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SECTION 033053 - MISCELLANEOUS CAST-IN-PLACE CONCRETE

Revise this Section by deleting and inserting text to meet Project-specific requirements.

This Section uses the term "Architect." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

PART 1 - GENERAL

Retain or delete this article in all Sections of Project Manual.

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 reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B. Related Sections:

Retain Sections in subparagraphs below that contain requirements Contractor might expect to find in this Section but are specified in other Sections.

- 1. Section 312000 "Earth Moving" for drainage fill under slabs-on-grade.
- 2. Section 321313 "Concrete Paving" for concrete pavement and walks.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
 - 1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

Retain "Design Mixtures for Credit ID 1.1" Subparagraph below if fly ash or ground granulated blast-furnace slag or other materials are used as portland cement replacements for LEED-NC, LEED-CS, or LEED for Schools Credit ID 1.1. To achieve this credit, replacement materials must be substituted for at least 40 percent of the portland cement that would otherwise be used.

2. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements. For each design mixture submitted, include an equivalent concrete mixture that does not contain portland cement replacements, to determine amount of portland cement replaced.

C. Other Action Submittal:

1. Design Mixtures: For each concrete mixture.

1.4 QUALITY ASSURANCE

- A. Ready-Mix-Concrete 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.

Always retain first paragraph below because this Section is based on ACI 301 (ACI 301M).

- B. Comply with the following sections of ACI 301 (ACI 301M), unless modified by requirements in the Contract Documents:

Usually retain first five subparagraphs below. Four other Sections of ACI 301 (ACI 301M), "Architectural Concrete," "Mass Concrete," "Prestressed Concrete," and "Shrinkage-Compensating Concrete," could be added but usually fall outside the scope of this Section.

1. "General Requirements."
2. "Formwork and Formwork Accessories."
3. "Reinforcement and Reinforcement Supports."
4. "Concrete Mixtures."
5. "Handling, Placing, and Constructing."

Retain subparagraph below if structural lightweight concrete is required.

6. "Lightweight Concrete."

- C. Comply with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

PART 2 - PRODUCTS

2.1 FORMWORK

- A. Furnish formwork and formwork accessories according to ACI 301 (ACI 301M).

2.2 STEEL REINFORCEMENT

Retain requirements in this Article or revise to suit Project.

Retain "Recycled Content of Steel Products" Paragraph below if recycled content is required for LEED. USGBC allows a default value of 25 percent to be used for steel, without documentation; higher percentages can be claimed if they are supported by appropriate documentation.

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [25] [60] <Insert number> percent.
- B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- C. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.
- D. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.
- E. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

2.3 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout Project:

Retain option for portland cement type in first subparagraph below.

- 1. Portland Cement: ASTM C 150, [Type I] [Type II] [Type I/II] [Type III] [Type V]. [Supplement with the following:]

Retain one or both of first two subparagraphs below if supplementary materials are permitted. Ready-mix-concrete manufacturer blends these materials with portland cement. Fly ash, slag, or pozzolanic materials may slow rate of concrete strengthening and affect color uniformity.

- a. Fly Ash: ASTM C 618, Class C or F.
- b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

Retain subparagraph below if factory-blended hydraulic cement is permitted; verify availability of options before specifying. Fly ash, slag, or pozzolanic materials in the nonportland cement part of blended hydraulic cement may slow rate of concrete strengthening and affect color uniformity.

- 2. Blended Hydraulic Cement: ASTM C 595, [Type IS, portland blast-furnace slag] [Type IP, portland-pozzolan] [Type I (PM), pozzolan-modified portland] [Type I (SM), slag-modified portland] cement.

Nominal maximum size of coarse aggregate in first paragraph below is common. Revise to smaller size if required. ACI 301 (ACI 301M) sets maximum sizes based on spacing of reinforcement, dimensions between sides of forms, and thicknesses of slabs.

- B. Normal-Weight Aggregate: ASTM C 33, graded, [**1-1/2-inch (38-mm)**] <Insert dimension> nominal maximum aggregate size.
- C. Lightweight Aggregate: ASTM C 330, [**1-inch (25-mm)**] <Insert dimension> nominal maximum aggregate size.
- D. Water: ASTM C 94/C 94M.

Retain paragraph below if using synthetic-fiber reinforcement. Revise fiber type if adding polyester or nylon fibers. Monofilament fibers help reduce plastic shrinkage cracking. Manufacturers claim fibrillated fibers also improve hardened concrete properties.

- E. Synthetic Fiber: [**Monofilament**] [or] [**fibrillated**] polypropylene fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, [**1/2 to 1-1/2 inches (13 to 38 mm)**] <Insert dimensions> long.

2.4 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

Retain one or more admixtures in subparagraphs below.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 RELATED MATERIALS

Retain one of first two paragraphs below for under-slab moisture protection. Vapor retarder in the first paragraph is considered more robust under construction loadings.

