

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

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Uniform General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies cast-in-place concrete, including formwork, reinforcement, concrete materials, mix design, placement procedures, and finishes.

1.3 DEFINITIONS

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

1.4 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Steel Reinforcement Shop Drawings: Details of fabrication, bending, and placement, prepared according to ACI 315, "Details and Detailing of Concrete Reinforcement." Include material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports of concrete reinforcement. Include special reinforcement required for openings through concrete structures.
- C. Recycled Content Certification: Manufacturer's or fabricator's certificate indicating percentage of post-consumer recycled content by weight and post-industrial recycled content by weight for each Product specified under this Section.
- D. Local/Regional Source Certification: Manufacturer or fabricator's certificate indicating location, and distance in miles from the Project Site, of each Product's final assembly, extraction, harvesting, or recovery prior to shipment to the Project Site.
- E. Certificates from manufacturers of concrete accessories, including, but not limited to, form release agents and form treatments, curing and sealing compounds, bond breakers and bonding agents, epoxy construction adhesives and coatings, hardeners, repair products, cleaners and strippers, attesting that their products comply with specification requirements and are suitable for the use indicated.
- F. Certification by manufacturer that concrete accessories comply with the National VOC rule of the United States Environmental Protection Agency as defined in "40 CFR Part 59, National Volatile Organic Compound Emission Standards for Architectural Coatings," local regulations controlling use of volatile organic compounds (VOC), or VOC limits specified under this Section, whichever is more stringent.
- G. Quality Assurance Submittals:
  - 1. Design mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
    - a. Mix designs shall have a history of not less than 12 test cylinders.
  - 2. Material test reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:
    - a. Aggregation gradation.
    - b. Deleterious substances within aggregate.
    - c. Aggregate durability.
    - d. Mix additives.

- e. Portland cement.
- f. Fly ash.
- g. Blast-furnace slag.
- 3. Material certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
  - a. Cementitious materials and aggregates.
  - b. Form-release agents.
  - c. Steel reinforcement and reinforcement accessories.
  - d. Admixtures.
  - e. Curing materials.
  - f. Bonding agents.
  - g. Adhesives.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed concrete Work similar in complexity to those required for this Project, and whose work has resulted in construction with a record of successful in-service performance.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
- C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.
- D. ACI Publications: Comply with the following, unless more stringent provisions are indicated:
  - 1. ACI 301, "Specification for Structural Concrete."
  - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle steel reinforcement to prevent bending and damage.
- B. Ready mixed concrete shall be handled and preserved in its "batched" proportions during transportation.
- C. Mixing time shall not exceed the following.
  - 1. 60 minutes when ambient temperature is above 90 degrees F.
  - 2. 75 minutes when ambient temperature is between 85 and 90 degrees F.
  - 3. 90 minutes when ambient temperature is below 80 degrees F.
- D. Water shall not be added to the mixed concrete.

### **PART 2 - PRODUCTS**

#### 2.1 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.
- 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, 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.
  - 2. Volatile organic compound (VOC) content: Not more than 450 grams per liter.

- 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 spalling of concrete on removal.
  - 1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of the exposed concrete surface.
  - 2. Furnish ties that, when removed, will leave holes not larger than 1 inch in diameter in concrete surface.

## 2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed, containing not less than 100 percent recycled steel.
- B. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

## 2.3 REINFORCEMENT ACCESSORIES

- A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place.
  - 1. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:
  - 2. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected or CRSI Class 2 stainless-steel bar supports.
- B. Joint Dowel Bars: Plain-steel bars, ASTM A 615, Grade 60, containing not less than 100 percent recycled steel.
  - 1. Cut bars true to length with ends square and free of burrs.

## 2.4 CONCRETE MATERIALS

- A. Portland cement: ASTM C 150, Type I.
- B. Fly Ash: ASTM C 618, Class C or F.
- C. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- D. Normal-Weight Aggregate: ASTM C 33, uniformly graded,
- E. Water: Potable and complying with ASTM C 94.

