

**SECTION 03 10 00**  
**CONCRETE FORMING AND ACCESSORIES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Formwork for cast-in place concrete, with shoring, bracing and anchorage.
- B. Openings for other work.
- C. Form accessories.
- D. Form stripping.

**1.02 RELATED REQUIREMENTS**

- A. Section 03 20 00 - Concrete Reinforcing.
- B. Section 03 30 00 - Cast-in-Place Concrete.
- C. Section 03 47 13 - Tilt-Up Concrete.
- D. Section 05 12 00 - Structural Steel Framing: Placement of embedded steel anchors and plates in cast-in-place concrete.
- E. Section 05 21 00 - Steel Joist Framing: Placement of embedded steel anchors, plates and joist seats in cast-in-place concrete.
- F. Section 05 31 00 - Steel Decking: Placement of steel anchors in composite decking.

**1.03 REFERENCE STANDARDS**

- A. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials; 2010.
- B. ACI 301 - Specifications for Structural Concrete; 2010 (Errata 2012).
- C. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; 2011.
- D. ACI 347R - Guide to Formwork for Concrete; 2014.
- E. ASME A17.1 - Safety Code for Elevators and Escalators; 2013.
- F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- G. PS 1 - Structural Plywood; 2009.

**1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on void form materials and installation requirements.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver prefabricated forms and installation instructions in manufacturer's packaging.
- B. Store prefabricated forms off ground in ventilated and protected manner to prevent deterioration from moisture.

**PART 2 PRODUCTS**

**2.01 FORMWORK - GENERAL**

- A. Provide concrete forms, accessories, shoring, and bracing as required to accomplish cast-in-place concrete work.
- B. Design and construct to provide resultant concrete that conforms to design with respect to shape, lines, and dimensions.
- C. Chamfer outside corners of beams, joists, columns, and walls.
- D. Comply with applicable state and local codes with respect to design, fabrication, erection, and removal of formwork.
- E. Comply with relevant portions of ACI 347R, ACI 301, and ACI 318.
- F. Use the following form types:
  - 1. Basement Walls Not Exposed To View: Site fabricated plywood.

2. Basement Walls Exposed To View: Site fabricated rough sawn lumber.
3. Elevated Floor Slabs: Prefabricated glass fiber pan forms, treated for exposed to view finish.

## **2.02 WOOD FORM MATERIALS**

- A. Form Materials: At the discretion of the Contractor shall be plywood, lumber, or other material for unexposed concrete. Lumber shall be dressed on at least two edges and one side for tight fit.
- B. Softwood Plywood: PS 1, B-B High Density Concrete Form Overlay, Class I (exposed concrete), Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing the legible trademark of an approved inspection agency.

## **2.03 REMOVABLE PREFABRICATED FORMS**

- A. Preformed Steel Forms: Minimum 16 gage, 0.0598 inch thick, matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.
- B. Pan Type: Glass fiber, of size and profile indicated.

## **2.04 VOID FORMS**

- A. Wax impregnated, corrugated fiber carton forms, structurally sufficient to support weight of wet concrete mix until initial set.
- B. Size: Depth as shown in the Contract Drawings.
- C. Product: Provide SureVoid manufactured by SureVoid Products or VoidForm by VoidForm International Limited or approved equal.
- D. Provide side retainers at all void form locations.

## **2.05 FORMWORK ACCESSORIES**

- A. Form Ties: Removable type, galvanized metal, fixed length, cone type, with waterproofing washer, \_\_\_\_ inch back break dimension, free of defects that could leave holes larger than 1 inch in concrete surface. Provide \_\_\_\_\_ manufactured by \_\_\_\_\_.
- B. Form Release Agent: Capable of releasing forms from hardened concrete without staining or discoloring concrete or forming bugholes and other surface defects, compatible with concrete and form materials, and not requiring removal for satisfactory bonding of coatings to be applied.
  1. Composition: Colorless reactive, mineral oil-based, soy-based, or vegetable-oil based compound.
  2. Do not use materials containing diesel oil or petroleum-based compounds.
  3. VOC Content: None; water-based.
  4. Products:
    - a. W.R. Meadows, Inc; Duogard: [www.wrmeadows.com/sle](http://www.wrmeadows.com/sle).
    - b. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Filler Strips for Chamfered Corners: Rigid plastic type; 3/4 x 3/4 inch size; maximum possible lengths.
- D. Flashing Reglets: Galvanized steel, at least 22 gage, 0.0299 inch thick, longest possible lengths, with alignment splines for joints, foam filled, release tape sealed slots, anchors for securing to concrete formwork.
- E. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.
- F. Embedded Anchor Shapes, Plates, Angles and Bars: As specified in Section 05 12 00.
- G. Waterstops: As indicated on the Contract Drawings.
  1. Polyvinyl chloride, minimum 1,750 psi tensile strength, minimum 50 degrees F to plus 175 degrees F working temperature range, 4 inch wide (or as shown on drawings), maximum possible lengths, ribbed profile, preformed corner sections, heat welded jointing.
  2. Strip applied expanding waterstop shall be comprised of bentonite clay, hydrophilic polymers, and butyl rubber. Product shall be Sika Greenstreak SWELLSTOP or Henry Synko-Flex with associated primer.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

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

### **3.02 EARTH FORMS**

- A. Earth forms are not permitted unless approved by the engineer.

### **3.03 ERECTION - FORMWORK**

- A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301.
- B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.
- C. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.
- D. Form orderly, even, symmetrical surfaces. Align joints and make watertight. Keep form joints to a minimum.
- E. Form smooth finish on concrete surfaces to be exposed to view or covered with a coating covering material that is applied directly to the concrete or bonded to the concrete such as waterproofing, dampproofing, painting, etc.
- F. Rough finish may be formed on concrete surfaces not exposed to view unless otherwise shown on drawings or otherwise specified.
- G. Obtain approval before framing openings in structural members that are not indicated on drawings.
- H. Install void forms in accordance with manufacturer's recommendations. Protect forms from moisture or crushing.
- I. Coordinate this section with other sections of work that require attachment of components to formwork.
- J. Erect formwork to provide minimum concrete cover, as indicated in the drawings, over reinforcement.

### **3.04 VOID FORMS**

- A. Install the void forms in accordance with the manufacturer's recommendations.
- B. Do not expose void forms to moisture prior to concrete placement. Improper handling, storage, or installation, as well as adverse weather or humidity conditions may affect the proper performance of the product.
- C. Use seam covers and end caps to prevent absorption of water and the flow of concrete into open protected areas.

### **3.05 APPLICATION - FORM RELEASE AGENT**

- A. Apply form release agent on formwork in accordance with manufacturer's recommendations.
- B. Do not apply form release agent where concrete surfaces will 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.

### **3.06 INSERTS, EMBEDDED PARTS, AND OPENINGS**

- A. Provide formed openings where required for items to be embedded in passing through concrete work.
- B. Form exposed corners and edges with chamfer strips as indicated in the drawings and elsewhere where chamfered edges are indicated in the drawings.
- C. Locate and set in place items that will be cast directly into concrete.
- D. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other work.

