

## SECTION 033000 - CAST-IN-PLACE CONCRETE

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
  - 1. Footings.
  - 2. Concrete Walls
  - 3. Slabs-on-grade.
  - 4. Concrete toppings.
- B. Related Sections:
  - 1. Division 03 Section "Cast-in-Place Concrete (Site)" for concrete pavement and walks.
  - 2. Division 31 Section "Earth Moving" for drainage fill under slabs-on-grade.

#### 1.3 DEFINITIONS

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

#### 1.4 PREINSTALLATION MEETINGS

- A. Pre-Concrete Floor Slab Conference: At least 15 days prior to the start of concrete slab construction, the General Contractor shall conduct a meeting at the project site to review the proposed mix designs and to discuss the required methods and procedures to achieve the required concrete construction. The General Contractor shall send a pre-concrete conference agenda to all attendees 10 days prior to the scheduled date of the conference.
  - 1. The contractor shall require responsible representatives of every party concerned with the concrete work to attend the conference, including but not limited to the following:
    - a. General Contractor's Superintendent.
    - b. Laboratory responsible for concrete mix design(s).
    - c. Laboratory responsible for field quality control.
    - d. Concrete subcontractor.

- e. Subgrade subcontractor.
  - f. Ready-mix concrete producer.
  - g. Admixture manufacturer(s).
  - h. Liquid densifier/sealer manufacturer.
  - i. Liquid densifier/sealer and polishing applicator.
  - j. Joint filling manufacturer
  - k. Joint filling applicator
  - l. Project Manager
  - m. Owner's Representative
  - n. Floor Slab Consultant (if contracted by Owner)
- 2. Minutes of the meeting shall be recorded, typed, and distributed by the contractor to all concerned parties, including the Owner's representative, the architect, and the structural engineer, within five days of the meeting.
  - 3. The minutes shall include a statement by the concrete supplier stating that the proposed concrete mix design, placing and consolidation procedures can produce the concrete quality required by these specifications.
  - 4. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

## 1.5 SUBMITTALS

- A. General: Submit in accordance with section 013300.
- B. See Section 013310 for Submittal Schedule.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete 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 in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Testing Agency Qualifications: An independent agency shall be retained by the owner, shall be acceptable to authorities having jurisdiction, and shall be qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 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. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."
- E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
1. ACI 301, "Specifications for Structural Concrete,"
  2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- 1.7 DELIVERY, STORAGE, AND HANDLING
- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

## **PART 2 - PRODUCTS**

### **2.1 CONCRETE, GENERAL**

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
1. ACI 301.
  2. ACI 117.

### **2.2 FORM-FACING MATERIALS**

- A. General: Formwork and accessories shall conform to ACI 301, Section 2.
- B. Contractor shall discuss with Architect forms that will be used for exposed finished concrete within finished spaces. Mock-ups may be requested by the Architect.
- C. 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.
- D. 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.
- E. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber reinforced plastic, paper, or fiber tubes that produce surfaces with gradual or abrupt irregularities not exceeding

specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

- F. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- G. 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.

## 2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Low-Alloy-Steel Reinforcing Bars (weldable): ASTM A 706/A 706M, deformed.
- C. Plain-Steel Welded Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.

## 2.4 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut 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.

## 2.5 CONCRETE MATERIALS

- A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, obtain admixtures from single source from single manufacturer.
- B. Cementitious Materials: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
  - 1. Portland Cement: ASTM C 150/C 150M, Type I or Type III.
  - 2. Fly Ash: ASTM C 618, Class F or C. Maximum substitute of up to 15% of the Portland Cement.
- C. Normal-Weight Aggregates: ASTM C 33/C 33M, coarse aggregate or better, graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: as indicated on the drawings.
  2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Water: ASTM C 94/C 94M and potable.

