

SECTION 03 30 00  
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
1. Formwork and accessories.
  2. Shoring, bracing, and anchorage.
  3. Reinforcing bars.
  4. Welded wire fabric.
  5. Inserts and accessories.
  6. Cast-in-place concrete.
- B. Related Sections:
1. Section 31 23 16 - Excavation and Backfill: Excavation for Work of this Section.
  2. Section 32 13 13 – Concrete Paving
  3. Section 32 31 13 – Chain Link Fences and Gates
  4. Section 33 11 00 – Water Utility Distribution Piping
  5. Section 33 31 00 – Sanitary Utility Sewerage Piping
  6. Section 33 34 00 – Sanitary Utility Sewerage Force Mains
  7. Section 33 41 00 – Storm Utility Drainage Piping
  8. Section 33 42 13 – Pipe Culverts

1.2 REFERENCES

- A. American Concrete Institute:
1. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials.
  2. ACI 301 - Specifications for Structural Concrete.
  3. ACI 305 - Hot Weather Concreting.
  4. ACI 306.1 - Standard Specification for Cold Weather Concreting.
  5. ACI 308.1 - Standard Specification for Curing Concrete.
  6. ACI 318 - Building Code Requirements for Structural Concrete.
  7. ACI 530.1 - Specifications for Masonry Structures.
  8. ACI SP-66 - ACI Detailing Manual.
- B. American Forest and Paper Association:
1. AF&PA - National Design Specifications for Wood Construction.
- C. The Engineered Wood Association:
1. APA/EWA PS 1 - Voluntary Product Standard for Construction and Industrial Plywood.
- D. ASTM International:
1. ASTM A184 - Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
  2. ASTM A496 - Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
  3. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
  4. ASTM A775 - Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
  5. ASTM A884 - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement.

6. ASTM A934 - Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.
  7. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
  8. ASTM C33 - Standard Specification for Concrete Aggregates.
  9. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
  10. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
  11. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
  12. ASTM C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
  13. ASTM C150 - Standard Specification for Portland Cement.
  14. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
  15. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
  16. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
  17. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
  18. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
  19. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
  20. ASTM C685 - Standard Specification for Concrete Made By Volumetric Batching and Continuous Mixing.
  21. ASTM C1017 - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
  22. ASTM C1064 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
  23. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
  24. ASTM C1218 - Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
  25. ASTM D994 - Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
  26. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
  27. ASTM D1752 - Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
  28. ASTM D3963 - Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Reinforcing Steel Bars.
  29. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
  30. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
  31. ASTM E1643 - Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill under Concrete Slabs.
  32. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
- E. American Welding Society:
1. AWS D1.4 - Structural Welding Code - Reinforcing Steel.
- F. Concrete Reinforcing Steel Institute:
1. CRSI - Manual of Standard Practice.
  2. CRSI - Placing Reinforcing Bars.
- G. West Coast Lumber Inspection Bureau:

1. WCLIB - Standard Grading Rules for West Coast Lumber.

### 1.3 PERFORMANCE REQUIREMENTS

- A. Vapor Retarder Permeance: Maximum 0.3 perm when tested in accordance with ASTM E96, Procedure A.

### 1.4 SUBMITTALS

- A. Section 01330 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data on joint devices, attachment accessories, and admixtures.
- C. Shop Drawings: Indicate bar sizes, spacing, locations, and quantities of reinforcing steel and welded wire fabric, bending and cutting schedules, and supporting and spacing devices.
- D. Certificates: Submit AWS qualification certificate for welders employed on the Work.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
  1. Submit certified copies of mill test report of reinforcement materials analysis.
- F. Concrete Design Data:
  1. Submit a concrete mix design for each concrete strength. Submit separate mix designs when admixtures are required for the following:
    - a. Hot and cold weather concrete work.
    - b. Air entrained concrete work.
  2. Identify mix ingredients and proportions, including admixtures.
  3. Identify chloride content of admixtures and whether or not chloride was added during manufacture.
- G. Manufacturer's Installation Instructions: Submit installation procedures and interface required with adjacent Work.
- H. Project Record Documents: Accurately record actual locations of embedded utilities and components concealed from view in finished construction.

