**SECTION 03 30 00**

**CAST-IN-PLACE CONCRETE**

**BASED ON DFD MASTER SPECIFICATION DATED 12/20/2023**

***This section has been written to cover most (but not all) situations that you will encounter. Depending on the requirements of your specific project, you may have to add material, delete items, or modify what is currently written. The Division of Facilities Development expects changes and comments from you.***

**PART 1 - GENERAL**

**SCOPE**

Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes. The work under this section consists of providing all work, materials, labor equipment and supervision necessary to provide cast in-place concrete as required in these specifications and the drawings.

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RELATED WORK

Applicable provisions of Division 1 govern work under this Section.

***(The A/E to review all scope of work and determine other related work, work which impacts this section, or work is impacted by this section. A/E to add or remove sections below as needed. (Examples may include site civil or utility work, interior flooring and finishes, coatings, etc.)***

Related work specified elsewhere:

033300 - Architectural Concrete: General building applications of specialty finished formed concrete.

035300 - Concrete Topping: Emery- and iron-aggregate concrete floor toppings.

042011 - Concrete Unit Masonry

0512 00 - Structural Steel Framing

055016 - Miscellaneous Metal for Utilities

071016 - Waterproofing for Utilities

076300 - Sheet Metal Roofing Specialties

312000 - Earth Moving: Drainage fill under slabs-on-grade

321313 - Concrete Paving: Concrete pavement and walks

321316 - Decorative Concrete Paving: Decorative concrete pavement and walks

Section 00 00 00 – (Section Title)

Section 00 00 00 – (Section Title)

**REFERENCES**

Incorporated Guides and References

American Concrete Institute (ACI):

 ACI 302.1R – Guide for Concrete Floor and Slab Construction.

 ACI 304R – Guide for Measuring, Mixing, Transporting and Placing Concrete.

 ACI 304.2R - Placing Concrete by Pumping Methods.

 ACI 305R - Hot Weather Concreting.

 ACI 309R – Guide for the Consolidation of Concrete.

 ACI 347 – Guide to Formwork for Concrete.

 ACI SP-66 – ACI Detailing Manual.

Specifications

American Concrete Institute (ACI):

 ACI 117 - Specifications for Tolerances for Concrete Construction and Materials.

 ACI 301 - Specifications for Structural Concrete.

 ACI 303.1 – Specification for Cast-In-Place Architectural Concrete.

 ACI 306.1 – Specification for Cold Weather Concreting.

 ACI 308.1 – Specification for Curing Concrete.

 ACI 315 - Details and Detailing of Concrete Reinforcement.

 ACI 318 - Building Code Requirements for Structural Concrete and Commentary.

ASTM International (ASTM):

ASTM A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

ASTM A704 – Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement.

ASTM A706 – Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.

 ASTM A775 – Standard Specification for Epoxy-Coated Steel Reinforcing Bars.

 ASTM A820 – Standard Specification for Steel Fibers for Fiber-Reinforced Concrete.

ASTM A884 – Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.

 ASTM A934 – Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.

ASTM A996 – Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.

 ASTM C33 – Standard Specification for Concrete Aggregates.

 ASTM C94 – Standard Specification for Ready-Mixed Concrete.

 ASTM C150 – Standard Specification for Portland Cement.

ASTM C156 – Standard Test Method for Water Loss (From a Mortar Specimen) Through Liquid Membrane-Forming Curing Compounds for Concrete.

 ASTM C171 – Standard Specification for Sheet Materials for Curing Concrete.

 ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete.

ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

 ASTM C494 – Standard Specification for Chemical Admixtures for Concrete.

ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for use in Concrete.

 ASTM C989 – Standard Specification for Slag Cement for Use in Concrete and Mortars.

ASTM C1059 – Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.

 ASTM C1116 – Standard Specification for Fiber-Reinforced Concrete.

 ASTM C1240 – Standard Specification for Silica Fume Used in Cementitious Mixtures.

ASTM C1602 – Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.

ASTM D1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).

ASTM D3963 – Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Steel Reinforcing Bars.

ASTM E164 3 – Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.

ASTM E1745 – Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.

**DEFINITIONS**

***(The A/E to include technical definitions for this section only. Do not include or repeat definitions found in related sections)***

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

W/C Ratio: The ratio by weight of water to cementitious materials.

Cured Concrete: The concrete strength at 28 days.

Dry Concrete: The measure of concrete at 80% relative humidity at 40% of the concrete slab-on-grade depth.

Self-Consolidating Concrete (SCC): a highly workable concrete that can flow through densely reinforced or complex structural elements under its own weight and adequately fill voids without segregation or excessive bleeding without the need for vibration.

Passing Ability: The ability of SCC to flow through openings such as the spaces between reinforcing bars without segregation or aggregate blocking.

J-Ring Test: Test used to determine the passing ability of SCC, or the degree to which the passage of concrete through the bars of the J-Ring apparatus is restricted.

J-Ring Flow: The distance of lateral flow of concrete using J-Ring in combination with a slump cone.

Slump Flow: Test method used to measure the unconfined flow and stability of SCC using a slump cone (upright or inverted)

Slump Flow Spread: The numerical value in inches of flow and stability of SCC using a slump cone (upright or inverted).

Slump Flow Spread: The numerical value in inches of flow determined as the average diameter of the circular deposit of SCC at the conclusion of the slump flow test.

T50 Value: Time (in seconds) the edge of the concrete mass takes to reach 50 cm (20 inches) diameter from the time the mold is first raised in the slump flow test.

Stability: The ability of a concrete mixture to resist segregation of the paste from the aggregates.

Static Segregation (Segregation Factor): Segregation of the mortar from the coarse aggregate that occurs after placement while the concrete is still in the plastic state.

Visual Stability Index (VSI) Rating: An assessment of the homogeneity of concrete based on the visual inspection of the concrete sample at the end of the slump flow test.

**PREINSTALLATION MEETINGS**

Prior to submitting design mixtures, contractor shall hold a meeting to review detailed requirements for preparing final concrete design mixes and to establish procedures for placing, finishing, curing, and protecting concrete to meet required quality under anticipated conditions. Representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

Contractor's superintendent.

Architect

DFD Construction Representative

Testing Laboratory responsible for field quality control.

Ready-mix concrete supplier.

Concrete Subcontractor.

Special concrete finish Subcontractor.

Minutes of the meeting shall be recorded, typed, reproduced and distributed by Contractor to all parties concerned within five working days of meeting. Minutes shall include a statement by admixture manufacturer(s) indicating that proposed mix design and placing can produce concrete quality required by this Section.

Contractor shall notify Architect at least 10 days prior to scheduled date of meeting.

**SUBMITTALS**

Product Data: For each type of product.

Sustainable Design Submittals: Comply with additional LEED submittal requirements specified in Section 01 81 13 and the following:

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.

Product Data for Credit IEQ 4.3: For [liquid floor treatments] [and] [curing and sealing compounds], documentation including printed statement of VOC content.

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, and for equivalent concrete mixtures that do not contain portland cement replacements.

Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

Indicate amounts of mixing water to be withheld for later addition at Project site.

Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

Location of construction joints is subject to approval of the Architect.

