

## **SECTION 033015 – CAST-IN-PLACE CONCRETE FOR BUILDING CONSTRUCTION**

### **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. This section includes the furnishing and placement of cast-in-place concrete.
- B. ACI Standard 347, "Guide to Formwork for Concrete", shall establish minimum requirements when not otherwise specified in this section.
- C. Nothing in this standard should be considered to apply to streets, pedestrian walkways, curbs, steam tunnels, or other concrete that is not part of a building. See Division 32 Sections "Curbs and Gutters" and "Concrete Pavement."
- D. A vapor barrier shall be installed under a slab on grade if required by the flooring manufacturer's warranty and will comply with that requirement.

#### **1.3 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: An independent agency, acceptable to MSU and any other authority having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
- B. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- C. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
  - 1. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
  - 2. ACI 301, "Specification for Structural Concrete."

#### **1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

### **PART 2 - PRODUCTS**

#### **2.1 FORM MATERIALS**

- A. Wood, plastic, fiberglass or metal, complete with shores, bracing etc. as required, conform to the shapes, lines, and dimensions of the members indicated on the Drawings.
- B. Forms for exposed concrete shall be constructed of metal or smooth plywood, or other material to provide a smooth surface finish.
- C. Form-Release Agent: Use 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. Use a form-release agent formulated with rust inhibitor for steel form-facing materials.

## 2.2 STEEL REINFORCEMENT

- A. Bar reinforcement: ASTM A615, Grade 60.
- B. Welded wire fabric: ASTM A185. Provide in flat sheets only.
- C. Epoxy coated reinforcing bar and applicable installation techniques are recommended for exterior concrete with no further coatings or sealers, especially in areas subject to salt exposure.
- D. Wire, bar and chain type reinforcement supports shall be corrosive resistant, hot dipped galvanized, epoxy, or plastic coated in accordance with CRSI recommendations.

## 2.3 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I shall be used unless otherwise indicated in the reviewed mix design.
- B. Normal-Weight Aggregates: ASTM C 33.
  - 1. Coarse aggregate shall be well graded gravel and crushed stone of hard, durable, uncoated particles, or limestone if specifically required. Other materials such as fly ash and ground blast furnace slag may be included subject to Owner's approval. Gradation and physical requirements to conform to MDOT Specification 6AA (ASTM C 33 one inch maximum size) or as included in the reviewed mix design.
  - 2. Fine Aggregate: Shall conform to the MDOT Specifications for Sand 2NS (ASTM C33).
- C. Water: ASTM C 94 and potable.

## 2.4 ADMIXTURES

- A. Admixtures will be allowed as indicated in this section or as included in the mix designs reviewed by the Engineer responsible for the structural integrity of the Project.
- B. Air-Entraining Admixture: ASTM C 260.
- C. Bonding Admixtures. Specify latex or acrylic bonding agents when placing new concrete against existing concrete. Mix bonding agents in concrete mix in accordance with manufacturer's recommendations when patches require thin and/or feathered sections.

## 2.5 WATERSTOPS

- A. Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
  - 1. Manufacturers:
    - a. Greenstreak.
    - b. Vinylex Corp.
    - c. Or as approved.
  - 2. Profile: Serrated, split, with center bulb.
  - 3. Extruded vinyl made only from virgin raw materials, highly resistant to alkalis, acids, oxygen, ozone, and waterborne chemicals.
- B. Other waterstop materials may be used with the specific prior written approval of the Owner.

## 2.6 CURING MATERIALS

- A. Damp curing is preferred over using curing compounds to avoid incompatibility with the many finish materials, hardeners, and sealers. Curing compounds shall be used where required by weather, approved construction schedules, and construction that is not adaptable to damp curing.
- B. The sodium silicate base curing compounds that follow are compatible with the MSU preferred sealer, most resilient floor covering adhesives, and many paint finishes.
  - 1. “Gardseal”; Lambert Corporation
  - 2. “Sonosil”; Sonnebore Building Products Div. (BASF Building Systems)
- C. Utilize other curing compounds as approved by the manufacturer of the finish materials to be installed. Curing compounds should contain a fugitive dye, or, when hot weather conditions dictate, a fugitive heat reflecting pigment.
- D. The use of hardeners should be considered for special areas, but the incidental hardening of most curing compounds and sealers has been adequate. Magnesium zinc fluoro-silicate hardener is generally compatible with the sodium silicate curing compounds listed above, but is not recommended for finished areas because the surface is often rough and mottled.