- E. Install accessories in accordance with manufacturer's instructions, so they are straight, level, and plumb. Ensure items are not disturbed during concrete placement.
- F. Install waterstops in accordance with manufacturer's instructions, so they are continuous without displacing reinforcement. Heat seal joints so they are watertight.
- G. 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.
- H. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

### **3.07 FORM CLEANING**

- A. Clean forms as erection proceeds, to remove foreign matter within forms.
- B. Clean formed cavities of debris prior to placing concrete.
  - 1. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.
  - 2. 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.

### **3.08 FORMWORK TOLERANCES**

- A. Construct formwork to maintain tolerances required by ACI 117, unless otherwise indicated.
- B. Construct and align formwork for elevator hoistway in accordance with ASME A17.1.
- C. Camber slabs and beams in accordance with ACI 301.

### **3.09 FIELD QUALITY CONTROL**

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.

### **3.10 FORM REMOVAL**

- A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.
- B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
- C. Store removed forms to prevent damage to form materials or to fresh concrete. Discard damaged forms.

### **3.11 STRIP APPLIED WATERSTOP**

- A. Apply primer to dry concrete surface per manufacturers instructions. Primer shall be minimum 2 inches wide continuously along the joint, maintaining a minimum of 2 inches clear cover to concrete face. Primer shall be allowed to "dry to the touch" per manufacturers instructions (typically 30 minutes to several hours; dependent on site conditions) prior to application of Strip Applied Waterstop.
- B. Continuously adhere Strip Applied Waterstop to concrete utilizing primer and maintaining a minimum of 2 inches clear cover to concrete face. Apply Strip Applied Waterstop the same day as primer. Strip applied waterstop shall be butt spliced pressing ends together ensuring no separation or air pockets. Provide concrete nails where required to secure on vertical or overhead applications. Remove release paper from Strip Applied Waterstop immediately prior to concrete placement.
- C. Protect Strip Applied Waterstop from moisture, dirt, oil, and sunlight during the progress of the work. Inspect Strip Applied Waterstop for premature swelling, discontinuity, and debris contamination prior to concrete pour. Replace unacceptable product.
- D. Place and thoroughly vibrate concrete, taking care not to disturb or displace the Strip Applied Waterstop. Do not allow vibrator to contact Strip Applied Waterstop.

**END OF SECTION**

**SECTION 03 20 00**  
**CONCRETE REINFORCING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Reinforcing steel for cast-in-place concrete.
- B. Supports and accessories for steel reinforcement.

**1.02 RELATED REQUIREMENTS**

- A. Section 03 10 00 - Concrete Forming and Accessories.
- B. Section 03 30 00 - Cast-in-Place Concrete.
- C. Section 04 20 00 - Unit Masonry: Reinforcement for masonry.
- D. Section 04 27 31 - Reinforced Unit Masonry: Reinforcement for engineered masonry.
- E. Section 31 63 29 - Drilled Concrete Piers and Shafts: Reinforcement for drilled pier foundations.

**1.03 REFERENCE STANDARDS**

- A. ACI 301 - Specifications for Structural Concrete; 2010 (Errata 2012).
- B. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; 2011.
- C. ACI SP-66 - ACI Detailing Manual; 2004.
- D. ASTM A184/A184M - Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement; 2006 (Reapproved 2011).
- E. ASTM A185/A185M - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete; 2007.
- F. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement; 2015.
- G. ASTM A706/A706M - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement; 2014.
- H. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2015.
- I. AWS D1.4/D1.4M - Structural Welding Code - Reinforcing Steel; 2011.
- J. CRSI (DA4) - Manual of Standard Practice; 2009.

**1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. All shop drawings shall be reviewed and approved by the Contractor before submitting to the Architect/Engineer.
- C. Shop Drawings: Comply with requirements of ACI SP-66. Include bar schedules, shapes of bent bars, spacing of bars, and location of splices.
  - 1. Submit a placement plan and elevation for all walls.
- D. Manufacturer's Certificate: Certify that reinforcing steel and accessories supplied for this project meet or exceed specified requirements.
- E. Reports: Submit certified copies of mill test report of reinforcement materials analysis.

**1.05 QUALITY ASSURANCE**

- A. Perform work of this section in accordance with ACI 301.
- B. Welders' Certificates: Submit certifications for welders employed on the project, verifying AWS qualification within the previous 12 months.

**PART 2 PRODUCTS**

**2.01 REINFORCEMENT**

- A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi).
  - 1. Deformed billet-steel bars.

- 2. Unfinished.
- B. Reinforcing Steel: ASTM A706/A706M, deformed low-alloy steel bars.
  - 1. Unfinished.
- C. Steel Welded Wire Reinforcement (WWR): Plain type; ASTM A1064/A1064M.
  - 1. Form: Flat Sheets.
  - 2. WWR Style: As indicated on drawings.
- D. Reinforcement Accessories:
  - 1. Tie Wire: Annealed, minimum 16 gage, 0.0508 inch.
  - 2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.
    - a. Bar supports for concrete resting on earth shall be precast concrete briquettes having tie wires embedded therein.
    - b. Bar supports for exposed concrete shall have plastic coated feet.

## 2.02 RE-BAR SPLICING:

- A. Coupler Systems: Mechanical devices for splicing reinforcing bars; capable of developing full steel reinforcing design strength in tension and compression.
  - 1. Products:
    - a. Dayton Superior Corporation; Bar Lock Coupler System: [www.daytonsuperior.com](http://www.daytonsuperior.com).
    - b. ERICO; Lenton Standard Coupler: [www.erico.com](http://www.erico.com).
- B. Dowel Bar Splicer with Dowel-Ins: Mechanical devices for connecting dowels; capable of developing full steel reinforcing design strength in tension and compression.
  - 1. Products:
    - a. Dayton Superior Corporation; Dowel Bar Splicer D101A with Straight Dowel-In: [www.daytonsuperior.com](http://www.daytonsuperior.com).
    - b. ERICO; Lenton Form Saver Couplers: [www.erico.com](http://www.erico.com).

## 2.03 FABRICATION

- A. Fabricate concrete reinforcing in accordance with CRSI (DA4) - Manual of Standard Practice.
- B. Welding of reinforcement is permitted only where specifically indicated on the drawings or with prior approval of the Engineer.
  - 1. Perform welding in accordance with AWS D1.4/D1.4M.
  - 2. All bars to be welded shall conform to ASTM A706.
- C. Locate reinforcing splices not indicated on drawings at point of minimum stress.

## PART 3 EXECUTION

### 3.01 MATERIAL STORAGE

- A. Reinforcing steel shall be stacked in tiers. Care shall be exercised to maintain all reinforcement free of dirt, mud, paint, rust, etc.

### 3.02 MARKING

- A. Plainly mark bars. Limit bundles to one size and one length.
- B. Tag each bundle with durable tags.

### 3.03 CLEANING

- A. Thoroughly clean reinforcement of rust, mill scale, dirt, oil, or other coatings which might tend to reduce the bonding of the concrete.