Concrete In-Situ Relative Humidity and pH Testing.

Report all test results in chart form listing test dates and time, depth of test holes, in-situ temperature and in-situ relative humidity, as well as pH levels of concrete slab surface to determine if the concrete is too dry to receive applied floor finishes.

List test hole locations on chart and show same on 8 ½ x 11” site map (when such a map is available to testing agency.)

Prepare a report of findings for the relative humidity and pH and distribution to Architect and General Prime Contractor.

Welding certificates.

Material Certificates: For each of the following, signed by manufacturers:

 Cementitious materials.

 Admixtures.

 Form materials and form-release agents.

 Steel reinforcement and accessories.

 Fiber reinforcement

 Waterstops

 Curing compounds

 Bonding agents

 Adhesives

 Vapor retarders

 Semirigid joint filler

 Joint-filler strips

 Repair materials

Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

 Aggregates

Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.

Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

Field quality-control reports.

Minutes of preinstallation conference.

Samples: For [**waterstops**] [**vapor retarder**] <**Insert products**>.

**QUALITY ASSURANCE**

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

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.

Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

Testing Agency Qualifications: An independent agency,[**acceptable to authorities having jurisdiction,**] qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

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.

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.

Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M.

Concrete In-Situ Relative Humidity and pH:

ASTM F2170-11 – Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs using In-Situ Probes.

ASTM F710-11 – Standard Practice for Preparing Concrete Floors and Other Monolithic Floors to Receive Resilient Flooring.

Digital “Reader” and calibrated relative humidity sensors

Factory-calibrated “Smart Sensors” using Touch-n-Sense TM technology or similar testing equipment.

National Institute of Standards for Testing (NIST) – traceable factory calibration.

Wide range pH paper, and distilled or de-ionized water.

**MOCK UP**

Cast concrete [**slab-on-grade**] [**and**] [**formed-surface**] panels to demonstrate typical joints, surface finish, texture, tolerances, floor treatments, and standard of workmanship.

Build panel approximately [**200 sq. ft. for slab-on-grade**] [**and**] [**100 sq. ft. for formed surface**] <**Insert area**> in the location indicated or, if not indicated, as directed by Architect.

Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion. [or Demolish and remove concrete mockups when directed.]

**DELIVERY, STORAGE, AND HANDLING**

Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.[**Avoid damaging coatings on steel reinforcement.**]

Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

**FIELD CONDITIONS**

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.

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.

Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

Hot-Weather Placement: Comply with ACI 301 and as follows:

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.

Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

**PART 2 - PRODUCTS**

**FORM-FACING MATERIALS**

Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces.

Furnish in largest practicable sizes to minimize number of joints.

Plywood, metal, or other approved panel materials.

Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

High-density overlay, Class 1 or better.

Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.

Structural 1, B-B or better; mill oiled and edge sealed.

B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

Overlaid Finnish birch plywood.

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.

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.

Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

Retain "Chamfer Strips" Paragraph below if chamfering is permitted.

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

Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

Formulate form-release agent with rust inhibitor for steel form-facing materials.

Form Ties: Factory-fabricated, removable or snap-off glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

Revise three subparagraphs below to suit Project; delete if not required.

Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.

Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.

Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

**STEEL REINFORCEMENT**

Revise this article to suit steel reinforcement requirements; delete if not required.

Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **[25] [60] <Insert number>** percent.

Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

***(AE Note: Any interior or exterior slab on grade to be reinforcement to be conventional rebar unless reviewed and approved by DFD.)***

Retain "Low-Alloy-Steel Reinforcing Bars" Paragraph below for reinforcement that is welded or if added ductility is sought.

Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

Retain "Galvanized Reinforcing Bars" Paragraph below for galvanized-steel reinforcement. Retain type of reinforcement from first set of options and zinc coating class from second set. Class I has at least 50 percent more zinc weight than Class II.

Galvanized Reinforcing Bars: [**ASTM A 615/A 615M, Grade 60**] [**ASTM A 706/A 706M**], deformed bars, ASTM A 767/A 767M, [**Class I**] [**Class II**] zinc coated after fabrication and bending.

Retain "Epoxy-Coated Reinforcing Bars" Paragraph below for epoxy-coated steel reinforcement. Retain type of reinforcement from first set of options and epoxy-coated product from second set. ASTM A 775/A 775M bars are usually epoxy coated before fabrication; ASTM A 934/A 934M bars are epoxy coated after fabrication and should not be field bent or rebent.

Epoxy-Coated Reinforcing Bars: [**ASTM A 615/A 615M, Grade 60**] [**ASTM A 706/A 706M**], deformed bars, [**ASTM A 775/A 775M**] [**or**] [**ASTM A 934/A 934M**], epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.

Retain "Stainless-Steel Reinforcing Bars" Paragraph below for stainless-steel reinforcement. Retain one of two options for reinforcement type.

Stainless-Steel Reinforcing Bars: ASTM A 955/A 955M, Grade 60, [**Type 304**] [**Type 316L**], deformed.

Steel Bar Mats: ASTM A 184/A 184M, fabricated from [**ASTM A 615/A 615M, Grade 60)**] [**ASTM A 706/A 706M**], deformed bars, assembled with clips.

Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.

Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, flat sheet.

**REINFORCEMENT ACCESSORIES**

Insert other products for dowels or dowel sleeves if required. These include circular and rectangular plastic dowel sleeves, square dowels, and plastic-surfaced or reinforced-paper-covered dowels.

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:

Retain one or more of three subparagraphs below; revise to suit Project.

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.

**Insert mechanical splices and connections for steel reinforcement here if required.**

**CONCRETE MATERIALS**

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, and obtain admixtures from single source from single manufacturer.

Cementitious Materials:

Retain type and color of portland cement from options in "Portland Cement" Subparagraph below.

Portland Cement: ASTM C 150/C 150M, [**Type I**] [**Type II**] [**Type I/II**] [**Type III**] [**Type V**], [**gray**] [**white**].

Retain supplementary cementing materials in "Fly Ash" and "Slag Cement" subparagraphs below if permitted. Ready-mix-concrete manufacturer blends these materials with portland cement. Fly ash, slag cement, or pozzolanic materials may slow rate of concrete strengthening and affect color uniformity. Class F fly ash is more readily available than Class C fly ash.

Fly Ash: ASTM C 618, [**Class F**] [**Class F or C**].

Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.

Retain "Blended Hydraulic Cement" Subparagraph below if factory-blended hydraulic cement is permitted; verify availability of options before specifying. Fly ash, slag cement, or pozzolanic materials in the nonportland cement part of blended hydraulic cement may slow rate of concrete strengthening and affect color uniformity. Insert ASTM C 1157 if acceptable.

Blended Hydraulic Cement: ASTM C 595/C 595M, [**Type IS, portland blast-furnace slag**] [**Type IP, portland-pozzolan**] [**Type IL, portland-limestone**] [**Type IT, ternary blended**] cement.

Silica fume in "Silica Fume" Subparagraph below is most often used in high-strength concrete and in special applications, such as bridge decks, to enhance durability by lowering permeability of concrete. ACI 301 (ACI 301M) identifies silica fume as a cementitious material.

Silica Fume: ASTM C 1240, amorphous silica.