### 1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 318.
- B. For wood products furnished for work of this Section, comply with AF&PA.
- C. Prepare shop drawings in accordance with ACI SP-66.
- D. Conform to ACI 305 when concreting during hot weather.
- E. Conform to ACI 306.1 when concreting during cold weather.
- F. Acquire cement and aggregate from one source for Work.

### 1.6 QUALIFICATIONS

- A. Welders: AWS qualified within previous 12 months.

### 1.7 ENVIRONMENTAL REQUIREMENTS

- A. Maintain concrete temperature after installation at minimum 50 degrees F for minimum 7 days.
- B. Maintain high early strength concrete temperature after installation at minimum 50 degrees F for minimum 3 days.

## 1.8 COORDINATION

- A. Coordinate placement of joint devices with erection of concrete formwork and placement of form accessories.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01600 - Product Requirements: Products storage and handling requirements.
- B. Deliver void forms and installation instructions in manufacturer's packaging. Store off ground in ventilated and protected manner to prevent deterioration from moisture.

## PART 2 PRODUCTS

### 2.1 WOOD FORM MATERIALS

- A. Softwood Plywood: APA/EWA PS 1, C Grade, Group 2.
- B. Lumber Forms:
  - 1. Application: Use for edge forms and unexposed finish concrete.
  - 2. Boards: 6 inches or 8 inches in width, ship lapped or tongue and groove, "Standard" Grade Douglas Fir, conforming to WCLIB Standard Grading Rules for West Coast Lumber. Surface boards on four sides.
- C. Plywood Forms:
  - 1. Application: Use for exposed finish concrete.
  - 2. Forms: Conform to PS 1; full size 4 x 8 feet panels; each panel labeled with grade trademark of APA/EWA.
  - 3. Plywood for Surfaces to Receive Membrane Waterproofing: Minimum of 5/8-inch thick; APA/EWA "B-B Plyform Structural I Exterior" grade.
  - 4. Plywood where "Smooth Finish" is required, as indicated on Drawings: APA/EWA "HD Overlay Plyform Structural I Exterior" grade, minimum of 3/4-inch thick.

### 2.2 PREFABRICATED FORMS

- A. Manufacturers:
  - 1. Aluma-Systems Inc., Burke Co.
  - 2. Economy Forms Corp.
  - 3. Molded Fiber Glass Concrete Forms Co.
  - 4. Perma Tubes.
  - 5. Sonoco Products Co.
  - 6. Symons Corp. Product Western Forms, Inc.
  - 7. Product Substitutions: Equal per Section 01600 - Product Requirements.
- B. Preformed Steel Forms: Minimum 16 gage matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

- C. Glass Fiber Fabric Reinforced Plastic Forms: Matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.
- D. Pan Type: Steel or glass fiber of size and profile required.
- E. Tubular Column Type: Round, spirally wound laminated fiber material; surface treated with release agent, non-reusable, sizes as indicated on Drawings.
- F. Void Forms: Moisture resistant treated paper faces, biodegradable, structurally sufficient to support weight of wet concrete mix until initial set; 4 inches thick.
- G. Steel Forms: Sheet steel, suitably reinforced and designed for particular use indicated on Drawings.
- H. Form Liners: Smooth, durable, grainless, and non-staining hardboard, unless otherwise indicated on Drawings.
- I. Framing, Studding, and Bracing: Stud or No. 3 structural light framing grade.

### 2.3 ARCHITECTURAL FORM LINERS

- A. Architectural Form Liners: As indicated on Drawings.