- A. Vapor Retarder: Plastic sheet, ASTM E 1745, Class A or B.
- B. Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils (0.25 mm) thick; or plastic sheet, ASTM E 1745, Class C.
- C. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.

2.6 CURING MATERIALS

Evaporation retarder in first paragraph below temporarily reduces moisture loss from concrete surfaces awaiting finishing in hot, dry, and windy conditions.

- A. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth or cotton mats.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.

Retain first paragraph below if a curing compound is required. Delete if a combination curing and sealing compound is required.

- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

Retain one option in paragraph below if a combination curing and sealing compound is required.

- F. Clear, **[Waterborne]** **[Solvent-Borne]**, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

2.7 CONCRETE MIXTURES

- A. Comply with ACI 301 (ACI 301M) requirements for concrete mixtures.
- B. Normal-Weight Concrete: Prepare design mixes, proportioned according to ACI 301 (ACI 301M), as follows:

Retain one option in subparagraph below or revise to suit Project.

- 1. Minimum Compressive Strength: **[4500 psi (31 MPa)] [4000 psi (27.6 MPa)] [3500 psi (24.1 MPa)] [3000 psi (20.7 MPa)] <Insert strength>** at 28 days.

Retain one option in first subparagraph below or revise to suit Project; delete subparagraph if in-service durability conditions are benign and limits on water-cementitious materials ratio are not required.

- 2. Maximum Water-Cementitious Materials Ratio: **[0.50] [0.45] <Insert ratio>**.

Retain "Cementitious Materials" Subparagraph below if required for LEED-NC, LEED-CS, or LEED for Schools Credit ID 1.1. This credit can be achieved by replacing at least 40 percent of the portland cement, which would otherwise be used in concrete, with other cementitious materials.

- 3. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.

Retain one option in subparagraph below or revise to suit Project.

4. Slump Limit: **[4 inches (100 mm)] [5 inches (125 mm)] [8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture] <Insert dimension>**, plus or minus 1 inch (25 mm).

ACI 301 (ACI 301M) sets air content depending on severity of exposure conditions of concrete. Air content in second sentence in subparagraph below is maximum recommended by ACI 302.1R for trowel-finished slabs

5. Air Content: Maintain within range permitted by ACI 301 (ACI 301M). Do not allow air content of trowel-finished floor slabs to exceed 3 percent.

Retain first paragraph below for structural lightweight concrete. Coordinate with lightweight aggregate supplier and structural engineer. Weights range from 95 to 115 lb/cu. ft. (1520 to 1840 kg/cu. m). Strengths range from 2500 to 6000 psi (17.2 to 41.4 MPa).

- C. Structural Lightweight Concrete Mix: ASTM C 330, proportioned to produce concrete with a minimum compressive strength of **[3000 psi (20.7 MPa)] <Insert strength>** at 28 days and a calculated equilibrium unit weight of **[110 lb/cu. ft. (1762 kg/cu. m)] <Insert weight>** plus or minus 3 lb/cu. ft. (48.1 kg/cu. m), as determined by ASTM C 567. Concrete slump at point of placement shall be the minimum necessary for efficient mixing, placing, and finishing.
1. Limit slump to 5 inches (125 mm) for troweled slabs and 4 inches (100 mm) for other slabs.

Synthetic-fiber dosage rates in paragraph below reflect typical recommendations of manufacturers. Retain first option for synthetic fiber used for reducing plastic shrinkage cracking. Retain second option for synthetic fiber used for improving hardened concrete properties, with dosage increased as needed.

- D. Synthetic Fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate but not less than a rate of **[1.0 lb/cu. yd. (0.60 kg/cu. m)] [1.5 lb/cu. yd. (0.90 kg/cu. m)] <Insert rate>**.

2.8 CONCRETE MIXING

Retain option in first paragraph below if synthetic fibers are required.

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M **[and ASTM C 1116/C 1116]**, and furnish batch ticket information.
1. When air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

Retain paragraph below if Project-site mixing is permitted.

- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, construct, erect, brace, and maintain formwork according to ACI 301 (ACI 301M).

3.2 EMBEDDED ITEMS

Retain this Article for embedded items and anchorage devices for other work attached to or supported by cast-in-place concrete.

- A. Place and secure anchorage devices and other embedded items required for adjoining work 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 VAPOR RETARDERS

Retain this Article if specifying vapor retarder under slabs-on-grade.

- A. Install, protect, and repair vapor retarders according to ASTM E 1643; place sheets in position with longest dimension parallel with direction of pour.
 1. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended adhesive or joint tape.

3.4 STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.5 JOINTS

Coordinate joint types, descriptions, and locations with Drawings.

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Locate and install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

Insert spacing of contraction (control) joints here or on Drawings if required. Contraction-joint spacings vary with slab thickness, aggregate size, and slump. Depth of joint may be varied to suit cutting method; early-entry saws may cut less than one-fourth of concrete thickness.

- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least [**one-fourth**] <Insert depth> of concrete thickness, as follows:

Retain one of two subparagraphs below, or retain both as Contractor's option.

- 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with groover tool to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.

Retain subparagraph below if saw cutting is permitted. Description does not distinguish conventional wet- and dry-cut saws from early-entry dry-cut saws. Timing is critical to sawed joints. Early-entry dry-cut saws have been used within one to two hours of finishing concrete. Conventional saw cutting must be delayed, usually 4 to 12 hours, to leave concrete undamaged, but not so long that uncontrolled cracking of concrete could occur.

- 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

- D. Isolation Joints: Install joint-filler strips at junctions with slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

- 1. Extend joint fillers full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.

3.6 CONCRETE PLACEMENT

- A. Comply with ACI 301 (ACI 301M) for placing concrete.

Retain one of first two paragraphs below. Retain first paragraph if adding water after batch mixing is permitted. ACI 301 (ACI 301M) permits water to be added to concrete mix on-site to adjust slump, up to amount allowed in design mixture. Retain second paragraph if adding water is not permitted.

- B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301 (ACI 301M).
- C. Do not add water to concrete during delivery, at Project site, or during placement.
- D. Consolidate concrete with mechanical vibrating equipment.

3.7 FINISHING FORMED SURFACES

Coordinate finishes in this Article with a finish schedule or indicate location of each on Drawings.

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding 1/2 inch (13 mm).
1. Apply to concrete surfaces [**not exposed to public view**] <Insert 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. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch (3 mm).

Revise locations in subparagraph below to suit Project. Retain second option if further finishing is required.

1. Apply to concrete surfaces [**exposed to public view,**] [**to receive a rubbed finish,**] [**or to be covered with a coating or covering material applied directly to concrete**] <Insert locations>.

If retaining first paragraph below, retain "Smooth-Formed Finish" Paragraph above.

- C. Rubbed Finish: Apply the following rubbed finish, defined in ACI 301 (ACI 301M), to smooth-formed finished as-cast concrete where indicated:

Retain one or more of three subparagraphs below for rubbed finish.

1. Smooth-rubbed finish.
 2. Grout-cleaned finish.
 3. Cork-floated finish.
- D. 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 UNFORMED SURFACES

Retain first paragraph below. Some floating and troweling machines have watering attachments. Adding water weakens concrete surface and can cause dusting, blistering, and scaling.

- A. General: Comply with ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

Retain first paragraph below before applying scratch finish, float finish, or trowel or broom finish.

- B. Screed surfaces with a straightedge and strike off. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane before excess moisture or bleedwater appears on surface.
1. Do not further disturb surfaces before starting finishing operations.

Retain one or more of five paragraphs below for types of slab finishes required. Coordinate slab finishes with a finish schedule or indicate location of each on Drawings.

- C. Scratch Finish: Apply scratch finish to surfaces indicated and surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes, unless otherwise indicated.
- D. Float Finish: Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, fluid-applied or direct-to-deck-applied membrane roofing, or sand-bed terrazzo.
- E. Trowel Finish: Apply a hard trowel finish to surfaces indicated and to floor and slab 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.
- F. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set methods. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.
- G. Nonslip Broom Finish: Apply a nonslip broom finish to surfaces indicated and to exterior concrete platforms, steps, and ramps. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

3.9 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 with ACI 301 (ACI 301M) for hot-weather protection during curing.

If evaporation rate in first paragraph below is exceeded, ACI 305R states that plastic shrinkage cracking is probable. See manufacturers' literature or ACI 305R for estimated moisture-loss chart relating relative humidity, air and concrete temperature, and wind velocity to rate of evaporation.

- B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m 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. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- D. Curing Methods: Cure formed and unformed concrete for at least seven days by one or a combination of the following methods:

Retain one or more of four subparagraphs below for curing method. Delete methods not approved or restrict use of curing methods to specific locations or types of surfaces if required.

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

Retain first three subparagraphs below as Contractor's options unless not suited for Project.

- a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) 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 (300 mm), 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.
 3. Curing Compound: Apply uniformly in 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. Maintain continuity of coating and repair damage during curing period.

Curing and sealing compound in subparagraph below is usually for floors and slabs and may act as a permanent surface finish.

4. 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.

3.10 FIELD QUALITY CONTROL

Revise field quality-control testing in this Article to suit Project or delete if not required.

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Tests: Perform according to ACI 301 (ACI 301M).

Retain one of two subparagraphs below. First subparagraph is an example of more frequent testing than second subparagraph, which is the testing frequency required to comply with ACI 301 (ACI 301M).

1. Testing Frequency: One composite sample shall be obtained for each day's pour of each concrete mix exceeding 5 cu. yd. (4 cu. m) but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
2. Testing Frequency: One composite sample shall be obtained for each 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mix placed each day.

3.11 REPAIRS

- A. Remove and replace concrete that does not comply with requirements in this Section.

END OF SECTION 033053