Retain class of aggregate from options in "Normal-Weight Aggregates" Paragraph below or revise to suit Project. ASTM C 33/C 33M limits deleterious substances in coarse aggregate, depending on climate severity and in-service location of concrete. Classes in first set of options are ASTM C 33/C 33M default classes for concrete exposed to weather for Severe, Moderate, and Negligible weathering regions, respectively. Revise first two options to Class 4S or 4M if concrete is exposed to frequent wetting. Retain last option if damage caused by concrete expansion from alkali silica or alkali carbonate reactions is anticipated.

Normal-Weight Aggregates: ASTM C 33/C 33M, [**Class 3S**] [**Class 3M**] [**Class 1N**] <**Insert class**> coarse aggregate or better, graded. Provide aggregates from a single source [**with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials**].

Retain coarse-aggregate size from three options in "Maximum Coarse-Aggregate Size" Subparagraph below; insert gradation requirements if preferred. Aggregate size limits relate to spacing of steel reinforcement, depth of slab, or thickness of concrete member.

Maximum Coarse-Aggregate Size: [**1-1/2 inches**] [**1 inch**] [**3/4 inch**] <**Insert dimension**> nominal.

Retain "Fine Aggregate" Subparagraph below if optional restriction for fine aggregate in ASTM C 33/C 33M is required.

Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

Retain "Lightweight Aggregate" Paragraph below if using lightweight aggregate for structural lightweight concrete. Retain size limit from four options below.

Lightweight Aggregate: ASTM C 330/C 330M, [**1-inch**] [**3/4-inch**] [**1/2-inch**] [**3/8-inch**] nominal maximum aggregate size.

**ADMIXTURES**

Admixtures to be used in the concrete mixture shall be submitted for approval as part of the mixture design. No other admixtures will be allowed except those listed without the Architect’s approval.

Air-Entraining Admixture: ASTM C 260/C 260M.

Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do 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 chemical admixtures from "Water-Reducing Admixture," "Retarding Admixture," "Water-Reducing and Retarding Admixture," "High-Range, Water-Reducing Admixture," "High-Range, Water-Reducing and Retarding Admixture," and "Plasticizing and Retarding Admixture" subparagraphs below.

Water-Reducing Admixture: ASTM C 494/C 494M, Type A.

Retarding Admixture: ASTM C 494/C 494M, Type B.

Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.

Viscosity-Modifying Admixture: ASTM C 494/C 494M, Type S.

High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.

High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.

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

**Editor Note: Check with project PM to verify if crystalline waterproofing is required. If Crystalline waterproofing Ad mix is required use the following:**

Cementitious Crystalline Concrete Waterproofing Admixture: Xypex C-1000/C-1000NF, BASF 300D, Penetron Admix SB or approved equal.

Retain "Set-Accelerating Corrosion-Inhibiting Admixture" Paragraph below if set-accelerating corrosion inhibitors are required. Set-accelerating products are usually calcium nitrite-based admixtures and comply with ASTM C 494/C 494M, Type C.

Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494/C 494M, Type C.

Retain "Non-Set-Accelerating Corrosion-Inhibiting Admixture" Paragraph below if corrosion inhibitors that do not affect concrete setting time are required.

Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

Retain "Color Pigment" Paragraph below for integrally colored concrete.

Color Pigment: ASTM C 979/C 979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable,[**free of carbon black,**] nonfading, and resistant to lime and other alkalis.

Retain one of three options in "Color" Subparagraph below.

Color: [**As indicated by manufacturer's designation**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**].

Insert other admixtures, such as integral waterproofing admixtures, in "Water" Paragraph below if required.

Water: ASTM C 94/C 94M[**and potable**].

**FIBER REINFORCEMENT**

***(AE Note: Fiber reinforcement to be reviewed and approved by DFD prior to use)***

Retain one of two "Carbon-Steel Fiber" paragraphs below if using steel-fiber reinforcement. Retain length of fiber from first set of options and the ratio of length to effective diameter from second set of options for aspect ratio.

Carbon-Steel Fiber: ASTM A 820/A 820M, Type 1, cold-drawn wire, deformed, minimum of [**1.5 inches**] [**2 inches**] [**2.4 inches**] <**Insert dimension**> long, and aspect ratio of [**35 to 40**] [**45 to 50**] [**60 to 65**] <**Insert ratio**>.

Carbon-Steel Fiber: ASTM A 820/A 820M, Type 2, cut sheet, deformed, minimum of [**1.5 inches**] [**2 inches**] [**2.4 inches**] <**Insert dimension**> long, and aspect ratio of [**35 to 40**] [**45 to 50**] [**60 to 65**] <**Insert ratio**>.

Retain one of two "Synthetic Micro-Fiber" paragraphs below if using synthetic micro-fiber reinforcement. Revise fiber type if inserting polyester or nylon fibers. Monofilament fibers help reduce plastic shrinkage cracking. Manufacturers claim fibrillated fibers also improve hardened concrete properties.

Synthetic Micro-Fiber: Monofilament polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, [**1/2 to 1-1/2 inches**] [**1 to 2-1/4 inches**] <**Insert dimensions**> long.

Synthetic Micro-Fiber: Fibrillated polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, [**1/2 to 1-1/2 inches**] [**1 to 2-1/4 inches**] <**Insert dimensions**> long.

Manufacturers claim macro-fiber reinforcement can be used for crack control and may substitute for wire mesh and some light steel-reinforcement bar configurations in slabs-on-ground and composite slabs. The quantity of fiber required to be inserted into the concrete is calculated by a structural engineer based on criteria furnished by the fiber manufacturer.

Synthetic Macro-Fiber: Polyolefin macro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, [**1 to 2-1/4 inches**] <**Insert dimensions**> long.

**WATERSTOPS**

***(AE Note: Bulb type waterstops are to be avoided, unless application requires chemically resistant waterstop, such as agricultural holding tanks or similar applications where hydrophilic materials are not allowed)***

Flexible Rubber Waterstops: CE CRD-C 513,[**with factory-installed metal eyelets,**] for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

Retain profile from options in "Profile" Subparagraph below. Insert others if required.

Profile: [**Flat dumbbell with center bulb**] [**Flat dumbbell without center bulb**] [**Ribbed with center bulb**] [**Ribbed without center bulb**] [**As indicated**] <**Insert profile**>.

Dimensions: [**4 inches by 3/16 inch thick**] [**6 inches by 3/8 inch thick**] [**9 inches by 3/8 inch thick**] <**Insert dimensions**>; nontapered.

Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops[**with factory-installed metal eyelets**], for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals. Factory fabricate corners, intersections, and directional changes.

Retain profile from options in "Profile" Subparagraph below. Insert others if required.

Profile: [**Flat dumbbell with center bulb**] [**Flat dumbbell without center bulb**] [**Ribbed with center bulb**] [**Ribbed without center bulb**] [**As indicated**] <**Insert profile**>.

Dimensions: [**4 inches by 3/16 inch thick**] [**6 inches by 3/16 inch thick**] [**6 inches by 3/8 inch thick**] [**9 inches by 3/16 inch thick**] [**9 inches by 3/8 inch thick)**] <**Insert dimensions**>; nontapered.

