 2010 Edition.

## 1.5 SUBMITTALS

- A. Materials list of items proposed to be provided under this Section.
- B. Manufacturer's specifications, certificates, and other data needed to prove compliance with the specified requirements.
- C. Concrete Mix Design: Contractor shall submit mix design, prepared, stamped and signed by a California registered engineer of the approved independent testing laboratory, for each type and strength of concrete a minimum of three weeks prior to start of concrete work. Do not begin concrete production until mixes have been reviewed by Engineer.
- D. Material Certificates: Provide in lieu of materials laboratory tests reports only when permitted by the Engineer. Material certificates shall be signed by the material manufacturer and the Contractor certifying that each material item complies with, or exceeds, the specified requirements.
- E. Shop Drawings: Submit for structural concrete and concrete slabs showing dimensioned locations of control joints, types of construction and expansion joints, and method of keying, location of openings, inserts and sleeves. Refer to Section 03 10 00 – Concrete Formwork.
- F. Delivery Tickets: Provide delivery ticket with each transit truck, signed by an authorized representative of the batch plant, containing all information required by ASTM C94, as well as time batched, type and brand of cement, cement content, maximum size of aggregate and total water content including that added in-transit or at the site. Loads delivered without ticket will be rejected.
- G. Inspection Reports: Owner's testing lab shall submit one copy of all inspection and testing reports to each entity listed on the distribution list.

- H. Samples:
1. Provide minimum of three (3) 4-foot-0-inch square samples of the heavy broom finish concrete, demonstrating variations for review and acceptability prior to execution of floor slab finishes throughout the structure.
  2. Provide minimum of three (3) 2-foot-0-inch square samples of the concrete to be used at the above grade structures, demonstrating color and finish for review and acceptability prior to execution of structure pours.

## 1.6 QUALITY ASSURANCE

- A. Do not commence placement of concrete until mix designs have been reviewed by the Engineer and by all governmental agencies having jurisdiction, and until reviewed copies are on file at the job site and the batch plant.
- B. If, in the opinion of the Inspector or Engineer the cement has been damaged in storage or transit or has been in storage at mixing plant for over 30 days, testing may be ordered. Aggregate and every item where the source or character has changed shall be tested for conformity to relevant ASTM Specifications. Payment for such tests shall be made by the Contractor to the testing laboratory.
- C. See other requirements for testing in Part 2 of this Section.
- D. Schedule construction loads so as not to overload structural members. Support stockpiles to evenly distribute load. Repair any damage resulting from overloading with construction loads at no additional cost to Owner, to the Engineer's satisfaction.
- E. Protect trowel/broom finished slabs from subsequent construction damage, including staining, concrete slurry build-ups from form leaks of overhead concrete pours and defacing of concrete deck surface finish from construction operations. Remove concrete slurry build-ups on slabs by wet blast cleaning prior to hardening or cure, where it occurs.
- F. Provide concrete finishes as specified herein and as approved by the Architect. Contractor shall make allowances to provide the required formwork, stripping, cleaning and patching required to provide the types of finished surfaces approved by the Architect.
1. The Contractor and the Architect shall review the finishing of the first slab on grade pour to approve the acceptable heavy broom finish as compared to the approved sample, to be used as the required standard quality expected on all subsequent slab-on-grade and deck pours.
  2. Interior surfaces (soffits, beams, columns and shearwalls) shall be reviewed by the Contractor and the Architect at the end of the first elevated deck pour to approve a representative area outlined in Section 305.A to establish a standard of quality to maintain throughout the interior of the structure.
  3. Exterior surfaces of spandrel panels, shear walls and columns shall be reviewed prior to painting. Coordinate with Architect to review surface finishes to determine production standards and acceptable patching.

4. Contractor shall be responsible for coordinating concrete finishes, release and curing compounds with architectural finishes selected.

## 1.7 REQUIREMENTS

- A. Contractor shall provide concrete for post-tensioned beams and slabs designed to obtain a minimum of psi as stated in the structural drawings.
- B. Correct concrete work that does not conform to the specified requirements, including strength, tolerances and finishes at no cost to the owner. Correct deficient concrete as directed by the Architect and/or Engineer.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Portland Cement:
  1. A standard domestic brand conforming to requirements of ASTM C 150, "Standard Specification for Portland Cement" Type II, mill tested. When concrete is mixed at the site of the work, deliver cement in sacks with the brand and name of the manufacturer clearly marked. Use only one brand of cement throughout the project unless otherwise required and approved in writing by the Engineer prior to use.
  2. Cement used for above grade exposed architectural walls shall be made using a mixture, proportioned to provide color as specified by the Architect.
- B. Water for Concrete: Clean, free from deleterious substances, and potable.
- C. Rock Concrete Aggregates: Conform to ASTM C 33, except as hereinafter provided.
  1. Reactive aggregate may not be used without prior permission from the Engineer. Request must show proof of cement alkali content, percentage aggregate reactivity and balance with statement from a testing laboratory having prior successful experience with aggregate from the same source as proposed in the request. Hardrock as specified herein shall be deemed to mean normal weight aggregate.
  2. Coarse Aggregates: Granite or limestone only, natural gravel or crushed rock sized per the chart on the Drawings. Submit reactivity test results with mix design.
  3. Fine Aggregates: Clean, natural sand having hard, strong, durable particles, from a source other than a current, dredged marine deposit. Submit reactivity test results with mix design.
  4. Pea Gravel or Other Aggregates: Pea gravel or aggregates smaller than specified in the chart on the Drawings are not acceptable for structural concrete without written approval by the Engineer. Provide crushed granite or limestone with angular faces only and increase compressive strength to  $f'_{CR} + 1000\text{psi}$ . Rounded river rock will not be accepted. Specifically identify locations for use and reason(s) for substitution.



5. Source of aggregate shall be constant and consistent for the duration of the Project.
  6. Silt and Clay content of coarse and fine aggregates shall be limited to 2 percent passing a #200 screen.
- D. Admixtures: Conform to IBC and ACI 318-05, Section 3.6
1. See Structural Drawings for required admixtures.
  2. Pozzolan: Use of fly ash or other pozzolanic or cementations materials to replace cement content is highly recommended per the following requirements. Percentage of fly ash in mix design shall be by weight, not by volume.
    - a. Class F fly ash may be substituted for cement up to 25% of minimum cement at substitution rate (not more than one pound of fly ash to one pound of cement) sufficient to provide required strength at specified ages. Calcium content shall be no more than 20% when freeze/thaw cycles are expected.
    - b. If strength or air content varies from that specified more than allowable tolerances, concrete shall be rejected by testing lab representative.
    - c. Submit all fly ash concrete mix designs per ACI 301.
  3. Evaporation Retarder
    - a. A VOC compliant, water-based, pigmented, monomolecular film-forming compound that reduces evaporation of moisture in fresh concrete to help prevent shrinkage cracks and facilitate finishing.
    - b. Acceptable Products:  
 "Atlas Finish Film" by Atlas Tech Products,  
 "Aquafilm" by Conspec  
 "Sure-Film J-74" by Dayton Superior Chemicals  
 Or approved equal.
  4. Water Reducing Admixture: ASTM C 494, Type A, D, or E, use only one brand. Admixtures when used are subject to approval of the Architect, and must reduce the mixing water at least 5 percent without entraining air in excess of 2 percent by volume.
  5. Corrosion Inhibitor: ASTM C494, Type F. W.R. Grace "DCI", or approved equal.
  6. Super-Plasticizers (High Range Water Reducers): ASTM C494, Type F or G. Master Builders "Rheobuild", Euclid "Eucon 37", or approved equal.
  7. Admixtures containing chloride, fluoride, sulphide, nitrate ions, or other substances detrimental to the reinforcing steel, are not permitted in concrete.
  8. Shrinkage Reducing Admixture: ASTM C157, W.R. Grace "Eclipse", or approved equal.