## 2.5 ADMIXTURES

- A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride.
- B. Air-Entraining Admixture: ASTM C 260.
- C. Water-Reducing Admixture: ASTM C 494, Type A.
- D. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
- E. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.
- F. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

## 2.6 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
  - 1. Available products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Conspec Marketing & Manufacturing Co., Inc.: Aquafilm.
    - b. Dayton Superior Corporation: Sure Film.
    - c. Euclid Chemical Co.: Eucobar.
    - d. L&M Construction Chemicals, Inc.: E-Con.
    - e. Master Builders, Inc.: Confilm.
    - f. Sika Corporation: Sika-Film.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 ounces per square yard dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Curing Compound: ASTM C309, Type 1D, Class B, minimum 30 percent solids, curing compound with maximum volatile organic compound (VOC) of 250 grams per liter

## 2.7 RELATED MATERIALS

- A. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

## 2.8 CONCRETE MIXES

- A. General Requirements:
  - 1. It is the intent of the University of Texas to incorporate concrete mixes that minimize the use of portland cement, while maximizing the use of fly ash as a substitute for portland cement. **Flyash content to be minimum 35%.**
  - 2. Bidders are required to submit proposed concrete mix designs within 48 hours of bid to the Construction Manager.
- B. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases, as follows:
  - 1. Proportion normal-weight concrete according to ACI 211.1 and ACI 301.
- C. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the laboratory trial mix basis.
- D. Class A2: Use for stairs and foundations. Proportion normal-weight concrete mix as follows:
  - 1. Minimum 56-day compressive strength: 4,000 pounds per square inch.
  - 2. Minimum fly ash content: 30 percent of cementitious materials by weight.
  - 3. Maximum size coarse aggregate size: 1 inch.
  - 4. Entrained/entrapped air at point of placement: 3-1/2 to 6-1/2 percent.
- E. Class E: Use for housekeeping pads. Proportion normal-weight concrete mix as follows:
  - 1. Minimum 28-day compressive strength: 3,000 pounds per square inch.
  - 2. Minimum fly ash content: 30 percent of cementitious materials by weight.
  - 3. Maximum size coarse aggregate size: 3/4 inch.
  - 4. Air-entraining admixture: Not allowed.
- F. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- G. Admixtures: Use admixtures according to manufacturer's written instructions.
  - 1. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.
  - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

3. Use water-reducing admixture in pumped concrete, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
4. Use corrosion-inhibiting admixture in concrete mixes where indicated.

## 2.9 FABRICATING REINFORCEMENT

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

## 2.10 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and ASTM C1116, furnish batch ticket information.

# PART 3 - EXECUTION

## 3.1 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 concrete 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 B, 1/4 inch.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces.
  1. Provide crush or wrecking plates where stripping may damage cast concrete surfaces.
  2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
  3. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
  4. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips to achieve required elevations and slopes in finished concrete surfaces.
  1. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.
  1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
  2. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete.
  1. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

### 3.2 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.
  - 1. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 2. Install anchor bolts, accurately located, to elevations required.

### 3.3 REMOVING AND REUSING FORMS

- A. General: Formwork, for sides of beams, walls, and similar parts of the Work, that does not support weight of concrete may be removed after cumulatively curing at not less than 50 degrees F for 24 hours after placing concrete provided concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained.
- B. Leave formwork structural elements that supports weight of concrete in place until concrete has achieved the following:
  - 1. At least 70 percent of 56-day design compressive strength.
- C. Clean and repair surfaces of forms to be reused in the Work.
  - 1. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces.
  - 2. Apply new form-release agent.
- D. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.
  - 1. Align and secure joints to avoid offsets.
  - 2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

### 3.4 SHORES AND RESHORES

- A. Comply with ACI 318, ACI 301, and recommendations in ACI 347R for design, installation, and removal of shoring and reshoring.
- B. Plan sequence of removal of shores and reshore to avoid damage to concrete.
  - 1. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

### 3.5 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.
- C. Accurately position, support, and secure reinforcement against displacement.
  - 1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
  - 2. Do not tack weld crossing reinforcing bars.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire fabric in longest practicable lengths on bar supports spaced to minimize sagging.
  - 1. Lap edges and ends of adjoining sheets at least one mesh spacing.
  - 2. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
  - 3. Lace overlaps with wire.