Flexible PVC Waterstops: CE CRD-C 572,[**with factory-installed metal eyelets,**] for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

Retain profile from options in "Profile" Subparagraph below. Insert others if required.

Profile: [**Flat dumbbell with center bulb**] [**Flat dumbbell without center bulb**] [**Ribbed with center bulb**] [**Ribbed without center bulb**] [**As indicated**] <**Insert profile**>.

Dimensions: [**4 inches by 3/16 inch thick**] [**6 inches by 3/8 inch thick**] [**9 inches by 3/8 inch thick**] <**Insert dimensions**>; nontapered.

Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer-modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.

**VAPOR RETARDERS**

Retain one "Sheet Vapor Retarder" Paragraph below if a nonbituminous water vapor retarder is required.

Retain option and insert water-vapor permeance in first "Sheet Vapor Retarder" Paragraph below if requiring less than the 0.3 perms permitted by ASTM E 1745. See the Evaluations.

Sheet Vapor Retarder: ASTM E 1745, Class A[**, except with maximum water-vapor permeance of** <**Insert rating**>]. Include manufacturer's recommended adhesive or pressure-sensitive tape.

Retain option and insert water-vapor permeance in first "Sheet Vapor Retarder" Paragraph below if requiring less than the 0.3 perms permitted by ASTM E 1745. See the Evaluations.

Sheet Vapor Retarder: ASTM E 1745, Class B[**, except with maximum water-vapor permeance of** <**Insert rating**>]. Include manufacturer's recommended adhesive or pressure-sensitive tape.

Retain option and insert water-vapor permeance in first "Sheet Vapor Retarder" Paragraph below if requiring less than the 0.3 perms permitted by ASTM E 1745. See the Evaluations.

Sheet Vapor Retarder: ASTM E 1745, Class C[**, except with maximum water-vapor permeance of** <**Insert rating**>]. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.

Retain "Sheet Vapor Retarder" Paragraph below if generic polyethylene, rather than compliance with ASTM E 1745, is permitted.

Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils thick.

Retain "Bituminous Vapor Retarder" Paragraph below if bituminous vapor retarder is required.

Bituminous Vapor Retarder: 110-mil- thick, semiflexible, seven-ply sheet membrane consisting of reinforced core and carrier sheet with fortified asphalt layers, protective weathercoating, and removable plastic release liner. Furnish manufacturer's accessories, including bonding asphalt, pointing mastics, and self-adhering joint tape.

Water-Vapor Permeance: 0.0011 grains/h x sq. ft. x inches Hg; ASTM E 154.

Tensile Strength: 140 lbf/inch; ASTM E 154.

Puncture Resistance: 90 lbf ; ASTM E 154.

MOISTURE METER

**FLOOR AND SLAB TREATMENTS**

Retain this article if one or more floor and slab treatments are required.

Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing [**3/8-inch**] [**No. 4**] [**No. 8** ] <**Insert size or gradation**> sieve.

Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.

Emery Dry-Shake Floor Hardener: [**Pigmented**] [**Unpigmented**], factory-packaged, dry combination of portland cement, graded emery aggregate, and plasticizing admixture; with emery aggregate consisting of no less than 60 percent of total aggregate content.

Retain one of three options in "Color" Subparagraph below if retaining first option in "Emery Dry-Shake Floor Hardener" Paragraph above.

Color: [**As indicated by manufacturer's designation**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**].

Metallic Dry-Shake Floor Hardener: [**Pigmented**] [**Unpigmented**], factory-packaged, dry combination of portland cement, graded metallic aggregate, rust inhibitors, and plasticizing admixture; with metallic aggregate consisting of no less than 65 percent of total aggregate content.

Retain one of three options in "Color" Subparagraph below if retaining first option in "Metallic Dry-Shake Floor Hardener" Paragraph above.

Color: [**As indicated by manufacturer's designation**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**].

Retain "Unpigmented Mineral Dry-Shake Floor Hardener" Paragraph below if unpigmented mineral dry-shake floor hardeners are required. Verify suitability with manufacturer if air content of concrete exceeds 3 percent.

Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.

Retain "Pigmented Mineral Dry-Shake Floor Hardener" Paragraph below if pigmented mineral dry-shake floor hardeners are required. Verify suitability with manufacturer if air content of concrete exceeds 3 percent.

Pigmented Mineral Dry-Shake Floor Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

Retain one of three options in "Color" Subparagraph below.

Color: [**As indicated by manufacturer's designation**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**].

**LIQUID FLOOR TREATMENTS**

Penetrating liquid floor treatment in "Penetrating Liquid Floor Treatment" Paragraph below is commonly applied to harden and densify floors of warehouses and distribution facilities, imparting a clear satin sheen to finished floor. Pigmented products may also be available. Although formulations vary, manufacturers claim these nonfluosilicate liquids improve abrasion and chemical resistance and dustproof concrete surface. When approved by manufacturers, these products may be installed over mineral dry-shake floor hardeners or integrally colored concrete.

Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

**CURING MATERIALS**

Evaporation retarders temporarily reduce moisture loss from concrete surfaces awaiting finishing in hot, dry, and windy conditions. Evaporation retarders are not curing compounds.

Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

Retain curing aids and materials from remaining paragraphs.

Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

Water: Potable.

Retain "Clear, Waterborne, Membrane-Forming Curing Compound" Paragraph below if a dissipating-type, waterborne, membrane-forming curing compound is required. Although the EPA mandates maximum VOC emissions of 350 g/L for curing compounds, verify VOC emission limits of authorities having jurisdiction. If slow breakdown of curing membrane could interfere with bonding of floor coverings, retain "Removal" Subparagraph in "Concrete Protecting and Curing" Article in Part 3.

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

Retain "Clear, Waterborne, Membrane-Forming Curing Compound" Paragraph below if a nondissipating-type, waterborne, membrane-forming curing compound with minimal solids content is required. Although the EPA mandates maximum VOC emissions of 350 g/L for curing compounds, verify VOC emission limits of authorities having jurisdiction. Retain option if applicable.

Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating[**, certified by curing compound manufacturer to not interfere with bonding of floor covering**].

Verify with manufacturer that retained products have been tested against interference with bonding of floor covering.

Retain "Clear, Waterborne, Membrane-Forming Curing Compound" Paragraph below if a nondissipating-type, waterborne, membrane-forming curing compound with a higher solids content is required. This product will partially seal the concrete. Although the EPA mandates maximum VOC emissions of 350 g/L for curing compounds, verify VOC emission limits of authorities having jurisdiction. Retain option if applicable.

Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating[**, certified by curing compound manufacturer to not interfere with bonding of floor covering**].

Retain "Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound" Paragraph below if a clear, nonyellowing, solvent-borne, membrane-forming curing and sealing compound is required. Although the EPA mandates maximum VOC emissions of 700 g/L for curing and sealing compounds, verify VOC emission limits of authorities having jurisdiction.

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

Retain "Clear, Waterborne, Membrane-Forming Curing and Sealing Compound" Paragraph below if a clear, nonyellowing, waterborne, membrane-forming curing and sealing compound is required. Although the EPA mandates maximum VOC emissions of 700 g/L for curing and sealing compounds, verify VOC emission limits of authorities having jurisdiction.

Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

**RELATED MATERIALS**

Retain one or all options in "Expansion- and Isolation-Joint-Filler Strips" Paragraph below. Joint-filler strips are used in floor isolation joints.

Expansion- and Isolation-Joint-Filler Strips: [**ASTM D 1751, asphalt-saturated cellulosic fiber**] [**or**] [**ASTM D 1752, cork or self-expanding cork**].

Retain one of two options in "Semirigid Joint Filler" Paragraph below if semirigid joint filler is required to fill joints and support edges of trafficked contraction and construction joints.

Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, [**epoxy resin with a Type A shore durometer hardness of 80**] [**aromatic polyurea with a Type A shore durometer hardness range of 90 to 95**] according to ASTM D 2240.

Bonding agent in "Bonding Agent" Paragraph below may be used directly from container or as an admixture in cement or sand-cement slurries and rubbing grout.

Bonding Agent: ASTM C 1059/C 1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

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

 [**Types I and II, nonload bearing**] [**Types IV and V, load bearing**], for bonding hardened or freshly mixed concrete to hardened concrete.

Retain "Reglets" Paragraph below if reglets are not specified elsewhere. Coordinate product requirements with Section 076200 "Sheet Metal Flashing and Trim" or Section 077100 "Roof Specialties" or in other Sections where reglets are supplied as auxiliary products with waterproofing or roofing membrane flashings.

Reglets: Fabricate reglets of not less than 0.022-inch- thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

**REPAIR MATERIALS**

Retain "Repair Underlayment" Paragraph below as a repair material for floor and slab areas beneath floor coverings.

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.

Cement Binder: ASTM C 150/C 150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.

Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.

Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.

Compressive Strength: Not less than [**4100 psi**] <**Insert strength**> at 28 days when tested according to ASTM C 109/C 109M.

Retain "Repair Overlayment" Paragraph below as a repair material for floor or slab areas remaining exposed and not receiving floor coverings.

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.

Cement Binder: ASTM C 150/C 150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.

Primer: Product of topping manufacturer recommended for substrate, conditions, and application.

Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.

Compressive Strength: Not less than [**5000 psi)**] <**Insert strength**> at 28 days when tested according to ASTM C 109/C 109M.

**CONCRETE MIXTURES, GENERAL**

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.

Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

Retain first option in "Cementitious Materials" Paragraph below if required for replacing part of the portland cement, which would otherwise be used in concrete, with other cementitious materials. Retain second option if limiting percentage of cementitious materials that can replace portland cement. Neither ACI 301 (ACI 301M) nor ACI 318 (ACI 318M) limit amount of cementitious materials that can replace portland cement unless concrete is exposed to deicing chemicals. Identify parts of building or structure affected by these limits unless extending them to all concrete.

Cementitious Materials:[**Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.**] [**Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:**]

Percentages in six subparagraphs below repeat ACI 301 (ACI 301M) limits for concrete exposed to deicing chemicals. Revise to suit Project.

Fly Ash: 25 percent.

Combined Fly Ash and Pozzolan: 25 percent.

Slag Cement: 50 percent.

Combined Fly Ash or Pozzolan and Slag Cement: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.

Retain "Silica Fume," "Combined Fly Ash, Pozzolans, and Silica Fume," and "Combined Fly Ash or Pozzolans, Slag Cement, and Silica Fume" subparagraphs below if silica fume is permitted. Limits of silica fume alone or in combination with other cementitious materials below are based on ACI 301 (ACI 301M) and ACI 318 (ACI 318M).

Silica Fume: 10 percent.

Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.

Combined Fly Ash or Pozzolans, Slag Cement, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.

Retain appropriate option in first paragraph below for chloride limits. Identify portions of building with different limits if required. Percentages below repeat ACI 301 (ACI 301M) limits, respectively, for prestressed (post-tensioned) concrete, reinforced concrete exposed to chloride, reinforced concrete that is not dry or protected from moisture, and reinforced concrete that is dry or protected from moisture. ACI 301 (ACI 301M) and ACI 318 (ACI 318M) express this percentage by weight of cement, not cementitious material.

Limit water-soluble, chloride-ion content in hardened concrete to [**0.06**] [**0.15**] [**0.30**] [**1.00**] <**Insert number**> percent by weight of cement.

Admixtures: Use admixtures according to manufacturer's written instructions.

Revise four subparagraphs below to suit Project; delete if not required.

Use [**water-reducing**] [**high-range water-reducing**] [**or**] [**plasticizing**] admixture in concrete, as required, for placement and workability.

Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a w/c ratio below 0.50.

Insert locations and dosage of corrosion-inhibiting admixture to subparagraph below if required.

Use corrosion-inhibiting admixture in concrete mixtures where indicated.

Retain "Color Pigment" Paragraph below if integrally colored concrete is required, and indicate locations here or on Drawings.

Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

CONCRETE MIXTURE SCHEDULE

***(AE Note: Below is a template schedule of mixes. AE is responsible for editing for specific design requirements encountered on project.)***

 Slump

 Before Air

 Min. Comp addn. of Max. Water Entrain-

 Strength HRWR Agg. Cement ment

 Type of @ 28 Days (in. +/- Size Ratio % +/-

 Class Construction (PSI) 1 in.) (in.) 1½% Notes

 1 Footings 3000 5 1.0 0.59 4.5 (1)

 1a Drilled piers 3000 4 1.0 0.59 4.5 (1) (4)

 placed by tremie

 2 Interior 3500 3 0.75 0.68 none (2)

 slab-on-grade

 2a Exterior 4500 3 0.75 0.44 6.0 (2)(4)

 slab-on-grade

 2b Exterior 4500 3 0.75 0.44 6.0 (2)(4)(6)

 Site concrete

 3 Elevated slabs, 4000 4 0.75 0.57 none (2)(3)

 beams and stairs

 3a Elevated slabs, 5000 4 0.75 0.48 none (2)(3)

 beams and stairs

 4 Walls and piers 4000 4 0.75 0.57 none (2)

 4a Exposed walls 4000 3 0.75 0.48 6.0 (2)(3)

 5 Columns 4000 4 0.75 0.57 none (2)(3)

 5a Columns 5000 4 0.75 0.48 none (2)(3)

 5b Exposed columns 4000 4 0.75 0.48 6.0 (2)(3)

 5c Exposed columns 5000 4 0.75 0.40 6.0 (2)(3)

 6 Metal deck topping 4000 4 0.75 0.57 none (2)(5)

 7 Precast topping 4000 3 0.75 0.57 none (2)

 8 Metal pan stairs 4000 3 0.375 0.57 none (2)

 9 Miscellaneous 3000 5 0.75 0.59 6.0 (2)

 non-scheduled

 concrete

 10 Utility Concrete 4500 3 0.75 0.48 6.0 (2)(3)

 10a Utility Concrete 4500 See SCC requirements below (7)

***(AE Note: Discuss the type of Utility concrete to be used for project with DFD as SCC concrete is typically only used on select projects.)***

Notes:

1. Use a maximum of 50% replacement of portland cement with ground granulated blast-furnace slag and fly ash at a 1:1 ratio, up to 350 pounds per cubic yard. If fly ash is used alone, limit the maximum replacement to 25%.
2. Use a maximum of 30% replacement of portland cement with ground granulated blast-furnace slag and fly ash at a 1:1 ratio, up to 350 pounds per cubic yard, with a maximum 25% fly ash. If fly ash is used alone, limit the maximum replacement to 25%.
3. Use High-Range, Water-Reducing Admixture in mixture.
4. High-Range, Water-Reducing Admixture may be used in mixture.
5. Maximum equilibrium dry weight of lightweight aggregate mix: 115 pounds per cubic foot, as determined by section 9.5 of ASTM C 567.
6. Coordinate with site/civil and landscape concrete elements. May contain colored concrete elements. Provide epoxy coated rebar for all concrete.
7. For SCC:

Water/Cementitious ratio shall be between 0.30 – 0.38 and shall not exceed 0.38 by weight.

