**SECTION 033300 - ARCHITECTURAL CONCRETE**

For more information, contact ***Master Builders Solutions***; 23700 Chagrin Blvd., Beachwood, OH 44122; Phone: (800) 628-9990; Website: [www.master-builders-solutions.com/en-us](http://www.master-builders-solutions.com/en-us);

Note: this document contains specific guidance (in green) that enables the user to select the appropriate solution for the required application. This three-part guide specification is representative of a specification meeting the CSI section code and containing multiple product options. For an individual product specification, visit: <https://master-builders-solutions.com/en-us/specifications/>

1. GENERAL
   * + 1. RELATED DOCUMENTS
          1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
       2. SUMMARY
          1. Section Includes:

Cast-in-place architectural concrete, including form facings, reinforcement accessories, concrete materials, concrete mixtures, concrete placement, and concrete finishes.

Requirements in Section 033000 "Cast-in-Place Concrete" apply to this Section.

* + - 1. DEFINITIONS

Retain terms that remain after this Section has been edited for a project.

Retain "Aggregate Exposure" Paragraph below if term is used in description of exposed-aggregate finish.

* + - * 1. Aggregate Exposure: Projection of coarse aggregate from matrix or mortar after completion of exposure operations.

Identify cast-in-place architectural concrete on Drawings and distinguish from structural concrete and other cast-in-place concrete not considered to be architectural.

* + - * 1. Cast-in-Place Architectural Concrete: Concrete that is exposed to view, is designated as architectural concrete, and that requires special concrete materials, formwork, placement, or finishes to obtain specified architectural appearance.

Definition in "Cementitious Materials" Paragraph below refers to those materials that make up the cementitious component of the water cement ratio (w/cm).

* + - * 1. 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 or metakaolin; materials subject to compliance with requirements.

Retain "Design Reference Sample" Paragraph below if design reference sample, chosen by Architect during Contract documentation, is proposed.

* + - * 1. Design Reference Sample: Sample designated by Architect in the Contract Documents that reflects acceptable surface quality and appearance of cast-in-place architectural concrete.
        2. w/cm: The ratio by mass of water to that of cementitious materials.
      1. PREINSTALLATION MEETINGS

Retain "Preinstallation Conference" Paragraph below if Work of this Section is extensive or complex enough to justify a conference.

* + - * 1. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

Require representatives of each entity directly concerned with cast-in-place architectural concrete to attend, including the following:

Contractor's superintendent.

Independent testing agency responsible for concrete design mixtures.

Ready-mixed concrete manufacturer.

Cast-in-place architectural concrete Subcontractor.

Review the following:

Special inspection and testing and inspecting agency procedures for field quality control.

Construction joints, control joints, isolation joints, and joint-filler strips.

Reinforcement accessory installation.

Cold- and hot-weather concreting procedures.

Concrete finishes and finishing.

Curing procedures.

Forms and form-removal limitations.

Shoring and reshoring procedures.

Concrete repair procedures.

Protection of cast-in-place architectural concrete.

Initial curing and field curing of field test cylinders (ASTM C31/C31M).

Protection of field-cured field test cylinders.

* + - 1. ACTION SUBMITTALS
         1. Product Data: For each of the following:

Form-facing panels.

Form liners.

Form joint tape.

Form joint sealant.

Wood sealer.

Form-release agent.

Surface retarder.

Form ties.

Bar supports.

Portland cement.

Fly ash.

Slag cement.

Blended hydraulic cement.

Silica fume.

Performance-based hydraulic cement.

Aggregates.

Admixtures:

Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.

Color pigments.

Repair materials.

* + - * 1. Sustainable Design Submittals:

Retain "Product Data" Subparagraph below to require minimum recycled content for LEED 2009, MRc 2, "Recycled Content."

Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

"Product Certificates" Subparagraph below applies to LEED 2009, MRc 5, "Regional Materials."

Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.

Retain first three subparagraphs below to be eligible for LEED v4 credit. See the Evaluations.

"Environmental Product Declaration" Subparagraph below applies to LEED v4 (all), MRc "Building Product Disclosure and Optimization - Environmental Product Declarations." Confirm with manufacturer that EPDs are available for each product.

Environmental Product Declaration: For each product.

"Health Product Declaration" Subparagraph below applies to LEED v4 (all), MRc "Building Product Disclosure and Optimization - Material Ingredients, Option 1 - Material Ingredient Reporting." Confirm with manufacturer that HPDs are available and meet requirements of the HPD Open Standard or approved USGBC program.

Health Product Declaration: For each product.

"Sourcing of Raw Materials" Subparagraph below applies to LEED v4 (all), MRc "Building Project Disclosure and Optimization - Sourcing of Raw Materials, Option 1 - Raw Material Source and Extraction Reporting." Confirm with manufacturer that corporate sustainability reports are available, have been prepared within the last year or are applicable to the year of production, and are by an organization approved by the USGBC.

Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

"Product Certificates" Subparagraph below applies to IgCC, which requires that a minimum of 55 percent of building materials or products be extracted, harvested, manufactured, or recovered within 500 miles (800 km) of Project. See IgCC-2012, 505.2.5.

Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.

Retain "Environmental Product Declaration" Subparagraph below if products specified in the Section are required to have an EPD to meet the IgCC's requirement of 55 percent recycled materials.

Environmental Product Declaration: For each product.

"Product Certificates" Subparagraph below applies to ASHRAE 189.1, which requires that a minimum of 15 percent of building materials or products be extracted, harvested, manufactured, or recovered within 500 miles (800 km) of Project. See ASHRAE 189.1-2014, 9.4.1.2.

Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.