## 2.6 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260/C 260M. Admixture manufacturer shall provide written certification that the air-entraining admixture is compatible with other required admixtures. All exterior slabs shall be air-entrained (4% - 6%). All interior floor slabs shall not include air-entraining admixture. Use one of the admixtures listed below:
1. "AEA-92" or "Air 40" by Euclid Chemical;
  2. "Micro Air" by BASF;
  3. "Daravair 1000" or "Darex-II" by W.R. Grace.
- 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.
1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A. Use one of the admixtures listed below:
    - a. "Eucon" Series by Euclid Chemical;
    - b. "Pozzolith" Series by BASF;
    - c. "WRDA" or "Daracem" Series by W.R. Grace.
  2. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D. Use one of the admixtures listed below:
    - a. "Retarder 75" by Euclid Chemical;
    - b. "Pozzolith R" or "100-XR" by BASF;
    - c. "Daratard 17" by W.R. Grace.
  3. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F. Use one of the admixtures listed below:
    - a. "Eucon 37" or "Plastol 341"/"5000" by Euclid Chemical;
    - b. "Rheobuild 1000" or "Glenium 3030" by BASF;
    - c. "Daracem-100" or "Adva Flow" by W.R. Grace.
  4. Water Reducing, Non-Corrosive Accelerating Admixture: Shall conform to ASTM C-494, Type C or Type E. Use one of the admixtures listed below:
    - a. "Accelguard 80"/"90" or "Accelguard NCA" by Euclid Chemical;
    - b. "NC534" or "Pozzutec 20" by BASF;
    - c. "Polarset" by W.R. Grace.

## **2.7 VAPOR RETARDERS**

- A. Sheet Vapor Retarder: ASTM E 1745, Class C, not less than 10 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive joint tape. Provide the following:
1. "Vapor Block" by Raven Industries Inc.
  2. "Griffolyn" by Reef Industries, Inc.
  3. "Stego Wrap" (10 mil) by Stego Industries LLC,

## **2.8 SLAB TREATMENTS**

- A. CURE-SEAL-HARDENER (ALL INTERIOR SLABS – U.N.O.): A water-based chemically reactive penetrating sealer and hardener that seals by densifying concrete so that water molecules cannot pass through but air and water vapor can, and allows concrete to achieve full compressive strength, minimizing surface crazing and eliminating dusting.
1. Products: "Ashford Formula" - Curecrete Chemical Company, Inc. in all locations, unless noted otherwise (No exceptions)
  2. Locations: All interior concrete floor slabs
- B. HARDENER (SEAFOOD AREA ONLY): Natural Aggregate Shake Hardener: Material shall be proprietary blend of quartz silica mixture of finely graded non-metallic aggregates, plasticizer, and cement binder. The product shall be delivered in the original, unopened packaging. It shall be labeled with the manufacturer's name, product name and lot number. Store materials at the job site under dry conditions and at temperatures between 60°F (16°C) and 80°F (27°C). Use the following with no exceptions:
1. "Surflex" (Natural Color), as manufactured by Euclid Chemical, 7506 East Independence Boulevard, Suite 100, Charlotte, NC 28227. Philip Brandt, Vice President of National Business Development (877)438-3826; fax (704)566-8085; e-mail: pbrandt@euclidchemical.com.
- C. CURING/ SEALING MATERIALS (SEAFOOD AREA): Curing Compound: Liquid-Type membrane-forming; ASTM C-309, Type I, Class A. Moisture loss not more than 0.055 GR./SQ.CM. when applied at 200 SQ. FT./GAL.
1. Product: "Super Aqua Cure Vox" (Euclid Chemical Company)
  2. Note: Certified compatibility with approved surface sealing agents, mastics, adhesives, colored hardeners, finishes and deferred bonding, is required, before compound may be used where subsequent finishes are indicated.

## **2.9 CURING MATERIALS**

- A. General: As per ACI 301, Section 5, Article 5.2, with selections and supplements as specified herein.

- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1 D, Class B, dissipating (sodium silicate type not permitted) having a fugitive dye to facilitate visual check of coverage.

