SECTION 034500 - PRECAST ARCHITECTURAL CONCRETE

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

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

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:

Architectural precast concrete cladding**[ and load-bearing]** units.

Insulated, architectural precast concrete units.

Thin-brick-faced, architectural precast concrete units.

Stone-faced, architectural precast concrete units.

* + - * 1. Related Requirements:

Retain subparagraphs below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.

Section 033000 "Cast-in-Place Concrete" for installing connection anchors in concrete.

Section 047200 "Cast Stone Masonry" for wet- or dry-cast cast stone facings, trim, and accessories.

Section 051200 "Structural Steel Framing" for furnishing and installing connections attached to structural-steel framing.

Section 055000 "Metal Fabrications" for kickers and other miscellaneous steel shapes.

Section 071900 "Water Repellents" for water-repellent finish treatments.

Section 085113 "Aluminum Windows" for windows set into architectural precast concrete units.

* + - 1. DEFINITIONS

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

Retain "Design Reference Sample" Paragraph below if a design reference sample has been preapproved by Director’s Representative.

* + - * 1. Design Reference Sample: Sample of approved architectural precast concrete color, finish and texture, preapproved by Director’s Representative.
      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.

If needed, insert list of conference participants.

* + - 1. SUBMITTALS
         1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
         2. Manufacturer’s installation instructions shall be provided along with product data.
         3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
         4. Product Data: For each type of product.

USE PARAGRAPH BELOW WITH EPD REQUIREMENT WHEN PROJECT ESTIMATE IS $1M OR MORE.

* + - * 1. Submit an Environmental Product Declaration (EPD) from the manufacturer for each type of precast structure within this specification section, if available. A statement of the contractor’s good faith effort to obtain the EPD shall be provided if not available.

Manufacturer-provided EPDs must be Product Specific Type III (Third-Party Reviewed), in adherence with ISO 14025 *Environmental labels and declarations*, ISO 14044 *Environmental management – Life cycle assessment*, and ISO 21930 *Core rules for environmental product declarations of construction products and services*.

* + - * 1. Design Mixtures: For each precast concrete mixture. Include compressive strength and water-absorption tests.
        2. Shop Drawings:

Detail fabrication and installation of architectural precast concrete units.

Indicate locations, plans, elevations, dimensions, shapes, and cross sections of each unit.

Indicate joints, reveals, drips, chamfers, and extent and location of each surface finish.

Indicate details at building corners.

Retain subparagraphs below applicable to Project.

Indicate separate face and backup mixture locations and thicknesses.

Indicate type, size, and length of welded connections by AWS standard symbols. Detail loose and cast-in hardware and connections.

Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.

Indicate locations, extent, and treatment of dry joints if two-stage casting is proposed.

Include plans and elevations showing unit location and sequence of erection for special conditions.

Indicate location of each architectural precast concrete unit by same identification mark placed on panel.

Indicate relationship of architectural precast concrete units to adjacent materials.

Indicate locations, dimensions, and details of thin-brick units, including corner units and special shapes, and joint treatment.

Indicate locations, dimensions, and details of stone facings, anchors, and joint widths.

If design modifications are proposed to meet performance requirements and field conditions, submit design calculations and Shop Drawings. Do not adversely affect the appearance, durability, or strength of units when modifying details or materials and maintain the general design concept.

Retain "Samples" Paragraph below if finishes, colors, and textures are preselected, specified, or scheduled. Coordinate with sample panels and range samples in "Quality Assurance" Article.

* + - * 1. Samples: Design reference samples for initial verification of design intent, for each type of finish indicated on exposed surfaces of architectural precast concrete units, in sets of three, representative of finish, color, and texture variations expected; approximately 12 by 12 by 2 inches.

When other faces of precast concrete unit are exposed, include Samples illustrating workmanship, color, and texture of backup concrete as well as facing concrete.

Retain subparagraph below if Samples of thin-brick facings are required.

Samples for each thin-brick unit required, showing full range of color and texture expected. Include Sample showing color and texture of joint treatment.

Retain one of or both "Grout Samples for Initial Selection" and "Grout Samples for Verification" subparagraphs below if joints for thin-brick facings are grouted.

Grout Samples for Initial Selection: Color charts consisting of actual sections of grout showing manufacturer's full range of colors.