### 3.04 BENDING

- A. Reinforcing bar sizes No. 3 to No. 5 may be field bent cold one time if the rebar temperature is a minimum of 32 degrees F. Preheat all other bars in accordance with ACI 301 for Field Bending and Straightening of reinforcing.
- B. Field bending of No. 3 to No. 8 rebar shall have a minimum bend diameter of 6 x bar diameter. Bending of the rebar shall not be closer to the concrete surface than the minimum bend diameter. Do not field bend bars No. 9 or greater.
- C. Do not use bars having kinks or bends not shown on the Contract Drawings.

### **3.05 PLACEMENT**

- A. Place, support and secure reinforcement against displacement by means of metal chairs or spacers. Do not deviate from required position.
  - 1. Hold bars in concrete walls in position, and to proper clearance, by means of concrete or metal spacers made especially for the locations where spacers are required.
  - 2. Hold bars in beams and slabs to exact location during placement of concrete by spacers, chairs, or other necessary supports. Provide support for the horizontal reinforcing within 2 inches of the end of the bars.
- B. Place reinforcement in conformance with ACI 301 tolerances.
- C. Do not displace or damage vapor barrier.
- D. Accommodate placement of formed openings.
- E. Provide concrete cover for reinforcing steel as shown on the Contract Drawings.
- F. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.

### **3.06 FIELD QUALITY CONTROL**

- A. An independent testing agency, as specified in Section 01 40 00, will inspect installed reinforcement for conformance to contract documents before concrete placement.

**END OF SECTION**

**SECTION 03 30 00**  
**CAST-IN-PLACE CONCRETE**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Concrete building frame members.
- B. Concrete for composite floor construction.
- C. Elevated concrete slabs.
- D. Floors and slabs on grade.
- E. Concrete shear walls, elevator shaft walls, and foundation walls.
- F. Concrete foundations and anchor bolts for pre-engineered building.
- G. Joint devices associated with concrete work.
- H. Miscellaneous concrete elements, including equipment pads, light pole bases, flagpole bases, thrust blocks, and manholes.
- I. Concrete curing.

**1.02 RELATED REQUIREMENTS**

- A. Section 03 10 00 - Concrete Forming and Accessories: Forms and accessories for formwork.
- B. Section 03 20 00 - Concrete Reinforcing.
- C. Section 05 12 00 - Structural Steel Framing.
- D. Section 07 92 00 - Joint Sealants: Products and installation for sealants for saw cut joints and isolation joints in slabs.

**1.03 REFERENCE STANDARDS**

- A. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials; 2010.
- B. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; 1991 (Reapproved 2009).
- C. ACI 211.2 - Standard Practice for Selecting Proportions for Structural Lightweight Concrete; 1998 (Reapproved 2004).
- D. ACI 301 - Specifications for Structural Concrete; 2010 (Errata 2012).
- E. ACI 302.1R - Guide for Concrete Floor and Slab Construction; 2004 (Errata 2007).
- F. ACI 302.2R-06 - Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials.
- G. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000.
- H. ACI 305R - Hot Weather Concreting; 2010.
- I. ACI 306R - Cold Weather Concreting; 2010.
- J. ACI 308R - Guide to Curing Concrete; 2001 (Reapproved 2008).
- K. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; 2011.
- L. ACI 347R - Guide to Formwork for Concrete; 2014.
- M. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement; 2015.
- N. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2013.
- O. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2015a.
- P. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2015.
- Q. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens); 2013.
- R. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2012.
- S. ASTM C150/C150M - Standard Specification for Portland Cement; 2015.
- T. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete; 2007.

- U. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete; 2014.
- V. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2014.
- W. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete; 2010a.
- X. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2011.
- Y. ASTM C330/C330M - Standard Specification for Lightweight Aggregates for Structural Concrete; 2014.
- Z. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2013.
- AA. ASTM C579 - Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes; 2001 (Reapproved 2012).
- AB. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2015.
- AC. ASTM C827/C827M - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures; 2010.
- AD. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 2014.
- AE. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2014.
- AF. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete; 2011.
- AG. ASTM D994/D994M - Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type); 2011.
- AH. ASTM D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction; 2004a (Reapproved 2013).
- AI. ASTM E1155 - Standard Test Method for Determining F(F) Floor Flatness and F(L) Floor Levelness Numbers; 1996 (Reapproved 2008).
- AJ. ASTM E1155M - Standard Test Method for Determining F(F) Floor Flatness and F(L) Floor Levelness Numbers (Metric); 2014.
- AK. ASTM E1643 - Standard Practice for Selection, Design, Installation and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs; 2011.
- AL. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2011.
- AM. COE CRD-C 572 - Corps of Engineers Specifications for Polyvinylchloride Waterstop; 1974.

#### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. All shop drawings shall be reviewed and approved by the Contractor before submitting to the Architect/Engineer.
- C. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
  - 1. For curing compounds, provide data on method of removal in the event of incompatibility with floor covering adhesives.
- D. Mix Design: Submit proposed concrete mix design.
  - 1. Indicate proposed mix design complies with requirements of ACI 318, Chapter 5 - Concrete Quality, Mixing and Placing.
- E. Manufacturer's Installation Instructions: For concrete accessories, indicate installation procedures and interface required with adjacent construction.
- F. Sustainable Design Submittal for LEED Certification Projects: If any fly ash, ground granulated blast furnace slag, silica fume, rice hull ash, or other waste material is used in mix designs to replace Portland cement, submit the total volume of concrete cast in place, mix design(s) used

showing the quantity of portland cement replaced, reports showing successful cylinder testing, and temperature on day of pour if cold weather mix is used; use LEED New Product Content Form.

- G. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.

### **1.05 QUALITY ASSURANCE**

- A. Perform work of this section in accordance with ACI 301 and ACI 318.
- B. Follow recommendations of ACI 305R when concreting during hot weather.
- C. Follow recommendations of ACI 306R when concreting during cold weather.
- D. The Contractor is responsible for correction of concrete work which does not conform to the specified requirements, including strength, tolerance, and finishes. Correct deficient concrete as directed by the Architect/Engineer.

## **PART 2 PRODUCTS**

### **2.01 FORMWORK**

- A. Comply with requirements of Section 03 10 00.

### **2.02 REINFORCEMENT**

- A. Comply with requirements of Section 03 20 00.

### **2.03 CONCRETE MATERIALS**

- A. Cement: ASTM C150, Type I - Normal unless indicated otherwise on the Drawings. Portland type.
  - 1. Acquire all cement for entire project from same source.
- B. Fine and Coarse Aggregates: ASTM C 33.
  - 1. Acquire all aggregates for entire project from same source.
- C. Lightweight Aggregate: ASTM C330/C330M.
- D. Fly Ash: ASTM C618, Class C or F.
- E. Do not use calcium chloride unless authorized in writing by the Architect/Engineer.
- F. Water: Clean and not detrimental to concrete.

### **2.04 ADMIXTURES**

- A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.
- B. Air Entrainment Admixture: ASTM C260/C260M.
- C. High Range Water Reducing and Retarding Admixture: ASTM C494/C494M Type G.
- D. High Range Water Reducing Admixture: ASTM C494/C494M Type F.
- E. Water Reducing and Retarding Admixture: ASTM C494/C494M Type D.
- F. Water Reducing Admixture: ASTM C494/C494M Type A.