## 2.10 RELATED MATERIALS

- A. Premolded Joint Filler: Expansion and Isolation Joint Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork. ½" thick x full depth of slab.
- B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Bond Breaker: 15# felt.
- D. Evaporation Retarder: Spray-applied, waterborne, monomolecular film, to aid in the prevention of rapid moisture loss from fresh concrete surfaces during the finishing operations. Use one of the following:
  - 1. "Eucobar" by Euclid Chemical;
  - 2. "Confilm" by BASF
- E. Non-Shrink, Non-Staining Grout: Shall comply with ASTM C 1107 and shall be furnished where indicated on the drawings. Use one of the following:
  - 1. "NS Grout" by Euclid Chemical;
  - 2. "Master flow 555" by BASF
- F. Expansion Joint (Column Wrap): Flexible foam expansion joint filler' ½" thick. Acceptable expansion joint manufacturer:
  - 1. "CERAMAR"
  - 2. Application: Wrap base of columns with appropriate height material to cover top of slab to top of base plate. Product shall be secured to column with sealant as recommended by manufacturer. Additional 4" high wrap shall extend from top of main wrap layer to above slab pour without use of sealant. Exposed portion of additional wrap shall be removed after all floor curing and finishing operations, but prior to painting of columns.
- G. Semi-Rigid Polyurea Joint Filler: The polyurea joint filler shall be a two (2) component, 100% solids compound, with a minimum shore D hardness of 50. Use the following with no exceptions:
  - 1. "Euco QWIKJoint 200", Euclid Chemical

## **2.11 REPAIR MATERIALS**

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
  - 1. Cement Binder: ASTM C 150/C 150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
  - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
  - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
  - 4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109/C 109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
  - 1. Cement Binder: ASTM C 150/C 150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
  - 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
  - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
  - 4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

## **2.12 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: The use of fly ash to reduce the total amount of portland cement, which would otherwise be used is permitted. Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
  - 1. Fly Ash: 15 percent.
- 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 and high-range 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 and concrete with a water-cementitious materials ratio below 0.50.

## 2.13 FABRICATING REINFORCEMENT

- A. General: Reinforcement shall conform to ACI 301, Section 3.
- B. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

## 2.14 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and furnish batch ticket information.
  1. 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.

# 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 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 347 as abrupt or gradual, as follows:
  1. Class A, 1/8 inch for smooth-formed finished surfaces exposed to view.
  2. Class B, 1/4 inch for rough-formed finished surfaces intended to receive plaster, stucco or wainscoting.
  3. Class C, 1/2 inch for permanently exposed surfaces where finishes are not specified
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
  1. Install keyways, reglets, recesses, and the like, for easy removal.
  2. Do not use rust-stained steel form-facing material.

- F. 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.
- G. 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
- H. All exterior corners and edges of permanently exposed concrete shall be chamfered where shown on the drawings.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, 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. 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. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303 "Code of Standard Practice for Steel Buildings and Bridges."

### 3.3 VAPOR-RETARDER INSTALLATION

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
  - 1. Lap joints 6 inches and seal with manufacturer's recommended tape.

### 3.4 STEEL REINFORCEMENT

- A. General: Reinforcement shall conform to ACI 301, and shall comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
  - 1. 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. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. 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.

### 3.5 JOINTS

- A. General: Joints shall conform to ACI 301, Section 5. 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. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
  - 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
  - 3. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
  - 4. Space vertical joints in walls at 60 ft. maximum. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth as shown in the drawing details.
  - 1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks (0-2 hours after the final finish at each joint location) using the early-entry dry-cut process per ACI 302.1R. The saw shall employ the use of a skid plate to prevent spalling and raveling of the slab.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with 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 finished concrete surface unless otherwise indicated.