Supplementary Cementitious Materials (SCM) shall not exceed the following percentages:

Fly ash or other pozzolans – 25

Slag Cement – 50

Silica Fume – 10

Combination of fly ash or other pozzolans, slag cement and silica fume – 50

Combination of fly ash or other pozzolans and silica fume – 35

Fly ash shall never constitute more than 25%

Slump Flow: The design slump flow shall be established after consideration of the project

requirements, but will typically be in the range of 24-30 inches. The slump flow used on the

project shall be the design slump flow plus/minus 2 inches.

Visual Stability Index (VSI): VSI rating shall not exceed 1.

J-Ring Flow: Difference between slump flow and J-Ring flow (as measured by ASTM

C1621/C1621M) shall not be more than 4 inches.

Stability: The stability of the concrete shall be determined in the laboratory prior to approval of

the SCC mixture using test method ASTM C1610/C1610M. All mixtures shall have a maximum

static segregation (segregation factor) of 15%.

Maximum Nominal Size of Coarse Aggregate: Not larger than ¾ of the minimum clear distance

between reinforcing bars or between bars and forms, whichever is the least.

Furnish to the Architect a mix proportion for the SCC to be used: proportion the mix according to

specific criteria (compressive strength, air content, slump flow, T50, VSI, J-Ring value,

segregation factor; use the same components in the trial batches as that to be used in the project,

including coarse and fine aggregates, water, source and type of cement, SCM and admixtures.

**FABRICATING REINFORCEMENT**

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

**CONCRETE MIXING**

Retain option in "Ready-Mixed Concrete" Paragraph below if steel or synthetic fibers are required.

Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M[**and ASTM C 1116/C 1116M**], and furnish batch ticket information.

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.

Retain "Project-Site Mixing" Paragraph below if Project-site mixing is permitted. ACI 301 (ACI 301M) applies measuring, batching, and mixing requirements from ASTM C 94/C 94M to Project-site mixing.

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.

For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.

For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..

Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

**PART 3 - EXECUTION**

**FORMWORK INSTALLATION**

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.

Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

Retain surface classes, usually two or more, in two subparagraphs below. See discussion in "Formwork" Article in the Evaluations. Coordinate with rough- and smooth-formed finishes in "Finishing Formed Surfaces" Article.

 [**Class A, 1/8 inch**] <**Insert dimension**> for smooth-formed finished surfaces.

 [**Class B, 1/4 inch**] [**Class C, 1/2 inch**] [**Class D, 1 inch**] <**Insert dimension**> for rough-formed finished surfaces.

Construct forms tight enough to prevent loss of concrete mortar.

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.

Install keyways, reglets, recesses, and the like, for easy removal.

Do not use rust-stained steel form-facing material.

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.

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.

Retain one of two options in first paragraph below. ACI 301 (ACI 301M) requires chamfers unless otherwise specified.

[**Chamfer**] [**Do not chamfer**] exterior corners and edges of permanently exposed concrete.

Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.

Determine sizes and locations from trades providing such items.

Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

**EMBEDDED ITEM INSTALLATION**

Specify embedded items and anchorage devices for other work attached to or supported by cast-in-place concrete. Insert specific requirements for installing embedded items, if any, that are part of the Work.

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.

Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.

Retain applicable subparagraphs below and insert others if required. Revise to suit Project.

Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

Install dovetail anchor slots in concrete structures as indicated.

**REMOVING AND REUSING FORMS**

Revise removal time in "General" Paragraph below if required. Period of 24 hours is halved to 12 hours in ACI 347. Commentary in ACI 318 (ACI 318M) recognizes 12 hours for concrete using regular portland cement but advises that this period may be insufficient for concrete using Type II and Type V portland cements or ASTM C 595/C 595M blended hydraulic cements, concrete with retarding admixtures, and concrete using ice during mixing.

General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for [**24**] <**Insert number**> hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

Retain option in first subparagraph below if adopting recommendation of ACI 347. ACI 301 (ACI 301M) requires concrete to reach its specified compressive strength.

Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved[**at least 70 percent of**] its 28-day design compressive strength.

Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material are not acceptable for exposed surfaces. Apply new form-release agent.

When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

**SHORING AND RESHORING INSTALLATION**

Review this article with structural engineer and revise if required.

Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

Do not remove shoring or reshoring until measurement of slab tolerances is complete.

Revise first paragraph below if setting more detailed requirements, such as a minimum number of floors.

In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

**VAPOR-RETARDER INSTALLATION**

Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

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

Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder according to manufacturer's written instructions.

**STEEL REINFORCEMENT INSTALLATION**

General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

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.

Retain subparagraph below if welding is permitted or required.

Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.

Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

Install welded-wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. 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.

Retain "Epoxy-Coated Reinforcement" Paragraph below if using epoxy-coated reinforcement.

Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.

Retain "Zinc-Coated Reinforcement" Paragraph below if using zinc-coated reinforcement.

Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material according to ASTM A 780/A 780M. Use galvanized-steel wire ties to fasten zinc-coated steel reinforcement.

**JOINTS**

Coordinate joint types, description, and location with Drawings. Joint types are consolidated in this article for consistency rather than for strict sequence of installation.

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

Revise criteria for locating construction joints in "Construction Joints" Paragraph below to suit Project.

Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

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.

Retain first subparagraph below if keyed joints are used. Keyed joints are used in walls and floors and between walls and slabs or footings. ACI 302.1R recommends limiting keyed joints to lightly trafficked floors, because keys may fail and lips may chip after concrete shrinks.

Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.

Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

Insert spacing of construction joints in first subparagraph below if preferred.

Space vertical joints in walls [**as indicated**] <**Insert spacing**>. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

Retain one of two subparagraphs below only if a bonding material is permitted.

Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

Insert spacing of contraction (control) joints here or on Drawings if required. Contraction-joint spacings vary with slab thickness, aggregate size, and slump based on PCA's recommendations. Depth of joint may be varied to suit cutting method or if steel-fiber reinforcement is used.

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-Third**] <**Insert depth**> of concrete thickness as follows:

Retain type of joint-forming method from "Grooved Joints" and "Sawed Joints" subparagraphs below or retain both subparagraphs as Contractor's option. Insert joint spacing if not indicated on Drawings.

Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes.