"Environmental Product Declaration" Subparagraph below applies to ASHRAE 189.1 if products specified in the Section are used to meet the requirements of paragraph 9.4.1.4, "Multiple-Attribute Product Declaration or Certification," which requires EPDs for a minimum of 10 products.

Environmental Product Declaration: For each product.

Environmental Assessment Report: Submit for the concrete mixture. Compare submitted concrete mixture with conventional/typical reference concrete mixture that would otherwise be used to achieve the specified performance. At minimum, include information in the following environmental impact areas: air emissions (climate change, acidification, photochemical ozone formation, ozone depletion), water emissions (aquatic eutrophication), consumption of raw materials (resource depletion - mineral, fossil), and human toxicity potential. Methodology used to conduct analysis and assessment should be in accordance with ISO 14040 and ISO 14044 (ecological part) and be third-party-verified by NSF International or another accredited third-party agency.

Subparagraphs below apply to Green Globes v1.4 if products specified in the Section are used to meet the requirements of paragraph 3.5.1.2 "Path B: Prescriptive Path for Building Core and Shell," which requires that a certain percentage of the materials used in the core and shell have EPDs, third-party certifications, and/or third-party life cycle assessments.

Environmental Product Declaration: For each product.

Third-Party Certifications: For each product.

Third-Party Certified Life Cycle Assessment: For each product.

Retain "Design Mixtures" Paragraph below only if concrete mixtures for architectural concrete are not specified in Section 033000 "Cast-in-Place Concrete."

* + - * 1. Design Mixtures: For each concrete mixture, include the following:

Mixture identification.

Minimum 28-day compressive strength.

Durability exposure class.

Maximum w/cm.

Calculated equilibrium unit weight, for lightweight concrete.

Slump limit.

Air content.

Nominal maximum aggregate size.

Steel-fiber reinforcement content.

Synthetic microfiber content.

Amounts of mixing water to be withheld for later addition at Project site if permitted.

Intended placement method.

Alternative design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

* + - * 1. Shop Drawings:

Formwork: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.

Show formwork construction, including form-liner layout, form-liner termination details, dimensioned locations of form-facing material joints, rustications, construction and contraction joints, form joint-sealant details, form-tie locations and patterns, inserts and embedments, cutouts, cleanout panels, and other items that visually affect cast-in-place architectural concrete.

Included separate layout for formwork used in [**field sample panels**] [**and**] [**mockups**].

Indicate proposed schedule and sequence of stripping of forms, shoring removal, and reshoring installation and removal.

Location of construction joints is subject to approval of Architect.

* + - * 1. Samples: For each of the following materials:

Retain applicable subparagraphs below. Insert samples of other materials if required.

Form-facing panels.

Form ties.

Form liners, 12-by-12-inch (305-by-305-mm) Sample, indicating texture.

Manufacturer's standard colors for color pigment.

Exposed aggregates.

Chamfers and rustications.

Samples in "Samples for Verification" Paragraph below may or may not be representative of a contractor's production on a project. Although the practice of manufacturing samples of plant-precast architectural concrete is widespread, samples of cast-in-place architectural concrete may be difficult to reproduce in the field.

* + - * 1. Samples for Verification: Architectural concrete Samples, cast vertically, approximately 18 by 18 by 2 inches (450 by 450 by 50 mm), of finishes, colors, and textures to match design reference sample. Include Sample sets showing the full range of variations expected in these characteristics.
        2. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:

Concrete Class designation.

Location within Project.

Exposure Class designation.

Formed Surface Finish designation and final finish.

Curing process.

* + - * 1. Placement Schedule: Submit before start of placement operations.
      1. INFORMATIONAL SUBMITTALS

Coordinate "Qualification Data" Paragraph below with qualification requirements in Section 014000 "Quality Requirements" and as may be supplemented in "Quality Assurance" Article.

* + - * 1. Qualification Data: For the following:

Installer: Include copies of applicable ACI certificates.

Ready-mixed concrete manufacturer.

Retain "Material Certificates" Paragraph below to require submittal of material certificates from manufacturers.

* + - * 1. Material Certificates: For each of the following:

Cementitious materials.

Admixtures.

Form materials and form-release agents.

Repair materials.

Retain "Material Test Reports" Paragraph below for material test reports that are Contractor's responsibility.

* + - * 1. Material Test Reports: For the following, by a qualified testing agency:

Portland cement.

Fly ash.

Slag cement.

Blended hydraulic cement.

Silica fume.

Performance-based hydraulic cement.

Retain option in "Aggregates" Subparagraph below if retaining service-record data with "Normal-Weight Aggregates" Paragraph in "Concrete Materials" Article.

Aggregates[**: Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity**].

* + - * 1. Research Reports: For concrete admixtures in accordance with ICC AC198.
        2. Preconstruction Test Reports: For each mix design.
        3. Concrete Repair: Submit a written, detailed description of materials, methods, equipment, and sequence of operations to be used for repairing architectural concrete, including protection of surrounding materials and Project site.

If materials and methods other than those indicated are proposed for any repairs to architectural concrete, add a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project and Installer's ability to use such materials and methods properly.

Retain paragraph below if preinstallation conference is held.

* + - * 1. Minutes of preinstallation conference.
      1. QUALITY ASSURANCE
         1. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

* + - * 1. Installer Qualifications: An experienced cast-in-place architectural concrete installer, as evidenced by not less than five consecutive years' experience, specializing in installing cast-in-place architectural concrete similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

Provide written evidence of qualifications and experience.

Include locations, descriptions, and photographs of completed projects, including name of architect, substantiating the quality of the installer's experience.