### 3.6 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
  - 1. Place joints perpendicular to main reinforcement.
  - 2. Continue reinforcement across construction joints, unless otherwise indicated.
  - 3. Form from preformed galvanized steel, plastic keyway-section forms, or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
  - 4. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Dowel Joints: Install dowel sleeves and dowels or dowel bar and support assemblies at joints where indicated.
  - 1. Use dowel sleeves or lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

### 3.7 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement.
- C. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness.
  - 1. If a section cannot be placed continuously, provide construction joints as specified.
  - 2. Deposit concrete to avoid segregation.
  - 3. Do not allow free fall of concrete to exceed 5 feet
- D. Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints.
  - 1. Place each layer while preceding layer is still plastic, to avoid cold joints.
  - 2. Consolidate placed concrete with mechanical vibrating equipment.
    - a. Use equipment and procedures for consolidating concrete recommended by ACI 309R.
  - 3. Do not use vibrators to transport concrete inside forms.
  - 4. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the vibrator.
  - 5. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer.
  - 6. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
  - 7. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix constituents to segregate.
- E. Cold-Weather Placement: Comply with ACI 306.1 and as follows.
  - 1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
  - 2. When air temperature has fallen to or is expected to fall below 40 degrees F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees F and not more than 80 deg F at point of placement.
  - 3. Do not use frozen materials or materials containing ice or snow.
  - 4. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  - 5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.
- F. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows, when hot-weather conditions exist:
  - 1. Cool ingredients before mixing to maintain concrete temperature below 90 degrees F at time of placement.
  - 2. 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.
    - a. Using liquid nitrogen to cool concrete is Contractor's option.
  - 3. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

4. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete.
  - a. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

### 3.8 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched.
  1. Remove fins and other projections exceeding ACI 347R limits for class of surface specified.
  2. Provide at concealed locations.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
  1. Repair and patch tie holes and defective areas.
  2. Remove fins and other projections exceeding 1/8 inch in height.
  3. Apply to concrete surfaces exposed to public view.
- C. Related Unformed Surfaces: 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.
  1. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

### 3.9 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place.
  1. Mix, place, and cure concrete, as specified, to blend with in-place construction.
  2. Provide other miscellaneous concrete filling indicated or required to complete Work.
- B. Curbs: Provide monolithic finish to interior curbs located at openings in floor slabs, 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: Provide machine and equipment bases and foundations as shown on Drawings.
  1. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

### 3.10 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
  1. Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305R for hot-weather protection during curing.
  2. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.
  3. Begin final curing procedures immediately following initial curing and before concrete has dried.
    - a. Continue final curing for at least 7 days in accordance with ACI 301 procedures.
    - b. Avoid rapid drying at end of final curing period.
  4. In order to avoid plastic or drying shrinkage cracks during warm, dry or windy weather, follow ACI 302 and ACI 308 using wind breaks and sun shades when recommended.
  5. Evaporation retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 pounds per square foot per hour before and during finishing operations.
    - a. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- B. Curing Methods: Perform curing of concrete by curing compound, by moist curing, by moisture-retaining cover curing, and by combinations thereof, as herein specified.
  1. Moisture curing: Keep surfaces continuously moist for not less than 7 days with the following materials:
    - a. Water.

- b. Continuous water-fog spray.
- c. Absorptive cover, water saturated, and kept continuously wet.
  - 1) Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
- 2. Moisture-retaining-cover curing: 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.
  - a. Cure for not less than seven days.
  - b. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
- 3. Curing compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions.
  - a. Recoat areas subjected to heavy rainfall within three hours after initial application.
  - b. Maintain continuity of coating and repair damage during curing period.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
  - 1. If forms remain during curing period, moist cure after loosening forms.
  - 2. If removing forms before end of curing period, continue curing with curing compound or by one of the other methods specified above, as applicable and except as follows:
- D. Unformed Surfaces: Begin curing immediately after finishing concrete.
  - 1. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces, by one or a combination of the methods specified above, as applicable.