### 2.4 FORMWORK ACCESSORIES

- A. Form Ties: Removable type, adjustable length, with waterproofing washer, free of defects capable of leaving holes larger than 1 inch in concrete surface, and leaving no metal within 1 inch of exposed surface.
- B. Spreaders: Standard non-corrosive metal form clamp assembly of type acting as spreaders and leaving no metal within 1 inch of concrete face. Wire ties, wood spreaders, or through bolts are not permitted.
- C. Form Anchors and Hangers:
  - 1. Do not use anchors and hangers exposed concrete leaving exposed metal at concrete surface.
  - 2. Symmetrically arrange hangers supporting forms from structural steel members to minimize twisting or rotation of member.
  - 3. Penetration of structural steel members is not permitted.
- D. Form Release Agent: Colorless mineral oil that will not stain concrete or absorb moisture or impair natural bonding or color characteristics of coating intended for use on concrete.
  - 1. Manufacturers:
    - a. Arcal Chemical Corporation, Arcal-80.
    - b. Industrial Synthetics Company, Synthex.
    - c. Nox-Crete Company, Nox-Crete Form Coating.
    - d. Substitutions: Section 01600 - Product Requirements.
- E. Corners exposed to view: Fillet and Chamfer; rigid plastic or wood strip type; 3/4 x 3/4 inch size; maximum possible lengths.
- F. Vapor Retarder: Where indicated on Drawings, 6 mil thick polyethylene sheet.
- G. Bituminous Joint Filler: ASTM D1751.

- H. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Size, strength, and character to maintain formwork in place while placing concrete.
- I. Water Stops: Polyvinyl chloride, minimum 1,750 psi tensile strength, minimum 50 degrees F to plus 175 degrees F working temperature range, width as shown on Drawings, maximum possible lengths, ribbed profile, preformed corner sections, heat welded jointing.

## 2.5 REINFORCEMENT

- A. Deformed Reinforcement: ASTM A615; 60 ksi yield strength, steel bars, unfinished or epoxy coated finish as indicated on Drawings.
- B. Deformed Bar Mats: ASTM A184; fabricated from ASTM A615 60 ksi yield strength, steel bars, unfinished or epoxy coated finish as indicated on Drawings.
- C. Welded Plain Wire Fabric: ASTM A185; in flat sheets or coiled rolls; unfinished or epoxy coated finish as indicated on Drawings.

## 2.6 REINFORCEMENT ACCESSORIES

- A. Tie Wire: Minimum 16 gage annealed type, epoxy coated.
- B. Chairs, Bolsters, Bar Supports, and Spacers: Sized and shaped for strength and support of reinforcement during concrete placement conditions including load bearing pad on bottom to prevent vapor retarder puncture.
- C. Special Chairs, Bolsters, Bar Supports, Spacers Adjacent to Weather Exposed Concrete Surfaces: Plastic-coated steel type; size and shape to meet Project conditions.
- D. Reinforcing Splicing Devices: Exothermic welding type or mechanical threaded type; full tension and compression; sized to fit joined reinforcing.
- E. Epoxy Coating Patching Material: Type as recommended by coating manufacturer.

## 2.7 REINFORCEMENT FABRICATION

- A. Fabricate concrete reinforcement in accordance with ACI 318.
- B. Form standard hooks for 180 degree bends, 90 degree bend, stirrup and tie hooks; and seismic hooks as indicated on Drawings.
- C. Form reinforcement bends with minimum diameters in accordance with ACI 318.
- D. Fabricate column reinforcement with offset bends at reinforcement splices.
- E. Form spiral column reinforcement from minimum 3/8-inch diameter continuous deformed bar or wire.
- F. Form ties and stirrups from the following:
  - 1. For bars No. 10 and Smaller: No. 3 deformed bars.
  - 2. For bars No. 11 and Larger: No. 4 deformed bars.
- G. Weld reinforcement in accordance with AWS D1.4.

- H. Epoxy-Coated Reinforcement: Clean surfaces, weld and re-protect welded joint in accordance with CRSI.
- I. Locate reinforcement splices not indicated on Drawings, at point of minimum stress. Review location of splices with Engineer.

## 2.8 SHOP FINISHING

- A. Epoxy Coated Finish for Steel Bars: ASTM A775; ASTM A934 if coating is applied after fabrication.
- B. Epoxy Coated Finish for Steel Wire: ASTM A884, Class A using ASTM A775; ASTM A934 if coating is applied after fabrication.

