

**SECTION 03300  
CAST-IN-PLACE CONCRETE**

**PART 1 - GENERAL**

**1.01 DESCRIPTION**

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
1. Footings.
  2. Foundation walls.
  3. Slabs-on-grade.
  4. Miscellaneous concrete.

**1.02 DEFINITIONS**

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

**1.03 REFERENCED STANDARDS AND SPECIFICATIONS**

- A. American Concrete Institute (ACI)
1. 117 Standard Specifications for Tolerances for Concrete Construction and Materials
  2. 201.1 Guide for Making a Condition Summary of Concrete In Service
  3. 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
  4. 214 Guide to Evaluation of Strength Test Results of Concrete
  5. 301 Specifications for Structural Concrete
  6. 302.1R Guide to Concrete Floor and Slab Construction
  7. 304 Guide for Measuring, Mixing, Transporting, and Placing Concrete
  8. 305R Guide to Hot Weather Concreting
  9. 306R Guide to Cold Weather Concreting

10. 308R Guide to External Curing of Concrete
  11. 309R Guide for Consolidation of Concrete
  12. 315R Guide to Presenting Reinforcing Steel Design Details
  13. 318 Building Code Requirements for Structural Concrete and Commentary
  14. 347R Guide to Formwork for Concrete
- B. American Society for Testing and Materials (ASTM)
1. A615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
  2. A1064 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
  3. C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field
  4. C33 Standard Specification for Concrete Aggregate
  5. C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
  6. C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
  7. C88 Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
  8. C94 Standard Specification for Ready-Mixed Concrete
  9. C138 Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
  10. C143 Standard Test Method for Slump of Hydraulic-Cement Concrete
  11. C150 Standard Specification for Portland cement
  12. C171 Standard Specification for Sheet Materials for Curing Concrete
  13. C172 Standard Practice for Sampling Freshly Mixed Concrete
  14. C173 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

15. C231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
  16. C260 Standard Specification for Air-Entraining Admixtures for Concrete
  17. C309 Standard Specification for Liquid Membrane-forming Compounds for Curing Concrete
  18. C494 Standard Specification for Chemical Admixtures for Concrete
  19. C535 Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
  20. C881 Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
  21. C1017 Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
  22. C1064 Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
  23. C1240 Standard Specification for Silica Fume Used in Cementitious Mixtures
  24. D1752 Standard Specification for Preformed Sponge Rubber, Cork, and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
  25. D2240 Standard Test Method for Rubber Property-Durometer Hardness
  26. E154 Standard Test Methods for Water Vapor Retarders used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover
  27. E1745 Standard Specification for Plastic Water Vapor Retarders Used in Contact With Soil or Granular Fill Under Concrete Slabs
- C. American Welding Society (AWS)
1. D1.4 Structural Welding Code – Reinforcing Steel
- D. American Association Of State Highway and Transportation Officials (AASHTO)
1. M182 Standard Specification for Burlap Cloth Made From Jute or Kenaf and Cotton Mats

#### **1.04 SUBMITTALS**

- A. Product Data: For each type of product indicated.

- B. Design Mixtures: For each concrete mixture in accordance with ACI 301 and ACI 318. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
  - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
- D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional Engineer detailing fabrication, assembly, and support of formwork.
- E. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
  - 1. Aggregates.
- F. Material Certificates: For each of the following, signed by manufacturers:
  - 1. Cementitious materials.
  - 2. Admixtures.
  - 3. Form materials and form-release agents.
  - 4. Steel reinforcement and accessories.
  - 5. Waterstops.
  - 6. Curing compounds.
  - 7. Bonding agents.
  - 8. Adhesives.
  - 9. Vapor barriers.
  - 10. Repair materials.
- G. Field quality-control test and inspection reports.

#### **1.05 QUALITY ASSURANCE**

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
  - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Testing Agency Qualifications: An independent agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
  - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
  - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
  - 1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5.
  - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

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

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

## **PART 2 - PRODUCTS**

### **2.01 FORM-FACING MATERIALS**

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
  - 1. Plywood, metal, or other approved panel materials.