Retain "Laboratory Testing Agency Qualifications" Paragraph below if Contractor retains testing agency for concrete mixture design or material test reports.

* + - * 1. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Technical Manager.

Retain first subparagraph below if requiring minimum qualifications for laboratory personnel performing testing and for laboratory supervisor.

Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Level I.

Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Level II.

Field sample panels may be used to verify that Contractor can produce cast-in-place architectural concrete of required finish, color, and texture. On simple projects, field samples may suffice and make mockups unnecessary. For more complex projects, field samples may be needed before producing full-scale mockups.

* + - * 1. Field Sample Panels: After approval of verification sample and before casting architectural concrete, produce field sample panels to demonstrate the approved range of selections made under Sample submittals. Produce a minimum of three sets of full-scale panels, cast vertically, approximately 48 by 48 by 6 inches (1200 by 1200 by 150 mm) minimum, to demonstrate the expected range of finish, color, and texture variations.

Locate panels as indicated or, if not indicated, as directed by Architect.

Demonstrate methods of curing, aggregate exposure, wood sealers, and coatings, as applicable.

In presence of Architect, damage part of an exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces.

Maintain field sample panels during construction in an undisturbed condition as a standard for judging the completed Work.

Demolish and remove field sample panels when directed.

Retain "Mockups" Paragraph below unless field sample panels will suffice and added expense of mockups is not required. If retaining, indicate location, size, concrete type, and other details of mockups on Drawings or by inserts. Revise wording if only one mockup is required.

* + - * 1. Mockups: Before casting architectural concrete, build mockups, using the same procedures, equipment, materials, finishing procedures, and curing procedures that will be used for producing architectural concrete, to verify selections made under Sample submittals and to demonstrate typical joints, surface finish, color, texture, tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

Revise or delete first six subparagraphs below to suit Project.

Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.

Retain first subparagraph below for large-scale mockup or include in Section 014000 "Quality Requirements." Indicate portion of wall represented by mockup on Drawings or draw mockup as separate element. Include requirements in other Sections for installation of additional components, such as brick, windows, doors, copings, or sealants needed to complete the mockup.

Build mockups of typical wall of cast-in-place architectural concrete as indicated on Drawings, including vertical and horizontal rustication joints, and any sculptured features.

Construct mockups to include at least two lifts having heights equal to those anticipated for construction.

Demonstrate curing, cleaning, and protecting of cast-in-place architectural concrete, finishes, and contraction joints, as applicable.

In presence of Architect, damage part of the exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair to match adjacent undamaged surfaces.

In presence of Architect, demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces.

Obtain Architect's approval of mockups before casting architectural concrete.

Retain subparagraph below if the intention is to make an exception to the default requirement in Section 014000 "Quality Requirements" for demolishing and removing mockups.

Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

* + - 1. PRECONSTRUCTION TESTING
         1. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

Include the following information in each test report:

Admixture dosage rates.

Slump.

Air content.

Seven-day compressive strength.

28-day compressive strength.

Permeability.

* + - 1. DELIVERY, STORAGE, AND HANDLING
         1. Comply with ASTM C94/C94M and ACI SPEC-301 (ACI SPEC-301M).
      2. FIELD CONDITIONS
         1. Cold-Weather Placement: Comply with Section 033000 "Cast-in-Place Concrete."
         2. Hot-Weather Placement: Comply with Section 033000 "Cast-in-Place Concrete."

1. PRODUCTS

Before inserting names, verify that manufacturers and products listed here comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications.

* + - 1. CONCRETE, GENERAL
         1. ACI Publications: Comply with ACI SPEC-301 (ACI SPEC-301M) unless modified by requirements in the Contract Documents.
      2. FORM-FACING MATERIALS
         1. Comply with Section 031000 "Concrete Forming and Accessories" for formwork and other form-facing material requirements, and as specified in this Section.
         2. Source Limitations: Obtain each type of form-facing material from a single source from a single manufacturer.
         3. Form-Facing Panels for [**As-Cast**] [**Exposed-Aggregate**] Finishes:

Retain one of two subparagraphs below, depending on type of surface finish, color, and texture sought; or revise to specify another form-facing material. ACI SPEC-301 (ACI SPEC-301M) requires formwork to have a high-density, nonvapor-transmitting form face. Steel- and glass-fiber-reinforced plastic in first subparagraph are usually considered nonvapor transmitting. Overlaid plywoods in second subparagraph, although not completely nonvapor transmitting, minimize moisture absorption into panel. Of options in second subparagraph, high-density overlaid plywood and Finnish birch impart a glossy finish; medium-density overlaid plywood imparts a matte finish. Verify that mill-applied release agent to medium-density overlay does not result in blotchy or stained concrete surfaces.

Steel- and glass-fiber-reinforced plastic, or other approved nonabsorptive panel materials that provide continuous, true, and smooth architectural concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

Exterior-grade plywood panels, nonabsorptive, that will provide continuous, true, and smooth architectural concrete surfaces, [**high-density overlay, Class 1, or better**] [**medium-density overlay, Class 1, or better, mill-applied release agent and edge sealed**], complying with DOC PS 1[**, or Finnish phenolic overlaid birch plywood**].

Retain "Form Liners" Paragraph below if using form liners. Revise to insert description or product names and manufacturers if required. Form liners may be produced from textured plywood, wood strips, and metals, although most are produced from thermoplastic sheet materials, such as polystyrene, PVC, or ABS; thermosetting plastics, such as glass-fiber-reinforced polyester; and polyurethane elastomers.

* + - * 1. Form Liners: Units of face design, texture, arrangement, and configuration [**indicated**] [**to match design reference sample**]. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent surface treatments and finishes of concrete.