### **2.05 ACCESSORY MATERIALS**

- A. Underslab Vapor Retarder: Multi-layer, fabric-, cord-, grid-, or aluminum-reinforced polyethylene or equivalent, complying with ASTM E1745, Class A; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs. The use of single ply polyethylene is prohibited.
  - 1. Accessory Products: Vapor retarder manufacturer's recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations in vapor retarder.
  - 2. Manufacturers:
    - a. Stego Industries, LLC; 10-mil (minimum): [www.stegoindustries.com](http://www.stegoindustries.com).
    - b. W.R. Meadows, Inc; PERMINATOR Class A - 15 mils: [www.wrmeadows.com/sle](http://www.wrmeadows.com/sle).
    - c. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Non-Shrink Cementitious Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.
  - 1. Grout: Comply with ASTM C1107/C1107M.

2. Minimum Compressive Strength at 28 Days, ASTM C109/C109M: 7,000 pounds per square inch.
3. Flowable Products:
  - a. Five Star Products, Inc; Five Star Fluid Grout 100: [www.fivestarproducts.com](http://www.fivestarproducts.com).
  - b. L&M Construction Chemicals, Inc., a subsidiary of Laticrete International, Inc; Duragrout: [www.lmcc.com](http://www.lmcc.com).
  - c. SpecChem, LLC; SC Precision Grout: [www.specchemllc.com/sle](http://www.specchemllc.com/sle).
  - d. W. R. Meadows, Inc; 588-10K: [www.wrmeadows.com/sle](http://www.wrmeadows.com/sle).
  - e. Substitutions: See Section 01 60 00 - Product Requirements.
4. Low-Slump, Dry Pack Products:
  - a. Five Star Products, Inc; Five Star Grout: [www.fivestarproducts.com](http://www.fivestarproducts.com).
  - b. L&M Construction Chemicals, Inc., a subsidiary of Laticrete International, Inc; Duragrout: [www.lmcc.com](http://www.lmcc.com).
  - c. SpecChem, LLC; SC Multipurpose Grout: [www.specchemllc.com/sle](http://www.specchemllc.com/sle).
  - d. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Embedded Anchor Shapes, Plates, Angles, and Bars: Specified in Section 05 12 00 - Structural Steel Framing .

## 2.06 BONDING AND JOINTING PRODUCTS

- A. Epoxy Bonding System:
  1. Application: to bond hardened concrete to fresh or hardened concrete.
    - a. Where used to repair spalling or defects, follow manufacturer's specifications.
  2. Manufacturers:
    - a. W.R. Meadows, Inc; Rezi-Weld Gel Paste, Rezi-Weld Gel Paste State, Rezi-Weld 1000: [www.wrmeadows.com/sle](http://www.wrmeadows.com/sle).
    - b. Sika Corporation; Sikadur 32 Hi-Mod, Sika Armatec 110 EpoCem where reinforcement protection is required: [www.sika.com](http://www.sika.com).
    - c. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Waterstops: Comply with the requirements of Section 03 10 00 - Concrete Forming and Accessories
- C. Reglets: Formed steel sheet, galvanized, with temporary filler to prevent concrete intrusion during placement. Comply with Section 03 10 00 - Concrete Forming and Accessories.
  1. Size: As indicated on drawings.
- D. Slab Isolation Joint Filler: 1/2 inch thick, height equal to slab thickness, with removable top section that will form 1/2 inch deep sealant pocket after removal.
  1. Material: ASTM D1752 sponge rubber (Type I).
- E. Slab Construction Joint Devices: Combination keyed joint form and screed, galvanized steel, with rectangular or round knockout holes for conduit or rebar to pass through joint form at 6 inches on center; ribbed steel stakes for setting.
  1. Provide removable plastic cap strip that forms wedge-shaped joint for sealant installation.
  2. Height: To suit slab thickness.
- F. Slab Construction Joint Dowels:
  1. Smooth bars: Refer to drawings for size and spacing.
  2. Diamond dowels: CMC Commercial Metals; Diamond Dowel System. Spacing as indicated on drawings.

## 2.07 CURING MATERIALS

- A. Curing Compound, Naturally Dissipating: Clear, water-based, liquid membrane-forming compound; complying with ASTM C309, Type 1.
  1. Application: Use at floor slabs without vinyl flooring and concrete wall panels.
    - a. Curing compound shall be warranted by manufacturer not to deter bond of floor covering materials.
    - b. Do not use liquid membrane-forming compounds when bond is required between hardened concrete in place and fresh concrete to be applied.
- B. Moisture-Retaining Sheet: ASTM C171.
  1. Curing paper, regular.
  2. Polyethylene film, clear, minimum nominal thickness of 0.0040 inch.

3. White-burlap-polyethylene sheet, weighing not less than 10 ounces per linear yard, 40 inches wide.

C. Water: Potable, not detrimental to concrete.

## **2.08 PENETRATING SPRAY-APPLIED CONCRETE TREATMENT**

- A. Liquid curing compound and moisture barrier control system for areas scheduled to receive vinyl flooring products.
- B. Concrete:
  1. Concrete mixes shall not use internal curing compounds or other membrane forming chemical additives such as crystalline silicate sealers (sodium, potassium, lithium, etc.) that can inhibit penetration of concrete treatment.
  2. Do not hard trowel or over-float concrete surface.
- C. Manufacturers:
  1. Spray-Lock Concrete Protection, LLC; SPC 327: [www.spraylockcp.com](http://www.spraylockcp.com)
  2. Creteseal; CS2000: [www.creteseal.com](http://www.creteseal.com)
  3. Substitutions: See Section 01.60.00 - Product Requirements.

## **2.09 CONCRETE MIX DESIGN**

- A. Continuity of supply: Supplier of ready-mixed concrete shall not be changed without specific approval of Architect/Engineer.
- B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
  1. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.
- C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended or required by manufacturer. All proposed admixtures shall be included in the field experience tests or trial mixtures for the proposed mix design.
- D. Normal Weight Concrete:
  1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: As indicated on drawings.
  2. Fly Ash Content: Maximum 20 percent of cementitious materials by weight, unless noted otherwise on drawings.
  3. Cement Content: Minimum 5 sacks (94 pounds per sack) of cement per cubic yard of concrete.
  4. Water-Cement Ratio: As indicated on drawings.
  5. Total Air Content: As indicated on drawings.
  6. Minimum and Maximum Slump: As indicated on drawings.
  7. Maximum Aggregate Size: Unless indicated otherwise in the drawings, the nominal maximum size of the aggregate shall not be larger than one-fifth of the narrowest dimension between sides of form, one-third of the depth of slabs, nor three-fourths of the minimum clear distance between reinforcing bars or between bars and forms whichever is least. In columns, the nominal maximum size of the aggregate shall be limited as above but shall not be larger than two-thirds of the minimum clear distance between bars.
- E. Structural Lightweight Concrete:
  1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: As indicated on drawings.
  2. Cement Content: Minimum 5 sacks (94 pounds per sack) of cement per cubic yard of concrete.
  3. Water-Cement Ratio: As indicated on drawings.
  4. Total Air Content: 3 percent for concrete not exposed to cycles of freezing and thawing, determined in accordance with ASTM C173/C173M.
  5. Minimum and Maximum Slump: As indicated on drawings.
  6. Maximum Aggregate Size: Unless indicated otherwise in the drawings, the nominal maximum size of the aggregate shall not be larger than one-fifth of the narrowest dimension between sides of form, one-third of the depth of slabs, nor three-fourths of the minimum clear distance between reinforcing bars or between bars and forms whichever is least. In columns, the nominal maximum size of the aggregate shall be limited as above but shall not be larger than two-thirds of the minimum clear distance between bars.