2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
  - a. High-density overlay, Class 1 or better.
  - b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
  - c. Structural 1, B-B or better; mill oiled and edge sealed.
  - d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- D. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
  1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- E. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spilling of concrete on removal.
  1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
  2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
  3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

## **2.02 STEEL REINFORCEMENT**

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Plain-Steel Welded Wire Reinforcement: ASTM A 1064, plain, fabricated from as-drawn steel wire into flat sheets.

## **2.03 REINFORCEMENT ACCESSORIES**

- A. Joint Dowel Bars: ASTM A 615, Grade 60, plain-steel bars, cut bars true to length with ends square and free of burrs.

- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
  - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

#### **2.04 CONCRETE MATERIALS**

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
  - 1. Portland Cement: ASTM C 150, Type I or Type II.
- B. Silica Fume: ASTM C 1240, amorphous silica.
- C. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source
  - 1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
  - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

#### **2.05 ADMIXTURES**

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride. Total chloride ions from admixtures and other measures shall be no greater than 0.1 percent by weight of cement in the concrete mix, immediately prior to service exposure. Prohibited Admixtures: Calcium chloride thiocyanates or admixtures containing more than 0.1 percent chloride ions are not permitted.
  - 1. Water-Reducing Admixture: ASTM C 494, Type A.
  - 2. Retarding Admixture: ASTM C 494, Type B.
  - 3. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
  - 4. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
  - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.

6. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.

## **2.07 VAPOR RETARDERS**

- A. Polyethylene sheet not less than 10 mils thick. ASTM E1745.

## **2.07 CURING MATERIALS**

- A. Evaporation Retarder
  1. Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
  2. Products (or equal)
    - a. "AquaFilm"; Dayton Superior
    - b. "VaporAid"; Kaufman Products, Inc.
    - c. "SikaFilm"; Sika Corporation
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
  1. Products: (or equal)
    - a. "MasterKure" Series; Master Builders Solutions US LLC
    - b. "Kurez"; Euclid Chemical Co.
    - c. "Clear Resin Cure J11W"; Dayton Superior

## **2.08 RELATED MATERIALS**

- A. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D 2240.
- B. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
  1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.



## 2.09 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
- B. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- C. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
  - 1. Fly Ash: 25 percent.
  - 2. Combined Fly Ash and Pozzolan: 25 percent.
  - 3. Ground Granulated Blast-Furnace Slag: 50 percent.
  - 4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
  - 5. Silica Fume: 10 percent.
  - 6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
  - 7. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
  - 8. Admixtures: Use admixtures according to manufacturer's written instructions.
    - a. Use water-reducing admixture in concrete, as required, for placement and workability.
    - b. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
    - c. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

## 2.10 CONCRETE MIXTURES

- A. For all concrete:

1. Minimum Compressive Strength: 4,500 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.42
3. Slump Limit: 3 inches prior to mid-range water reducer
4. Air Content: 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size

## **2.11 FABRICATING REINFORCEMENT**

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

## **2.12 CONCRETE MIXING**

- A. Ready-Mixed Concrete:
1. Measure, batch, mix, and deliver concrete according to ASTM C 94, and furnish batch ticket information.
  2. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
- B. Project-Site Mixing:
1. Measure, batch, and mix concrete materials and concrete according to ASTM C 94.
  2. Mix concrete materials in appropriate drum-type batch machine mixer.
  3. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
  4. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
  5. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

## **PART 3 - EXECUTION**

### **3.01 FORMWORK**

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
  - 1. Class A, 1/8 inch for smooth-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces.
- F. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Install keyways, reglets, recesses, and the like, for easy removal.
- G. Do not use rust-stained steel form-facing material.
- H. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- I. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- J. ACI 301 requires chamfers, unless otherwise specified.
  - 1. Chamfer exterior corners and edges of permanently exposed concrete.
  - 2. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- K. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

- L. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- M. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

### **3.02 EMBEDDED ITEMS**

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.
- B. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- C. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

### **3.03 REMOVING AND REUSING FORMS**

- A. Period of 24 hours is halved to 12 hours in ACI 347R.
- B. Commentary in ACI 318 recognizes 12 hours for concrete using regular Portland cement but advises that this period may be insufficient for concrete using Type II and Type V Portland cements or ASTM C 595 blended hydraulic cements, concrete with retarding admixtures, and concrete using ice during mixing.
- C. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
- D. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
- E. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- F. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- G. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Engineer.