Indicate sizes, locations, and details of rustication strips on Drawings.

* + - * 1. Rustication Strips: Metal[**, dressed wood,**] or rigid plastic, with sides beveled and back kerfed; nonstaining; in longest practicable lengths.

Retain "Chamfer Strips" Paragraph below if chamfering is permitted. Insert other configurations or dimensions if needed.

* + - * 1. Chamfer Strips: Metal, rigid plastic, elastomeric rubber, or dressed wood, 3/4 by 3/4 inch (19 by 19 mm), minimum; nonstaining; in longest practicable lengths.
        2. Form Joint Tape: Compressible foam tape; pressure sensitive; AAMA 800; minimum 1/4 inch (6 mm) thick.
        3. Form Joint Sealant: Elastomeric sealant complying with ASTM C920, Type M or Type S, Grade NS, that adheres to form joint substrates, does not stain, does not adversely affect concrete surfaces, and does not impair subsequent treatments and finishes of concrete surfaces.
        4. Wood Sealer: Penetrating, clear, polyurethane wood sealer formulated to reduce absorption of bleed water and prevent migration of set-retarding chemicals from wood and does not stain, does not adversely affect concrete surfaces, and does not impair subsequent treatments and finishes of concrete surfaces.
        5. Form-Release Agent: Commercially formulated, colorless form-release agent that does not bond with, stain, or adversely affect architectural concrete surfaces and will not impair subsequent treatments and finishes of architectural concrete surfaces.

Retain "Basis-of-Design Product" Subparagraph below to identify a specific product or a comparable product.

Basis-of-Design Product: Subject to compliance with requirements, provide Master Builders Solutions; MasterFinish Series (Pre-2014: Cast Off and Rheofinish Series) or comparable product.

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

Form-release agent for form liners shall be acceptable to form-liner manufacturer.

Product in "Surface Retarder" Paragraph below is applied to the form to retard surface hardening, if needed, for some exposed-aggregate finishes.

* + - * 1. Surface Retarder: Water-soluble chemical liquid set retarder, for application on form-facing materials, capable of temporarily delaying final hardening of newly placed architectural concrete surface to depth of aggregate exposure specified.

Retain "Basis-of-Design Product" Subparagraph below to identify a specific product or a comparable product.

Basis-of-Design Product: Subject to compliance with requirements, provide Master Builders Solutions; MasterFinish Series or comparable product.

Source Limitations: Obtain surface retarder from a single source from a single manufacturer.

Options in "Form Ties" Paragraph below have been limited to heavy-duty, glass-fiber-reinforced plastic ties; internally disconnecting ties, such as she-bolt and coil ties; and removable ties, such as greased taper ties and plastic-sleeved threaded bars. Light-duty snap-off ties, such as loop, flat, and snap ties, are not included. Removable ties leave holes that penetrate concrete and may require plugging. Insert stainless steel ties if required.

* + - * 1. Form Ties: Factory-fabricated, [**glass-fiber-reinforced plastic**] [**internally disconnecting**] [**or**] [**removable**] ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

Retain first subparagraph below if retaining internally disconnecting or removable ties.

Furnish ties[**with tapered tie cone spreaders**] that, when removed, will leave holes no larger than [**3/4 inch (19 mm)**] [**1 inch (25 mm)**] [**1-1/4 inches (32 mm)**] [**1-1/2 inches (38 mm)**] <**Insert dimension**> in diameter on architectural concrete surface.

Retain one or more of remaining subparagraphs below if removable ties are not required. Retain option in first subparagraph if exposed-aggregate finish is required.

Furnish internally disconnecting ties that will leave no metal closer than 1-1/2 inches (38 mm)[**, after exposing aggregate,**] from architectural concrete surface.

Glass-fiber-reinforced plastic form ties, cut flush with concrete surface, leave no holes. Diameters of 1/2 and 1 inch (13 and 25 mm) are produced. Verify sizes and color availability with manufacturers.

Furnish glass-fiber-reinforced plastic ties, not less than 1/2 inch (13 mm) and not more than 1 inch (25 mm) in diameter, of color [**to match Architect's sample**] [**selected by Architect from manufacturer's full range**].

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

* + - 1. REINFORCEMENT ACCESSORIES
         1. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire fabric in place.

Manufacture bar supports in accordance with CRSI's "Manual of Standard Practice."

Revise color of plastic in subparagraph below to color closer to concrete after verifying availability if required.

Where legs of wire bar supports contact forms, use [**gray, all-plastic**] [**CRSI Class 1, gray, plastic-protected**] [**or**] [**CRSI Class 2, stainless steel**] bar supports.

* + - 1. CONCRETE MATERIALS

Retain this article only if concrete materials for architectural concrete have different requirements or restrictions than concrete specified in Section 033000 "Cast-in-Place Concrete."

"Regional Materials" Paragraph below applies to LEED 2009 NC, CS, and LEED 2009 for Schools, MRc 5 and to LEED 2009 CI, MRc 5, Option 2; before retaining, verify availability of materials that comply.

* + - * 1. Regional Materials: Concrete shall be manufactured within 500 miles (800 km) of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.

"Regional Materials" Paragraph below applies to LEED 2009 CI, MRc 5, Option 1.

* + - * 1. Regional Materials: Concrete shall be manufactured within 500 miles (800 km) of Project site.

"Regional Materials" Paragraph below applies to LEED v4.

* + - * 1. Regional Materials: Concrete shall be manufactured within 100 miles (160 km) of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

"Indigenous Materials" Paragraph below applies to IgCC; before retaining, verify availability of materials that comply.