2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 07 "Joint Sealants," are indicated.
  3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

### 3.6 CONCRETE PLACEMENT

- A. General: As per ACI 301, Section 5, except as noted.
- B. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed, including cleaning of reinforcing steel and forms.
- C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Engineer.
- D. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. 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.
  2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- E. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1 and as follows:
1. Maintain concrete temperature below 90 deg F at time of placement. 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. Using liquid nitrogen to cool concrete is Contractor's option.
  2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.
- F. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is 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.
1. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
  2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. 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.
- G. 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.
  1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  2. Maintain reinforcement in position on chairs during concrete placement.
  3. Screed slab surfaces with a straightedge and strike off to correct elevations.
  4. Slope surfaces uniformly to drains where required.
  5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

### 3.7 FINISHING FORMED SURFACES

- A. General: As per ACI 301, Section 5, Article 5.3.3.
- B. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
  1. Apply to concrete surfaces not exposed to public view.
- C. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
  1. Apply to concrete surfaces to be covered with a coating or covering material applied directly to concrete such as waterproofing, dampproofing, painting or other similar systems.
- D. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete exposed to public view, except when smooth formed finish for exposed overhead surfaces, whether or not painted.
  1. Smooth-Rubbed Finish: 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.
- E. 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. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

### 3.8 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
  - 1. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
  - 1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
  - 2. Finish floor surfaces to the following tolerances, according to ASTM E 1155, for all interior floor slabs unless noted otherwise on drawings:
    - a. Specified overall values of flatness, F(F) 50; and of levelness, F(L) 35; with minimum local values of flatness, F(F) 35; and of levelness, F(L) 25.
- D. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated on the architectural drawings. While concrete is still plastic, slightly scarify surface with a fine broom.
  - 1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.
- E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
  - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

### 3.9 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. 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.

### 3.10 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 305.1 for hot-weather protection during curing.
- B. Evaporation Retarder: 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. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: 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. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
  - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    - a. Water.
    - b. Continuous water-fog spray.
    - c. Absorptive cover, water saturated, and kept continuously wet. 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. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
    - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    - c. 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.
  - 3. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

**3.11 APPLICATION OF CURE/ SEAL/ HARDENER (ALL INTERIOR SLABS EXCEPT AS NOTED)**

**1. First Application**

- a. Follow manufacturer's recommendations for application.
- b. New Concrete: Apply cure-seal-hardener to new concrete as soon as the concrete is firm enough to work on after troweling.
- c. Spray on at rate of 200 ft<sup>2</sup>/gal (5 m<sup>2</sup>/L).
- d. Keep surface wet with cure-seal-hardener for a minimum soak-in period of 30 minutes without allowing it to dry out or become slippery. In hot weather, slipperiness may appear before the 30 minute time period has elapsed. If that occurs, apply additional cure-seal-hardener as needed to keep the entire surface in a non-slippery state for the first 15 minutes. For the remaining 15 minutes, mist the surface as needed with water to keep the material in a non-slippery state. In hot weather conditions, follow manufacturer's special application procedures.
- e. When the treated surface becomes slippery after this period, lightly mist with water until slipperiness disappears.
- f. Wait for surface to become slippery again, and then flush entire surface with water to remove all cure-seal-hardener residue.
- g. Squeegee surface completely dry, flushing any remaining slippery areas until no residue remains.
- h. Wet vacuum or scrubbing machines can be used in accordance with manufacturer's instructions to remove residue.

**1. Second Application (Spiff Coat)**

- a. Follow manufacturer's recommendations for application.
- b. Prior to installation of racking, install a second coat of Ashford Sealer.
- c. Spiff coat shall be applied to an Ashford-treated concrete that is clean, bare and free of contaminants.
- d. Perform test patch prior to application.
- e. Spray on at a rate of 400 ft<sup>2</sup>/gal (5 m<sup>2</sup>/L).
- f. Consult w/ manufacturer for additional requirements.
- g. Do not allow standing water on floor surface for 30 days.

**3.12 APPLICATION OF CURE/ HARDENER (SEAFOOD AREA)**

1. Apply natural aggregate shake hardener: Natural aggregate shake hardener: all slabs, in seafood department and other areas noted on the drawings, shall receive an application of the mineral aggregate hardener applied at the rate of 1.0 lbs/ft<sup>2</sup>. The hardener shall be applied in two applications by mechanical spreader. The first shake shall comprise 2/3 of the specified amount of hardener. This application shall be made after the initial floating operation unless climatic conditions dictate earlier application. The hardener shall be floated in and the second application made. The surface shall be floated again to properly bond the hardener to the base concrete slab. The surface shall then be troweled, at least twice, to a smooth, dense finish. After completion of broadcasting and floating, apply trowel finish as herein specified.