7. Maximum dry unit weight: 115 lb per cubic foot, unless indicated otherwise on the drawings.

## **2.10 MIXING**

- A. Transit Mixers: Comply with ASTM C94/C94M.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify lines, levels, and dimensions before proceeding with work of this section.

### **3.02 PREPARATION**

- A. Verify that forms are clean and free of rust before applying release agent.
- B. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.
- C. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning and applying bonding agent in according to bonding agent manufacturer's instructions.
  1. Use epoxy bonding system for bonding to damp surfaces, for structural load-bearing applications, and where curing under humid conditions is required.
- D. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and epoxy grout.

### **3.03 INSTALLING UNDER SLAB VAPOR RETARDER**

- A. Install vapor retarder according to ASTM E1643.
- B. Install vapor retarder at the following locations:
  1. Under interior slabs on grade.
  2. Under and around perimeter grade beams.
  3. Under and around interior grade beams.
- C. Lap joints minimum 6 inches. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions.
- D. Seal edges of vapor retarder per ASTM E1643-11: Extend vapor retarder over footings and seal to foundation wall, grade beam, or slab at the top of the slab or terminate at impediments such as water stops or dowels. Seal around penetrations such as utilities and columns in order to create a monolithic membrane between the surface of the slab and moisture sources below the slab as well as at the perimeter.
- E. Repair damaged vapor retarder before covering.

### **3.04 PLACING CONCRETE**

- A. Place concrete in accordance with ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
- B. Place concrete for floor slabs in accordance with ACI 302.1R - Guide for Concrete Floor and Slab Construction.
- C. Notify Architect not less than 24 hours prior to commencement of placement operations. Inform Architect/engineer of placing schedule to show sufficient time, without delaying work, for inspection prior to beginning of placement.
- D. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- E. Total amount of water added to the concrete shall not exceed the maximum water to cementitious materials ratio of the submitted and accepted mix design. Any portion of water added at the truck mixer shall be carefully measured and included in the concrete placement records.
- F. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.
- G. Where form coatings are not used, thoroughly wet wood forms without beading, immediately before placing concrete.
- H. Place concrete continuously without construction (cold) joints wherever possible; where construction joints are necessary, before next placement prepare joint surface by removing

laitance and exposing the sand and sound surface mortar, by sandblasting or high-pressure water jetting.

- I. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section.
- J. Handle concrete from mixer or transport vehicle to place of final deposit in continuous manner as rapidly as practicable until given operation is completed. Do not use vibrators to transport concrete inside of forms.
- K. Deposit concrete in forms in horizontal layers not deeper than 24" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
- L. Consolidate placed concrete by mechanical vibrating equipment and procedures for consolidation of concrete in accordance with the recommended practices of ACI 309, to suit the type of concrete and project conditions.
- M. Deposit and consolidate concrete slabs in a continuous operation, within the limits of construction joints, until the placing of a panel or section is completed.
- N. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners. Bring slab surfaces to the correct level with a straight edge and strike-off. Use bull floats or darbies to smooth the surface, leaving it free of humps or hollows. Do not sprinkle water on the plastic surface. Do not disturb the slab surfaces prior to beginning finishing operations.
- O. Maintain reinforcing in the proper position during concrete placement operations.
- P. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.

### **3.05 WEATHER PROTECTION**

- A. Cold weather conditions: Protect concrete work from physical damage or reduced strength which could be caused by low temperatures, or winds in compliance with ACI 306R - Cold Weather Concreting and as herein specified.
  - 1. Do not place concrete when temperature is below 40 degrees F. except with specific approval of the Architect.
  - 2. Slabs-on-grade, footings, and grade beams shall not be placed on frozen subgrade.
  - 3. Protect concrete from multiple freeze thaw cycles until the concrete reaches a minimum compressive strength of 3,500 psi.
  - 4. Concrete cylinders during cold weather conditions shall not be field cured.
- B. Hot weather conditions: When hot weather conditions exist that would seriously impair the quality and strength of concrete, mix and place concrete in compliance with ACI 305R - Hot Weather Concreting and as herein specified.
  - 1. Concrete at time of placement must be below 95 degrees F. Mixing water may be chilled, or chopped ice may be used, to control concrete temperature.
  - 2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
  - 3. Wet forms thoroughly before placing concrete.
  - 4. Do not use retarding admixtures unless otherwise accepted in mix design.

### **3.06 SLAB JOINTING**

- A. Locate joints as indicated on the drawings.
- B. Anchor joint fillers and devices to prevent movement during concrete placement.
- C. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.
  - 1. Install wherever necessary to separate slab from other building members, including columns, walls, equipment foundations, footings, stairs, manholes, sumps, and drains.
- D. Saw Cut Contraction Joints: Saw cut joints before concrete begins to cool, within 4 to 12 hours after placing; use 3/16 inch thick blade and cut at least 1 inch deep but not less than one quarter (1/4) the depth of the slab.

- E. Construction Joints: Where not otherwise indicated, use slab construction joint devices and slab construction joint dowels.

### **3.07 SEPARATE FLOOR TOPPINGS**

- A. Prior to placing floor topping, roughen substrate concrete surface and remove deleterious material. Broom and vacuum clean.

### **3.08 FLOOR FLATNESS AND LEVELNESS TOLERANCES**

- A. Minimum F(F) Floor Flatness and F(L) Floor Levelness Values:
  - 1. Unless otherwise indicated on the drawings, F(F) of 35; F(L) of 25, on-grade only.
- B. Measure F(F) Floor Flatness and F(L) Floor Levelness in accordance with ASTM E1155 (ASTM E1155M), within 48 hours after slab installation; report both composite overall values and local values for each measured section.
- C. Correct the slab surface if composite overall value is less than specified and/or if local value is less than 3/5 of specified value.
- D. Correct defects by grinding or by removal and replacement of the defective work. Areas requiring corrective work will be identified. Re-measure corrected areas by the same process.