* + - * 1. Indigenous Materials: Concrete shall be manufactured within 500 miles (800 km) of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

"Regional Materials" Paragraph below applies to ASHRAE 189.1; before retaining, verify availability of materials that comply.

* + - * 1. Regional Materials: Concrete shall be manufactured within 500 miles (800 km) of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
        2. Cementitious Materials:

Retain type and color of portland cement from options in "Portland Cement" Subparagraph below if different than requirements in Section 033000 "Cast-in-Place Concrete."

Portland Cement: ASTM C150/C150M, [**Type I**] [**Type II**] [**Type I/II**] [**Type III**], [**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. Slag cement will result in a lighter concrete color, and is sometimes used instead of white portland cement, including when a color pigment is incorporated into the design mixture. Verify, with local architectural concrete producers, before not allowing supplementary cementing materials.

Fly Ash: [**ASTM C618, Class C**] [**ASTM C618, Class F**] [**ASTM C618, Class C or Class F**] [**Not allowed**].

Slag Cement: [**ASTM C989/C989M, Grade 100 or Grade 120**] [**Not allowed**].

Silica Fume: ASTM C1240 amorphous silica.

Retain "Basis-of-Design Product" Subparagraph below to identify a specific product or a comparable product.

Basis-of-Design Product: Subject to compliance with requirements, provide Master Builders Solutions; MasterLife SF 100 (Pre-2014: Rheomac SF100) or comparable product.

Metakaolin: ASTM C618, Class N.

Retain "Basis-of-Design Product" Subparagraph below to identify a specific product or a comparable product.

Basis-of-Design Product: Subject to compliance with requirements, provide Master Builders Solutions; MasterLife MK 828 or comparable product.

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 C1157/C1157M if acceptable.

Blended Hydraulic Cement: ASTM C595/C595M, [**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, although it is seldom used in architectural concrete.

Silica Fume: [**ASTM C1240 amorphous silica**] [**Not allowed**].

Retain one or more options in "Performance-Based Hydraulic Cement" Paragraph below. For low reactivity with alkali-silica-reactive aggregates, add the optional suffix "(R)" to selected type [**e.g., Type MS(R)**]. This suffix should only be specified for use with aggregates with known alkali-reactivity.

Performance-Based Hydraulic Cement: ASTM C1157/C1157M: [**Type GU, general use**] [**Type HE, high early strength**] [**Type MS, moderate sulfate resistance**] [**Type HS, high sulfate resistance**] [**Type MH, moderate heat of hydration**] [**Type LH, low heat of hydration**].

Retain class of aggregates from options in "Normal-Weight Aggregates" Paragraph below or revise to suit Project. ASTM C33/C33M limits deleterious substances in coarse aggregate, depending on climate severity and in-service location of concrete. Exposed architectural concrete is classified as Class 5S or Class 5M. For Negligible (N) weathering regions, Class 1N is stricter than Class 2N. Retain last option below if anticipating damage caused by concrete expansion from alkali-silica or alkali-carbonate reactions.

* + - * 1. Normal-Weight Aggregates: ASTM C33/C33M, [**Class 5S**] [**Class 5M**] [**Class 1N**] <**Insert class**> coarse aggregate or better, graded. Provide aggregates from single source from single manufacturer.

Retain "Alkali-Silica Reaction" Subparagraph below if damage caused by concrete expansion from alkali-silica or alkali-carbonate reactions is anticipated.

Alkali-Silica Reaction: Comply with one of the following:

Expansion Result of Aggregate: Not more than 0.04 percent at one year when tested in accordance with ASTM C1293.

Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at 16 days when tested in accordance with ASTM C1567.

Alkali Content in Concrete: Not more than 4 lb./cu. yd. (2.37 kg/cu. m) for moderately reactive aggregate or 3 lb./cu. yd. (1.78 kg/cu. m) for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI SPEC-301 (ACI SPEC-301M).

Retain one option in "Maximum Coarse-Aggregate Size" and "Gradation" subparagraphs below. Aggregate size limits relate to spacing of steel reinforcement, depth of slab, or thickness of concrete member. See the Evaluations for further information. Indicate locations of concrete if using different aggregate sizes and gradations. Gap-graded aggregates produce a harsh mix that is difficult to place with uniform results; determine workable mixture proportions that achieve a predictable appearance. Insert color requirements or special aggregate descriptions if preselected.

Maximum Coarse-Aggregate Size: [**1 inch (25 mm)**] [**3/4 inch (19 mm)**] [**1/2 inch (13 mm)**] [**3/8 inch (10 mm)**].

Gradation: [**Uniformly**] [**Gap**] graded.

* + - * 1. Normal-Weight Fine Aggregate: [**ASTM C33/C33M**] [**or**] [**ASTM C144**], manufactured or natural sand, free of materials with deleterious reactivity to alkali in cement, from same source for entire Project.
        2. Chemical Admixtures: As specified in Section 033000 "Cast-in-Place Concrete," and 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 admixtures containing intentionally added chlorides.

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

* + - * 1. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable,[**free of carbon black,**] nonfading, and resistant to lime and other alkalis.

Retain "Basis-of-Design Product" Subparagraph below to identify a specific product or a comparable product.

Basis-of-Design Product: Subject to compliance with requirements, provide Master Builders Solutions; MasterColor or comparable product.

Source Limitations: Obtain color pigment from single source from single manufacturer.

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**].

* + - * 1. Water and Water Used to Make Ice: ASTM C1602/C1602M, potable [**or**] [**complying with ASTM C1602/C1602M, including all limits listed in Table 2 and requirements of paragraph 5.4**].
      1. CURING MATERIALS
         1. Comply with Section 0330000 "Cast-in-Place Concrete."