### 3.11 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
  - 1. Defer joint filling until concrete has aged at least 6 months.
  - 2. Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semirigid epoxy joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints.
  - 1. Overfill joint and trim joint filler flush with top of joint after hardening.

### 3.12 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Concrete which, in the opinion of the Architect, does not conform to required lines, details, dimensions, tolerances, or specified requirements, or, in the opinion of the Architect, concrete with excessive honeycomb or embedded debris.
- B. Concrete which has been determined by Architect to be defective, shall be repaired or replaced as directed by Architect.
  - 1. Repair and patch defective areas when approved by Architect.
  - 2. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- C. Patching Mortar: 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.
- D. Repairing Formed Surfaces: 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.
  - 1. For areas that the Architect determines can be repaired, repair as follows.
    - a. 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.
      - 1) Make edges of cuts perpendicular to concrete surface.
    - b. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
    - c. Fill and compact with patching mortar before bonding agent has dried.

- d. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
  - e. 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.
  - f. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
  - g. Compact mortar in place and strike off slightly higher than surrounding surface.
  - h. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- E. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface.
- 1. Correct low and high areas.
  - 2. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
  - 3. For areas that the Architect determines can be repaired, repair as follows
    - a. Repair finished surfaces containing defects.
      - 1) Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
    - b. After concrete has cured at least 14 days, correct high areas by grinding.
    - c. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar.
      - 1) Finish repaired areas to blend into adjacent concrete.
    - d. Correct other low areas scheduled to receive floor coverings with a repair underlayment.
      - 1) Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
      - 2) Feather edges to match adjacent floor elevations.
    - e. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.
      - 1) Remove defective areas with clean, square cuts and expose steel reinforcement with at least 3/4-inch clearance all around.
      - 2) Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
      - 3) Mix patching concrete of same materials and mix as original concrete except without coarse aggregate.
      - 4) Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
    - f. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.
      - 1) Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles.
      - 2) Dampen cleaned concrete surfaces and apply bonding agent.
      - 3) Place patching mortar before bonding agent has dried.
      - 4) Compact patching mortar and finish to match adjacent concrete.
      - 5) Keep patched area continuously moist for at least 72 hours.
- F. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- G. Repair materials and installation not specified above may be used, subject to Architect's approval.
- 3.13 FIELD QUALITY CONTROL
- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement.
- 1. Sampling and testing for quality control may include those specified in this Article.

- B. Inspection Services: Owner's testing agency will performed the following inspections.
  - 1. Verify formwork dimensions and elevations prior to concrete placement.
  - 2. Monitor formwork movements during concrete placement to ensure tolerances are maintained.
  - 3. Verify concrete reinforcement sizes and locations comply with Contract Documents.
  
- C. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
  - 1. Testing frequency: Obtain 1 composite sample for each day's pour of each concrete mix exceeding 5 cubic yards but less than 25 cubic yards plus one set for each additional 50 cubic yards or fraction thereof.
    - a. When frequency of testing will provide fewer than 5 compressive-strength tests for each concrete mix, testing shall be conducted from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
  - 2. Slump: ASTM C 143; 1 test at point of placement for each composite sample, but not less than 1 test for each day's pour of each concrete mix.
    - a. Perform additional tests when concrete consistency appears to change.
  - 3. Air content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; 1 test for each composite sample, but not less than 1 test for each day's pour of each concrete mix.
  - 4. Concrete temperature: ASTM C 1064; 1 test hourly when air temperature is 40 degrees F and below and when 80 degrees F and above, and 1 test for each composite sample.
  - 5. Compression test specimens: ASTM C 31; cast and laboratory cure one set of 5 standard cylinder specimens for each composite sample.
  - 6. Compressive-strength tests: ASTM C 39; test 1 laboratory-cured specimen at 3 days, 1 at 7 days, 1 at 28 days, and 2 at 56 days.
    - a. The 3-day compressive-strength test in not required for the mat foundation.
    - b. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at age indicated.
  
- D. 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.
  