## 2.9 SOURCE QUALITY CONTROL

- A. Section 01400 - Quality Requirements: Testing, inspection, and analysis requirements.
- B. When fabricator is approved by authority having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents. Specified shop tests are not required for Work performed by approved fabricator.

## 2.10 CONCRETE MATERIALS

- A. Cement: ASTM C150, Type I – Normal, Type IA - Air Entraining, Type II – Moderate, Type IIA - Air Entraining, or Type V - Sulfate Resistant Portland type.
- B. High Early Strength Cement: ASTM C150, Type III or Type III – Air Entraining only when indicated on Drawings.
- C. Normal Weight Aggregates: ASTM C33.
  - 1. Coarse Aggregate Maximum Size: In accordance with ACI 318.
- D. Water: ACI 318; potable, without deleterious amounts of chloride ions.

## 2.11 CONCRETE ADMIXTURES

- A. Manufacturers:
  - 1. Degussa Admixtures, Inc. (Master Builders).
  - 2. Euclid Chemical Co.
  - 3. Fritzpak Concrete Admixtures Co.
  - 4. Grace Construction Products.
  - 5. Larsen Products Corp.
  - 6. L & M Construction Chemicals.
  - 7. Sika Chemical Co.
  - 8. W. R. Meadows Inc.
  - 9. Substitutions: Section 01600 - Product Requirements.
- B. Air Entrainment: ASTM C260.
- C. Chemical: ASTM C494:
  - 1. Type A - Water Reducing.
  - 2. Type B – Retarding.
  - 3. Type C – Accelerating.
  - 4. Type D - Water Reducing and Retarding.

5. Type E - Water Reducing and Accelerating.
6. Type F - Water Reducing, High Range.
7. Type G - Water Reducing, High Range and Retarding.

- D. Fly Ash: ASTM C618, Class F or C.
- E. Plasticizing: ASTM C1017, Type I - Plasticizing or Type II - Plasticizing and retarding.

## 2.12 CONCRETE ACCESSORIES

- A. Bonding Agent:
1. Not exposed to water after placement: Polyvinyl Acetate.
  2. Exposed to water after placement: Latex emulsion or epoxy adhesive.
- B. Vapor Retarder: ASTM E1745 Class A; 6 mil thick clear polyethylene film; type recommended for below grade application. Furnish joint tape recommended by manufacturer.
- C. Non-Shrink Grout: ASTM C1107, Grade A or B; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 4,000 psi in 3 days and 7,000 psi in 28 days.

## 2.13 JOINT DEVICES AND FILLER MATERIALS

- A. Joint Filler: ASTM D1751 or ASTM D994; Preformed asphalt impregnated fiberboard or felt, thickness as indicated on Drawings; tongue and groove profile.
- B. Sealant: ASTM D6690, Type III.

## 2.14 CONCRETE MIX

- A. Select proportions for normal weight concrete in accordance with ACI 301 Method 1 or Method 2.
- B. Admixtures: Include admixture types and quantities indicated in concrete mix designs only when approved by Engineer.
1. Use accelerating admixtures in cold weather. Use of admixtures will not relax cold weather placement requirements.
  2. Do not use calcium chloride or admixtures containing calcium chloride.
  3. Use set retarding admixtures during hot weather.
  4. Add air entrainment admixture to concrete mix for work exposed to freezing and thawing or deicing chemicals.
  5. For concrete exposed to deicing chemicals, limit fly ash to less than 25 percent of the combined weight of cement and fly ash.
- C. Ready Mixed Concrete: Mix and deliver concrete in accordance with ASTM C94.
- D. Site Mixed Concrete: Mix concrete in accordance with ACI 318.

## 2.15 CURING COMPOUNDS

- A. Membrane Curing Compound: ASTM C309 Type 1, Class B.
1. Manufacturers:
    - a. Degussa Admixtures, Inc., Confilm.
    - b. Euclid Chemical Co., Kurez W VOX.

- c. W. R. Meadows, Inc., 1100-Clear Series.
  - d. Substitutions: Equal per Section 01600 - Product Requirements.
- B. Water: Potable, not detrimental to concrete.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify requirements for concrete cover over reinforcement.
- C. Verify anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with placing concrete.