### **3.09 CONCRETE FINISHING**

- A. Repair and patch defective areas of exposed formed concrete surfaces immediately after removal of forms. Cut out honeycombs, voids over 1/2" in diameter, and holes left by tie rods and bolts, down to solid concrete, but in no case to a depth of less than 1". Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water and brush with a coat of concrete bonding agent all surfaces to be patched. Patch with patching concrete of same type or class as the original adjacent concrete. Mix patching concrete with bonding agent in accordance with manufacturer's recommendations. Place concrete to blend with adjacent concrete. Cure in same manner as adjacent concrete.
- B. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch or more in height.
- C. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/4 inch or more in height. Provide finish as follows:
  - 1. Grout Cleaned Finish: Blend standard Portland cement and white cement to match color of formed concrete. Provide trial color samples for Architect's approval. Wet areas to be cleaned and apply grout mixture by brush or spray; scrub immediately to remove excess grout. After drying, rub vigorously with clean burlap, and keep moist for 36 hours.
- D. Concrete Slabs: Finish to requirements of ACI 302.1R - Guide for Concrete Floor and Slab Construction and as follows:
  - 1. Apply trowel finish to all slab surfaces. Consolidate the concrete surface to the final hand troweling operation, free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance as indicated in the Floor Flatness and Levelness Tolerances section above. The dusting of dry cement and/or sand to take up excess moisture will not be permitted. Grind smooth surface defects which would telegraph through applied floor covering system.
  - 2. Apply non-slip broom finish to exterior concrete platforms, steps, ramps, and sidewalks and elsewhere as shown on Drawings. Immediately after trowel finishing, slightly roughen the concrete surface by brooming in direction perpendicular to the main traffic route.
  - 3. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains as indicated on drawings.

### **3.10 CURING AND PROTECTION**

- A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
  - 1. Normal concrete: Not less than 7 days.
- C. Formed Surfaces: Cure by moist curing with forms in place for full curing period.
- D. Surfaces Not in Contact with Forms:

1. Slabs and Floors To Receive Adhesive-Applied Flooring: Curing compounds and other surface coatings are usually considered unacceptable by flooring and adhesive manufacturers. If such materials must be used, either obtain the approval of the flooring and adhesive manufacturers prior to use or remove the surface coating after curing to flooring manufacturer's satisfaction.
2. Protect concrete surfaces from loss of moisture by one of the following methods:
  - a. Moisture-Retaining Sheet: Cover all exposed concrete with moisture retaining cover. Lap sides at least 3" and seal with waterproof tape or adhesive; secure at edges. Keep cover sealed during curing period.
  - b. Curing Compound: Apply in two coats at right angles, using application rate recommended by manufacturer.
  - c. Penetrating spray-applied concrete treatment: Provide and install concrete treatment at time of placement for areas scheduled to receive vinyl flooring products in accordance with manufacturer's recommendations.

### 3.11 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.
  1. Report test results in writing to the Architect, Engineer and the Contractor on the same day that tests are made. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of contractor, name of concrete supplier and truck number, name of concrete testing service, concrete type and class, location of concrete batch in the structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength and type of break for both 7 day tests and 28 day tests.
  2. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate the specific concrete strengths and other characteristics have not been attained in the structure, as directed by the Architect/Engineer. The testing service shall conduct tests to determine the adequacy of concrete by cored cylinders complying with ASTM C-42 or by other methods as directed.
- B. Provide free access to concrete operations at project site and cooperate with appointed firm.
- C. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
- D. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.
- E. Sampling of fresh concrete: Obtain representative samples of fresh concrete for testing in accordance with ASTM C172/C172M, as modified for slump to comply with ASTM C94/C94M.
- F. Compressive Strength Tests: For each test, mold and cure four concrete test cylinders in accordance with ASTM C31/C31M. Obtain test samples for every 100 cu yd, or fraction thereof, of each concrete class placed in any one day and for each 5,000 sq. ft. of surface area placed. Test cylinders in accordance with ASTM C39/C39M. Test one cylinder at 7 days for information, test two cylinders at 28 days for acceptance, and retain one cylinder in reserve for later testing if required. The compressive strength test results for acceptance shall be the average of the compressive strengths from the cylinders tested at 28 days.
  1. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
  2. When the frequency of testing will provide less than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
  3. When the total quantity of a given class of concrete is less than 50 cu. yds., the compressive strength tests may be waived by the Architect/Engineer, if in his judgment, adequate evidence of satisfactory strength is provided.
- G. Slump Tests: Perform slump tests for each concrete load at point of discharge and for each set of test cylinders taken, following procedures of ASTM C143/C143M.
- H. Air Content: ASTM C231/C231M, pressure method, one for each set of compressive strength test specimens.

- I. Concrete Temperature: Test concrete temperature in accordance with ASTM C1064/C1064M. Temperature shall be obtained for each concrete load discharged and each time a set of compression test specimens is made.

### **3.12 DEFECTIVE CONCRETE**

- A. Test Results: The testing agency shall report test results in writing to Architect and Contractor within 24 hours of test.
- B. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
- C. Repair or replacement of defective concrete will be determined by the Architect. The cost of additional testing shall be borne by Contractor when defective concrete is identified.
- D. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect for each individual area.

### **3.13 PROTECTION**

- A. Do not permit traffic over unprotected concrete floor surface until fully cured.

**END OF SECTION**

**SECTION 03 47 13**  
**TILT-UP CONCRETE**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Tilt-up, site cast concrete wall panels, integrally insulated, load bearing, erected from forms to final position.
- B. Site cast tilt-up concrete units other than wall panels.
- C. Supports, devices, load bearing supports, and attachments.
- D. Grouting under panels.

**1.02 RELATED REQUIREMENTS**

- A. Section 03 10 00 - Concrete Forming and Accessories: Formwork requirements.
- B. Section 03 20 00 - Concrete Reinforcing: Reinforcing steel and welding requirements.
- C. Section 03 30 00 - Cast-in-Place Concrete: Requirements for concrete for tilt-up panels.
- D. Section 05 12 00 - Structural Steel Framing.
- E. Section 05 50 00 - Metal Fabrications: Miscellaneous metal for embedment.
- F. Section 07 62 00 - Sheet Metal Flashing and Trim: Requirements for reglets recessed in units.
- G. Section 07 92 00 - Joint Sealants: Sealing perimeter and intermediate joints.
- H. Section 09 91 13 - Exterior Painting: Field applied painting of tilt-up panels.

**1.03 REFERENCE STANDARDS**

- A. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000.
- B. ACI 305R - Hot Weather Concreting; 2010.
- C. ACI 306R - Cold Weather Concreting; 2010.
- D. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; 2011.
- E. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.
- F. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- G. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- H. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts; 2007a (Reapproved 2014).
- I. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement; 2015.
- J. ASTM A706/A706M - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement; 2014.
- K. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field; 2012.
- L. ASTM C78/C78M - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading); 2016.
- M. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2015.
- N. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2012.
- O. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2011.
- P. ASTM F436 - Standard Specification for Hardened Steel Washers; 2011.
- Q. ASTM F959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners; 2013.

- R. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions; 2015a.
- S. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015.
- T. AWS D1.4/D1.4M - Structural Welding Code - Reinforcing Steel; 2011.

#### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. All shop drawings shall be reviewed and approved by the Contractor before submitting to the Architect/Engineer.
- C. Shop Drawings: Indicate layout, tilt-up unit locations, configuration, unit identification marks, reinforcement, connection details, support items, location of lifting devices, dimensions, openings, relationship to adjacent components, and special reinforcement necessary for lifting and erection. Show each structural concrete tilt-up panel elevation with dimensions, structural embedded items, openings, chamfers, and reveals. The lifting and bracing submittal shall be signed and sealed by the responsible Designer.
- D. Proposed Mix Design: Submit proposed mix design for each tilt-up unit type before starting work, complying with Section 01 40 00 - Quality Requirements.
- E. Laboratory Reports: Submit certified laboratory test reports confirming physical characteristics of materials used in performance of the Work of this section.
- F. Sustainable Design Reporting for LEED Certification Projects: If any fly ash, ground granulated blast furnace slag, silica fume, rice hull ash, or other waste material is used in mix designs to replace Portland cement, submit the total volume of concrete, mix design(s) used showing the quantity of Portland cement replaced, reports showing successful cylinder testing, and temperature on day of pour if cold weather mix is used; use Material Content Form.