- E. Grout
1. A non-shrink, non-metallic, cement-based, premixed grout that meets Corp of Engineers CRD C-621 and ASTM C1107, Grades A, B and C. Grout shall be non-corrosive, non-staining and contain no calcium chloride. Compressive strength shall reach a minimum of 3,500 psi (24 MPa) in 1 day and 8,000 psi (55 MPa) in 28 days at a flowable consistency when tested in accordance with ASTM C109. Grout shall exhibit positive expansion when tested in accordance with ASTM C827.
  2. Acceptable Products:  
"Atlas Hi Flow Grout" by Atlas Tech Products,  
"Sure Grip High Performance Grout" by Dayton Superior  
"Construction Grout" Masters Builders Company  
"Sika Grout 212" Sika  
"588" W. R. Meadows  
Or approved equal
- F. Drypack
1. Field mixture of one part Portland cement to two parts fine aggregate mixed to a damp consistency such that a ball molded in the hands will stick together and hold its shape. At contractor's option, the specified admixture may be added for increased workability at lower water/cement ratio. In lieu of field mixing, contractor may use a factory mixed drypack grout.
  2. Acceptable Products:  
"Atlas Construction Grout" by Atlas Tech Products,  
"1107 Advantage Grout" by Dayton Superior Chemicals  
"Construction Grout" Master Builders  
"Euco Dry Pack Grout" Euclid  
Or approved equal
- G. Curing Compound: Comply with ACI 301-10, Section 2
1. For Vertical Concrete Surfaces:
    - a. A VOC compliant, liquid, membrane-forming, water-based, non-staining compound that will not affect the appearance of the concrete, nor adversely affect the bond or effectiveness of subsequent treatments to be applied to the concrete surface.
    - b. Curing compound to be applied to concrete surfaces that are to receive subsequent coatings or treatments, such as paint, waterproofing, sealers, etc. shall be specially formulated for such use and shall be certified by the manufacturer not to inhibit the bonding and/or penetration qualities of the treatments.
  2. For Horizontal Concrete Surfaces:
    - a. A VOC compliant, liquid, membrane-forming, resin-based emulsion curing compound conforming to ASTM C309, Type 1, Class A and B.
    - b. Curing compound shall dissipate from concrete surface within 40 days but not less than 28 days of application when exposed to sunlight and construction traffic. Once dissipated, curing compound shall not discolor concrete, nor affect the bond or effectiveness of subsequent treatments to be applied to the concrete surface.

- c. Acceptable Products:
  - "Atlas Res-Cure" by Atlas Tech Products,
  - "Day-Chem Rez-Cure J-11" by Dayton Superior Chemicals
  - "Aqua Resin Cure" by EDOCO
  - "Kurez-DR VOX" by Euclid
  - "1100 Clear" by W. R. Meadows
  - Or approved equal
  
- H. Curing Paper: Comply with ASTM C 171 and ASTM D2103 Type 00001, regular or polyethylene sheet, 5 mil minimum thickness.
  - 1. Curing Paper: Fortifiber Corp. "Orange-Label" Sisalkraft curing paper.
  - 2. Blankets: 5 mil opaque polyethylene extruded onto 10-ounce burlap, JPS Specialties Inc., Cure Lap or Summer Cure 9 mil aluminized coating, or approved equal, 12-feet x 100-feet.
  - 3. Polyethylene Sheeting: TRM Manufacturing, Weather-All Film, or approved equal, 4-mil white polyethylene sheeting.
  
- I. Vapor Barrier: Design is based on products of Stego Industries. Equal products of alternate manufacturer may be acceptable based on submittal review.
  - 1. Series: Stego Wrap
  - 2. Tensile Strength: Class A per ASTM E154.9
  - 3. Puncture Force: Class B per ASTM E154.10
  - 4. Perm Rating: .014 max U.S. perms per ASTM E154.7
  - 5. Water Vapor Transmission Rate: .006 per ASTM E96
  - 6. Thickness: 15 mil
  - 7. Color: Yellow
  
- J. Expansion Joint Filler: Refer to Section 03 11 13 - "Concrete Formwork".
  
- L. Bonding Agent
  - 1. A VOC compliant, water-based, non-re-emulsifiable, acrylic latex-bonding agent that meets ASTM C1059, Type II.
  - 2. Acceptable Products:
    - "Atlas Acryl Bond" by Atlas Tech Products
    - "Strong Bond" by Conspec
    - "Day-Chem Ad Bond J-40" by Dayton Superior Chemicals
    - Or approved equal
  - 3. Provide a high strength polymer modified or epoxy bonding slurry to increase adhesion between fill material and existing concrete surfaces. Master Builders "Concessive LPL", Sika "32 Hi-Mod", Euclid Chemical "Euco-452", W.R. Meadows "Rezi-Weld 1000", or approved equal.
  
- M. Self Leveling Concrete Topping:
  - 1. Self-leveling cementitious floor topping containing no gypsum
  - 2. Thickness: 1/4" minimum
  - 3. Aggregate: Add aggregate where recommended by the manufacturer.
  - 4. Primer: As recommended by the manufacturer.
  - 5. Compressive Strength: ASTM C109 with 5,000psi minimum.
  - 6. Suitable for interior or exterior wearing surface.

7. Provide one of the following, subject to compliance with requirements:
  - a. Ardex, Inc. "Ardex K-500"
  - b. Sonneborn - "Sonoflow" (interior), "Sonopatch 300" (exterior)
  - c. Master Builders "Topping 112"
- N. Interior Wall Sealer: Provide per Section 03 36 16, 2.2, B.
- O. Resurfacing 'Sacking' Material; for rubbing, smoothing, restoration, resurfacing, and repairing of concrete surfaces with thin coat patching: Provide a Portland cement based product with graded silica aggregate and special chemical additives for bonding, hardening and moisture retention. Provide 'Pavecrete', as manufactured by Lyons Manufacturing, Inc., or approved equal. For surfaces which are slick due to steel or overlay forming, replace percentage of the mixing water with an acrylic polymer, quantity as recommended by the manufacturer.
- P. All concrete for roof decks (all decks exposed to weather), shall contain Fibermesh 300 synthetic fibers. Dosage rate per the Structural Drawings.

## 2.2 PROPORTIONING AND DESIGN OF MIXES BY THE CONTRACTORS TESTING LABORATORY

- A. The Contractor shall use an independent testing laboratory acceptable to the Architect, Engineer and Owner for preparing and reporting proposed mix designs. Testing laboratory shall not be associated with the materials supplier. Prepare design mixes for each type and strength of concrete in accordance with applicable provisions of ASTM C 94.
- B. Prepare all mix designs in accord with ACI 301 and IBC Section 1905.3. The required average strength used as a basis for selecting proportions for each mix to be minimum 15 percent higher than the specified 28-day design strength. For design strength of concrete at 28 days see Structural Drawings.
- C. Durability requirements for concrete exposed to weather (all concrete except foundations) shall be included in all mix design. Concrete shall have maximum water/Portland cement ratios as shown on the Structural Drawings.
- D. Mix design shall provide for an average plus one standard deviation drying shrinkage of concrete after 35 days of total curing not to exceed that indicated on the Drawings (0.04% UON). Submit trial batch or historical shrinkage data (for the specific mix proposed), wet stamped and signed by a licensed Civil or Structural Engineer with proposed mix designs to the Project Structural Engineer for review.

- E. Admixtures:
1. Include admixtures, if used, in design mix only as accepted by the Engineer. Not more than one admixture is acceptable unless specifically permitted in writing by the Engineer. Comply with Section 2.01 Item E above.
    - a. Use admixtures in strict compliance with the manufacturer's directions. Admixtures to increase cement dispersion or provide increased workability for low-slump concrete may be used subject to the Engineer's acceptance.
    - b. Use amounts of admixtures as recommended by the admixture manufacturer for climatic conditions prevailing at the time of placing. Adjust quantities of admixtures as required to maintain quality control and provide revised mix designs for review.
    - c. Do not use admixtures containing chloride ions.
- F. Design strengths of concrete shall attain minimum specified values as noted on the structural drawings. Slump to be as determined by ASTM C143 as indicated on the structural drawings.
- G. Proportion the amount of fine and coarse aggregates with respect to each other, and respect to the water content so that the concrete can be placed without segregation, and produce proper strength. Water quantity, including any moisture in aggregate, is to conform to all Code provisions.
- H. Submit mix designs to the Engineer at least 15 working days prior to start of work. Each design shall include proportions of each material, admixtures if any, pozzolan-cementitious material ratio, maximum allowable water content and slump. For each material, provide manufacturer's name and brand, type, designation and source along with material certifications and letters of compatibility of materials and analysis of chloride ion content. Provide aggregate's sieve sizes and gradations, as well as 2-3 day (as required), 7- and 28-day compressions test results and shrinkage test results where required.
- I. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, at no additional cost to Owner and as acceptable by Engineer. Laboratory data for revised mix design and strength results shall be submitted to and accepted by the Engineer, the Owner and the governing Jurisdiction, before using in the work.

### 2.3 FIELD TESTS OF CONCRETE BY OWNER'S TESTING LABORATORY

Evaluation and Acceptance of concrete in conformance with IBC, Chapter 17 - Structural Tests and Special Inspections and ACI Section 5.6, except where more stringent requirements are specified:

- A. Test Cylinders: Perform sampling for test cylinders as the concrete is delivered from the mixer to the concrete pump hopper, unless required at the point of discharge by Code or agency of jurisdiction, testing laboratory or Engineer.