### 3.2 PREPARATION

- A. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent. Remove laitance, coatings, and unsound materials.
- B. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with epoxy.
- C. Remove debris and ice from formwork, reinforcement, and concrete substrates.
- D. Remove water from areas receiving concrete before concrete is placed.
- E. Earth Forms:
  - 1. Trench earth forms neatly, accurately, and at least 2 inches wider than footing widths indicated on Drawings.
  - 2. Trim sides and bottom of earth forms.
  - 3. Construct wood edge strips at top of each side of trench to secure reinforcing and prevent trench from sloughing.
  - 4. Form sides of footings where earth sloughs.
  - 5. Tamp earth forms firm and clean forms of debris and loose material before depositing concrete.
- F. Formwork - General:
  - 1. Provide top form for sloped surfaces steeper than 1.5 horizontal to 1 vertical to hold shape of concrete during placement, unless it can be demonstrated that top forms can be omitted.
  - 2. Construct forms to correct shape and dimensions, mortar-tight, braced, and of sufficient strength to maintain shape and position under imposed loads from construction operations.
  - 3. Camber forms where necessary to produce level finished soffits unless otherwise shown on Drawings.
  - 4. Carefully verify horizontal and vertical positions of forms. Correct misaligned or misplaced forms before placing concrete.
  - 5. Complete wedging and bracing before placing concrete.
- G. Forms for Smooth Finish Concrete:
  - 1. Use steel, plywood or lined board forms.
  - 2. Use clean and smooth plywood and form liners, uniform in size, and free from surface and edge damage capable of affecting resulting concrete finish.

3. Install form lining with close-fitting square joints between separate sheets without springing into place.
  4. Use full size sheets of form lines and plywood wherever possible.
  5. Tape joints to prevent protrusions in concrete.
  6. Use care in forming and stripping wood forms to protect corners and edges.
  7. Level and continue horizontal joints.
  8. Keep wood forms wet until stripped.
- H. Architectural Form Liners:
1. Erect architectural side of formwork first.
  2. Attach form liner to forms before installing form ties.
  3. Install form liners square and straight, with joints and pattern aligned.
  4. Seal form liner joints to prevent grout leaks.
  5. Dress joints and edges to match form liner pattern and texture.
- I. Forms for Surfaces to Receive Membrane Waterproofing: Use plywood or steel forms. After erection of forms, tape form joints to prevent protrusions in concrete.
- J. Framing, Studding and Bracing:
1. Size framing, bracing, centering, and supporting members with sufficient strength to maintain shape and position under imposed loads from construction operations.
  2. Distribute bracing loads over base area on which bracing is erected.
  3. When placed on ground, protect against undermining, settlement, or accidental impact.
- K. Erect formwork, shoring, and bracing to achieve design requirements in accordance with requirements of ACI 318.
- L. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.
- M. Obtain Engineer's approval before framing openings in structural members not indicated on Drawings.
- N. Install fillet and chamfer strips on external corners of exposed corners.
- O. Install void forms in accordance with manufacturer's recommendations.
- P. Do not reuse wood formwork with damaged faces or edges for concrete surfaces to be exposed to view. Do not patch formwork.

### 3.3 APPLICATION - FORM RELEASE AGENT

- A. Apply form release agent on formwork in accordance with manufacturer's recommendations.
- B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.
- C. Do not apply form release agent where concrete surfaces are indicated to receive special finishes or applied coverings that are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.
- D. Reuse and Coating of Forms: Thoroughly clean forms and reapply form coating before each reuse. For exposed work, do not reuse forms with damaged faces or edges. Apply form coating to forms in accordance with manufacturer's specifications. Do not coat

forms for concrete indicated to receive "scored finish". Apply form coatings before placing reinforcing steel.