Grout Samples for Verification: Showing color and texture of joint treatment.

Retain "Delegated-Design Submittal" Paragraph below if design services have been delegated to Contractor.

* + - * 1. Delegated-Design Submittal: For architectural precast concrete indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer, registered in New York State, responsible for their preparation.

Show governing panel types, connections, types of reinforcement, including special reinforcement, and concrete cover on reinforcement. Indicate location, type, magnitude, and direction of loads imposed on the building structural frame from architectural precast concrete.

Coordinate "Qualification Data" Paragraph below with qualification requirements in "Quality Assurance" Article.

* + - * 1. Qualification Data: For **[Installer] [fabricator] [testing agency]**.

Retain "Welding certificates" Paragraph below if retaining "Welding Qualifications" Paragraph in "Quality Assurance" Article.

* + - * 1. Welding certificates.

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

* + - * 1. Material Certificates: For the following items:

Cementitious materials.

Reinforcing materials and prestressing tendons.

Admixtures.

Bearing pads.

Structural-steel shapes and hollow structural sections.

Thin-brick units and accessories.

Stone anchors.

Insulation.

Aggregates.

* + - * 1. Material Test Reports: For aggregates.

Retain "Preconstruction test reports" Paragraph below if specifying preconstruction testing in "Preconstruction Testing" Article as Contractor's responsibility and submittal is required.

* + - * 1. Preconstruction test reports.

Retain "Source quality-control test reports" Paragraph below if submittal is required.

* + - * 1. Source quality-control test reports.

Retain "Field quality-control (and special inspection) reports" Paragraph below if Contractor is responsible for field quality-control testing and inspecting. Retain option if Contractor is responsible for special inspections.

* + - * 1. Field quality-control**[ and special inspection]** reports.
      1. QUALITY ASSURANCE

Retain one of two "Installer Qualifications" paragraphs below if qualifying erectors. Retain first paragraph if PCI-certified erector is required. See PCI's Web site, www.pci.org, for current listing of erectors.

* + - * 1. Installer Qualifications: A precast concrete erector qualified and designated by PCI's Certificate of Compliance to erect **[Category A (Architectural Systems) for non-load] [Category S2 (Complex Structural Systems) for load]**-bearing members.

Retain "Installer Qualifications" Paragraph below if PCI-certified erector is not required or is not available in Project location. Basis of audit is PCI MNL 127, "PCI Erector's Manual - Standards and Guidelines for the Erection of Precast Concrete Products."

* + - * 1. Installer Qualifications: A precast concrete erector who has retained a "PCI-Certified Field Auditor" to conduct a field audit of a project in same category as this Project and who can produce an Erectors' Post-Audit Declaration.
        2. Fabricator Qualifications: A firm that assumes responsibility for engineering architectural precast concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer, registered in New York State.

Usually retain first subparagraph below. PCI plant certification was established in 1967 and is a different program than APA's plant certification established in 1993. Consult APA or PCI for further information.

Designated as a PCI-certified plant for Group A, Category A1 - Architectural Cladding and Load Bearing Units**[ at time of bidding][ or designated as an APA-certified plant for production of architectural precast concrete products]**.

Retain "Testing Agency Qualifications" Paragraph below if Contractor selects testing agency for testing in addition to that required under PCI's certification program. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.

* + - * 1. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 117, "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products."

Retain "Welding Qualifications" Paragraph below if shop or field welding is required. If retaining, also retain "Welding certificates" Paragraph in "Informational Submittals" Article.

* + - * 1. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel"; and AWS D1.4, "Structural Welding Code - Reinforcing Steel."

PCI recommends review of preproduction sample panels. Revise number and size of sample panels in "Sample Panels" Paragraph below to suit Project.

* + - * 1. Sample Panels: After sample approval and before fabricating architectural precast concrete units, produce a minimum of two sample panels approximately 16 sq. ft. in area for review by Director’s Representative. Incorporate full-scale details of architectural features, finishes, textures, and transitions in sample panels.

Locate panels where indicated or, if not indicated, as directed by Director’s Representative.

Damage part of an exposed-face surface for each finish, color, and texture, and demonstrate adequacy of repair techniques proposed for repair of surface blemishes.