## 2.7 RELATED MATERIALS

**Select one or all options in paragraph below. Joint filler strips are used in floor isolation joints.**

**Bonding agent in first paragraph below may be used directly from container or as an admixture in cement or sand cement slurries and rubbing grout.**

**Select types from two options in subparagraph below based on service loadings.**

- A. Dovetail Anchor Slots: Stainless steel sheet, not less than 0.0336 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

## 2.8 EXPANSION JOINT FILLERS

- A. Interior Applications: Where expansion filler materials are required by design, foam expansion joint material shall generally be used. Interior joint fillers are needed in isolation joints, such as around column block outs in slabs on grade and between slabs on grade and walls, where the floor finish will not be compromised by the filler.
- B. Exterior Applications:
  - 1. Asphalt impregnated expansion joint fillers: Premolded rigid cane fiber board product, uniformly impregnated with an asphalt compound to prevent degradation. Joint filler shall meet or exceed ASTM D994 or D1781.
  - 2. Polyvinyl chloride expansion joint fillers: Closed cell, non-extruding PVC or polyurethane foam, or equal. Joint filler should normally be 1/2 inch thick.
  - 3. Polyethylene expansion joint fillers: Ultraviolet stable and of closed cell sheet material with a density of 2.5-3.0 lbs./cu.ft. and shall have a water absorption rate of less than 2% after 48 hours with 10 ft. of head.

## 2.9 CONCRETE MIXTURES, GENERAL

- A. The concrete mix design criteria shall be specified by the Architect or Engineer to meet the project design conditions and minimum loading conditions indicated in these standards. The mix design shall be submitted to the Architect or Engineer for review.
- B. Unless specified otherwise by the Engineer, a maximum allowable slump before the addition of water reducer (if any) shall be 4-1/2 inches, air entrainment shall be 5% to 7%, and compressive strength shall be 4,000 psi with a minimum of six sacks of cementitious products per cubic yard of concrete. Use non-air entrained concrete for interior concrete slabs.
- C. The Contractor shall provide the Project Representative with delivery tickets which shall list slump, sack mix, percent of air entraining agent, time the truck left the plant, time of arrival on the job site, and time of departure from the job site.
- D. When requested, the Contractor shall provide documentation from the concrete supplier certifying the concrete meets the specifications of this section.
- E. Retempering of concrete will not be allowed.
- F. Where conditions make consolidation or finishing of concrete difficult, or where reinforcement is congested, separate concrete mix designs shall be specified, submitted, and reviewed prior to placement. For example, specify concrete with smaller coarse aggregate for concrete fill of metal pan stairs.

## 2.10 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."
- B. Welding of reinforcing steel is not permitted.

### PART 3 - EXECUTION

#### 3.1 FORMWORK

- A. Formwork design shall be the responsibility of the Contractor.
- B. 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.
- C. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. 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. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, ice, snow, dirt, and other debris just before placing concrete. The Project Representative shall inspect forms prior to placing the concrete.
- I. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- J. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.
- K. Forms shall be cleaned and treated each time they are used.

#### 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.

### 3.3 STEEL REINFORCEMENT

- A. The latest publication of the following standards shall establish the minimum requirements when not otherwise specified in this section:
  - 1. “Placing Reinforcing Bars”: CRSI.
  - 2. “Manual of Standard Practice”: CRSI.
  - 3. “Manual of Structural and Placing Drawings for Reinforced Concrete Structures”: ACI 315R.
- B. Fasten the reinforcement securely to supports unless required otherwise by the joint design. At control joints the reinforcement shall be held 1-1/2-inch short of the joint. Reinforcement cover shall conform to ACI 318 requirements.
- C. When reinforcing a slab on grade use one of the following methods:
  - 1. Place half the thickness of concrete followed by the laying of the flat reinforcement, followed by the second half thickness and vibrate it into the first.
  - 2. Provide supports for the flat reinforcement to prevent it sinking in the pour.

### 3.4 WATERSTOPS

- A. Below grade construction joints in concrete shall have waterstops.
- B. Waterstops shall be centered in concrete with half of the waterstop embedded in the first pour of concrete. The other half shall be spread open and stapled or nailed to the bulkhead. After removing the first pour formwork, the split flange shall be joined by rings or staple and then the second pour made.
- C. Waterstop splices shall be heat sealed according to manufacturer’s directions.