### 3.4 INSTALLATION - INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Install formed openings for items to be embedded in or passing through concrete work.
- B. Locate and set in place items required to be cast directly into concrete.
- C. Coordinate with Work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other Work.
- D. Install accessories straight, level, and plumb. Ensure items are not disturbed during concrete placement.
- E. Install water stops continuous without displacing reinforcement. Heat seal joints watertight.
- F. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.
- G. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.
- H. Form Ties:
  - 1. Use sufficient strength and sufficient quantity to prevent spreading of forms.
  - 2. Place ties at least 1 inch away from finished surface of concrete.
  - 3. Leave inner rods in concrete when forms are stripped.
  - 4. Space form ties equidistant, symmetrical, and aligned vertically and horizontally unless otherwise shown on Drawings.
  - 5. Set with waterstops.
- I. Arrangement: Arrange formwork to allow proper erection sequence and to permit form removal without damage to concrete.
- J. Construction Joints:
  - 1. Install surfaced pouring strip where construction joints intersect exposed surfaces to provide straight line at joints.
  - 2. Just prior to subsequent concrete placement, remove strip and tighten forms to conceal shrinkage.
  - 3. Show no overlapping of construction joints. Construct joints to present same appearance as butted plywood joints.
  - 4. Arrange joints in continuous line straight, true and sharp.
- K. Embedded Items:
  - 1. Make provisions for pipes, sleeves, anchors, inserts, reglets, anchor slots, nailers, water stops, and other features.
  - 2. Do not embed wood or uncoated aluminum in concrete.
  - 3. Obtain installation and setting information for embedded items furnished under other Specification sections.
  - 4. Securely anchor embedded items in correct location and alignment prior to placing concrete.
  - 5. Verify conduits and pipes, including those made of coated aluminum, meet requirements of ACI 318 for size and location limitations.
- L. Openings for Items Passing Through Concrete:

1. Frame openings in concrete where indicated on Drawings. Establish exact locations, sizes, and other conditions required for openings and attachment of work specified under other sections.
2. Coordinate work to avoid cutting and patching of concrete after placement.
3. Perform cutting and repairing of concrete required as result of failure to provide required openings.

M. Screeds:

1. Set screeds and establish levels for tops of concrete slabs and levels for finish on slabs.
2. Slope slabs to drain where required or as shown on Drawings.
3. Before depositing concrete, remove debris from space to be occupied by concrete and thoroughly wet forms. Remove freestanding water.

N. Screed Supports:

1. For concrete over waterproof membranes and vapor retarder membranes, use cradle, pad, or base type screed supports which will not puncture membrane.
2. Staking through membrane is not permitted.

O. Cleanouts and Access Panels:

1. Provide removable cleanout sections or access panels at bottoms of forms to permit inspection and effective cleaning of loose dirt, debris, and waste material.
2. Clean forms and surfaces against which concrete is to be placed. Remove chips, saw dust and other debris. Thoroughly blow out forms with compressed air just before concrete is placed.

### 3.5 FORM CLEANING

- A. Clean forms as erection proceeds to remove foreign matter within forms.
- B. Clean formed cavities of debris prior to placing concrete.
- C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.
- D. During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out forms unless formwork and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.

### 3.6 FORM REMOVAL

- A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads or removal has been approved by Engineer.
- B. Leave forms in place for minimum number of days as specified in ACI 347.
- C. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
- D. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.
- E. Twist ties off, point and patch holes with non-shrink grout within 48 hours of form removal.

### 3.7 ERECTION TOLERANCES

- A. Tolerances: Construct formwork to produce completed concrete surfaces within construction tolerances specified in ACI 117.
- B. Camber slabs and beams in accordance with ACI 318.

3.8 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and items are secure.
- C. Notify Engineer after placement of reinforcing steel in forms but prior to placing concrete.
- D. Schedule concrete placement to permit formwork inspection before placing concrete.