#### **1.05 QUALITY ASSURANCE**

- A. Perform work in accordance with ACI 318.
- B. Designer Qualifications: Design bracing and lifting devices, special reinforcing, and erection procedures under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State in which the Project is located.
- C. Fabricator Qualifications: Company specializing in site-cast tilt-up concrete construction with minimum 5 years of documented experience.
- D. Welding Qualifications: Welding processes and welding operators qualified within previous 12 months in accordance with AWS D1.1/D1.1M and AWS D1.4/D1.4M.

#### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Handling Tilt-up Units: Lift units to position, consistent with their shape and design. Lift and support only from support points.
- B. Blocking and Lateral Support During Erection: Use materials that are clean and non-staining. Provide temporary lateral support to prevent bowing, warping, or cracking.
- C. Protect units from staining, chipping, or spalling.

#### **1.07 FIELD CONDITIONS**

- A. Adverse Weather: Do not construct formwork, place reinforcing steel or concrete, or erect panels during adverse weather unless measures acceptable to Architect are taken to prevent damage.
- B. Cold Weather: Comply with provisions of ACI 306R for freezing or near-freezing conditions.
  - 1. Provide adequate equipment for heating and protecting concrete materials.
  - 2. Do not use concrete materials, reinforcing steel, forms, fillers, ground surface, or other materials that are frozen, frost-covered or that contain ice.
- C. Hot Weather: Comply with provisions of ACI 305R for high temperature conditions.
  - 1. During periods of dry winds, low humidity, and other conditions that cause rapid drying, protect fresh concrete with an evaporation retardant or fine fog spray of water applied immediately after screeding and bull floating.

2. Maintain protection until final finishing and curing compounds are applied.

## **PART 2 PRODUCTS**

### **2.01 TILT-UP PANEL UNITS**

- A. Tilt-Up Panel Units:
  1. Concrete: As indicated in the Drawings.
  2. Calculate structural properties of units in accordance with ACI 318.
  3. The professional engineer responsible for the erection design and procedures shall specify the required concrete strength to lift the panels. Panels are not to be lifted until concrete strengths have exceeded the required concrete strength.
  4. Provide connections that accommodate building movement and thermal movement and adjust to misalignment of structure without unit distortion or damage.
  5. Provide lifting hardware and lifting system appropriate to panel size and configuration.

### **2.02 PANEL MATERIALS**

- A. Forms: Provide formwork in accordance with Section 03 10 00.
- B. Concrete: Provide concrete materials in accordance with Section 03 30 00.
- C. Reinforcing Steel: As specified in Section 03 20 00.
- D. Form Bond Breaker: Integral with or compatible with curing compound and other finishes, including paint and floor finish.
- E. Curing Compound: Liquid membrane-forming compound complying with ASTM C309, Type I and ID, Class B.
- F. Non-Shrink Grout: ASTM C1107/C1107M; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.
  1. Minimum Compressive Strength at 28 Days: 7,000 psi.
- G. Bonding Agent: Weld-Crete by Larsen Products Corporation.
- H. Reveals: For reveals or relief in panel face, provide materials of adequate strength to withstand construction traffic and loads without damage.

### **2.03 SUPPORT AND LIFTING DEVICES**

- A. Lifting Hardware, Connecting, and Support Devices: ASTM A36/A36M steel; hot-dip galvanized in accordance with ASTM A153/A153M.
  1. For support of reinforcing steel, plastic-tipped steel or all plastic supports are also acceptable.
- B. Miscellaneous Metal Items: Provide inserts, dowels, and other items to be cast into panels as specified in Section 05 50 00, galvanized after fabrication in accordance with ASTM A123/A123M.
- C. All-Plastic Supports: Provide units of adequate strength, with surface contact of not more than 0.10 sq. inches per contact point, and colored to blend with concrete.
- D. Bolts, Nuts, and Washers: ASTM F3125, Grade A325, heavy hex structural bolts, Type 1, plain, with matching ASTM A563 (ASTM A563M nuts, and washers as follows:
  1. Standard Washers: ASTM F436 washers, in finish matching bolts.
  2. Compressible Direct Tension Indicators: ASTM F959, Type 325.

### **2.04 ACCESSORIES**

- A. Bearing Pads: High Density Plastic or Steel, 1/8 inch thick, smooth both sides.
- B. Embedded Anchor Shapes, Plates, Angles, and Bars: Specified in Section 05 12 00 - Structural Steel Framing.
- C. Reglets: Specified in Section 07 62 00.
- D. Sealants: Specified in Section 07.92.00.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that building structure, anchors, devices, and openings are ready to receive work of this section.

- B. Verify that casting slab is cured and ready for work of this section. Fill cracks, saw cuts, joints, or defects that would adversely affect appearance of tilt-up panels.

### **3.02 PREPARATION**

- A. Coordinate site cast tilt-up operations with work of other sections to expedite the Work and avoid omissions and delays.
- B. Apply bondbreaker to casting slab in accordance with manufacturer's recommendations.
- C. Provide for erection procedures and induced loads during erection, and provide for temporary bracing that will remain in place until elevated floor and roof diaphragms have been completely installed and connected.

### **3.03 FORMING PANELS**

- A. General: Maintain environmental records and quality control program during production of tilt-up units. Make records available upon request.
- B. Lay out panels in manner that will minimize slab control and construction joints on panel faces. Coordinate installation of inserts and anchorages.
- C. Layout panel forms on floor slab with slab side becoming outside face of panels, unless noted otherwise in the Drawings.
  - 1. Layout forms for reveals, chamfers, and openings on floor slab surface per drawings.
  - 2. Coat floor slab with minimum two coats of bond breaking agent.
- D. Maintain consistent quality during construction of forms.
- E. Fabricate connecting devices, plates, angles, inserts, bolts, and accessories. Fabricate to permit initial placement and final attachment.
- F. Embed reinforcing steel, anchors, inserts, plates, angles, and other cast-in items as indicated.
- G. Place and embed flashing reglets in continuous lengths without gaps, and properly positioned. Refer to Section 07 62 00.
- H. Ensure reinforcement, inserts, and embedded parts will not be disturbed during concrete placement.
- I. Locate hoisting devices to permit removal after erection.
- J. Work concrete thoroughly around reinforcement, around embedded items, and into corners of the forms. Consolidate concrete in accordance with ACI recommendations.
- K. Cold joints are not permitted in any individual panel.