After acceptance of repair technique, maintain one sample panel at manufacturer's plant and one at Project site in an undisturbed condition as a standard for judging the completed Work.

Demolish and remove sample panels when directed.

PCI recommends production of finish and texture range samples when color and texture uniformity concerns could be an issue, Director’s Representative or precaster has not had previous experience with specified mixture and finish, or a large project has multiple approving authorities.

* + - * 1. Range Samples: After sample panel approval and before fabricating architectural precast concrete units, produce a minimum of **[three] [five]** sets of samples, approximately 16 sq. ft. in area, representing anticipated range of each color and texture on Project's units. Maintain one set of range samples at Project site and remaining range sample sets at manufacturer's plant as color and texture approval reference.

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

* + - * 1. Mockups: After sample panel**[ and range sample]** approval but before production of architectural precast concrete units, construct full-sized mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for materials and execution.

Revise or delete three subparagraphs below to suit Project.

Build mockup as indicated on Drawings including **[aluminum framing, glass, sealants,]** <Insert construction> and architectural precast concrete complete with anchors, connections, flashings, and joint fillers.

Retain first subparagraph below if mockups are not only for establishing appearance factors.

Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Director’s Representative specifically approves such deviations in writing.

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

If retaining "Preconstruction Testing Mockup" Paragraph below, determine where preconstruction mockup testing will be specified and include requirements in that Section. Requirements in paragraph below are limited to building a preconstruction testing mockup at a testing agency's facility.

* + - * 1. Preconstruction Testing Mockup: Provide a full-size mockup of architectural precast concrete indicated on Drawings for preconstruction testing. See Section **<Insert Section number> "<Insert Section title>"** for preconstruction testing requirements.

Revise or delete subparagraphs below to suit Project. Coordinate with other Sections that include construction to be included in a preconstruction testing mockup to clearly indicate extent of work required in this Section.

Build preconstruction testing mockup as indicated on Drawings including **[aluminum framing, glass, sealants,] <Insert construction>** and architectural precast concrete complete with anchors, connections, flashings, and joint fillers.

Build preconstruction testing mockup at testing agency facility.

* + - 1. PRECONSTRUCTION TESTING

Retain this article for preconstruction stone anchor testing if stone facing is used and Contractor designs stone anchorage system.

* + - * 1. Preconstruction Stone Anchor Testing: Engage a qualified testing agency to perform preconstruction testing according to ASTM C1354 or ASTM E488, modified as follows:

Furnish test specimens, including stone anchors, that are representative of materials proposed for incorporation into the Work.

Anchorage Tests: Test 12 inches square samples for**[ each combination of]** stone variety, orientation of cut, finish, and anchor type proposed for use on Project. Test for shear and tensile strength of anchorage system.

* + - 1. COORDINATION
         1. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction without delaying the Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.
      2. DELIVERY, STORAGE, AND HANDLING
         1. Deliver architectural precast concrete units in such quantities and at such times to limit unloading units temporarily on the ground or other rehandling.
         2. Support units during shipment on nonstaining shock-absorbing material.
         3. Store units with adequate dunnage and bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.
         4. Place stored units so identification marks are clearly visible, and units can be inspected.
         5. Handle and transport units in a manner that avoids excessive stresses that cause cracking or damage.
         6. Lift and support units only at designated points indicated on Shop Drawings.

1. PRODUCTS

Manufacturers and products listed in SpecAgent and MasterWorks Paragraph Builder are neither recommended nor endorsed by the AIA or Deltek. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications.

* + - 1. MANUFACTURERS

Delete this article unless naming fabricators. Designer to input suppliers that are local to the project site. See PCI's magazine "Ascent" or its Web site, www.pci.org, for current PCI-certified plant listings.

* + - 1. PERFORMANCE REQUIREMENTS

Retain "Delegated Design" Paragraph below if Contractor is required to assume responsibility for design.

* + - * 1. Delegated Design: Engage a qualified professional engineer, registered in New York State, to design architectural precast concrete units**[ including stone facing system]**.
        2. Design Standards: Comply with ACI 318 and design recommendations of PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of architectural precast concrete units indicated.

Retain "Calculated Fire-Test-Response Characteristics" Paragraph below if fire-rated units or assemblies are required. Retain either option, or both, if acceptable to authorities having jurisdiction.