Make from full size batches of concrete taken from each pour or day's operation for each class of concrete so as to represent 50 cubic yards of concrete and not less than once for each 2,000 square feet of surface area for slabs and walls.

Each sample for test to consist of a set of a minimum of four (4) cylinders for regular concrete and five (5) cylinders for post-tensioned concrete sampled in conformance with ASTM C172, 'Sampling Freshly Mixed Concrete' and made and cured in accordance with ASTM C31, "Curing Test Specimens in the Field". Place in protected area and moist cure as required. Provide test cylinders, number, and indicate point from which sample was taken, and project location for where mix was placed. Indicate slump test results of sample, air content, if any, temperature of air and concrete at project site.

- B. Test Cylinders for compressive strength, in accordance with ASTM C39. One cylinder shall be tested at three (3) days for post-tensioned concrete, one at seven (7) days and two (2) at 28-days. One cylinder shall be kept as a spare and is to be tested at 56 days if previous cylinders fail to meet strength requirements. Make frequent slump tests in the field to control consistency of concrete, minimum one slump test at beginning of placement and at the same time test cylinders are made. Conform to ASTM C143 for slump test methods.
- C. The Contractor may request and pay for taking and testing of any additional cylinders for purposes other than stated above. Contractor can use high early strength results to sequence construction scheduling provided he meets minimum code requirements.
- D. If the 28-day tests fail to meet minimum ultimate compressive design strength, concrete will be considered defective. At a minimum, 56-day tests on spare cylinders and/or cores from selected areas taken in accordance with ASTM C42 as directed by the Engineer shall be performed to determine strength of defective concrete.
- E. If compressive tests of core specimens fail to meet desired design strength, concrete work shall be assumed to be defective and shall be further tested and, if required, adequately strengthened or removed and replaced by Contractor at no cost to Owner in a manner acceptable to the Architect.
- F. Repair concrete work to match existing surfaces when coring or other testing is done. Costs of coring, testing of work-in-place cores and all necessary repairs pertaining thereto, to be at Contractor's expense.
- G. Contractor shall provide at no additional cost to Owner, such incidental labor, materials and/or equipment as may be necessary in order to assist the deputy inspection firm with the temporary and secure handling and storage-on-site of test cylinder specimens.

- H. During construction, take "drying shrinkage" specimens of each class of concrete (minimum - elevated slabs and slabs on grade) to insure continued compliance with these Specifications. Take at least one set of 3 specimens from each slab-on-grade or elevated deck pour. Take "drying shrinkage" specimens from the same concrete used for preparing compression test specimens.

## 2.4 CONCRETE INSPECTION BY OWNER'S TESTING LABORATORY

- A. Comply with IBC Chapter 17, Section 1704.
- B. Owners inspector shall be continuously on project site to perform inspection for all concrete to verify placing technique, and to determine concrete deposited is uniform, vertical drop is not excessive, check depth of layers and for proper steel reinforcing placement and coverage.

## 2.5 TESTS BY OWNER'S TESTING LABORATORY

- A. During the progress of the work make a reasonable number of tests as hereinafter specified and when instructed by the Engineer. Engineer shall not be responsible to search reports to verify the results of the test. Testing lab shall clearly underline and bold the results of the tests for easy review. Make tests for the following in accordance with ASTM Standards:
  - 1. Reactivity of Aggregate: C 289 / 227
  - 2. Organic Impurities: C 40
  - 3. Fineness Tests: C 117
  - 4. Soundness of Aggregates: C 131
  - 5. Weight, Air Content: C 138
  - 6. Shrinkage Tests: C 157
  - 7. Air entrainment: C233
  - 8. Chloride Content: C1218
- B. Concrete Shrinkages Tests:
  - 1. Before placing any concrete deck slabs, prepare a trial batch of the mix design, using the same aggregates, cement and admixtures (if any) proposed for use on the Project. Prepare at least 3 specimens for determining the "drying shrinkage" of the mix design.

## 2.6 INSPECTION REPORTS

The Owner will pay for services of testing laboratory test samples only to the extent shown on Drawings or specified herein, and for continuous inspection of the depositing of structural concrete. Four (4) copies of reports of all testing and inspection of concrete placing shall be furnished by Owner's testing lab, and kept by the Architect, Contractor, Engineer and Owner. Make all log entries available at all times. See Structural Drawings for inspection requirements.

## PART 3 - EXECUTION

### 3.1 SURFACE CONDITIONS

Examine the areas and conditions under which work will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

### 3.2 CONCRETE MIXING - Refer to IBC Section 1905, and ACI Sections 5, 7, 8, 9, & 10.

- A. Transit Mixed Concrete: From an approved plant and conforming to the latest issue of ASTM C 94. Quality and quantity of materials used in batched aggregate shall be subject to inspection at locations where materials are measured. At time of delivery of each load of concrete, manufacturer of transit mixed concrete shall furnish certified statement stating quantity of cement, water and aggregate contained in the load, as well as time of first adding water to mixture, brand and quantity of admixture, if any.
1. Rotate the drum at the rate specified by the manufacturer of the mixer as "mixing speed".
  2. Whenever there is a delay in unloading, rotate the drum slowly at intervals to prevent incipient set of concrete.
  3. Discharge concrete under observation of a designated deputy inspector.
  4. Concrete will be rejected if not placed in final position within 1-1/2 hours after water is first added to the batch.
    - a. Obtain a concrete mixture temperature of not less than 50 degrees F or more than 90 degrees F at any time during mixing, transporting, or at point of placement.
    - b. Do not use frozen materials containing ice or snow.
    - c. Do not use materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix design by Engineer in writing.
  5. Concrete at time of placing shall be in such condition that it can be placed and finished properly.
  6. Discharge all wash water from the mixing drum before the truck reloads at the batching plant.
- B. Store aggregate materials at batching site on tightly floored space, protected against mixing with the ground or with other types, sizes or sources of aggregate. Monitor amount of water in aggregate and adjust added water to achieve total required by approved mix design.
- C. Deliver cement to batching site in original, unbroken sacks, or other suitable method acceptable by the Engineer to guarantee that only the specified manufacturer's product covered under requested mill reports will be used in the work. Store cement in a weather-protected, well-ventilated place, having a floor clear off the ground. All cement shall come from the same supplier and be of same brand.



- D. Control of poured concrete mix requires all aggregates shall be measured by weight or by an equivalent approved method. Accurately control proportions of water-to-cement.
- E. Use concrete mixers equipped with automatic apparatus for timing and for metering or measuring water and liquid admixtures. Apparatus shall have locks that will prevent unauthorized changing of the adjustments.
- F. Concrete Consistency:
  - 1. Use the amount of water established by the approved mix design.
    - a. Do not exceed the maximum quantity specified for the grade of concrete.
    - b. Use the minimum amount of water necessary to produce concrete of the workability required by the Engineer.
    - c. Do not supplement the predetermined amount of water with additional water for any reason.
  - 2. Measure concrete consistency by ASTM C143 method.
    - a. As part of the routine testing and inspecting, test twice each day or partial day's run of the mixer.
    - b. Maintain a complete and accurate record of tests.

### 3.3 PREPARATION FOR CONCRETE PLACEMENT

- A. Remove all free water from forms before concrete is deposited. Remove hardened concrete debris, and foreign materials from interior surfaces of forms, exposed reinforcing and from surfaces of mixing and conveying equipment.
- B. Wetting: Wet wood forms sufficiently to tighten up cracks. Wet other materials sufficiently to reduce absorption and to help maintain concrete workability.
- C. Earth Subgrade: If required by the Geotechnical Engineer, dampen 24 hours before placing concrete; do not muddy. Re-roll where necessary for smoothness; remove loose material.
- D. Vapor Barrier: Install per "Earthwork" and "Concrete Formwork" Sections.
- E. Screeds: Set screeds at walls and at a maximum of 10 foot between centers. Set to provide level floor. Check with instrument level, transit or laser during placing operations to maintain level floor.
- F. Screeds over Vapor Barrier: Use weighted pad or cradle type screeds and do not drive stakes through the vapor barrier.
- G. Expansion Joint Filler: Install where slabs abut building, or as indicated. Install full depth of concrete with top level with finished surface of concrete.