3.9 PLACEMENT

- A. Place, support, and secure reinforcement against displacement. Do not deviate from required position beyond specified tolerance.
  - 1. Do not weld crossing reinforcement bars for assembly except as permitted by Engineer.
- B. Do not displace or damage vapor retarder.
- C. Accommodate placement of formed openings.
- D. Space reinforcement bars with minimum clear spacing in accordance with ACI 318.
- E. Maintain concrete cover around reinforcement as indicated in Drawings with a minimum cover as follows:

Reinforcement Location		Minimum Concrete Cover
Footings and concrete formed against earth		3 inches
Concrete exposed to earth or weather	No. 6 bars and larger	2 inches
	No. 5 bars and smaller	1-1/2 inches
Supported slabs, walls, and joists	No. 14 bars and larger	1-1/2 inches
	No. 11 bars and smaller	3/4-inch
Beams and columns		1-1/2 inches
Shell and folded plate members	No. 6 bars and larger	3/4-inch
	No. 5 bars and smaller	1/2-inch

- F. Splice reinforcing only where indicated on Drawings or approved by Engineer. Splice in accordance with splicing device manufacturer's instructions.
- G. Bond and ground reinforcement in accordance with requirements of Section 33 79 00.

3.10 ERECTION TOLERANCES

- A. Section 01400 - Quality Requirements: Tolerances.
- B. Install reinforcement within the following tolerances for flexural members, walls, and compression members:

Reinforcement Depth	Depth Tolerance	Concrete Cover Tolerance
Greater than 8 inches	Plus or minus 3/8-inch	Minus 3/8-inch
Less than 8 inches	Plus or minus 1/2-inch	Minus 1/2-inch

- C. Install reinforcement within the tolerances specified in ACI 530.1 for foundation walls.

### 3.11 PLACING CONCRETE

- A. Place concrete in accordance with ACI 318.
- B. Notify testing laboratory and Engineer minimum 48 hours prior to commencement of operations.
- C. Ensure reinforcement, inserts, embedded parts, formed expansion, and contraction joints are not disturbed during concrete placement.
- D. Install vapor retarder under interior slabs on grade in accordance with ASTM E1643. Lap joints minimum 6 inches and seal watertight by taping edges and ends.
- E. Repair vapor retarder damaged during placement of concrete reinforcing. Repair with vapor retarder material; lap over damaged areas minimum 6 inches and seal watertight.
- F. Separate slabs on grade from vertical surfaces with 1/2 inch thick joint filler.
- G. Place joint filler in slab pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.
- H. Extend joint filler from bottom of slab to within 1/2 inch of finished slab surface.
- I. Install construction joint devices in coordination with slab pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.
- J. Install joint device anchors. Maintain correct position to allow joint cover to be flush with floor and wall finish.
- K. Install joint covers in longest practical length, when adjacent construction activity is complete.
- L. Deposit concrete at final position. Prevent segregation of mix.
- M. Place concrete in continuous operation for each panel or section determined by predetermined joints.
- N. Consolidate concrete.
- O. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken. Keep records on site in Contractor's office or file with Engineer.

- P. Place concrete continuously between predetermined expansion, control, and construction joints.
- Q. Do not interrupt successive placement; do not permit cold joints to occur.
- R. Place floor slabs in pattern indicated.
- S. Saw cut joints prior to concrete set. Thickness and depth as indicated on Drawings
- T. Screed floors and slabs on grade level, maintaining surface flatness of maximum 1/4 inch in 10 feet.

### 3.12 SEPARATE FLOOR TOPPINGS

- A. Prior to placing floor topping, roughen substrate concrete surface and remove deleterious material. Broom and vacuum clean.
- B. Place required dividers, edge strips, reinforcing and other items to be cast in.
- C. Apply bonding agent to substrate.
- D. Place concrete floor toppings to required lines and levels.
- E. Screed toppings level, maintaining surface flatness of maximum 1/8 inch in 10 feet.

### 3.13 CONCRETE FINISHING

- A. Provide formed concrete surfaces to be left exposed smooth rubbed, sand float, or sack rubbed finish as indicated on Drawings.
- B. Finish concrete floor surfaces in accordance with ACI 318.
- C. Steel trowel surfaces which are indicated to be exposed.
- D. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains at 1/8 inch per foot nominal or as indicated on Drawings.