### **3.04 VAPOR RETARDER**

- A. Lap joints 6 inches and seal with manufacturer's recommended tape.

- B. Granular Course: Cover vapor retarder with granular fill, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch or minus 3/4 inch.
  - 1. Place and compact a 1/2-inch- thick layer of fine-graded granular material over granular fill.

### **3.05 STEEL REINFORCEMENT**

- A. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
- D. Weld reinforcing bars according to AWS D1.4, where indicated.
- E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging.
- F. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

### **3.06 JOINTS**

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints
  - 1. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.
  - 2. Place joints perpendicular to main reinforcement.
  - 3. Continue reinforcement across construction joints, unless otherwise indicated.
- C. Doweled Joints
  - 1. Install dowel bars and support assemblies at joints where indicated.
  - 2. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

### 3.07 CONCRETE PLACEMENT

#### A. General

1. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Engineer.
3. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
4. Do not add water to concrete after adding high-range water-reducing admixtures to mixture. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
5. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
6. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
  - a. Do not use vibrators to transport concrete inside forms.
  - b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
  - c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
  - d. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
7. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
8. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
9. Maintain reinforcement in position on chairs during concrete placement.

10. Screed slab surfaces with a straightedge and strike off to correct elevations.
11. Slope surfaces uniformly to drains where required.
12. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
13. Do not further disturb slab surfaces before starting finishing operations.

B. Cold-Weather Placement:

1. Comply with ACI 306R and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
2. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
3. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
4. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

C. Hot-Weather Placement

1. Comply with ACI 301 and ACI 305R, and as follows:
  - a. Maintain concrete temperature below 90 deg F at time of placement.
  - b. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water.
  - c. Using liquid nitrogen to cool concrete is Contractor's option.
  - d. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete.
  - e. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

**3.08 FINISHING FORMED SURFACES**

A. Rough-Formed Finish:

1. As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched.
2. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
3. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish

1. As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
2. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
3. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.

C. Rubbed Finish

1. Apply the following to smooth-formed finished as-cast concrete where indicated:
  - a. Smooth-Rubbed Finish (SRF): Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
  - b. Grout-Cleaned Finish (GCF): Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part Portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
  - c. Cork-Floated Finish (CFF): Wet concrete surfaces and apply a stiff grout. Mix one part Portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white Portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

D. Related Unformed Surfaces



1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces.
2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

### **3.09 FINISHING FLOORS AND SLABS**

#### **A. General**

1. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
2. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
3. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

#### **B. Slip-Resistive Finish**

1. Before final floating, apply slip-resistive aggregate finish where indicated and to concrete stair treads, platforms, and ramps.
2. Apply according to manufacturer's written instructions and as follows:
  - a. Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistive aggregate over surface in 1 or 2 applications. Tamp aggregate flush with surface, but do not force below surface.
  - b. Revise float finish in first subparagraph below to trowel finish if required.
  - c. After broadcasting and tamping, apply float finish.
  - d. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aggregate.

### **3.10 MISCELLANEOUS CONCRETE ITEMS**

#### **A. Filling In**

1. Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place.
2. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

- B. Curbs
  - 1. Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations
  - 1. Provide machine and equipment bases and foundations as shown on Drawings.
  - 2. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
- D. Cast-in inserts and accessories as shown on Drawings.
- E. Screed, tamp, and trowel-finish concrete surfaces.

### **3.11 CONCRETE PROTECTING AND CURING**

- A. General
  - 1. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306R for cold-weather protection and ACI 305R for hot-weather protection during curing.
- B. Evaporation Retarder
  - 1. Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations.
  - 2. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces
  - 1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms.
  - 2. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces
  - 1. Begin curing immediately after finishing concrete.

2. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
3. Cure concrete according to ACI 308R, by one or a combination of the following methods:
  - a. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    - 1) Water.
    - 2) Continuous water-fog spray.
    - 3) Absorptive cover, water saturated, and kept continuously wet.
    - 4) Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
  - b. Moisture-Retaining-Cover Curing
    - 1) Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.
    - 2) Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
    - 3) Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    - 4) Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    - 5) Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
  - c. Curing Compound
    - 1) Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions.
    - 2) Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

- 3) After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.
  - 4) Curing and sealing compound in subparagraph below is usually for floors and slabs and may act as a permanent surface finish.
- d. Curing and Sealing Compound:
- 1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions.
  - 2) Recoat areas subjected to heavy rainfall within three hours after initial application.
  - 3) Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

### **3.12 CONCRETE SURFACE REPAIRS**

#### **A. Defective Concrete**

1. Repair and patch defective areas when approved by Engineer.
2. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.

#### **B. Patching Mortar**

1. Mix dry-pack patching mortar, consisting of one part Portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
2. Insert provision for testing repair technique on a mockup or surface to be concealed later, before repairing surfaces.

#### **C. Repairing Formed Surfaces**

1. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

2. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth.
3. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
4. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
5. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by the Engineer.
6. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.
7. Repair materials and installation not specified above may be used, subject to Engineers's approval.

### **3.13 FIELD QUALITY CONTROL**

- A. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports. See Section 01400.
- B. Inspections:
  1. Steel reinforcement placement.
  2. Steel reinforcement welding.
  3. Headed bolts and studs.
  4. Verification of use of required design mixture.
  5. Concrete placement, including conveying and depositing.
  6. Curing procedures and maintenance of curing temperature.
  7. Verification of concrete strength before removal of shores and forms from beams and slabs.
- C. Concrete Tests

1. Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
  - a. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd. but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
  - b. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Slump
  - a. ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  - b. Perform additional tests when concrete consistency appears to change.
3. Air Content
  - a. ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31.
  - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
  - b. Cast and field cure sets of two standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39
7. Test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
  - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
  - b. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate

operations and provide corrective procedures for protecting and curing in-place concrete.

- c. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- d. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

8. Nondestructive Testing

- a. Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.

D. Additional Tests

- 1. Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer.
- 2. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Engineer.
- 3. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- 4. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- 5. Measure floor and slab flatness and levelness according to ASTM E within 48 hours of finishing.

**END OF SECTION 03300**

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**SECTION 03410  
PRECAST STRUCTURAL CONCRETE**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Contractor shall provide all materials, labor, equipment and services necessary to design, construct and install precast concrete structures, as shown on the Contract Drawings.
- B. The structures shall be constructed of precast reinforced concrete. They shall be watertight, non-corrosive, durable and structurally sound. All inlet and outlet connections shall be sealed.

**1.02 SUBMITTALS**

- A. Shop Drawings: Submit detailed fabrication and installation drawings certified by a Professional Engineer registered in the State of Maryland prior to fabrication. Show plans, elevations, dimensions, cross sections, openings, joint design, and indicate location, size and type of reinforcing steel.
- B. Calculations: Submit manufacturer's complete design calculations certified by a Professional Engineer registered in the State of Maryland, including load calculations, buoyancy calculations, and concrete mix design.
- C. Certifications: Submit manufacturer's certifications and laboratory test reports including mill certification for the reinforcing steel, certificates of compliance for all flexible connectors and/or inlet and outlet seals, and certified test reports specified in referenced ASTM Standards.
- D. Watertightness test procedures and test results data.

**1.03 DESIGN CRITERIA**

- A. All precast structures shall be designed in accordance with ACI 350 "Building Code Requirements for Environmental Engineering Concrete Structures."
- B. Top slab must be separate and removable from structure. Structures shall be designed to accommodate pumps, piping, valves and other equipment, as shown or specified.
- C. Loads:
  - 1. Live Load: MDSHA HS-27 (135% of AASHTO HS20-44 Loading).

- 2. Dead Load: Earth at 125-pcf with an at rest coefficient equal to 0.53. Hydrostatic pressure should be included as applicable.
- D. Flotation design shall have a factor of safety of 1.5 minimum.
- E. Wall thicknesses shown on Contract Drawings are the minimum.
- F. All mechanical connections between precast units and any cast-in-place concrete or precast units shall be 316 stainless steel.
- G. Precast structures shall be designed to account for all reaction loads resulting from hoisting equipment, handrails, hatches, and other equipment, either embedded or attached to the structure, with a minimum thickness to fully embed all sleeves, bases, frames, anchors and other items that will impact the design.
- H. The base with riser walls and shelf shall be cast monolithically as a single unit. Rectangular vaults with an interior width dimension greater than 6'-0" or interior length dimension greater than 12'-0" may have a cast-in-place concrete bottom in-lieu of a monolithic cast bottom, provided the design is in accordance with the Contract Documents and is included in the design calculations as required above. The interface between the cast-in-place and precast units shall be sealed to provide a watertight structure, and all mechanical connections between the precast units and cast-in-place concrete bottom shall be 316 stainless steel.