* + - * 1. Calculated Fire-Test-Response Characteristics: Provide architectural precast concrete units with fire-resistance rating indicated as calculated according to **[ACI 216.1] [PCI MNL 124, "Design for Fire Resistance of Precast Prestressed Concrete,"]** and acceptable to authorities having jurisdiction.
        2. Structural Performance: Provide architectural precast concrete units and connections capable of withstanding the following design loads within limits and under conditions indicated:

Retain "Loads" Subparagraph below if design loads are shown on Drawings.

Loads: As indicated.

Retain five loads subparagraphs below if including design loads here; revise requirements to suit Project, and insert other performance and design criteria if applicable.

Dead Loads: **<Insert applicable dead loads>**.

Live Loads: **<Insert applicable live loads>**.

Wind Loads: **<Insert applicable wind loads or wind-load criteria, positive and negative for various parts of building as required by applicable building code or ASCE/SEI 7, including basic wind speed, importance factor, exposure category, and pressure coefficient>**.

Seismic Loads: **<Insert applicable seismic design data including seismic performance category, importance factor, use group, seismic design category, seismic zone, site classification, site coefficient, and drift criteria>**.

Project-Specific Loads: **<Insert applicable loads>**.

Design precast concrete units and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live-load deflection, shrinkage and creep of primary building structure, and other building movements as follows:

Indicate locations here or on Drawings if different movements are anticipated for different building elements. If preferred, change deflection limits in first subparagraph below to ratios such as L/300 for floors and L/200 for roofs.

Upward and downward movement of **[1/2 inch] [3/4 inch] [1 inch]**.

Revise "Thermal Movements" Subparagraph below to suit local conditions. Temperature data are available from National Climatic Data Center, www.ncdc.noaa.gov.

Thermal Movements: Provide for in-plane thermal movements resulting from annual ambient temperature changes of **[80 deg F] [120 deg F]**.

Retain "Fire-Resistance Rating" Subparagraph below if required. Fire ratings depend on occupancy and building construction type and are generally a building code requirement.

Fire-Resistance Rating: Select material and minimum thicknesses to provide **[1] [2]**-hour fire rating.

Retain "Window Washing System" Subparagraph below if required. Indicate design criteria here or on Drawings for window washing system, including material and equipment.

Window Washing System: Design precast units supporting window washing system indicated to resist pull-out and horizontal shear forces transmitted from window washing equipment.

Retain "Vehicular Impact Loads" Subparagraph below if precast units are used in parking structures to resist impact load. Revise loads to suit Project. Load is based on requirement in the Uniform Code.

Design Consultant to review code references and verify that the referenced sections/tables are current. Note that code references shall be based on the current version of the Uniform Code.

Vehicular Impact Loads: Design spandrel beams acting as vehicular barriers for passenger cars to resist a single 6000-lb load applied horizontally in any direction to the spandrel beam, with anchorages or attachments capable of transferring this load to the structure. Design spandrel beams assuming the load to act at a height of 18 or 27 inches above the floor or ramp surface, whichever is more severe, on an area not to exceed 1 sq. ft..

* + - 1. MOLD MATERIALS
         1. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that provides continuous and true precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.

Mold-Release Agent: Commercially produced form-release agent that does not bond with, stain or adversely affect precast concrete surfaces and does not impair subsequent surface or joint treatments of precast concrete.

Retain "Form Liners" Paragraph below if required. Form liners may be used to achieve a special off-the-form finish or to act as a template for thin-brick facings. Revise to add description of selected form liner if required.

* + - * 1. Form Liners: Units of face design, texture, arrangement, and configuration **[indicated] [to match those used for precast concrete design reference sample]**. Use with manufacturer's recommended form-release agent that does not bond with, stain, or adversely affect precast concrete surfaces and does not impair subsequent surface or joint treatments of precast concrete.

Retain "Surface Retarder" Paragraph below if surface retarder is applied to molds to help obtain exposed-aggregate finish.

* + - * 1. Surface Retarder: Chemical set retarder, capable of temporarily delaying final hardening of newly placed concrete mixture to depth of reveal specified.
      1. REINFORCING MATERIALS

Retain one or more paragraphs in this article to suit steel reinforcement requirements. Distinguish locations of each type of reinforcement here or on Drawings. If retaining Part 2 "Performance Requirements" Article, consider reviewing selections with fabricators.