2. Cure slab surface with curing compound recommended by hardener manufacturer. Apply curing compound immediately after final finishing.

### 3.13 SURFACE SEALING (SEAFOOD AREA)

1. Follow manufacturer's recommendations for application.
2. Apply Super Aqua Cure Vox" (Euclid Chemical Company in Seafood only)

### 3.14 INSTALLATION OF SEMI-RIGID POLYUREA JOINT FILLER

1. Surface Cleaning of Joints:
2. Clean out joints immediately before installing joint filler
  - a. Remove foreign material from joint substrates that could interfere with adhesion of joint filler.
  - b. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint filler. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
  - c. Remove laitance and form-release agents from concrete.
  - d. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues could interfere with adhesion of joint sealants.
  - e. All surfaces to be filled shall be clean and dry.
3. Joint Filler Installation: Comply with recommendations in ACI 302 for use of joint fillers as applicable to materials, applications, and conditions indicated.
  - a. The joint must be clean and dry. All oil, dirt, debris, paint, and any other material that may be a bond breaker must be removed from the joint surfaces.
  - b. All concrete floor sealer and polishing processes must be completed prior to installation of filler.
  - c. For proper load transfer, joints must be filled full depth, but in no case should the joint filler be any less than 1" deep in the joint.
  - d. Mixing: Joint filler is a two part product requiring machine mixing and placing. Premix Part B separately before using. Follow pump manufacturer's equipment instructions.
  - e. Placement: Joint filler shall be filled full depth. NO BACKER ROD IS ALLOWED. Joints should be overfilled and shaved even with the surrounding joint edge giving the floor joints a flat, smooth appearance.
  - f. Shaving of excess joint filler can be approximately 30 minutes after placement, and up to 24 hours later, depending on jobsite conditions such as concrete and ambient temperatures.

### 3.15 INTERIOR FLOOR SLAB – CLEANING AND BURNISHING PROCESS (FOR CURE/ SEAL/ HARDENER - ASHFORD)

1. Cleaning and Burnishing Process

- a. Scrub the entire floor with an automatic scrubber capable of a minimum of 50-120 pounds head pressure, each head to be equipped with cleaning combo or light bristle brushes and water. Cleaning process shall be applied within 3 inches of walls, partitions, etc. Remove liquid as the floor is scrubbed. Allow slab to air dry.
- b. High Speed Burnishing Machine: Propane equipment used for high speed burnishing operation shall be specifically designed to burnish concrete. Use a 27 inch machine similar to the following:
  - 1) "Speedstar" by Pioneer Eclipse; Contact: 877-482-8700.
- c. High Speed Burnishing Pad: Provide patented, diamond impregnated pads for high speed burnish as manufactured by the following:
  - 1) "Twister" diamond impregnated pads by HTC, Inc.; Contact: 877-482-8700
- d. Verify that floor surface is dry prior to burnishing procedure.
- e. Apply liquid/densifier sealer with a low pressure sprayer at approximately 700 square feet per gallon). With high speed burnisher, burnish the surface to achieve the specified gloss. Burnishing process shall be applied within 3 inches of walls, partitions, etc.
- f. Conduct burnishing operations until the specified gloss is attained. Achieve specified gloss no later than 2 weeks prior to Owner Possession.
- g. Clean and polish floors using suitable processes to maintain specified gloss levels until Owner Possession.