Eliminate groover tool marks on concrete surfaces.

Retain "Sawed Joints" 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 are used within one to two hours of finishing concrete. To leave concrete undamaged from sawing, conventional saw cutting must be delayed, usually 4 to 12 hours, but not so long that uncontrolled cracking of concrete could occur.

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 does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

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.

Retain one or both of first two subparagraphs below. If both are required, indicate location of each on Drawings.

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

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 Section 079200 "Joint Sealants," are indicated.

Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

Retain "Doweled Joints" Paragraph below if doweled contraction or expansion joints are used; revise if precoated dowels are required.

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.

**WATERSTOP INSTALLATION**

Retain "Flexible Waterstops" or "Self-Expanding Strip Waterspots" Paragraph below, depending on type of waterstop required.

Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

**CONCRETE PLACEMENT**

Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.

Retain one of first two paragraphs below. ACI 301 (ACI 301M) permits water to be added to concrete mixture on-site to adjust slump, up to amount allowed in design mixture.

Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.

Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

Retain subparagraph below if high-range water-reducing admixtures are permitted.

Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete 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.

Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.

Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

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.

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.

Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.

Maintain reinforcement in position on chairs during concrete placement.

Screed slab surfaces with a straightedge and strike off to correct elevations.

Slope surfaces uniformly to drains where required.

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.

**FINISHING FORMED SURFACES**

Retain types of formed finishes required in this article. Coordinate finishes retained with finish schedule or indicate location of each finish on Drawings.

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.

Apply to concrete surfaces [**not exposed to public view**] <**Insert locations**>.

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.

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

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 "Rubbed Finish" Paragraph below, retain "Smooth-Formed Finish" Paragraph above.

Rubbed Finish: Apply the following to smooth-formed-finished as-cast concrete where indicated:

Retain one or more rubbed finishes in "Smooth-Rubbed Finish," "Grout-Cleaned Finish," and "Cork-Floated Finish" subparagraphs below.

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.

Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix 1 part portland cement to 1-1/2 parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix 1 part portland cement and 1 part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

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.

**FINISHING FLOORS AND SLABS**

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

Retain one or more of "Scratch Finish," "Float Finish," "Trowel Finish," "Trowel and Fine-Broom Finish," and "Slip-Resistive Finish" paragraphs below for types of slab finishes required. Coordinate slab finishes retained with finish schedule or indicate location of each finish on Drawings.

Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.

Revise locations of scratch finish in subparagraph below to suit Project.

Apply scratch finish to surfaces [**indicated**] [**and**] [**to receive concrete floor toppings**] [**to receive mortar setting beds for bonded cementitious floor finishes**] <**Insert locations**>.

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 restraightening until surface is left with a uniform, smooth, granular texture.

Revise locations of float finish in subparagraph below to suit Project.

Apply float finish to surfaces [**indicated**] [**to receive trowel finish**] [**and**] [**to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo**] <**Insert locations**>.

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.

Revise locations of trowel finish in first subparagraph below to suit Project.

Apply a trowel finish to surfaces [**indicated**] [**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**] <**Insert locations**>.

Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:

Revise surface plane tolerances to suit Project. See the Evaluations for description of F-number system. ACI 301 (ACI 301M) suggests that all residential floors and nonresidential floors less than 10,000 sq. ft. (929 sq. m) be measured by straightedge method and that other nonresidential floors be measured by F-number system.

Retain floor flatness and levelness values required for Project from first four subparagraphs below, or revise values to suit type of floor. ACI 302.1R suggests values in first subparagraph be used for carpeted slabs; those in second and third, for thin floor coverings; and those in fourth, for very flat floors for high-speed forklifts, air pallets, and ice and roller rinks.

Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15.

Specified overall values 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; for slabs-on-grade.

Specified 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; for suspended slabs.

Specified overall values of flatness, F(F) 45; and of levelness, F(L) 35; with minimum local values of flatness, F(F) 30; and of levelness, F(L) 24.

Retain straightedge method in subparagraph below if deleting F-number system above.

Finish and measure surface, so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed [**1/4 inch**] [**3/16 inch**] [**1/8 inch**].

Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces [**indicated**] [**where ceramic or quarry tile is to be installed by either thickset or thin set method**]. While concrete is still plastic, slightly scarify surface with a fine broom.

Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

Retain "Broom Finish" Paragraph below if applicable. Broom finish is generally used on exterior concrete steps and platforms, ramps, and other surfaces subject to light foot traffic.

Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.

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.

Retain "Slip-Resistive Finish" Paragraph below if applicable. This finish is generally used on interior and exterior concrete treads, platforms, and ramps subject to moderate foot traffic.

Slip-Resistive Finish: Before final floating, apply slip-resistive [**aggregate**] [**aluminum granule**] finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:

Uniformly spread [**25 lb/100 sq. ft.**] <**Insert rate**> of dampened slip-resistive [**aggregate**] [**aluminum granules**] over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.

Revise float finish in first subparagraph below to trowel finish if required.

After broadcasting and tamping, apply float finish.

After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive [**aggregate**] [**aluminum granules**].

Retain Dry-Shake Floor Hardener Finish Paragraph below if pigmented or unpigmented dry-shake floor hardener finish is required.

Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces according to manufacturer's written instructions and as follows:

Consult manufacturers and revise rate of application in first subparagraph below if required. This rate is usually recommended for light traffic.

Uniformly apply dry-shake floor hardener at a rate of [**100 lb/100 sq. ft.**] <**Insert rate**> unless greater amount is recommended by manufacturer.

Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.

Coordinate selection of curing compounds for compatibility with dry-shake floor hardener, and revise lists of manufacturers in Part 2 accordingly if required.

After final floating, apply a trowel finish. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

**VAPOR RETARDER**

**QUANTIFICATION OF RELATIVE HUMIDITY AT 40% OF CONCRETE THICKNESS**

Comply with the manufactures installation and equipment utilizing requirements.

The test site should be maintained at the same temperature and humidity conditions as those anticipated during normal occupancy. These temperature and humidity levels should be maintained for 48 hours prior and during test period. When a building is not under HVAC control, a recording hygrometer or data logger shall be in place recording conditions during the test period. A transcript of this information must be included with the test report.

The number of in-situ relative humidity test sites is determined by the square footage of the facility. The minimum number of tests to be placed is equal to 3 in the first 1,000 square feet, and 1 per each additional 1,000 square feet.

Determine the thickness of the concrete slab, typically from construction documents.

Utilizing a rotary-hammer drill, drill test holes to a depth equal to 40% of the concrete thickness, i.e., 2” deep for a 5” thick slab, or 1.6” deep for a 4” thick slab. Hole diameter shall not exceed outside diameter of the probe by more than 0.04”. Drilling operation must be dry.

Vacuum and brush all concrete dust from test hole.

Insert a relative humidity probe (sensor) to the full depth of test hole. Place cap over probe. If appropriate provide additional security to prevent cap removal using packing tape.

Permit test holes with probes to acclimate, or equilibrate for 72 hours prior to taking relative humidity readings.

Remove the cap, insert the cylindrical reading device, and obtain reading from the in-situ probe.