* + - * 1. Reinforcing Bars: ASTM A615, Grade 60, deformed.

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

* + - * 1. Low-Alloy-Steel Reinforcing Bars: ASTM A706, deformed.

Retain "Galvanized Reinforcing Bars" Paragraph below where corrosive environment or severe exposure conditions justify extra cost. Presence of chromate film on the surface of galvanized coating is usually visible as light yellow tint on the surface. ASTM B201 describes a test method for determining presence of chromate coatings.

* + - * 1. Galvanized Reinforcing Bars: **[ASTM A615, Grade 60] [ASTM A706]**, deformed bars, with ASTM A767, Class II zinc coating and chromate treatment.**[ Galvanize after fabrication and bending.]**

Consider using epoxy coating where corrosive environment or severe exposure conditions justify extra cost. In "Epoxy-Coated Reinforcing Bars" Paragraph below, retain ASTM A775 for a bendable epoxy coating; retain ASTM A934 for a nonbendable epoxy coating.

* + - * 1. Epoxy-Coated Reinforcing Bars: **[ASTM A615, Grade 60] [ASTM A706]**, deformed bars, **[ASTM A775] [or] [ASTM A934]** epoxy coated.
        2. Steel Bar Mats: ASTM A184, fabricated from **[ASTM A615, Grade 60] [ASTM A706]**, deformed bars, assembled with clips.
        3. Plain-Steel Welded Wire Reinforcement: ASTM A185, fabricated from **[as-drawn ][galvanized-]**steel wire into flat sheets.
        4. Deformed-Steel Welded Wire Reinforcement: ASTM A497, flat sheet.
        5. Epoxy-Coated-Steel Wire: ASTM A884, Class A coated, **[plain] [deformed], flat sheet, [Type 1 bendable] [Type 2 nonbendable]** coating.
        6. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 117.
      1. PRESTRESSING TENDONS

Retain this article if precast concrete units are prestressed, either pretensioned or post-tensioned.

* + - * 1. Prestressing Strand: ASTM A416, Grade 270, uncoated, seven-wire, low-relaxation strand.

For aggressive climates, revise subparagraph below by adding an anchorage device encapsulation system consisting of caps and sleeves.

Coat unbonded post-tensioning strand with post-tensioning coating complying with ACI 423.7 and sheath with polypropylene tendon sheathing complying with ACI 423.7. Include anchorage devices and coupler assemblies.

* + - 1. CONCRETE MATERIALS

Retain materials in this article that are required; revise to suit Project.

* + - * 1. Portland Cement: ASTM C150, Type I or Type III, gray, unless otherwise indicated.

Mixing with white cement improves color uniformity. White cement has greater color consistency than gray cement and should be used for pastel colors. For darker colors, variations of gray cement have less effect on final color hue.

For surfaces exposed to view in finished structure, use gray or white cement, of same type, brand, and mill source.

* + - * 1. Supplementary Cementitious Materials:

Retain mineral or cementitious admixtures from first four subparagraphs below. Because fly ash and gray silica fume affect color uniformity, they are not recommended by PCI where appearance is important. White silica fume is available.

Fly Ash: ASTM C618, Class C or F, with maximum loss on ignition of 3 percent.

Metakaolin: ASTM C618, Class N.

Silica Fume: ASTM C1240, with optional chemical and physical requirement.

Ground Granulated Blast-Furnace Slag: ASTM C989, 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, or pozzolanic materials in the nonportland cement part of blended hydraulic cement may slow rate of concrete strengthening and affect color uniformity.

Blended Hydraulic Cement: ASTM C595, **[Type IS, portland blast-furnace slag] [Type IP, portland-pozzolan] [Type I (PM), pozzolan-modified portland] [Type I (SM), slag-modified portland]** cement.

ASTM C33 limits deleterious substances in coarse aggregate depending on climate severity and in-service location of concrete. Class 5S is the most restrictive designation for architectural concrete exposed to severe weathering. PCI MNL 117 also establishes strict limits on deleterious substances for fine and coarse aggregates.

* + - * 1. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C33, with coarse aggregates complying with Class 5S. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.