#### **1.04 QUALITY ASSURANCE**

- A. Fabricator Qualifications: Fabrication shall be by a firm experienced in the manufacturing of precast concrete units similar to the ones indicated for this project and with a record of successful in-service performance.
- B. Design Standards: Comply with ACI 350 "Building Code Requirements for Environmental Engineering Concrete Structures" and the design recommendations of PCI MNL 120, "PCI Design Handbook—Precast and Prestressed Concrete".

#### **1.05 DELIVERY, STORAGE AND HANDLING**

- A. Store precast concrete units at the project site in a manner to prevent cracking, distorting, warping, or other physical damage, and so that markings are visible.
- B. Lift and support precast concrete units only at designated lifting and supporting points as shown on approved shop drawings.

#### **1.06 JOB CONDITIONS**

- A. Verify dimensions at the project site and prepare shop drawings to reflect actual field conditions and dimensions.

## **PART 2 - PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Subject to compliance with requirements, manufacturers that may be used include:
1. Concrete Pipe & Precast,
  2. Gillespie Precast,
  3. Monarch Products Company, Inc.

### **2.02 MATERIALS**

- A. Concrete Materials
1. Portland Cement: ASTM C150, Type II.
  2. Aggregates: Except as modified by PCI MNL 116, use ASTM C33 coarse aggregates.
  3. Water: Potable, in accordance with ACI 318 and 350.
  4. Air-Entraining Admixture: ASTM C260, certified by manufacturer to be compatible with other required admixtures.
  5. Water-Reducing; Retarding; Water-Reducing and Retarding; High-Range, Water-Reducing; and High-Range, Water-Reducing and Retarding Admixtures: ASTM C494.
  6. Fly Ash or Natural Pozzolans: ASTM C618.
  7. Silica Fume: ASTM C1240.
  8. Calcium chloride or admixtures containing chlorides shall not be used.
- B. Reinforcing Steel
1. Reinforcing Bars: ASTM A615, Grade 60, deformed, epoxy coated.
  2. Welded Wire Reinforcement: ASTM A1064, furnish in flat sheets, epoxy coated or galvanized.
  3. Epoxy Coating: Epoxy coated reinforcing steel shall be fusion bonded epoxy powder. The epoxy protective coating shall be a one coat, heat curable, thermosetting powdered coating that is electro-statically applied on metal surfaces. For reinforcement steel the color shall be a bright color to contrast

with the normal color of reinforcement steel and rust (e.g., orange, red, green, yellow, etc., and not brown or any color in the rust family). If reinforcement steel is coated before fabrication, all hairline cracks and minor damage on fabrication bends shall be patched, even if there is no bond loss. Epoxy coatings shall conform to ASTM D3963.

C. Joints

1. Joints between precast concrete units shall comply with ASTM C990, and shall be sealed watertight using CS-102 as Manufactured by Concrete sealants, Inc., or approved equal.

**2.03 CONCRETE MIXES**

- A. Compressive Strength: 5,000 psi at 28-days.
- B. Maximum Water-Cement Ratio: 0.40.
- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air-content as follows, with a tolerance of plus or minus 1½ percent:
  1. Air Content: 5 percent for 1½-inch nominal maximum aggregate size.
  2. Air Content: 6 percent for ¾-inch nominal maximum aggregate size.
  3. Air Content: 7 percent for ½-inch nominal maximum aggregate size.

**2.04 COATINGS**

- A. Coat exterior surface of precast concrete units with Carboline Bitumastic 300-M, or approved equal, 32 mil minimum thickness. Coat interior surfaces in accordance with Section 09900 unless drawings call for an interior coating in accordance with Section 09960.

**2.05 FABRICATION**

- A. Reinforcement: Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing and supporting reinforcement.
- B. Mix concrete according to PCI MNL 116. After concrete batching, no additional water may be added.
- C. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in the precast concrete units. Comply with PCI MNL 116 for measuring, mixing, transporting, and placing concrete.