- E. Strength of each concrete mix will be satisfactory if every average of any 3 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 pounds per square inch.
  
- F. Inspection and test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of inspection and testing.
  - 1. 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 or 56 days, as specified, concrete mix proportions and materials, compressive breaking strength, and type of break for 3, 7, 28, and 56 day tests.
  
- G. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
  
- H. Additional Tests: 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 Architect.
  - 1. 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 Architect.

END OF SECTION 03300

**SECTION 03532 - CONCRETE FLOOR TOPPING**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Uniform General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
  - 1. Interior and exterior concrete floor topping with dry shake floor hardener

1.3 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Certification by manufacturer that applicable products comply with the National VOC rule of the United States Environmental Protection Agency as defined in "40 CFR Part 59, National Volatile Organic Compound Emission Standards for Architectural Coatings," local regulations controlling use of volatile organic compounds (VOC), or VOC limits specified under this Section, whichever is more stringent.
- C. Recycled Content Certification: Manufacturer's or fabricator's certificated indicating percentage of post-consumer recycled content by weight and post-industrial recycled content by weight for each Product specified under this Section.
- D. Local/Regional Source Certification: Manufacturer or fabricator's certificate indicating location, and distance in miles from the Project Site, of each Product's final assembly, extraction, harvesting, or recovery prior to shipment to the Project Site.
- E. Minutes of pre-installation conference.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Contractor's Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
- C. Mockups: Cast topping mockups to demonstrate typical joints, surface finish, bonding, texture, color, wet and dry slip resistance, tolerances, and standard of workmanship.
  - 1. Build mockups approximately 70 square feet in the location indicated or, if not indicated, as directed by Architect.
  - 2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
  - 3. Obtain Architect's approval of mockups before starting construction.
  - 4. If Architect determines that mockups do not meet requirements, demolish and remove them from the site and cast others until mockups are approved.
  - 5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
  - 6. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

- D. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings."

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage, mixing with other components, and application.
- B. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

#### 1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting topping performance.
  - 1. Place topping only when ambient temperature and temperature of base slabs are between 50 and 86 deg F.
- B. Close areas to traffic during topping application and, after application, for time period recommended in writing by manufacturer.

### **PART 2 - PRODUCTS**

#### 2.1 MATERIALS

- A. Concrete Materials: As specified under Section 03300.
- B. Pigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of Portland cement, graded aggregate, coloring pigments, and plasticizing admixture. Use coloring pigments that are finely ground, nonfading mineral oxides interground with cement.
  - 1. Colors: As selected by Architect from manufacturer's full range for these characteristics with not less than 24 color options.
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. L. M. Scofield Company: Lithochrome Color Hardener.
- C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Synthetic Fiber: Fibrillated polypropylene fibers engineered and designed for use in concrete, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Fibrasol F; Axim Concrete Technologies.
    - b. Fibermesh; Fibermesh, Div. of Synthetic Industries.
    - c. Forta; Forta Corporation.
    - d. Grace Fibers; W. R. Grace & Co., Construction Products Div

#### 2.2 CURING MATERIALS

- A. Interior Curing Compound: ASTM C309, two-component modified methyl-methacrylate water-based emulsion.
  - 1. Volatile organic compound content: Not more than 350 grams per liter.
  - 2. Color: Match pigmented mineral dry-shake floor hardener.
  - 3. Products: Subject to compliance with requirements, provide one of the following:
    - a. L. M. Scofield Company: Colorcure Concrete Sealer.
- B. Exterior Curing Compound: ASTM C309, two-component water-based emulsion.
  - 1. Volatile organic compound content: Not more than 350 grams per liter.
  - 2. Color: Match pigmented mineral dry-shake floor hardener.
  - 3. Products: Subject to compliance with requirements, provide the following:
    - a. L. M. Scofield Company: Lithochrome Colorwax.