### 3.4 DEPOSITING

- A. Comply with CBC Section 1905.10.
- B. Convey concrete from the mixer and deposit within thirty minutes after discharge from the mixer, but in no case more than 1-1/2 hours from the time of first adding water on site. But no more than 2 hours from initial batching
- C. Place each unit of a structure, whenever possible, in one continuous operation. Place required vertical and horizontal construction joints in approved locations. Make all construction joints straight, horizontal or vertical, coinciding with reveals or top of forms, as applicable. Make surfaces of the concrete level where ever a run is stopped. Place reinforcing steel at construction joints as detailed on the Drawings. Prepare joints as shown, if required, to expose aggregate of previous pour, then wash thoroughly with water jet.
- D. When placing slabs that are inclined uphill, i.e. sloped post tensioned slabs, deposit concrete uphill to minimize tension cracking.
- E. Pour all walls and columns full story height. No horizontal joint will be allowed between floor line and top of wall, except as otherwise shown on Drawings or approved by Architect. Do not allow concrete to drop freely more than six feet, for concealed concrete and three feet for exposed concrete. Where deeper sections are being poured use tremies or metal chutes to limit the free fall. Place concrete by methods that prevent segregation of materials.
- F. Construction Joint Key: Finished smooth and straight, with proper forming strip allowing for easy removal. Tool top edges of slab construction joints to provide seat for caulking; v-groove bottom as detailed.
- G. Deposit concrete on forms as nearly as practicable at its final position. Deposit concrete into forms in horizontal layers around the building, proceeding along the forms at a uniform rate pouring concrete into edge of the concrete last poured.

Do not pour concrete into an accumulation of water ahead of the pour. Do not flow concrete along the forms to its place of final deposit. Do not cause concrete to flow such that the lateral movement will cause segregation of the coarse aggregate mortar or water from the concrete mass.

- 1. Do not place any subsequent pour without a construction joint against a previous pour which has set or been in place more than one hour.
- 2. Construction joint surfaces in walls and wall footings are to be raked to produce a rough, ridged surface of 1/4-inch amplitude perpendicular to direction of walls: refer to structural details. Comply with CBC Section 1905.7 and Section 1906.4.

- H. Do not retemper mix which has partially set. Place concrete in forms not more than 1-1/2 hours after water is added to the mix. Place no concrete when such wind, heat or limitations of provided facilities will prevent proper and uniform curing.
- I. Do not use grout in the vicinity of prestressing tendons, or anchors, or column regions of beams and slabs.
- J. Place vibrators in the concrete rapidly to minimize entrapped air between concrete and forms. Consolidate concrete and work to all points to provide solid, continuous contact with forms. Use power vibrators immediately during pour. Vibrating forms from the outside will only be used in addition to internal vibration at congested areas. Vibrate for sufficient time and supplement by rodding or spading by hand, to accomplish thorough compaction and complete embedment of reinforcement and fixtures, but not cause segregation of ingredients. Remove vibrator slowly from concrete to break up and release air entrapped between concrete and forms. Insure smooth surfaces free from voids, aggregate pockets or honeycombs, supplement mechanical vibration as necessary.
- K. Pour floor slabs, concrete pavements and walks, compacted and rodded accurately to the level and thickness as shown on the Drawings within a tolerance of 1/4-inch when tested with a 10-foot straightedge. Slope deck surface to elevations indicated, to drains wherever they occur. Where mesh reinforcement was not installed in a manner to support weight of workers during depositing, lift and recheck behind placing, for proper depth as indicated on Drawings.
- L. Set top of floor drains a minimum of 1/2-inch lower than surrounding concrete finish surface. Dish concrete within a three (3) foot radius of drain, to provide positive drainage to drain. Coordinate with plumbing work and verify before placing concrete. Where no such positive drainage is accomplished, remove drain and rework concrete. Reinstall drain to achieve drainage as stated above.
- M. Inserts, Anchors, and Embedded Items: Use cast-in fasteners wherever practicable. Set and build into the work anchorage devices and other embedded items required for other work that is attached to, or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of the items to be attached thereto. Coordinate with other trades for proper location.
  - 1. Powder driven or drilled concrete fasteners may be used in flat slab areas and columns only when approved in advance by the Engineer. Said fasteners may be used in tension only for support of light loads such as acoustical ceilings, duct work, conduits, pipes, and similar items when such loads are limited to less than 75 pounds. Submit load, location and hardware data for review to Engineer. Fasteners to be located 8-inch minimum from post tensioned tendons and penetration limited to 3/4-inch.
  - 2. Where drilled-in anchor bolts are used for significant gravity loads or seismic anchorage furnish data and proposed locations for review to Engineer. Do not use in post tensioned members or slabs without the specific approval of the Engineer in writing.

3. Where hanger rods, bolts, wire, coil inserts or similar items are used to suspend construction items, place in the concrete as required and/or indicated.
- N. Conduits and Sleeves:
1. Locate so as not to reduce the strength of construction.
  2. Provide layout drawings showing exact conduit path and spacings in all concrete members.
  3. Conduit up to 1-1/4 inch nominal outside diameter may be embedded in the central one-third thickness of slabs when layouts are submitted and approved by the Engineer. In no case may conduits displace reinforcing.
  4. Conduit shall not be placed beneath the bottom reinforcing steel or over top of top reinforcing bars.
  5. In placing conduits at slabs on earth, place below the reinforcement, and encase in concrete by increasing thickness of the slab locally to at least 3-inches of concrete around the conduit on all sides.
  6. Conduits shall be independently supported and shall not be tied to reinforcing or post-tensioning.
- O. Coring of columns, beams and post-tensioned members is not permitted unless specifically approved by Engineer in writing.
- P. Where openings in floors and walls are required by the work of other sections, but are not detailed on the Drawings, reinforce as required and directed by the Engineer.
- Q. Concrete shall not be placed until reinforcement, conduits, outlet boxes, anchors, sleeves; hangers, bolts and other embedded materials are securely and properly fastened in their correct positions.
- R. Where concrete equipment pads are required by electrical, plumbing and mechanical trades or for raised curbs, but are not detailed, reinforce as directed by Engineer, but shall have a minimum reinforcing of #4 at 18-inches on center each way including dowels to structural slab.
1. Concrete pads shall be installed horizontally, level, at typical floors and sloped to provide positive drainage at roofs, unless detailed otherwise or required by equipment manufacturer.
  2. Concrete raised curbs shall be installed horizontally, level at both the typical and roof levels, unless detailed otherwise or required by equipment manufacturer.
- S. Concrete slab on-grade paving for all miscellaneous walks, driveways, etc. shall be reinforced with 6-inchx 6-inch/W1.4 x W1.4 mid-depth, unless otherwise indicated on the Structural Drawings.

### 3.5 PATCHING AND FINISHING OF FORMED INTERIOR/EXTERIOR CONCRETE SURFACES

- A. Patching Concrete: Fill all rock pockets, "honeycombs", and random holes in excess of 3/16-inch, as well as heavy concentrations of air holes. This includes damage resulting from removal of nails, rod and cone ties, separators and core samples, etc. unless indicated otherwise. Chip away defective areas to solid concrete, forming perpendicular edges or slightly undercut edges. Drench area of patch and surrounding area with water. Pack full with mortar (sacking slurry) mix. Match surrounding concrete surfaces in color and texture using part white Portland cement, if necessary. Remove fins and irregularities in exposed concrete surfaces while concrete is green.

### 3.6 CONCRETE FINISHING

- A. Walls, Columns, Beams, Ceilings: See Section 03 11 13, 1.6, C.
- B. Concrete Slab Finishing: Bring the concrete slabs, using screed, to the required floor level and strike off true with a straightedge. Remove excess water and laitance. Compact with a grid tamper, if desired, then float and trowel finish as specified.
- C. Troweled finish for slabs in general which are to remain exposed or receive non-bonded finish (Storage, Electrical Room, etc.): Unless otherwise indicated or specified, all slabs to receive a simple steel trowel finish in two troweling operations.
  - 1. When the concrete has hardened sufficiently after floating, so that the fine particles do not work to the surface, hand or machine trowel and bring to a smooth surface, free from defects and blemishes.  
  
Do not sprinkle dry cement, or a mixture of cement and sand directly on the surface to absorb moisture or stiffen the mix.
  - 2. After the concrete has hardened sufficiently to prevent mortar from collecting on the trowel, trowel to a hard burnished surface, free from trowel marks. Continue troweling until there is a distinct ring under the trowel, but avoid excessive troweling.
- D. Raised Cast-In-Place Curbs, Cast-In-Place Stairs, and Concrete Landings: Trowel finish with final finish to be a medium broom finish.
- E. Float Finish For Slabs Scheduled To Receive Other Bonded Finish Materials: Finish with wood floats and lightly broom and brush clean to provide proper bond for finished materials. Verify finish requirements for surfaces to receive elastomeric coating with coating manufacturer.
- F. Trowel Finish For Garage Floors, Driveways, Ramps: Handtrowel finish with magnesium trowel, finish in rotary pattern to obtain heavy/coarse, sweated swirl finish. Finish is subject to Architect's approval.
- G. Sidewalks: Provide a medium broom finish

- H. Handicap Ramps- Accessibility Compliance: At 'Path of Travel' (ramps), concrete surfaces shall be finished with a heavy broom finish at slopes exceeding 6 percent, and medium broom finish at slopes up to 6 percent. Provide with a tactile warning as required for accessibility in accordance with International Building Code and the local jurisdiction requirements.
- I. Radius-tooled Edges: 1/4-inch radius typical for all slabs not metal edged and the tops of walls and beams where indicated unless noted otherwise.