- D. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items. Use equipment and procedures complying with PCI MNL 116.
- E. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture.
- F. Product tolerances: Fabricate precast concrete units straight and true to size and shape with exposed edges and corners precise and true so the finished units comply with PCI MNL 116 product tolerances.
- G. Pipe Openings:
  - 1. Pipe openings 12" and smaller can be core drilled in the field, provided that the Contractor coordinates the locations of pipe openings with the precast concrete manufacturer to ensure that the structural and watertight integrity of the unit remains intact. Modular casing seals shall be used to seal the annular space around pipe penetrations to maintain the watertight integrity of the unit. The distance of the core drilled hole from a riser joint, another hole, or edge of a wall or slab shall be a minimum of 4" in all directions. Otherwise, all pipe penetrations shall be cast into the precast units as described below.
  - 2. All pipe openings cast into the precast units shall be provided with a gasket cast integrally into the structure. Gasket shall be rubber, meeting the requirements of ASTM C923, and manufactured by A-Lok Products Corp., Vertex Inc., or approved equal. Pipe opening elevations are fixed. Non-standard riser units shall be provided, as necessary, so that joints do not occur within 6" of pipe openings.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

- A. Install precast concrete units on undisturbed soil with a stone bedding, which has been leveled and compacted as shown on the Contract Drawings. Excavation shall be free of standing water until backfilling is complete.
- B. Install precast concrete units level, plumb, square and true, without exceeding the recommended erection tolerances in PCI MNL 127, "Recommended Practice for Erection of Precast Concrete".

### 3.02 WATERTIGHTNESS OF STRUCTURES

- A. The provisions of this section are applicable to precast concrete structures used as underground vaults that are intended to be dry, and precast concrete structures used as tanks that are intended to be wet.
- B. The Contractor shall provide all labor, materials, tools, equipment and devices for testing the water-tightness of new structures, constructed under this Contract. Testing shall be performed prior to the acceptance or placing the structure in operation. All structures, both water holding and dry, are meant to be watertight and free from discernible infiltration and exfiltration.
- C. Structures Designed to Contain Liquid
  - 1. Structures designed to contain liquid shall be thoroughly cleaned prior to the introduction of water for test purposes. Before testing a structure, all pipelines connecting to the structure shall have been tested and approved for leakage. All structures shall be tested for leakage and shall be tested in accordance with ACI 350.1. Testing shall be conducted prior to back filling soil around structures, unless otherwise noted.
  - 2. If any structure fails to meet the above requirements for water tightness, then the Contractor shall drain the structure, locate and repair all leaks and retest the structure as many times as is necessary to obtain a watertight structure as defined herein, all to the satisfaction of the Engineer and at no extra cost to the Owner.
- D. Structures designed to be dry shall have the interior thoroughly cleaned below finished grade and pumped dry if necessary. Openings below grade shall be bulkheaded and made tight. After a period of 5 days, interior surfaces will be inspected for accumulation of moisture and any excess accumulation indicative of defects in the structure in the judgment of the Engineer shall be repaired by the Contractor at no cost to the Owner and to the satisfaction of the Engineer.
- E. All leaks and defects in structures shall be repaired or remedied without additional compensation at whatever time during the course of the Contract they become apparent.
- F. Potable water shall be used for filling structures for leakage tests. It shall be the Contractor's responsibility to convey all water from hydrants or other approved source, as needed for the leak testing. The Contractor shall notify and coordinate with the appropriate Fire Department prior to using hydrants.
- G. No separate payment will be made for testing structures neither for water tightness nor for the cost of the water used. The cost thereof shall be considered as included in the lump sum bid for this Contract.

**END OF SECTION 03410**

**SECTION 03600  
GROUT**

**PART 1 - GENERAL**

**1.01 DESCRIPTION**

- A. The work of this section includes grouting as indicated on the drawings or specified in other sections. Unless otherwise specified, all grouting shall be done with non-shrinking grout.