### 3.14 CURING AND PROTECTION

- A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
  - 1. Protect concrete footings from freezing for minimum five days.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- C. Cure concrete in accordance with ACI 308.1 using method approved by Engineer.
- D. Maintain 100 percent coverage over floor slab areas continuously for seven days.

### 3.15 FIELD QUALITY CONTROL

- A. Section 00 14 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Perform field inspection and testing in accordance with ACI 318.

- C. Provide free access to Work and cooperate with appointed firm.
- D. Reinforcement Inspection:
  - 1. Placement Acceptance: Specified and ACI 318 material requirements and specified placement tolerances.
  - 2. Welding: Inspect welds in accordance with AWS D1.1.
  - 3. Periodic Placement Inspection: Inspect for correct materials, fabrication, sizes, locations, spacing, concrete cover, and splicing.
  - 4. Continuous Weld Inspection: Inspect reinforcement as required by ACI 318.
  - 5. Periodic Weld Inspection: Other welded connections.
- E. Concrete Inspections:
  - 1. Continuous Placement Inspection: Inspect for proper installation procedures.
  - 2. Periodic Curing Inspection: Inspect for specified curing temperature and procedures.
- F. Strength Test Samples:
  - 1. Sampling Procedures: ASTM C172.
  - 2. Cylinder Molding and Curing Procedures: ASTM C31, cylinder specimens, standard cured or field cured.
  - 3. Sample concrete and make one set of 4 cylinders for every 50 cubic yards or less of each class of concrete placed each day and for every 5,000 square feet of surface area for slabs and walls.
  - 4. When volume of concrete for any class of concrete would provide less than five sets of cylinders, take samples from five randomly selected batches or from every batch when less than five batches are used.
- G. Field Testing:
  - 1. Slump Test Method: ASTM C143.
  - 2. Air Content Test Method: ASTM C173 or ASTM C231.
  - 3. Temperature Test Method: ASTM C1064.
  - 4. Measure slump and temperature for each compressive strength concrete sample.
  - 5. Measure air content in air entrained concrete for each compressive strength concrete sample.
- H. Cylinder Compressive Strength Testing:
  - 1. Test Method: ASTM C39.
  - 2. Test Acceptance: In accordance with ACI 318.
  - 3. Test one cylinder at 7 days.
  - 4. Test one cylinder at 14 days.
  - 5. Test one cylinder at 28 days.
  - 6. Retain one cylinder for testing when requested by Engineer.
  - 7. Dispose remaining cylinders when testing is not required.
- I. Core Compressive Strength Testing:
  - 1. Sampling and Testing Procedures: ASTM C42.
  - 2. Test Acceptance: In accordance with ACI 318.
  - 3. Drill three cores for each failed strength test from concrete represented by failed strength test.
- J. Water Soluble Chloride Ion Concentration Test Method: ASTM C1218; tested at 28 days.
  - 1. Maximum Concentration: As permitted by applicable code.

- K. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

### 3.16 PATCHING

- A. Allow Engineer to inspect concrete surfaces immediately upon removal of forms.
- B. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Engineer upon discovery.
- C. Patch imperfections as directed by Engineer in accordance with ACI 318.

### 3.17 DEFECTIVE CONCRETE

- A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances, or specified requirements.
- B. Repair or replacement of defective concrete will be determined by Engineer.
- C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Engineer for each individual area.

### 3.18 SCHEDULE - CONCRETE TYPES AND FINISHES

- A. Foundation Walls: 3,000 psi 28 day concrete, form finish with honeycomb filled surface.
- B. Underside of Supported Floors and Structure Exposed to View: 4,000 psi, 28-day concrete, sack rubbed finish.
- C. Exposed Portico Structure: 4,000 psi 28 day concrete, air entrained, smooth stone rubbed finish.

### 3.19 SCHEDULE – REINFORCEMENT

- A. Reinforcement for Superstructure Framing Members: Deformed bars, unfinished.
- B. Reinforcement for Foundation Wall Framing Members and Slab-on-Grade: Deformed bars and wire fabric, epoxy coated finish.
- C. Reinforcement for Parking Structure Framing Members: Deformed bars, epoxy-coated finish.

END OF SECTION