Revise "Face-Mixture-Coarse Aggregates" and "Face-Mixture-Fine Aggregates" subparagraphs below to add descriptions of selected coarse- and fine-face aggregate colors and sources if required.

Face-Mixture-Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match selected finish sample.

Retain one option in "Gradation" Subparagraph below or insert gradation and maximum aggregate size if known. Fine and coarse aggregates are not always from same source.

Gradation: **[Uniformly graded] [Gap graded] [To match design reference sample]**.

Face-Mixture-Fine Aggregates: Selected, natural or manufactured sand compatible with coarse aggregate; to match approved finish sample.

Lightweight aggregates in a face mixture are not recommended in cold or humid climates (if exposed to the weather) unless their performance has been verified by tests or records of previous satisfactory usage in similar environments. If normal-weight aggregates are used in face mixture, PCI does not recommend lightweight aggregates in backup mixture due to bowing potential.

* + - * 1. Lightweight Aggregates: Except as modified by PCI MNL 117, ASTM C330, with absorption less than 11 percent.

Retain "Coloring Admixture" Paragraph below if required. Add color selection if known.

* + - * 1. Coloring Admixture: ASTM C979, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading.
        2. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117.
        3. Air-Entraining Admixture: ASTM C260, certified by manufacturer to be compatible with other required admixtures.
        4. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.

Retain one or more chemical admixtures from nine admixture subparagraphs below if chemical admixtures are permitted; limit chemical admixture types if required. Water-reducing admixtures, Types A, D, and E, or a high-range water reducer, Type F, predominate.

Water-Reducing Admixtures: ASTM C494, Type A.

Retarding Admixture: ASTM C494, Type B.

Water-Reducing and Retarding Admixture: ASTM C494, Type D.

Water-Reducing and Accelerating Admixture: ASTM C494, Type E.

High-Range, Water-Reducing Admixture: ASTM C494, Type F.

High-Range, Water-Reducing and Retarding Admixture: ASTM C494, Type G.

Plasticizing Admixture: ASTM C1017, Type I.

Plasticizing and Retarding Admixture: ASTM C1017, Type II.

Corrosion Inhibiting Admixture: ASTM C1582.

* + - 1. STEEL CONNECTION MATERIALS

Revise this article to suit Project. Add other materials as required.

* + - * 1. Carbon-Steel Shapes and Plates: ASTM A36.
        2. Carbon-Steel-Headed Studs: ASTM A108, AISI 1018 through AISI 1020, cold finished, AWS D1.1, Type A or Type B, with arc shields and with minimum mechanical properties of PCI MNL 117, Table 3.2.3.
        3. Carbon-Steel Plate: ASTM A283, Grade C.
        4. Malleable Iron Castings: ASTM A47, Grade 32510 or Grade 35028.
        5. Carbon-Steel Castings: ASTM A27, Grade 60-30.
        6. High-Strength, Low-Alloy Structural Steel: ASTM A572.
        7. Carbon-Steel Structural Tubing: ASTM A500, Grade B or Grade C.
        8. Wrought Carbon-Steel Bars: ASTM A675, Grade 65.
        9. Deformed-Steel Wire or Bar Anchors: ASTM A496 or ASTM A706.

ASTM A307 defines the term "studs" to include stud stock and threaded rods.

* + - * 1. Carbon-Steel Bolts and Studs: ASTM A307, Grade A or ASTM F1554, Grade 36; carbon-steel, hex-head bolts and studs; carbon-steel nuts, ASTM A563; and flat, unhardened steel washers, ASTM F844.

High-strength bolts are used for friction-type connections between steel members and are not recommended by PCI between steel and concrete because concrete creep and crushing of concrete during bolt tightening reduce effectiveness.

* + - * 1. High-Strength Bolts, Nuts, and Washers: ASTM F3125,Grade A325 Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436, Type 1, hardened carbon-steel washers.

Retain "Zinc-Coated Finish" Paragraph if galvanized finish is required. Revise locations of galvanized items if required. Field welding should generally not be permitted on galvanized elements unless galvanizing is removed or acceptable welding procedures are submitted. Hot-dip galvanized finish provides greater corrosion resistance than electrodeposited zinc coating. Electrodeposition is usually limited to threaded fasteners.