**1.02 REFERENCES**

- A. American Concrete Institute:
  - 1. ACI 308, Recommended Practice for Curing Concrete.
- B. American Society for Testing and Materials:
  - 1. ASTM C33; Concrete Aggregates.
  - 2. ASTM C109; Test Method for Compressive Strength of Hydraulic Cement Mortars (Using two inch or 50-mm Cube Specimens).
  - 3. ASTM C150; Specification for Portland Cement.
  - 4. ASTM C191; Test Method for Time of Setting of Hydraulic Cement by Vicat Needle.
  - 5. ASTM C596; Test Method for Drying Shrinkage of Mortar Containing Portland Cement.
  - 6. ASTM C827; Test Method for Early Volume Change of Cementitious Mixtures.

**1.03 SUBMITTALS**

- A. Submit a statement of compliance, together with supporting data, from the materials suppliers attesting to the conformance of products and ingredients with these specifications.
- B. Submit manufacturer's instructions for mixing, handling, surface preparation, and placing the epoxy type and the non-shrink, non-metallic type grouts.

**1.04 QUALITY ASSURANCE**

- A. Manufacturer's Qualifications: Grout manufacturer shall furnish copies of current independent laboratory test results showing the non-shrink, non-metallic grout as non-shrink from time of placement according to the following:

1. The grout indicates no expansion after final set according to ASTM C827.
2. The grout indicates 4,000-psi strength developed with a trowelable mix within 24 hours according to ASTM C109.
3. The grout indicates placement time limitation based on initial set of not less than 60 minutes according to ASTM C191.
4. Test results, as supplied by the grout manufacturer, shall indicate that in projects of similar scope and size, the effective bearing area was between 95 and 100 percent.

#### **1.05 DELIVERY, STORAGE AND HANDLING**

- A. Provide protection for the products to prevent moisture damage and contamination of the grout materials.
- B. Store the grout in undamaged condition with seals and labels intact as packaged by the manufacturer.

#### **1.06 PROJECT CONDITIONS**

- A. Protect freshly poured grout against high and low temperatures and unfavorable environmental conditions in accordance with ACI Standards 308.

### **PART 2 - PRODUCTS**

#### **2.01 MATERIALS**

- A. Portland Cement: ASTM C150, Type II.
- B. Water: Potable; containing no impurities, suspended particles, algae, organic substances, acids, alkalis, or dissolved natural salts in quantities that will cause:
  1. Corrosion of steel,
  2. Volume change that will increase shrinkage cracking,
  3. Efflorescence,
  4. Excess air entraining.
- C. Fine Aggregate:
  1. Washed natural sand.
  2. Gradation in accordance with ASTM C33 and represented by a smooth granulometric curve within the required limits.



- 3. Free from injurious amounts of organic impurities as determined by ASTM C40.

**2.02 RAPID-CURING EPOXY GROUT**

- A. High strength, three-component epoxy grout formulated with thermosetting resins and inert fillers.
- B. Grout shall be rapid curing, have high adhesion, and be resistant to ordinary chemicals, acids and alkalis.

<u>Physical Properties</u>	<u>Reference Spec.</u>
Compressive Strength 12,000 psi (7-day)	ASTM C579
Tensile Strength 2,000 psi minimum	ASTM C307
Coefficient of Expansion $3 \times 10^{-6}$ in/in/°F	ASTM C531
Shrinkage None	ASTM C827

**2.03 NON-SHRINK, NON-METALLIC CEMENTITIOUS GROUT**

- A. Pre-mixed ready for use formulation requiring only the addition of water; non-shrink, non-corrosive, non-metallic, non-gas forming, no chlorides. No more water shall be used than is necessary to produce a flowable grout.
- B. Certified to maintain initial placement volume or expand after set and meet the following minimum properties when tested in accordance with Corps of Engineers Specification CRD-C621, for Type D non-shrink grout:

Setting Time:	Initial	2 hours (Approx.)
ASTM C191	Final	3 hours (Approx.)
Expansion:		0.4% Maximum
Compressive Strength:	1 day	4,000 psi
CRD-C621	7 days	7,000 psi
	28 days	10,000 psi

**PART 3 - EXECUTION**

**3.01 SURFACE PREPARATION**

- A. Remove defective concrete, laitance, dirt, oil, grease and other foreign material from concrete surfaces by brushing, hammering, chipping or other similar means until a sound, clean concrete surface is achieved. Perform additional surface preparation in accordance with non-shrink, non-metallic grout manufacturer's instructions.
- B. Lightly roughen the concrete, but not enough to interfere with the proper placement of grout.
- C. Remove foreign materials from metal surfaces in contact with grout.
- D. Align, level and maintain final positioning of components to be grouted.