## 2.3 RELATED MATERIALS

- A. Concrete Sealer: ASTM C309, water-based modified methyl-methacrylate emulsion.
  - 1. Volatile organic compound content: Not more than 350 grams per liter.
  - 2. Products: Subject to compliance with requirements, provide the following:
    - a. L. M. Scofield Company: Cementone Clear Sealer.
- B. Joint Sealant: ASTM 920, Type M, Grade NS, Class 25, Uses T/NT, A, M, and O.
  - 1. Volatile organic compound content: Not more than 50 grams per liter.
  - 2. Color: Match pigmented mineral dry-shake floor hardener
  - 3. Products: Subject to compliance with requirements, provide the following:
    - a. L. M. Scofield Company: Lithoseal Trafficalk-3G.
- C. Joint-Filler Strips: ASTM D 1752, cork or self-expanding cork.
- D. Joint-Backer Rods: Extruded polyolefin foam with nonabsorbent skin with an interior of open and closed cells, acceptable to joint sealant manufacturer.
- E. Bond Breaker Tapes: Continuous strips of self-adhesive polyethylene.
- F. Water: Potable.
- G. Epoxy-Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements, and as follows:
  - 1. Type II, non-load bearing, for bonding freshly mixed concrete to hardened concrete.
  - 2. Volatile organic compound content: Not more than 350 grams per liter.

## 2.4 CONCRETE MIXES

- A. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases, as follows:
  - 1. Proportion normal-weight concrete according to ACI 211.1 and ACI 301.
- B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the laboratory trial mix basis.
- C. Concrete Mixes: Proportion normal-weight concrete mix as follows:
  - 1. Interior locations:
    - a. Minimum 28 day compressive strength: 4,000 pounds per square inch.
    - b. Minimum cement content: 517 pounds per yard
    - c. Maximum fly ash content: 15 percent of cementitious materials by weight.
    - d. Maximum size coarse aggregate size: 1/2 inch.
    - e. Synthetic fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than 1 pound per cubic yard.
    - f. Air-entraining admixture: Not allowed.
    - g. Maximum slump: 4 inches.
    - h. High-range water reducing admixtures: Not allowed.
  - 2. Exterior locations:
    - a. Minimum 28 day compressive strength: 4,000 pounds per square inch.
    - b. Minimum cement content: 517 pounds per yard
    - c. Maximum fly ash content: 15 percent of cementitious materials by weight.
    - d. Maximum size coarse aggregate size: 1/2 inch.
    - e. Synthetic fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than 1 pound per cubic yard.
    - f. Air-entraining admixture: 4 to 6 percent.
    - g. Maximum slump: 4 inches.
    - h. High-range water reducing admixtures: Not allowed.
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

- E. Admixtures: Use admixtures according to manufacturer's written instructions.
  - 1. Use water-reducing admixture in concrete, as required, for placement and workability.
  - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
  - 3. Use water-reducing admixture in pumped concrete, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
  - 4. Use corrosion-inhibiting admixture in concrete mixes where indicated.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates, with Installer present, for conditions affecting performance of topping. Proceed with application only after unsatisfactory conditions have been corrected.
- B. Verify that base slabs meet finish and surface profile requirements in Division 3 Section "Cast-in-Place Concrete."
- C. Verify that base slabs are visibly dry and free of moisture.
  - 1. Test for capillary moisture by the plastic sheet method according to ASTM D 4263.

#### **3.2 PREPARATION**

- A. Existing Concrete: Remove existing surface treatments and deteriorated and unsound concrete. Mechanically abrade base slabs to produce a heavily scarified surface profile with an amplitude of 1/4 inch.
  - 1. Clean existing base slabs.
    - a. Fill voids, cracks, and cavities in base slabs.
  - 2. Mechanically remove contaminants from existing concrete that might impair bond of topping.
  - 3. Saw cut existing contraction and construction joints to a depth of 1/2 inch and fill with epoxy joint filler.
- B. Install joint-filler strips where topping abuts vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
  - 1. Extend joint-filler strips full width and depth of joint, terminating flush with topping surface, unless otherwise indicated.
  - 2. Terminate full-width joint-filler strips 1/2 inch below topping surface where joint sealants are indicated.
  - 3. Install joint-filler strips in lengths as long as practicable.
    - a. Where more than one length is required, lace or clip sections together.