* + - * 1. Zinc-Coated Finish: For exterior steel items**[, steel in exterior walls,]** and items indicated for galvanizing, apply zinc coating by **[hot-dip process according to ASTM A123 or ASTM A153] [electrodeposition according to ASTM B633, SC 3, Types 1 and 2]**.

For steel shapes, plates, and tubing to be galvanized, limit silicon content of steel to less than 0.03 percent or to between 0.15 and 0.25 percent or limit sum of silicon and 2.5 times phosphorous content to 0.09 percent.

Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035B or SSPC-Paint 20.

Retain "Shop-Primed Finish" Paragraph below if paint finish is required. Revise locations of priming if required. MPI 79 in first option below provides some corrosion protection, while SSPC-Paint 25, without topcoating, provides minimal corrosion protection.

* + - * 1. Shop-Primed Finish: Prepare surfaces of nongalvanized steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3 and shop-apply **[lead- and chromate-free, rust-inhibitive primer, complying with performance requirements in MPI 79] [SSPC-Paint 25]** according to SSPC-PA 1.
        2. Welding Electrodes: Comply with AWS standards.
      1. STAINLESS STEEL CONNECTION MATERIALS

Retain this article if required. Retain when resistance to staining merits extra cost in parking structures and other high-moisture or corrosive areas.

* + - * 1. Stainless Steel Plate: ASTM A240 or ASTM A666, Type 304, Type 316, or Type 201.
        2. Stainless Steel Bolts and Studs: ASTM F593, Alloy Group 1 or 2 hex-head bolts and studs; ASTM F594, Alloy Group 1 or 2 stainless steel nuts; and flat, stainless steel washers.

Lubricate threaded parts of stainless steel bolts with an antiseize thread lubricant during assembly.

* + - * 1. Stainless Steel-Headed Studs: ASTM A276, Alloy 304 or Alloy 316, with minimum mechanical properties of PCI MNL 117, Table 3.2.3.
      1. BEARING PADS

Retain this article if applicable. Choice of bearing pad can usually be left to fabricator; coordinate selection with structural engineer if required.

* + - * 1. Provide one of the following bearing pads for architectural precast concrete units**[ as recommended by precast fabricator for application]**:

Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, Type A durometer hardness of 50 to 70, ASTM D2240, minimum tensile strength 2250 psi, ASTM D412.

Random-Oriented-Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. Type A durometer hardness of 70 to 90, ASTM D2240; capable of supporting a compressive stress of 3000 psi with no cracking, splitting, or delaminating in the internal portions of pad. Test one specimen for every 200 pads used in Project.

Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer; Type A durometer hardness of 80 to 100, ASTM D2240; complying with AASHTO's "AASHTO LRFD Bridge Design Specifications," Division II, Section 18.10.2; or with MIL-C-882E.

Frictionless Pads: PTFE, glass-fiber reinforced, bonded to stainless or mild-steel plate, or random-oriented-fiber-reinforced elastomeric pads; of type required for in-service stress.

High-Density Plastic: Multimonomer, nonleaching, plastic strip.

* + - 1. ACCESSORIES

Retain one of two "Reglets" paragraphs below if applicable. Coordinate reglet material with counterflashing materials and details. Delete both paragraphs if specifying surface applied reglets in Section 076200 "Sheet Metal Flashing and Trim," which avoids misalignment from one panel to the next.

* + - * 1. Reglets: Specified in Section 076200 "Sheet Metal Flashing and Trim."
        2. Reglets: **[PVC extrusions,] [Stainless steel, Type 302 or Type 304,] [Copper,]** felt or fiber filled, or with face opening of slots covered.
        3. Precast Accessories: Provide clips, hangers, high-density plastic or steel shims, and other accessories required to install architectural precast concrete units.
      1. GROUT MATERIALS

Add other proprietary grout systems to suit Project. Indicate locations of each type of grout in this article or on Drawings if retaining more than one type.

* + - * 1. Sand-Cement Grout: Portland cement, ASTM C150, Type I, and clean, natural sand, ASTM C144 or ASTM C404. Mix at ratio of 1 part cement to 2-1/2 to 3 parts sand, by volume, with minimum water required for placement and hydration. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C1218.