### 3.7 CONTROL JOINTS

- A. Locate control joints on grade slabs where shown on the drawings or as follows:
  - 1. Provide saw cuts at all column centerlines and at uniform intervals no more than 20 feet on center in each direction. Submit proposed layout for approval by the Engineer. Resulting panels shall not exceed 400 square feet.
  - 2. Provide keyed joints at all slab on grade construction joints except where otherwise detailed on structural drawings.
- B. Approved method for saw cutting is to be by wet, soft cut, within 6 hours of pour following final troweling/finishing, 1/4 the depth of the slab, (1-inch minimum) unless indicated otherwise on Drawings.

### 3.8 SACKED FINISH AT EXTERIOR OF GARAGE WALLS

- A. Remove all fins and projections from concrete surfaces.
- B. Apply the pre-packaged slurry specified hereinbefore. Only upon special approval of the Architect may the Contractor proportion the slurry from one part cement to 1-1/2 parts sand, passing a No. 16 sieve, by damp loose volume, mixed with sufficient water and bond enhancing acrylic admixture to form a grout having the consistency of thick paint.
- C. Prior to applying slurry to surfaces, dampen concrete sufficiently to prevent water absorption. Spread slurry over surfaces with a clean sponge rubber float or burlap pads to completely fill all holes and imperfections. Float surface vigorously and, while slurry is still plastic, remove excess slurry.
- D. Allow to dry and then rub with burlap to completely remove dry slurry so that no visible film remains. The entire sacking operation for any area must be completed the day it is started. Surface when completed shall be smooth, free from air, pin or rock pockets and/or discoloration or defects, uniform in color and texture, free of dust and ready to paint.

### 3.9 SANDBLASTED FINISH

Sandblast surfaces as indicated on Drawings using a wet abrasive blast, in such a manner that the resulting surfaces have a uniform appearance and texture. Monitor water and abrasive blast pressure so as not to adversely affect, compromise or damage the original concrete color. Sandblasting method must match the approved samples and mock-up as selected by the Architect.

- A. As indicated on the Drawings.

### 3.10 DEFECTIVE CONCRETE

Work that is not in conformance with the Contract Documents, will be considered as defective material and/or faulty workmanship, and when directed, shall be removed and replaced at the Contractor's expense with work that conforms to the indicated requirements.

### 3.11 CURING

- A. Cure with an approved curing compound applied in accordance with manufacturer's instructions.

### 3.12 WEATHER CONDITIONS AND PROTECTION

- A. Protect concrete placing operations and freshly poured work from rain with canvas or other approved covering until set, giving special attention to protection of floor slabs during this period.
- B. Concrete placed when atmospheric temperature is below 40 degrees F. or is anticipated to be at freezing or near freezing temperature within 72 hours, shall have a temperature of not less than 50 degrees F., nor more than 80 degrees F. and shall be maintained at a temperature of at least 50 degrees F. for not less than five (5) days after placing. Additives to prevent freezing will not be permitted. Methods to maintain temperature of the air, forms or materials in contact must be reviewed by the Engineer.
- C. Cold weather concreting shall be as per ACI 306R. Cold weather concreting shall be performed only upon approval of the Engineer.  
  
Cold weather concreting methods shall be used under the conditions stated and in accordance with the recommendations and directions as contained in ACI 306. Do not use admixtures unless specifically permitted by the Engineer.
- D. Hot weather concreting shall be in accordance with all the recommendations, directions and requirements of ACI 305R. Do not use admixtures unless specifically permitted by the Engineer.

### 3.13 CLEANING

- A. Upon completion, wash and clean concrete flat work and vertical walls and columns leaving free from cement and concrete droppings or splatters, form release agents, curing compounds, oil, paint, plaster and other foreign substances, leaving ready to receive the scheduled coverings and paint.
- B. Where surfaces are to remain exposed, surfaces are to be free of stains, markings or other discolorations, which mar the appearance of the concrete. Contractor shall include as part of the Scope of Work all procedures required to clean surfaces exposed to view. Procedures shall include, but not be limited to power washing, acid washing or wet sandblasting, or concrete cleaner as approved by the Engineer.

### 3.14 CONCRETE STAIRS/MASONRY WALLS

Care shall be exercised that no concrete spillage or staining of masonry work occurs at stairs or other masonry work. Construct forms tight at wall intersections. Remove stains from masonry by means of washing immediately following the concrete pour.

### 3.15 MISCELLANEOUS CONCRETE ITEMS

- A. Grouting: Fill-in holes, surface defects, and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other sections is in place. Mix, place, and cure concrete as herein specified to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete the work. Refer to Structural Drawings for column base plate and other structural grouting requirements.

### 3.16 ANCHORING SYSTEMS

- A. Post-installed anchors will not be permitted in post-tensioned concrete unless specifically approved by the Engineer prior to use. Submit all requests for use to Engineer for review prior to starting work.
- B. Adhesive/Injection/Epoxy Systems: Installation to be as instructed by the manufacturer based on type of insert to be used as approved by the Engineer.
- C. Provide special inspection.

END OF SECTION



## SECTION 03 38 16

### POST TENSIONED CONCRETE

#### PART 1 - GENERAL

##### 1.1 WORK INCLUDED

- A. Requirements of the General Conditions, Supplementary General Conditions and Division I apply to work of this Section.
- B. Furnish all labor, materials, services, equipment and appliances required to perform all work to complete the Contract, including but not limited to these major items:
  - 1. Post-tensioning materials, including pre-stressing steel tendons, anchorage, distribution plates, and tendon enclosures.
  - 2. Placing of post-tensioning strands at the top deck (only) .
  - 3. Performing all post-tensioning operations, including jacking and anchoring.
  - 4. Cooperate in keeping records of elongations, gauge readings, etc.

##### 1.2 RELATED WORK IN OTHER SECTIONS

- A. Division 1
- B. Section 03 11 13: Concrete Formwork
- C. Section 03 20 00: Concrete Reinforcement
- D. Section 03 30 00: Cast-in-Place Concrete
- E. Section 05 50 00: Metal Fabrications

##### 1.3 CONDITIONS

The "General Notes" on the structural drawings are part of these specifications.

##### 1.4 REFERENCE STANDARDS

- A. American Concrete Institute (ACI)
  - ACI 301 Standard Specifications for Structural Concrete
  - ACI 318 Building Code Requirements for Reinforced Concrete.
  - ACI 423.3R Recommendations for Concrete Members Pre-stressed with Unbonded Tendons
- B. American Society for Testing and Materials (ASTM).
  - ASTM A416 Specifications for Uncoated Seven-Wire Stress Relieved Strand for Pre-stressed Concrete with supplement for Low Relaxation Strand
  - ASTM A421 Specifications for Uncoated Stress Relieved Wire for Pre-stressed Concrete
  - ASTM E328 Recommended Practice for Stress-Relaxation Tests for Materials and Structures.

- C. Post Tensioning Institute (PTI).

Guide Specifications for Post Tensioning Materials  
Performance Specification for Corrosion Preventive Coating

Specification for Un-bonded Single Strand Tendons  
Field Procedures Manual for Un-bonded Single Strand Tendons

- D. Precast / Pre-stressed Concrete Institute PCI Journal

- E. California Building Code CBC 2010, Chapter 19

## 1.5 QUALITY ASSURANCE

- A. Provide post-tensioning system from a fabricator with a minimum of five (5) years experience in the fabrication of post tensioning materials. Post tensioning fabricator shall be PTI Certified Plant. Upon special request, the Architect may approve a non-PTI certified fabricator if a 'Letter of Certification' from an independent testing lab states that all specified materials indicated herein conform to the referenced standards. Post tensioning product shall be of a manufacturer whose complete system has been approved by ICC certification and local Building Department.
- B. Post tension cable and anchor placement along with stressing procedures shall be performed by a company that has been successfully performing installations of a similar size and scale as the work of this Contract for a minimum period of five (5) years.
- C. All post tensioned concrete work shall be under the immediate supervisory control of a person experienced in this type of work. Exercise rigid control and documentation of all operations for full compliance with specified and referenced requirements.
- D. All work shall conform to Post Tensioning Institute (PTI) manual standards entitled "Specification for Un-bonded Single Strand Tendons" for minimum standards required. Where there is conflict between the referenced manual and the requirements specified herein, the most stringent governs.
- E. Concrete mix designs that are to be post tensioned shall conform to the requirements of Section 03 30 00 – Concrete and Concrete Finishes.
  - 1. Calcium chloride or admixtures that contain chloride ions shall not be used in design mixes that are in contact with post tensioning steel.
  - 2. Minimum design mix concrete strength shall be as indicated on the contract documents.
  - 3. Maximum drying shrinkage of the mix design shall not exceed that indicated per Section 03 30 00, 2.5.B.4.