For integrally colored concrete, curing materials shall be approved by color pigment manufacturer.

For concrete indicated to be sealed, curing materials shall be compatible with sealer.

* + - 1. REPAIR MATERIALS

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

* + - * 1. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
        2. Epoxy Bonding Adhesive: ASTM C881/C881M two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements.

Retain "Basis-of-Design Product" Subparagraph below to identify a specific product or a comparable product.

Basis-of-Design Product: Subject to compliance with requirements, provide Master Builders Solutions; MasterEmaco ADH (Pre-2014: Concresive Series) or comparable product.

Retain types in subparagraph below based on service loadings.

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

* + - 1. CONCRETE MIXTURES, GENERAL

Retain this article only if concrete mixtures for architectural concrete are not specified in Section 033000 "Cast-in-Place Concrete."

* + - * 1. Obtain each color, size, type, and variety of concrete mixture from a single manufacturer with resources to provide cast-in-place architectural concrete of consistent quality in appearance and physical properties.
        2. Prepare design mixtures for each type and strength of cast-in-place architectural concrete proportioned on basis of laboratory trial mixture or field test data, or both, in accordance with ACI SPEC-301 (ACI SPEC-301M).

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

Retain "Cementitious Materials" Paragraph below if cementitious materials other than portland cement are permitted. Neither ACI SPEC-301 (ACI SPEC-301M) nor ACI CODE-318 (ACI CODE-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.

* + - * 1. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

Percentages in five subparagraphs below repeat ACI SPEC-301 (ACI SPEC-301M), Table 4.2.1.1(b) limits for concrete Exposure Class F3. Revise to suit Project.

Fly Ash or Other Pozzolans: 25 percent by mass.

Slag Cement: 50 percent by mass.

Limits of silica fume alone or in combination with other cementitious materials below are based on ACI SPEC-301 (ACI SPEC-301M) and ACI CODE-318 (ACI CODE-318M). Revise to suit Project.

Silica Fume: 10 percent by mass.

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

Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.

* + - * 1. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

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

* + - * 1. Color Pigment: Add color pigment to concrete mixture in accordance with manufacturer's written instructions and to result in hardened concrete color consistent with approved [**design reference sample**] [**field sample panels**] [**mockups**].
      1. CONCRETE MIXTURES

Retain this article only if concrete mixtures for architectural concrete are not specified in Section 033000 "Cast-in-Place Concrete." First paragraph below is only an example of a concrete mixture. Revise or add other concrete mixtures if required. ASTM C94/C94M requires each "class" of concrete mixture be assigned a designation to facilitate identification of each concrete mixture delivered to Project, and that this designation be identified on the delivery ticket. Do not duplicate "Class" designations used in Section 033000 "Cast-in-Place Concrete." Consider inserting minimum cementitious material content for mix designs.

* + - * 1. Class [**K**] <**Insert designation**>: Normal-weight concrete.

Exposure Class: ACI CODE-318 (ACI CODE-318M) [**F0**] [**F1**] [**F2**] [**F3**] [**S0**] [**S1**] [**S2**] [**S3**] [**W0**] [**W1**] [**C0**] [**C1**] [**C2**].

Retain strength from first five options in "Minimum Compressive Strength" Subparagraph below or revise to suit Project. Coordinate compressive strength with w/cm if concrete is subject to special exposure conditions or sulfate exposure, as identified in ACI CODE-318 (ACI CODE-318M). 5000 psi (34.5 MPa) is the minimum recommended compressive strength for concrete that will receive acid washing, mechanical tooling, or waterblasting.

Minimum Compressive Strength: [**5000 psi (34.5 MPa)**] [**4500 psi (31 MPa)**] [**4000 psi (27.6 MPa)**] [**3500 psi (24.1 MPa)**] [**3000 psi (20.7 MPa)**] [**As indicated**] <**Insert strength**> at 28 days.

Revise "Maximum w/cm" Subparagraph below to suit Project or delete if in-service durability conditions are benign and limits on w/cm are not required. 0.46 w/cm is maximum recommended in ACI 303R. Revise to lower w/cm if needed for corrosion protection. Coordinate with minimum compressive strength.

Maximum w/cm: 0.46.

Consider deleting "Slump Limit" Subparagraph below and allow Contractor to select a target slump based on ASTM C143/C143M, as permitted under ACI SPEC-301 (ACI SPEC-301M). If retaining subparagraph, retain slump limit from options below or revise to suit Project.

Slump Limit: [**3 inches (75 mm), plus or minus 1 inch (25 mm)**] [**4 inches (100 mm), plus or minus 1 inch (25 mm)**] [**8 inches (200 mm), plus or minus 1 inch (25 mm) for concrete containing a high-range water-reducing admixture**] <**Insert dimension(s)**>.

"Slump Flow Limit" Subparagraph below is for self-consolidating concrete. Consider deleting and allow Contractor to select a target slump flow based on ASTM C1611/C1611M, as permitted under ACI SPEC-301 (ACI SPEC-301M). If retaining subparagraph, retain slump flow limit from options below or revise to suit Project.

Slump Flow Limit: [**22 inches (550 mm), plus or minus 1.5 inches (40 mm)**] [**30 inches (760 mm), plus or minus 2.5 inches (65 mm)**] <**Insert limits**>.

Air Content:

Options in "Exposure Class F1" and "Exposure Classes F2 and F3" subparagraphs below are examples only. Revise to suite Project. See ACI SPEC-301 (ACI SPEC-301M), Table 4.2.2.7(b)1 for air content for additional exposure classes and aggregate sizes.