2. Polish Results:

- a. Perform burnish and polish to the degree to attain an average gloss reading of not less than 30 as measured using a Horiba IG-320 Gloss Checker. Gloss checker is available through HTC, Inc; at 877-482-8700.
- b. Clean and polish concrete surface to produce Specified Average Gloss Value (SOGV)  $\geq 35$  and Minimum Average Local Gloss Value (MLGV)  $\geq 30$ .
- c. Gloss shall be considered as a quantitative value that expresses the degree of reflection when light hits the concrete floor surface. Gloss measurements will be taken independent of ambient lighting and will be taken within a sealed measurement window located beneath the test unit.

3.16 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. 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.

- C. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
1. Repair finished surfaces containing defects. 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.
  2. After concrete has cured at least 14 days, correct high areas by grinding.
  3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
  4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
  5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
  6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
  7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- D. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- E. Repair materials and installation not specified above may be used, subject to Architect's approval.

### 3.17 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a special inspector to perform field tests and inspections and prepare test reports.
- B. Concrete testing shall be in accordance with ACI 301, Section 1, Article 1.6 except as noted herein.
- C. Required special inspection and verification as outlined in the applicable building code including but not limited to:

1. Steel reinforcement and placement.
  2. Embedded bolts and studs to be installed in concrete prior to concrete placement.
  3. Verification of use of required design mixture.
  4. At the time concrete is sampled for test cylinders, perform slump and air content tests and temperature of concrete.
  5. Concrete placement, including conveying and depositing.
  6. Curing procedures and maintenance of curing temperature.
- D. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture of less than 25 cu. yd. plus one set for each additional 50 cu. yd. or fraction thereof, unless authorized otherwise by the engineer.
    - a. 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. All samples shall be taken after any addition of water at the job site is complete. When pumping or pneumatic equipment is used, samples shall be taken at discharge end. This is for both cylinders and slump tests.
  3. Slump: ASTM C 143/C 143M; 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. Perform additional tests when concrete consistency appears to change.
  4. Air Content: ASTM C 231/C 231M, 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.
    - a. Air content tests shall be made on all concrete whether the concrete is designated as air-entrained or not.
    - b. Additional air contents tests, for concrete specified as air-entrained, shall be made when any of the following conditions occur:
      - 1) A change in appearance or consistency of concrete.
      - 2) Possible reduction of air content due to time delays of truck and/or hot weather.
      - 3) When air temperature is over 80 deg F, check each truck load.
    - c. Inform Engineer immediately of any slump and/or air content tests that do not meet these specifications. If strength, durability or aesthetics of the structure would be impaired, that concrete shall not be used.
  5. Concrete Temperature: ASTM C 1064/C 1064M; 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.
  6. Compression Test Specimens: ASTM C 31/C 31M.
    - a. Cast and laboratory cure either 6" x 12" or 4" x 8" standard cylinder specimens for each composite sample as follows:

- 1) Four cylinders, each 6 inches diameter by 12 inches tall, or
    - 2) Five cylinders, each 4 inches diameter by 8 inches tall.
  7. Compressive-Strength Tests: ASTM C 39/C 39M; test one laboratory-cured specimen at 7 days (2 days for post-tensioned concrete) and one set of specimens at 28 days. Retain one specimen for possible 56 day test if required.
    - a. The 28-day compressive-strength test shall be the average compressive strength from a set of laboratory-cured specimens obtained from same composite sample and tested at age indicated.
    - b. Each set of 28-day laboratory-cured specimens shall consist of one of the following, at a minimum. Cylinder sizes shall remain consistent for each concrete mixture for the duration of the project.
      - 1) Two cylinders, each 6 inches diameter by 12 inches tall.
      - 2) Three cylinders, each 4 inches diameter by 8 inches tall.
  8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive 28-day compressive-strength tests equals or exceeds specified compressive strength and no 28-day compressive-strength test value falls below specified compressive strength by more than 500 psi.
  9. Test results shall be reported in writing to the Structural Engineer, Architect, 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.
  10. Verbal information on any concrete not meeting these specifications shall be communicated to the engineer immediately by phone.
  11. 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.
  12. 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. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M by other methods as directed by Architect.
  13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
  14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- E. Measure slab flatness and levelness according to ASTM E 1155 within 48 hours of finishing.

END OF SECTION 033000