## 1.6 REQUIREMENTS

- A. Stressing (post tensioning) shall commence when concrete cylinders manufactured and cured under the same conditions as member to be stressed indicates a compressive strength as required for anchorage bearing, but not less than 3000 psi.
- B. Contractor shall not drill into PT. slabs, beams or girders unless approved by the Engineer. When the project specific request and the proposed means and methods are approved, the Contractor shall x-ray the surfaces of completed post tensioned concrete members where drilling is necessary in order to exactly locate tendon locations, prior to executing the work.

## 1.7 TESTING AND INSPECTION

- A. Material Tests: Owner's testing laboratory will provide all material tests specified herein and indicated in the contract documents, as required by the governing Building Department. Conform to ACI Section 18, CBC Chapter 19, Section 1918 and 1929 and as specified herein.
  - 1. Samples for testing shall be accompanied by vendor's certification that submitted samples are representative of material being furnished for the project.
  - 2. Pre-stressing steel shall be tested for tensile strength and elongation at rupture.
- B. If inadequate product data and test results are provided by the manufacturer or the installer, regarding performance characteristics of the pre-stressing system, the Architect may require additional tests performed on individual components or the entire system to test material suitability and their conformance to project requirements.
- C. Owner will arrange and pay for the services of a Special Registered Deputy Building Inspector for continuous inspection of all post tensioning work. Inspector will inspect the placing of post tensioning materials and be continuously present during concrete placement and post tensioning operations. Inspector shall provide written report at completion of the work of this section stating that placement of cable and anchors and that the means and methods of installation and jacking procedures have been performed in compliance with CBC requirements, contract documents and as specified herein.
- D. Field Quality Control: Contractor shall furnish the following samples to Testing Laboratory for testing:
  - 1. One sample of wire strand from each heat of wire to be used:
    - a. Submittal of samples shall be accompanied by a transmittal and vendor affidavit that all samples submitted are from and representative of the materials that will be furnished and installed in the work.

- b. Pre-stressing steel shall be tested for modulus of elasticity and tensile strength, elongation at rupture and relaxation unless indicated otherwise. Each coil / size of strand shipped to the site shall be tagged with the assigned individual lot number and heat number classification for identification purposes.
- c. Both test pieces of each broken sample shall be fastened together and tagged with the job name, heat number, coil number, date tested and ultimate load, and shall be retained for inspection at any time.

## 1.8 SUBMITTALS

- A. Prepare all submittals in compliance with the current edition of ACI 301.
- B. Product Data:
  - 1. Submit manufacturer's technical data for post tensioning products including certification that each product complies with specified requirements. Include instructions for handling, storage, installation and protection of each product.
  - 2. Material Data: Contractor shall furnish the following information to Architect, and Testing Laboratory.
    - a. Certified mill test reports for each coil pack of strands containing as a minimum the following information.
      - Identification of each coil by heat number
      - Diameter and net area of the strand
      - Standard mill chemical analysis for each heat of steel
      - Record of the test strand stressing results to determine the
        - Ultimate tensile strength
        - Yield strength at 1% extension under load
        - Elongation at failure
        - Modulus of elasticity
        - Low relaxation evidence
        - Stress-strain curves for each heat
  - 3. Contractor shall furnish the following data prior to executing the field stressing procedures:
    - a. Gauge calibration chart/curve data sheet for each piece of stressing equipment with each numbered to the report. Calibration shall be performed and dated just prior to use of equipment.
    - b. Proposed field stressing procedure to be used.
- C. Shop Drawings:
  - 1. Show tendon layout and dimensions locating tendons in horizontal plane at all points. Detail horizontal curvature of tendons at block-outs and tail anchorages. Show all openings in slabs and beams.
  - 2. Provide tendon profiles showing chair heights, locations and any required placement steel that is required. Clearly indicate the location of each individual tendon or bundled tendons and the method of support.

3. Detail post tensioning and reinforcement at column and beam intersections around stressing pockets and closures, or where interference with post-tension tendons or anchors may occur. Coordinate any conflicts with reinforcing and conduit placement.
  4. Show required elongation of each tendon at jacking point.
  5. Complete pre-stressing procedure report to include the following:
    - a. Jack force and jacking pressure.
    - b. Maximum temporary jacking force and jacking pressure.
    - c. Certified gauge calibrations and method of jack identification.  
**NOTE:** Non-calibrated jack and pump combination units shall not be used on the job.
    - d. Method of determining anchor force or force remaining in tendons after anchorage.
  6. Furnish method of burning-off excess tendons after anchorage.
  7. Indicate the method of sealing tendons ends and sealing of stressing pockets.
- D. Calculations - Anchorage and Bearing Stress: Include calculations signed by a California Registered Civil Engineer of friction losses, initial stresses and anchorage stresses on the shop drawings to determine that design forces are obtainable.
- E. Samples: Provide for review, one sample tendon (uncoated and sheathed) from each heat of wire as required for testing and proposed for use, complete with tendon and anchoring system end components.
- F. Warranty: Provide manufacturer's written guarantee that post-tensioning materials and components of the specified system proposed to be furnished and installed into the work of this project conform to the strength indicated and requirements specified.
- G. Review of shop drawings by the Architect / Structural Engineer will be for general consideration only. Compliance with requirements for materials, fabrication, installation and performance of post-tensioning work is the Contractor's responsibility.
- H. When shop drawings and data sheets are reviewed for materials to be furnished without any exceptions noted, Contractor shall not change materials nor shall construction operations be deviated unless either / or both are resubmitted and re-reviewed.

#### 1.9 DELIVERY, STORAGE AND HANDLING

- A. Package the same heat lot and sized tendon/coils to be placed within the same area of the structure within the same labeled package of tendon coils that are bundled and wired together or plastic stretch wrap banded clearly marked with manufacturer's labels to positively identify where in the structure they are to be installed. Protect sheathing from being cut by binding materials. No part of the tendon shall be unprotected against moisture. Use of corrosion preventative coated on bare strand is unacceptable as a substitute for sheathing.

- B. Cable delivered to site prior to installation shall be protected from damage during transit and storage. Store tendon coils under cover, off ground, in a dry location to prevent damage from weather, moisture, soiling, corrosion or construction activities.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Pre-stressing Steel: Pre-stressing steel shall be plastic sheathed, or as otherwise approved, low relaxation, high tensile cold drawn wire 7 wire strand of 1/2" diameter minimum (area = 0.153 sq. in. min.), approximate modulus of elasticity of 28,000 ksi. Yield load shall be 35,000 lbs. at 1% extension with initial load of 4,130 lbs. and shall conform to requirements of CBC and to the following:

SEVEN-WIRE STRAND

ASTM Designation	A416/E328
Ultimate Strength	270 ksi
Temporary Stress to Overcome Friction	216 ksi
Anchor Stress	189 ksi
Elongation	0.0825 in/ft
Relaxation	2% Max. @ 1000 hours

- B. Concrete - As indicated on contract documents and as specified in Section 03 30 00 – Concrete and Concrete Finishes.
- C. Design and configuration of bearing plates, anchorage devices, stressing grippers, slippage sheathing and related materials shall be standard for the ways and means methods of post-tensioning to be used, and shall conform to the reviewed shop drawings, product data and ICC ES approval.
- D. Distribution Plates and Anchorages: Pre-stressing steel shall be secured at ends with approved non-corrosive anchoring devices.
  - 1. Provide ICC ES approved anchoring devices that will not kink, neck down or otherwise be damaged. Devices shall hold the pre-stressing steel without exceeding anticipated set at loads equal to 100% of the minimum ultimate tensile strength of the pre-stressing strand and conform to requirements of ACI Title 66-8.
  - 2. Distribution plates shall conform to ASTM A36 and be either welded steel, cast steel or cast steel bearing assemblies that permanently support and distribute the load from anchoring devices. Bending stress failure in anchor plates induced by pull of pre-stressing steel shall not exceed 27,000 psi for structural steel or 15,000 psi for cast steel. Castings shall be non-porous and free of sand, blowholes, voids or other defects.