- E. Take special precautions during periods of extreme weather conditions in accordance with the manufacturer's written instructions.
- F. Saturate concrete surfaces with clean water; remove excess water, leave none standing.

### **3.02 FORMWORK**

- A. Construct leakproof forms anchored and shored to withstand grout pressures, so that no movement is possible.
- B. Provide clearance between the formwork and the area to be grouted to permit proper placement of grout.
- C. Forms shall be provided where structural components of baseplates or bedplates will not confine the grout.
- D. Pre-treat wood forms with forming oils so that they do not absorb moisture.
- E. Remove supports only after grout has hardened.

### **3.03 MIXING**

- A. Portland Cement Grout:
  - 1. Prepare grout composed of Portland cement, sand and water; do not use ferrous aggregate or staining ingredients in grout mix.
  - 2. Use proportions of 2 parts sand and 1 part cement, measured by volume.
  - 3. Prepare grout with sufficient water to obtain consistency to permit placing and packing.
  - 4. Mix water and grout in two steps; pre-mix using approximately 2/3 of the water; after partial mixing, add the remaining amount of water to bring mix to the desired placement consistency and continue mixing 2-3 minutes.
  - 5. Mix only that quantity of grout that can be placed within 30 minutes after mixing.
  - 6. After the grout has been mixed, do not add more water for any reason.
- B. Epoxy Grout & Non-Shrink Cementitious Grout: Mix and prepare epoxy grout and non-shrink cementitious grout in strict accordance with the manufacturer's instructions.
- C. Mix grout components as close to the work area as possible and transport the mixture quickly and in a manner that does not permit segregation of materials.

### 3.04 PLACING

- A. Unless otherwise specified or indicated on the drawings, the thickness of grout under baseplates shall be 1-1/2 inches. Grout shall be placed in strict accordance with the directions of the manufacturer so that all spaces and cavities below the top of baseplates and bedplates are completely filled, without voids.
- B. Place grout material quickly and continuously.
- C. Do not use pneumatic-pressure or dry-packing methods.
- D. Apply grout from one side only to avoid entrapping air. The final installation shall be thoroughly compacted and free of air pockets.
- E. Do not vibrate the placed grout mixture, or permit it to be placed if the area is being vibrated by nearby equipment.
- F. In all locations where the edge of the grout will be exposed to view, the grout shall be finished smooth after it has reached its initial set. Except where shown to be finished on a slope, the edges of grout shall be cut off flush at the baseplate, bedplate, member, or piece of equipment.
- G. Do not remove leveling shims for at least 48 hours after grout has been placed.
- H. Unless otherwise noted in the drawings, anchor bolts and threaded rod anchors shall be epoxy grouted in holes drilled into hardened concrete. Diameters of holes shall be as follows:

<u>Item</u>	<u>Diameter of Hole</u>
Threaded Rod Anchors	1/8 inch larger than the bar or rod outside diameter
Anchor Bolts	Per manufacturer's instructions

- I. The embedment depth for epoxy grouted anchor bolts and threaded rod anchors, shall be not less than 15 bolt or rod diameters, unless otherwise indicated on the drawings. Holes shall be prepared for grouting as recommended by the grout manufacturer.
- J. Anchor bolts and threaded rod anchors shall be clean, dry, and free of grease and other foreign matter at time of installation. The bolts, rods, and bars shall be set and positioned, and the epoxy grout shall be placed and finished in accordance with the recommendations of the grout manufacturer. Particular care shall be taken to ensure that all space and cavities are filled with epoxy grout, without voids.
- K. During assembly of all threaded stainless steel components, anti-seize thread lubricant shall be liberally applied to the threaded portion not embedded in concrete.

**3.05 CURING**

- A. After grout has attained its initial set, keep damp for a minimum of 3 days.
- B. Prevent rapid loss of water from the grout during the first 48 hours by the use of an approved membrane-curing compound or with the use of the wet burlap method.

**END OF SECTION 03600**