Exposure Class F1: [**5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**] [**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**] [**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

Exposure Classes F2 and F3: [**6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**] [**6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**] [**5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].

Retain appropriate option in subparagraph below for chloride limits. Percentages below repeat ACI CODE-318 (ACI CODE-318M) limits. First option is for Exposure Class C0; second option is for Exposure Class C1; third option is for Exposure Class C2. ACI SPEC-301 (ACI SPEC-301M) and ACI CODE-318 (ACI CODE-318M) express this percentage by mass of cement, not cementitious material.

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

* + - 1. CONCRETE MIXING

To maintain consistency from batch to batch and to produce uniform architectural concrete, ready-mixed concrete produced in a central plant is required. In some larger projects, temporary batching and mixing plants may be set up to site-produce architectural concrete in accordance with ASTM C94/C94M.

The slump/workability, air content, and temperature of freshly batched concrete can be maintained beyond the limits in ASTM C94/C94M through the use of hydration-controlling admixtures, workability-retaining admixtures, and other means as specified in ACI SPEC-305.1. Accordingly, the following note is provided in ASTM C94/C94M to make users of the standard aware of these technologies: "Depending on the project requirements the technology is available to the manufacturer to alter fresh concrete properties (such as setting time, slump or slump flow, air content, etc.). On some projects the manufacturer may request changes to certain fresh concrete properties due to the distance or projected transportation time between the batch plant and the point of delivery."

Since their introduction into the concrete industry, Master Builders Solutions’ "MasterSet DELVO" hydration-controlling admixture and its "MasterSure Z 60" workability-retaining admixture have been used successfully to maintain the fresh properties of concrete beyond the 1-1/2 hour limit for concrete discharge in ASTM C94/C94M.

* + - * 1. [**Ready-Mixed**] [**or**] [**Project-Site-Mixed**] Architectural Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M[**and ASTM C1116/C1116M**], and furnish batch ticket information.

Clean equipment used to mix and deliver cast-in-place architectural concrete to prevent contamination from other concrete.

For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.

For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).

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.

1. EXECUTION
   * + 1. INSTALLATION OF FORMWORK
          1. Comply with Section 031000 "Concrete Forming and Accessories" for formwork, embedded items, and shoring and reshoring, and as specified in this Section.
          2. Limit deflection of form-facing panels to not exceed ACI SPEC-301 (ACI SPEC-301M) requirements.
          3. Limit cast-in-place architectural concrete surface irregularities, as follows:

Retain finish in "Surface Finish-1.0," "Surface Finish-2.0," and "Surface Finish-3.0"subparagraphs below. ACI SPEC-301 (ACI SPEC-301M) recommends Class A for surfaces prominently exposed to public view, where appearance is of special importance. ACI SPEC-301 (ACI SPEC-301M) recognizes Class A as a basis for a smooth-form finish.

Surface Finish-1.0: ACI SPEC-117 (ACI SPEC-117M) Class D, 1 inch (25 mm).

Surface Finish-2.0: ACI SPEC-117 (ACI SPEC-117M) Class B, 1/4 inch (6 mm).

Surface Finish-3.0: ACI SPEC-117 (ACI SPEC-117M) Class A, 1/8 inch (3.0 mm).

* + - * 1. Construct forms to result in cast-in-place architectural concrete that complies with ACI SPEC-117 (ACI SPEC-117M).

Retain subparagraph below if exceptions to ACI SPEC-117 (ACI SPEC-117M) are required.

Also comply with the following tolerances: <**Insert tolerances**>.

* + - * 1. Seal form joints, chamfers, rustication joints, and penetrations at form ties with form joint tape or form joint sealant to prevent cement paste leakage.

Provide closure backing materials if indented rustication is used over a ribbed form line, and seal joint between rustication strip and form with joint sealant.

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

* + - * 1. [**Chamfer**] [**Do not chamfer**] exterior corners and edges of cast-in-place architectural concrete.
        2. Coat contact surfaces of wood rustications and chamfer strips with wood sealer before placing reinforcement, anchoring devices, and embedded items.

Retain first paragraph below for concrete surfaces that do not require surface retarding.

* + - * 1. Coat contact surfaces of forms with form-release agent, in accordance with manufacturer's written instructions, before placing reinforcement, anchoring devices, and embedded items.

Retain first paragraph below for exposed-aggregate surfaces needing surface retarder to achieve required finish.

* + - * 1. Coat contact surfaces of forms with surface retarder, in accordance with manufacturer's written instructions, before placing reinforcement, anchoring devices, and embedded items.

Retain paragraph below if using form liners.

* + - * 1. Place form liners accurately to provide finished surface texture indicated.

Provide solid backing and attach securely to prevent deflection and maintain stability of liners during concreting.

Secure form liners in place using fasteners that will not transfer impressions onto surface of concrete.

Prevent form liners from sagging and stretching in hot weather.

Seal joints of form liners and form-liner accessories to prevent mortar leaks.

Coat form liner with form-release agent.

* + - 1. INSTALLATION OF REINFORCEMENT AND ACCESSORIES
         1. Comply with Section 032000 "Concrete Reinforcing" for fabricating and installing steel reinforcement and accessories.
      2. REMOVING AND REUSING FORMS

Revise removal time in first paragraph below if required. Period of 24 hours is halved to 12 hours in ACI PRC-347. Commentary in ACI CODE-318 (ACI CODE-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 C595/C595M blended hydraulic cements, concrete with retarding admixtures, and concrete using ice during mixing. If approved surface appearance and color can be achieved, as verified on design reference sample, field sample panels, or mockups, revise below to leave forms in place until concrete is cured.