Read and record temperature and relative humidity in each test hole. These test results are used to determine if the slab-on-grade has experienced moisture depletion to the relative humidity level to assist in the proper adhesion of the moisture sensitive floor coverings.

**QUANTIFYING pH LEVEL**

At or near the relative humidity test site perform pH test.

Place several drops of water onto the concrete surface to form a puddle approximately 1” in diameter.

Allow the water to set for approximately 60 seconds

Dip the pH paper into the water and remove immediately, compare color to chart provided by paper supplier to determine pH reading

Record and report results. These test results are used to determine if the slab-on-grade has experienced moisture depletion to the relative humidity level to assist in the proper adhesion of the moisture sensitive floor coverings.

**MISCELLANEOUS CONCRETE ITEM INSTALLATION**

This article is an example only. Insert, revise, or delete items to suit Project.

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.

Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

Equipment Bases and Foundations:

Coordinate sizes and locations of concrete bases with actual equipment provided.

Construct concrete bases [**4 inches**] [**6 inches**] [**8 inches**] <**Insert dimension**> high unless otherwise indicated, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.

Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.

Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.

Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

**CONCRETE PROTECTING AND CURING**

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 301 for hot-weather protection during curing.

If evaporation rate in "Evaporation Retarder" 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.

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.

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 remainder of curing period.

Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

Cure concrete according to ACI 308.1, by one or a combination of the following methods:

Retain one or more of "Moisture Curing," "Moisture-Retaining-Cover Curing," "Curing Compound," and "Curing and Sealing Compound" subparagraphs below. Restrict use of curing methods to specific locations or types of surfaces if required.

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 unsuited for Project.

Water.

Continuous water-fog spray.

Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

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.

Retain first three subparagraphs below or revise to suit Project.

Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.

Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.

Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies does not interfere with bonding of floor covering used on Project.

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.

Retain "Removal" Subparagraph below if requiring removal of curing compounds that may interfere with adhesion of floor coverings.

Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer[**unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project**].

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

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.

**LIQUID FLOOR TREATMENT APPLICATION**

Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.

Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.

Some manufacturers state that the penetrating liquid floor treatment also functions as a curing aid. If used as a cure, delete minimum age of concrete in first subparagraph below and revise application method to follow manufacturer's written instructions. Coordinate with "Concrete Protecting and Curing" Article.

Do not apply to concrete that is less than [**three**] [**seven**] [**14**] [**28**] days' old.

Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

Usually delete "Sealing Coat" Paragraph below if two coats of curing and sealing compound have already been applied during curing stage. Sealing coat may be used as turnover coat, independent of means of curing, to improve appearance of an exposed concrete floor at end of Project.

Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

**JOINT FILLING**

Retain this article if joint filling is required.

Prepare, clean, and install joint filler according to manufacturer's written instructions.

ACI 302.1R recommends joint filling be deferred as long as possible in concrete floors. Use of polyurea joint fillers may allow joint filling to proceed earlier; verify minimum time period with manufacturer. Typically, up to 30 percent of concrete shrinkage takes place in first month, with 80 to 90 percent during first 12 months. Revise period in subparagraph below if too short or too long. Joints must be filled before industrial floors can be placed in service.

Defer joint filling until concrete has aged at least [**one**] [**six**] month(s). Do not fill joints until construction traffic has permanently ceased.

Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

**CONCRETE SURFACE REPAIRS**

This article provides basic applications for repairing concrete surfaces. Revise or delete to suit Project.

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.

Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

Insert provision for testing repair technique on a mockup or surface to be concealed later, before repairing surfaces.

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

Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar matches surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.

Compact mortar in place and strike off slightly higher than surrounding surface.

Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

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.

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.

After concrete has cured at least 14 days, correct high areas by grinding.

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.

Retain one or both of first two subparagraphs below if applicable. First subparagraph uses an underlayment; second, a topping.

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.

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.

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.

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.

Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

Repair materials and installation not specified above may be used, subject to Architect's approval.

**FIELD QUALITY CONTROL**

Retain "Special Inspections" or "Testing Agency" Paragraph below.

Retain first option in "Special Inspections" Paragraph below if authorities having jurisdiction require Owner to engage a special inspector. Retain last option if Owner engages testing agency, with or without a special inspector. See "Testing and Inspecting Considerations" Article in the Evaluations.

Special Inspections: Owner will engage a [**special inspector**] [**and**] [**qualified testing and inspecting agency**] to perform field tests and inspections and prepare test reports.

Retain "Testing Agency" Paragraph below if Contractor engages testing agency.

Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

Inspections:

Retain seven subparagraphs below if special inspections are required. Items below are examples of special inspections and are based on IBC requirements; revise to insert other inspections or to suit requirements of other building codes.

Steel reinforcement placement.

Steel reinforcement welding.

Headed bolts and studs.

Verification of use of required design mixture.

Concrete placement, including conveying and depositing.

Curing procedures and maintenance of curing temperature.

Verification of concrete strength before removal of shores and forms from beams and slabs.

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:

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

Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.

Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

Retain first subparagraph below with either "Testing Agency" Subparagraph retained above.

When frequency of testing provides 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.

Petrographic Analysis:

One test for each day’s pour. Perform additional tests when concrete consistency appears to change. Analysis shall include the following:

1. Water/Cement ratio and porosity distribution
2. Air content and distribution

**Editor Note: Check with project PM to verify if Petrographic Analysis is required.**

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.

For SCC; test slump flow in accordance with ASTM C1611. Cone can be used either upright or inverted. Same procedure shall be followed throughout project.

For SCC; tester shall record the Visual Stability Index (VSI)

Air Content: ASTM C 231/C 231M, pressure method, for normal-weight concrete; [**ASTM C 173/C 173M, volumetric method, for structural lightweight concrete;**]one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.

Retain "Unit Weight" Subparagraph below if structural lightweight concrete is required.

Unit Weight: ASTM C 567/C 567M, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

Compression Test Specimens: ASTM C 31/C 31M.

Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.

Field-cured specimens in first subparagraph below may be required to verify adequacy of curing and protection of concrete, to verify strength for tilt-up concrete and post-tensioning concrete, or to verify strength for removal of shoring and reshoring in multistory construction. Revise number of test specimens if required.

Cast and field cure [two] <Insert number> sets of two standard cylinder specimens for each composite sample.

Coordinate the number of compression test specimens in last subparagraph above with number of compressive-strength tests in "Compressive-Strength Tests" Subparagraph below.

Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at [24 hrs, 48 hrs, 7] days and one set of two specimens at [7, 28] days.

Revise age at testing in first subparagraph below or delete if not required. Limit field testing to concrete in designated structural elements if not required throughout Project.

Test one set of two field-cured specimens at [24 hrs,7] days and one set of two specimens at [48 hrs, 7, 28] days.

A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

Retain first subparagraph below if field-cured specimens are required.

When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

Test results shall be reported in writing to 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.

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.

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 or by other methods as directed by Architect.

Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

Retain paragraph below if measurements of floor flatness and levelness tolerances are required.

Measure floor and slab flatness and levelness according to ASTM E 1155 within [**24**] [**48**] <**Insert number**> hours of finishing.

**PROTECTION OF LIQUID FLOOR TREATMENTS**

Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 033000