3. Wedge grippers shall be designed to preclude premature failure of the prestressing steel due to notch or pinching effects under the static and/or dynamic test load conditions as outlined in Post-Tensioning manual for static and dynamic test requirements.
  - a. Finish of the anchorage wedge-seating zone shall not exceed micro-finish of 125 for stressing end anchorages or 250 for fixed anchorages.
4. Special reinforcement required for the performance of the anchorage shall be designed, supplied and installed by the Contractor. Such reinforcement shall not be less than (2) No. 4 bars unless shown otherwise on the Drawings.
5. Maximum concentrated bearing stresses in concrete shall not exceed that permitted by PTI bearing stresses.
6. Installation design shall conform to latest AISC and AWS standards, including qualification testing and certification of welders.
7. End bearing forces and grouting shall be provided as specified herein.
8. Anchorages shall be recessed to provide the minimum grout or concrete coverage of the steel reinforcing indicated on the contract documents or as required by Code, but in no case less than 1-1/2" concrete cover over anchors.

E. Sheathing:

1. The tendon sheathing shall be made of material with the following properties:
  - a. Sufficient strength to withstand un-repairable damage during fabrication, transport, installation, concrete placement and tensioning.
  - b. Water tightness over the entire sheathing length.
  - c. Chemical stability, becoming brittle, damage or softening over the anticipated exposure temperature range and during the service life of the structure.
  - d. Non-reactive with concrete, steel or the tendon corrosion preventive coating.
2. Minimum thickness of the sheathing shall not be less than 0.040 inches for medium or high-density polyethylene or polypropylene.
3. Sheathing shall have an inside diameter at least 0.010 inches greater than the maximum diameter of the strand.
4. Sheathing shall be continuous and watertight between anchor faces. Any area of exposed steel strand shall be covered with a water resistant tape.

F. Corrosion Preventive Coating:

1. Corrosion preventive coating material shall be lithium based, containing corrosion inhibitors, wetting agents, less than 50 parts per million of chlorides, sulfides or nitrates and have the following properties:
  - a. Corrosion protection for the duration of the service life of the building.
  - b. Lubrication between the strand and the sheathing.
  - c. Resist flow from the sheathing with the anticipated temperature range of exposure.

- d. Continuous non-brittle film at the lowest anticipated temperature of exposure.
  - e. Chemically stable and non-reactive with the pre-stressing steel, sheathing material and the concrete.
2. Protective film shall be an organic coating with appropriate polar moisture displacing and corrosion preventive additives.
  3. Minimum weight of coating material shall be not less than 2.5 pounds of coating material per 100 feet of 0.5-inch diameter strand. The amount of coating material used shall be sufficient to ensure essentially complete filling of annular space between the strand and the sheathing. The coating shall extend over the entire tendon length. The minimum thickness shall be 0.005-inch over the crest of the strands.
  4. Corrosion preventive coating material shall comply with following performance specifications:

CRITERIA	TEST METHOD	ACCEPTANCE
a. Dropping Point Deg. F (Deg. C)	ASTM D566 or ASTM D2265	Minimum 300(148.9)
b. Oil Separation @ 160 deg. F (71.1 deg. C) % by weight	FTMS 791B Method 321.2	Maximum 0.5
c. Water, % Maximum	ASTM D95	0.1
d. Flash Point, deg. F (deg. C) (Refers to oil component)	ASTM D92	Minimum 300(148.9)
e. Corrosion Test 5% Salt Fog @ 100 deg, F (37,8 deg, C) 5 mils, min. hours (Q Panel Type S)	ASTM B117	Rust grade 7 or better after 1000 hours of exposure according to ASTM D610
f. Water Soluble Ions (2) 1) Chlorides, ppm max. 2) Nitrates, ppm max. 3) Sulfides, ppm max.	ASTM D512 ASTM D992 APHA 427D (15th Ed)	10 10 10
g. Soak Test 5% Salt Fog at 100 deg. F (37.8 deg. C) 5 mils coating Q panels, Type S. Immerse panels 50% in a salt solution and expose to salt fog	ASTM B117 (Modified)	No emulsification of the coating after 720 hours of exposure



- |    |  |            |  |
|----|--|------------|--|
| h. | Compatibility with sheathing   |            | Permissible change hardness 15%            |
|    | 1) Hardness and volume change of polymer after exposure to grease, 40 days @ 150 deg. F. | ASTM D4289 | Permissible change in volume 10%           |
|    | 2) Tensile strength change of polymer after exposure to grease, 40 days @ 150 deg. F.    |            | Permissible change in tensile strength 30% |
- G. Broken strands or strands showing fabrication defects shall be removed and replaced, otherwise the member may be rejected.
- H. All pre-stressing steel tendons or anchors within a specific tagged group shall be of the same type and size of members, shall be of the same heat, where practicable and tagged accordingly.
- I. All pre-stressing steel shall be protected from rust or other corrosion or defects prior to placement and shall be free from deleterious substances when tensioned.

## 2.2 TENDON ANCHORAGES AND COUPLINGS

- A. Anchorages and couplings shall be designed to develop static and dynamic strength requirements per CBC and PTI requirements. Castings shall be non-porous and free of sand, blowholes, voids and other defects. Seal barrel end on stressing side of anchor with specified non-corrosive coating. Bearing side of anchor casting shall have provisions for plastic sleeve to prevent moisture leaks into anchor casting and tendon sheathing. For wedge type anchorages, wedge grippers shall be designed to preclude premature failure of pre-stressing steel due to notch or pinching effects under static and dynamic test load conditions stipulated for low relaxation pre-stressing steel materials.
- B. Block Outs: Use plastic pocket formers at stressing ends to provide a minimum 2 inch recess to anchor casting and 3 inch minimum width to allow access to cut off excess strands. Provide grommets at intermediate stressing ends to prevent moisture leaks into anchor casting or tendon sheathing.

## 2.3 OTHER MATERIALS

- A. Provide all other materials required for a complete installation but not specifically described, as subject to review by the Architect.
- B. Tape: 3M Tape No. 226, or approved equal.

- C. Tendon Tail and Anchor Coating Material:
  - 1. Bituminous: Tnemec 46-465 High Bolt Tneme-col, Farbertite Bituminous Coating by Briggs Bituminous Composition Co., or approved equal.
  - 2. Epoxy: Dayton Superior Rebar Epoxy Spray (J-62), or approved equal.
- D. Resin Bonding Agent for Anchor Pockets: Sikadur 32 High-Mod epoxy as manufactured by Sika Corporation, or approved equal.
- E. Provide non-ferrous or plastic tipped chairs for supports of cables.
- F. Grout: Refer to requirements of Section 03 30 00.

## PART 3 - EXECUTION

### 3.1 EXAMINATION OF SUBSTRATE

Examine areas and conditions which post tensioning work is to be performed and correct conditions detrimental to proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION REQUIREMENTS

- A. Pre-stressing tendons shall be firmly supported at intervals not exceeding 42 inches, or less where shown on the Drawings. Provide a sufficient number of positioning devices to prevent displacement during concrete placement. Remove staple legs projecting from concrete surfaces after forms are removed. Tie tendons to supporting chairs and reinforcement so sheathing is not damaged.
- B. Drapes shall conform to controlling points shown on Drawings and shall be in an approximate parabolic drape between supports. Dimensionally locate center of gravity of the tendon or group of tendons. Low points are at mid-span unless indicated otherwise.
- C. Slab strands shall be tied and chaired at intersections where they contact accessories or strands in perpendicular directions by a standard "snap U" tie. In addition to indicated reinforcing steel, extra support steel shall be provided and tied to strands and chairs to prevent lateral movement during concreting operations. Strands shall not be supported on beam top bars or ties.
- D. Vertical deviations in tendon placement location shall be kept to 1/4 in. maximum for slabs, 3/8 in. for concrete with dimensions over 8 in. but not over 2 ft. and 1/2 inch in concrete with dimensions over 2 ft. Maintain minimum required concrete coverage.
- E. All strands shall be straight in plan. Offset of strands and adjustment of spacing shall be done only with approval of Architect.

Horizontal plane deviations that may be necessary to avoid openings, ducts, chases, inserts, etc., shall be detailed to scale on the shop drawings and submitted for review.

- F. Tendons shall not be exposed to excessive temperatures, welding sparks or electric ground currents.