### 3.5 EXPANSION JOINTS

- A. Install expansion joint fillers slightly below the finished surface. Foam expansion joint fillers shall be placed to allow for a well designed bead of sealant. Asphalt impregnated joint fillers shall not be caulked over.

### 3.6 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. Placing the concrete shall not commence until the subgrade, reinforcing, and forms have been approved. A sufficient quantity of forms shall be in place to accommodate all of the concrete

that is scheduled to be placed at any one time. Concrete shall be deposited with a minimum of rehandling and shall be consolidated, particularly adjacent to forms and joints. In the case of isolation joints, concrete shall be placed simultaneously against both sides of the joint.

- C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
- D. 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.
- E. 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.
- F. Hot-Weather Placement: Comply with ACI 301 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.

### 3.7 FINISHING FLOORS AND SLABS

- A. General: When not otherwise specified below, comply with ACI 302.1R recommendations for screeding, restraightening and finishing operations for concrete surfaces. Do not wet concrete surfaces while finishing.
- B. Concrete shall be carefully compacted and screeded off to the correct elevation. Bull-float shortly after placing. Move stone pockets to sandier area of slab and tamp or vibrate.
- C. When floors are sufficiently hard, machine float surface to remove irregularities and secure a uniformly dense floor. Provide necessary jointing and edging.
- D. Mechanical steel troweling and a minimum of one hand troweling shall be used to bring slabs to a true hard surface such as will ring with the touch of a trowel.

- E. Interior floors, including areas to receive vinyl sheetgoods, vinyl tile, or carpet, shall have a smooth troweled finish unless other finish is recommended by the supplier of the finished flooring materials.
- F. Exterior slabs shall have a finished steel flat surface, followed up by a broom finish.
- G. Concrete surfaces on interior or exterior loading docks shall have a broom finish to provide a non-skid finish.
- H. Floor finish tolerance (Random Traffic Floor):
  - 1. F-Number system in accordance with ASTM E1155 shall be used to specify flatness and levelness.
  - 2. If requested by MSU, conformance to flatness and levelness tolerances will be evaluated by a testing agency. If conformance with flatness and levelness tolerances is confirmed, MSU will pay for the cost of the test. If conformation with flatness and levelness tolerances is not met, Contractor shall remove and replace the concrete and will pay for all testing required to achieve conformance with required flatness and levelness tolerances.
  - 3. For slabs on grade, the minimum flatness and levelness to be specified shall be overall value of flatness, (F(F)35; and of levelness, F(L)25; with minimum local values of flatness, F(F)24; and of levelness, F(L)17, unless a lesser or greater value is appropriate for the specific situation and approved in advance by MSU.
  - 4. For suspended slabs, the minimum flatness and levelness to be specified shall be overall values of flatness, F(F) 30; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 15, unless a lesser or greater value is appropriate for the specific situation and approved in advance by MSU.

### 3.8 CONCRETE PROTECTING AND CURING

- A. General: Concrete shall be cured in accordance with ACI 301 procedures and as described herein. Water loss from new concrete will be limited to a rate of 1 lb./sq.ft. per 72 hours. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

### 3.9 CONTROL JOINTS IN SLABS ON GRADE

- A. Joint Type: Sawcut or formed. Joint depth shall be between 1/4 and 1/3 the thickness of the slab.
- B. For a 4-inch slab on grade, reinforced with welded wire fabric, joints should be spaced from ten to twenty feet on center, creating slab panels that have aspect ratios of 1.5 or less.

### 3.10 FLOOR SEALING



- A. Interior floors and stairs not receiving additional finishes shall receive a sealer to provide a smooth non-dusting surface for ease of maintenance. Air plenum chamber floors and areas to receive carpet shall also be sealed.
- B. The sealer will generally be sodium silicate, applied by the MSU Custodial Department as described below. (During the design stage, coordinate the schedule, level of cleaning, and who will perform the tasks.)
  - 1. Clean floor by power scrubbing with a good detergent or vegetable oil soap.
  - 2. First coat: Mix one part sodium silicate (water glass) with four parts water. Apply a heavy coat using a mop and work into the floor for ten minutes or until the solution becomes tacky. Mop up puddles and runs immediately. Mop floor dry and allow to dry for a minimum of eight hours.
  - 3. Second and third coats: Mix one part sodium silicate (water glass) with three parts water. Apply each coat using the same method as the first coat, allowing each coat to dry a minimum of eight hours.

END OF SECTION 033015