#### **3.3 TOPPING APPLICATION**

- A. Existing Concrete: Apply epoxy-bonding adhesive, mixed according to manufacturer's written instructions, and scrub into dry base slabs to a thickness of 1/16 to 1/8 inch, without puddling.
  - 1. Place topping while adhesive is still tacky.
- B. Place topping continuously in a single layer, tamping and consolidating to achieve tight contact with bonding surface.
  - 1. Do not permit cold joints or seams to develop within pour strip.
  - 2. Screed surface with a straightedge and strike off to correct elevations.
  - 3. Slope surfaces uniformly where indicated.
  - 4. Begin initial floating using bull floats to form a uniform and open-textured surface plane free of humps or hollows.
- C. Mineral Dry-Shake Floor Hardener Finish: After initial floating, apply mineral dry-shake materials to surfaces according to manufacturer's written instructions and as follows:
  - 1. Uniformly apply mineral dry-shake materials at a rate of 100 pounds per 100 square feet, unless greater amount is recommended by manufacturer for color selected.
  - 2. Begin application beginning at slab edges.

3. Uniformly distribute approximately two-thirds of mineral dry-shake materials over surface by hand or with mechanical spreader, and embed by power floating.
  4. Follow power floating with a second mineral dry-shake application, uniformly distributing remainder of material, and embed by power floating.
    - a. Apply second application 90 degrees to initial application.
  5. Schedule: Provide floor hardener at the following locations:
    - a. All areas at Level 1 except the following:
      - 1) Auditorium 127.
      - 2) Areas with in the building west of Grid Line C.4 and north of Stair No. 1 (central stair.)
- D. After final floating, apply a trowel finish.
- E. Finishing: Consolidate surface with power-driven floats as soon as topping can support equipment and operator.
  1. Restraighten, cut down high spots, and fill low spots.
  2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
  3. Hard trowel finish: After floating surface, apply first trowel finish and consolidate topping by power-driven trowel so no blisters develop.
    - a. Continue troweling passes and restraighten until surface is smooth and uniform in texture.
    - b. Trowel slabs in consistent direction to form a slip-resistant flat-troweled finish.
- F. Finish interior surfaces to specified overall values of flatness, F(F) 25; and levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and levelness, F(L) 15, measured within 24 hours according to ASTM E 1155 for a randomly trafficked floor surface.
- G. Finish and measure exterior surface so gap at any point between topping surface and an unleveled freestanding 10-foot- long straightedge, resting on two high spots and placed anywhere on
- H. Construction Joints: Construct joints true to line with faces perpendicular to surface plane of topping, at locations indicated or as approved by Architect.
- I. Contraction Joints: Form weakened-plane contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades.
  1. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before topping develops random contraction cracks.
  2. Form joints in topping over contraction joints in base slabs, unless otherwise indicated.
  3. Construct contraction joints for a depth equal to one-half of topping thickness, but not less than 1/2 inch deep.
- 3.4 PROTECTION AND CURING
- A. General: Protect freshly placed topping from premature drying and excessive cold or hot temperatures.
- B. Begin curing immediately after finishing topping.
  1. Curing compound: Apply uniformly in two coats in continuous operations by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
- 3.5 JOINT FILLING
- A. Prepare and clean contraction joints and install epoxy joint filler, according to manufacturer's written instructions, once topping has fully cured.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install joint filler in accordance with manufacturer's instructions and ASTM C 1193.

3.6 CONCRETE SEALING

- A. Seal concrete using concrete sealer in accordance with manufacturer's instructions.
- B. Install at interior floors using a lambswool applicator at the following rate.
  - 1. First coat: 800 square feet per gallon.
  - 2. Second coat: 800 square feet per gallon.
- C. Install at exterior pavement using an airless sprayer at the following rate.
  - 1. First coat: 350 square feet per gallon.
  - 2. Second coat: 350 square feet per gallon.

3.7 REPAIRS

- A. Defective Topping: Repair and patch defective topping areas, including areas that have not bonded to concrete substrate.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform tests and to prepare test reports as specified under Section 03300.

END OF SECTION 03532