* + - * 1. 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 (10 deg C) 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.

Schedule form removal to maintain surface appearance that matches approved [**design reference sample**] [**field sample panels**] [**mockups**].

Retain option in first subparagraph below if adopting recommendation of ACI PRC-347. ACI SPEC-301 (ACI SPEC-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.

Retain subparagraph below if glass-fiber-reinforced plastic form ties are required. Revise to cut off tie at embedded tip of cone if using cone spreaders.

Cut off and grind glass-fiber-reinforced plastic form ties flush with surface of concrete.

* + - * 1. Clean and repair surfaces of forms to be reused in the Work.

Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.

Apply new form-release agent.

* + - * 1. 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 cast-in-place architectural concrete surfaces.

* + - 1. JOINTS

Revise criteria in "Construction Joints" Paragraph below to suit locations of construction joints on Project.

* + - * 1. Construction Joints: Install construction joints true to line, with faces perpendicular to surface plane of cast-in-place architectural concrete, 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.

Retain first subparagraph below if using keyed joints. Keyed joints are used in walls and floors and between walls and slabs or footings. ACI PRC-302.1 recommends limiting keyed joints to lightly trafficked floors, because keys may fail and lips may chip after concrete shrinks. Retain option if a minimum embedment dimension is required.

Form keyed joints as indicated.[**Embed keys at least 1-1/2 inches (38 mm) into concrete.**] Align construction joint within rustications attached to form-facing material.

Locate joints for beams, slabs, joists, and girders at third points 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 top of footings or floor slabs.

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

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

Retain bonding material in subparagraph below or delete subparagraph if bonding materials are not permitted. Verify acceptance of use with structural engineer.

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

Indicate contraction joint details, joint pattern, and locations on Drawings. Joint location may be influenced by size and shape of concrete element, extent of shrinkage cracking, curing effectiveness, and amount of steel reinforcement. Consider joint sealant requirements, specified in Section 079200 "Joint Sealants," to guard against mortar leakage.

* + - * 1. Contraction Joints: Form weakened-plane contraction joints true to line, with faces perpendicular to surface plane of cast-in-place architectural concrete, so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
      1. CONCRETE PLACEMENT
         1. Comply with Section 033000 "Cast-in-Place Concrete."
      2. FINISHING FORMED SURFACES
         1. Comply with Section 033000 "Cast-in-Place Concrete."

Retain "Architectural Concrete Finish" Paragraph below if architectural concrete finishes are based on a design reference sample. Revise to identify and describe design reference sample if appropriate.

* + - * 1. Architectural Concrete Finish: Match Architect's design reference sample, identified and described as indicated, to satisfaction of Architect.
        2. As-Cast Surface Finishes: Comply with Section 033000 "Cast-in-Place Concrete" for the following:

Retain one of more of three subparagraphs below. If retaining more than one, indicate location of each Surface Finish on Drawings.

ACI SPEC-301 (ACI SPEC-301M) Surface Finish-1.0 (SF-1.0).

ACI SPEC-301 (ACI SPEC-301M) Surface Finish-2.0 (SF-2.0).

ACI SPEC-301 (ACI SPEC-301M) Surface Finish-3.0 (SF-3.0).

* + - * 1. Final Concrete Finish: Comply with Section 033000 "Cast-in-Place Concrete" for the following:

Retain one or more of the seven subparagraphs below. If retaining more than one, indicate location of each finish on Drawings.

Smooth-rubbed finish.

Grout-cleaned rubbed finish.

Cork-floated finish.

Abrasive-blast finish.

Scrubbed finish.

High-pressure water-jet finish.

Bushhammer finish.

* + - * 1. Form-Liner Finish: Produce a textured surface free of pockets, streaks, and honeycombs, and of uniform appearance, color, and texture.
        2. Maintain uniformity of architectural concrete finishes over construction joints unless otherwise indicated.
      1. CONCRETE CURING
         1. Comply with Section 033000 "Cast-in-Place Concrete" using identical curing procedures to that used for [**field sample panels**] [**mockups**].
      2. REPAIR
         1. Comply with ACI SPEC-301 (ACI SPEC-301M).
         2. Repair damaged finished surfaces of cast-in-place architectural concrete when repairing is approved by Architect.
         3. Match repairs to color, texture, and uniformity of surrounding surfaces and to repairs on approved [**field sample panels**] [**mockups**].
         4. Remove and replace cast-in-place architectural concrete that cannot be repaired to Architect's approval.
      3. FIELD QUALITY CONTROL
         1. Comply with Section 033000 "Cast-in-Place Concrete."
      4. CLEANING
         1. Clean cast-in-place architectural concrete surfaces after finish treatment to remove stains, markings, dust, and debris.
         2. Wash and rinse surfaces in accordance with concrete finish applicator's written instructions.

Protect other Work from staining or damage due to cleaning operations.

Do not use cleaning materials or processes that could change the appearance of cast-in-place architectural concrete finishes.

* + - 1. PROTECTION
         1. Protect corners, edges, and surfaces of cast-in-place architectural concrete from damage; use guards and barricades.
         2. Protect cast-in-place architectural concrete from staining, laitance, and contamination during remainder of construction period.
      2. FINAL ACCEPTANCE

First option in paragraph below is based on ACI SPEC-301 (ACI SPEC-301M) requirements. Revise to suit Project.

* + - * 1. Final acceptance of completed architectural concrete Work will be determined by Architect by comparing approved [**design reference sample**] [**field sample panels**] [**mockups**] with installed Work, when viewed at a distance of [**20 ft. (6 m)**] <**Insert distance**>.

END OF SECTION 033300