### **3.04 PLACING AND CURING CONCRETE**

- A. Mix and deliver concrete in accordance with ASTM C94/C94M, Option A, and in compliance with recommendations of ACI 304R.
- B. Notify Architect not less than 24 hours prior to commencement of placement operations. Inform Architect/engineer of placing schedule to show sufficient time, without delaying work, for inspection prior to beginning of placement.
- C. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- D. Protect freshly placed concrete from premature drying and excessively hot or cold temperatures.
- E. Total amount of water added to the concrete shall not exceed the maximum water to cementitious materials ratio of the submitted and accepted mix design. Any portion of water added at the truck mixer shall be carefully measured and included in the concrete placement records.
- F. Cure units to develop concrete quality, and to minimize appearance blemishes such as non-uniformity, staining, or surface cracking.
- G. Apply liquid membrane curing compound in accordance with manufacturer's recommendations.
- H. Minor patching is acceptable, providing structural adequacy and appearance of units are not impaired. Patching grout shall be cement and sand mortar mixed with specified bonding agent and shall match color and finish of the concrete.

### **3.05 FINISHING CONCRETE**

- A. Finish exposed surfaces of panels as indicated on drawings.
- B. Clean interior and exterior faces of dirt and stains which may be on the panels after erection and completion of joint treatments by high pressure water spraying or light sandblasting. Protect other work from damage due to cleaning operations. Do not use cleaning materials or processes which could change the character of the exposed concrete finishes.
- C. Grade A - Architectural Finish:
  - 1. Panel surfaces must be free of voids, holes, pockets, and other surface deformations greater than 1/8 inch and must not telegraph imperfections from the casting surface, including floor joints.
  - 2. Cracks in excess of 1/32 inch width are not acceptable.
  - 3. Reveals may not deviate from their correct position by more than 1/8 inch in 10 feet.
  - 4. Repairs must not be apparent from a minimum distance of 10 feet.
- D. Interior Finish: Steel Trowelled finish backside surface of wall panels.
- E. Painting: Prepare surfaces to be painted as specified in Section 09 91 13.

### **3.06 SITE FABRICATION TOLERANCES**

- A. Unless otherwise approved by Architect, provide panels conforming to casting tolerances as specified below.
- B. Panel Height and Width:
  - 1. Up to 20 feet: 1/4 inch maximum.
  - 2. 20 to 30 feet: 3/8 inch maximum.
  - 3. Each additional 10 ft increment: 1/8 inch maximum.
- C. Panel Thickness: 3/16 inch maximum average variation through any vertical or horizontal cross section.
- D. Skew of Panel or Opening: Measured as difference in length of the two diagonals:
  - 1. Per 6 feet of diagonal dimension: 1/8 inch maximum.
  - 2. Maximum total difference: 1/2 inch.
- E. Panel Openings:
  - 1. Size: 1/4 inch maximum.
  - 2. Location of Centerline: 1/4 inch maximum.
- F. Location and Placement of Embedded Items:
  - 1. Inserts, Bolts, and Pipe Sleeves: 3/8 inch.
  - 2. Lifting and Bracing Inserts: As specified by manufacturer.
  - 3. Weld Plate Embedments: 1 inch for location; 1/4 inch for tipping and flushness.

### **3.07 FIELD QUALITY CONTROL**

- A. An independent testing agency, as specified in Section 01 40 00 - Quality Requirements, will perform concrete mix testing.
- B. Take a minimum of 4 cylinders for each 100 cubic yds or fraction thereof, of each class of concrete, for each day concrete is cast, or not less than once for each 5000 sq ft of panel area. Field cure test specimens. Cylinders: Make and cure test cylinders in accordance with ASTM C31/C31M. Test two cylinders at 7 days and two at 28 days.
- C. Take slump tests for every four test cylinders in accordance with ASTM C143/C143M or at noticeable changes in the concrete material.
- D. Take one air entrainment test for each set of exterior concrete test cylinders taken.
- E. Submit copies of test reports within 24 hours of test, indicating location of panels for each set of test results.

### **3.08 DEFECTIVE CONCRETE**

- A. Defective Concrete: If test results indicate concrete not conforming to specified requirements, Contractor with the agreement of Architect must adjust mix to provide acceptable concrete on subsequent work. For concrete not meeting specified requirements, Owner may require core

specimens to be taken and tested, at Contractor's expense. Concrete cores that test below specified requirements will be deemed to be defective.

- B. Repair or replacement of defective concrete will be determined by the Architect and will be paid for by Contractor. The cost of additional testing shall be borne by Contractor when defective concrete is identified.
- C. Do not patch, fill, touch-up, repair, or replace damaged or defective concrete except upon express direction of Architect for each individual area.

### **3.09 ERECTION**

- A. Before beginning erection operations, verify that site conditions are appropriate for the work. Mark elements to conform to designations indicated on approved shop drawings.
- B. Excavate trenches to foundations for setting as required. Do not excavate until two days prior to erecting panels.
- C. Employ erection equipment that will prevent damage to existing construction, permanent floor slabs, and tilt-up panels. Protect panels to prevent staining, warping, or cracking.
- D. Do not erect panels until they have attained sufficient compressive strength to withstand all erection stresses.
- E. Set panels in assigned positions. Erect members level and plumb within allowable tolerances. Grout space under panels for full bearing, or provide additional support until subsequent grouting operations are completed.
- F. Align and maintain uniform horizontal and vertical joints, as erection progresses.
- G. When members require adjustment beyond design or tolerance criteria, discontinue affected work; advise Architect.
- H. Weld units in place. Perform welding, including tack welds, in accordance with AWS D1.1/D1.1M. Welds shall be made by certified welders as specified in 05 12 00 - Structural Steel Framing.
- I. Touch-up field welds and scratched or damaged galvanized surfaces.
- J. Brace panels not attached to building frame at time of erection, using a bracing system designed to resist wind and other applicable loads until all structural connections have been made. Provide minimum of two braces per panel and maintain connections daily.
- K. Set units dry, without grout, attaining joint dimension with lead or plastic spacers. Grout pack base of unit.
- L. Exposed Joint Dimension: Joint dimensions shall be as indicated in the Drawings. Adjust units as required to bring joint dimensions within allowable tolerances.
- M. Patch holes, cut-off anchors, surface defects, and damaged corners to match panel with epoxy/cement paste adhesive.
- N. After panel erection, patch holes or other blemishes in casting slab that were caused by the panel casting or erection processes, using techniques acceptable to Architect.

### **3.10 ERECTION TOLERANCES**

- A. Unless otherwise approved by Architect, install site-cast tilt-up panels within erection tolerances as specified below.
- B. Replace panels that cannot be installed within specified tolerances.
- C. Joint Width Variation:
  - 1. Up to 20 feet tall panels: 1/4 inch maximum.
  - 2. Each additional 10 ft increment: 1/8 inch maximum.
  - 3. Do not increase or decrease joint width more than 50 percent from specified joint width in any case, as measured between panels at exterior face.
- D. Joint Taper:
  - 1. Up to 20 feet tall panels: 1/4 inch maximum.
  - 2. Each additional 10 ft increment: 1/8 inch maximum.
  - 3. Maximum for entire length of panel: 3/8 inch width difference for non-parallel panel edges.
- E. Panel Alignment:

1. Horizontal and Vertical Joints: 1/4 inch maximum.
2. Offset in Adjacent Exterior Panel Faces: 1/4 inch.

**END OF SECTION**