### 3.3 STRESSING ANCHORAGES

- A. Stressing anchorages shall be installed perpendicular to the tendon axis. Curvature in the tendon profile shall not be closer than three feet from the stressing anchorage unless indicated otherwise by the Architect.
- B. Stressing anchorages shall be attached to the bulkhead forms by either bolts, nails or threaded pocket former fittings. Connections shall be sufficiently rigid to avoid accidental loosening due to construction traffic or concrete placement.
- C. Pocket formers used to provide or form a void at the stressing and intermediate stressing anchorage ends shall positively preclude intrusion of concrete or cement paste into the wedge cavity during concrete placement. The depth of the pocket former from the edge of the concrete to the face of the anchorage shall not be less than 1-1/2 inches.

### 3.4 INTERMEDIATE ANCHORAGES

- A. Intermediate anchorages shall be embedded in the concrete at the construction joint locations, if used.
- B. Minimum concrete cover for the anchorage shall be as indicated. Minimum concrete coverage requirements apply also to intermediate anchorages.

### 3.5 FIXED ANCHORAGES

- A. Fixed end anchorages shall be installed on the tendon at the point of supply plant prior to shipment to job site.
- B. Fixed end wedge type anchors shall be seated with a load of not more than 80% of the minimum ultimate tensile strength of the tendon. The seating load shall be sufficient to ensure adequate capacity of anchorage.
- C. Fixed end anchorages shall be placed in the formwork with 2" minimum, 3" maximum clearance from inside of edge form at the locations indicated on the placing drawings and securely fastened to the reinforcing steel.

### 3.6 SHEATHING INSPECTION

- A. Tendon sheathing shall be inspected for damage after installing tendons in the forms and prior to concrete placement.
- B. Repair damaged corrosion preventive coating and repair sheathing with additional strip of sheathing taped in position with a water resistant tape. Watertight sheathing protection for strands shall extend to anchor faces at each end.

- C. Sheathing Repair:
  - 1. Restore tendon corrosion preventative coating at damaged area.
  - 2. Place a piece of longitudinally slit sheathing around corrosion preventative coated tendon. Slit shall be on side of tendon opposite tear. Length of slit sheathing shall overlap corrosion preventative coated area by 2 inch at each end.
  - 3. Tape entire length of split sheathing spirally wrapping tape around sheathing to provide at least two layers of tape. Tape used to repair sheathing shall be adhesive moisture proof tape. Tape sheathing to anchorages to attain continuity of sheathing.

### 3.7 TENDON STRESSING - POST TENSIONING

- A. Perform under inspection of the Owners special deputy / inspector.
- B. Losses in stress due to creep, slip at anchorage, elastic shortening, shrinkage of concrete, relaxation of steel and sequence of stressing shall be assumed to be not less than 15,000psi unless substantiated by tests and calculations, and as accepted by the Structural Engineer.
- C. Stressing (post tensioning) shall commence within 72 hours after concrete pour/placement, when concrete cylinders manufactured and cured under the same conditions as member to be stressed indicates a compressive strength as required for anchorage bearing, but not less than 3,000psi.
- D. Hydraulic stressing rams used to stress un-bonded single strand tendons shall be equipped with stressing grippers that will not notch the strand more severely than normal anchoring wedges.
- E. Stressing rams and gauges shall individually be identified and calibrated against known standards and within 30 days of their use. Calibration certificates shall accompany each gauge.
- F. Adequate provision shall be made for access of stressing equipment when placing strands. The minimum stressing equipment space of 3 ft. normal to the stressing edge of any member shall be kept clear of construction material, equipment or other obstructions until stressing operations are completed.
- G. Inserts in concrete work shall be accurately installed and secured in place including pre-stressing items such as enclosures, spacer bars, anchorages, etc., as well as all inserts required for attaching electrical, mechanical, steel studs and other items of equipment. Use of powder driven studs shall not be permitted. Embedded inserts, conduits, etc., shall not be attached to pre-stressing strands.
- H. All pockets required for anchorage shall be adequately reinforced so not to decrease the strength of the structure. All pockets shall be waterproof to eliminate water leakage through the pocket or into the protective sheathing.
- I. Holes other than those shown on plans are not permitted within 24 inches of pre-stressing anchorage.

- J. Strands shall be stressed by hydraulic jacks equipped with accurate reading, calibrated, hydraulic gauges of at least 6 inches diameter and having a fine pointer to permit stress in pre-stressing steel to be computed at any time. A certified calibration curve shall accompany each gauge / jack combination. Jack gauges shall be immediately recalibrated, if inconsistencies between the measured elongation and the jack gauge reading occur.
- K. Stressing procedure for each strand in general, shall be as follows:
1. Stress to the required elongation. Stress may be increased to, but not exceed 216ksi, 80% of ultimate, to overcome friction.
  2. Gradually reduce load and set grippers to transfer full force to anchorage at 189ksi, 70% ultimate strength.
  3. Elongation measurements shall be made at each stressing location to verify that the tendon force has been properly achieved.
  4. Elongation of strands shall be recorded on an approved form. A variation of plus or minus 7% is acceptable for any one strand provided that sum of initial force in any three adjacent strands is no less than the sum of the required force for these three strands. Cumulative negative tolerance that would result in an overall reduction of initial force exceeding 3% will not be permitted.
  5. Discrepancies exceeding above variations shall be resolved with the Architect.
  6. Cut tendon tails (per requirements hereafter) when stressing is approved by the structural engineer / inspector. No tendon tail shall be cut off from a member whose attained force is not within 7% of the required force without written permission of the Architect or Structural Engineer.
  7. Coat the anchorage and inside pocket prior to grouting the wall-stressing pocket flush with adjoining surfaces.
- L. Stressing operations shall be per approved sequence. Uniformly distributed tendons shall be stressed before banded tendons and uniformly spaced slab tendons shall be stressed before beam tendons, or band tendons. Beam tendons shall be stressed before girder tendons.
- M. Stressing records shall be compiled during the tensioning operation, with the following data recorded as a minimum:
1. Tendon mark or identification
  2. Required elongation
  3. Gauge pressure to achieve required elongation
  4. Actual elongation achieved
  5. Actual gauge pressure
  6. Date of stressing operation
  7. Signature of the stressing operator or inspector
  8. Serial or identification number of jacking equipment and calibration date -  
Stressing records shall be submitted to the Architect and Structural Engineer for review.

### 3.8 ALLOWABLE STRESSES FOR PRESTRESSING STEEL

- A. Maximum stress (jacking stress): Tendons may be temporarily stressed to a value higher than the anchoring stress in order to overcome stressing friction. In no case shall temporary stress exceed 80% of the guaranteed ultimate tensile strength of the strand ( $0.8f_{pu}$ ).
- B. Initial stress (anchoring stress): Maximum stress in strand at anchorage immediately after seating shall not be greater than 70% of the guaranteed ultimate tensile strength of the strand ( $0.70f_{pu}$ ). Maximum stress anywhere in strand shall not exceed 74% of the guaranteed ultimate strength of the strand ( $0.74f_{pu}$ ). Jacking force shall be decreased and elongations adjusted as required to meet these criteria.

### 3.9 TENDON FINISHING

- A. Stressing End – Wall Pocket: Trim excess tendon tail length only after approval of tensioning. The tendon tail length protruding beyond the seating wedge after cutting shall be between 3/4 and 1-1/4 inches and in no case less than 1/2 inch. Minimum concrete cover over tendon tail shall be 3/4 inch. Cut tendon tail by means of either, oxyacetylene torch cutting, abrasive wheel or hydraulic shears. Avoid directing the flame from the oxyacetylene torch toward seating wedges when cutting / burning off tendon tails.
- B. Dead End – Pour Strip: Strands in delayed cast pour strips shall be left uncut / extended, but not longer than the width of the pour strip and cleaned of protective coating.
- C. Stressing pockets shall be filled with non-shrink grout after tendon stressing and cutting. Under no circumstances shall the grout used for pocket filling contain chlorides or other chemicals known to be deleterious to the pre-stressing steel tendon.
  - 1. The exposed strands and wedge areas shall be coated with bituminous tendon coating material or approved equal protective coating. Coat the inside concrete pocket surfaces including steel wedge with a heavy coat of resin bonding agent, prior to installing the pocket grout. Place grout fill while bonder is still wet. Install per manufacturer's printed instructions.
  - 2. Grouting operations, per manufacturer's instructions with products as specified under Section 03300 - Concrete and Concrete Finishes.
  - 3. When adjoining concrete is indicated as being left exposed (unpainted), the grout pocket fill shall be smoothed and rubbed to match and blend in with adjoining surfaces.

### 3.10 SAFETY PRECAUTIONS

- A. Take precautions to prevent workers from standing directly behind, above or in front of the stressing jacks.
- B. Comply with requirements issued by CAL-OSHA Industrial Relations Department, State of California.