Retain "Nonmetallic, Nonshrink Grout" Paragraph below if required or if cement-grout shrinkage could cause structural deficiency. For critical installations, require manufacturer to provide field supervision.

* + - * 1. Nonmetallic, Nonshrink Grout: Packaged, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C1107, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C1218.
        2. Epoxy-Resin Grout: Two-component, mineral-filled epoxy resin; ASTM C881, of type, grade, and class to suit requirements.
      1. THIN BRICK AND ACCESSORIES

Retain "Products" Paragraph and list of manufacturers and products below to require specific products or a comparable product from other manufacturers.

* + - * 1. Products: Subject to compliance with requirements, provide one of the following:

**<Insert, in separate subparagraphs, manufacturer's name; product name or designation>.**

* + - * 1. Thin Brick: Not less than 1/2 inch or more than 1 inch thick, and as follows:

Thin-brick units that comply with ASTM C1088 Type TBX may be too dimensionally variable to fit securely within form liner templates. Tighter tolerances in "Dimensional Tolerances" Subparagraph below can be achieved by many thin-brick manufacturers.

Dimensional Tolerances: Plus 0 inch or minus 1/16 inch for any dimension 8 inches or less and plus 0 inch or minus 3/32 inch for any dimension more than 8 inches.

Out-of-Square Tolerance: Plus or minus 1/16 inch.

Warpage Tolerance: Plus 0 inch or minus 1/16 inch.

Variation of Shape from Specified Angle: Plus or minus one degree.

Modulus of Rupture: Not less than 250 psi when tested according to ASTM C67.

Tensile Bond Strength: Not less than 150 psi when tested before and after freeze-thaw test according to ASTM E488 as modified: Adhere a steel plate with a welded rod on a single thin-brick face with epoxy for each test.

24-Hour Cold-Water Absorption: Not more than 6 percent when tested according to ASTM C67.

Freeze-Thaw Resistance: No detectable disintegration or separation after 300 freezing-and-thawing cycles when tested according to ASTM C666, Method B.

Chemical Resistance: Tested according to ASTM C650 and rated "not affected."

Efflorescence: Tested according to ASTM C67 and rated "not effloresced."

Retain "Surface Coating" Subparagraph below if surface-coated thin brick is used.

Surface Coating: Thin brick with colors or textures applied as coatings shall withstand 50 cycles of freezing and thawing; ASTM C67 with no observable difference in applied finish when viewed from 10 feet.

Retain "Back Surface Texture" Subparagraph below, deleting inapplicable descriptions if required.

Back Surface Texture: Scored, combed, wire roughened, ribbed, keybacked, or dovetailed.

Indicate details of special conditions and shapes on Drawings if required.

* + - * 1. Special Shapes: Include corners, edge corners, and end edge corners.
        2. Face Size: **[2-1/4 inches high by 7-5/8 inches long] [2-1/4 inches high by 11-5/8 inches long] [3-5/8 inches high by 7-5/8 inches long] [3-5/8 inches high by 11-5/8 inches long]**.
        3. **[Where indicated to "match existing," ]**provide thin brick matching color, texture, and face size of existing adjacent brick work.

**<Insert information on existing brick if known>**.

Revise "Face Color and Texture" Paragraph below to suit Project or delete if thin brick is specified in last paragraph above by product name. Options are examples of descriptive requirements for appearance where a proprietary specification cannot be used. If approving a color range for thin brick, view sufficient area of loose thin bricks or a completed building to make an informed determination.

* + - * 1. Face Color and Texture: **[Match Director’s Representative’s samples] [Match color, texture, and face size of adjacent existing brick]**.

Retain "Sand-Cement Mortar" Paragraph below if filling thin-brick joints with mortar before placing precast concrete mix.

* + - * 1. Sand-Cement Mortar: Portland cement, ASTM C150, Type I, and clean, natural sand, ASTM C144. Mix at ratio of 1 part cement to 4 parts sand, by volume, with minimum water required for placement.

Retain "Pointing Grout" Paragraph below if filling thin-brick joints with pointing grout after precast concrete panel production.

* + - * 1. Pointing Grout: Packaged, polymer-modified, sanded grout complying with ANSI A118.7.

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

Bostik, Inc.

C-Cure.

Custom Building Products.

DAP Products Inc.

Approved equivalent.

Polymer Type: Acrylic resin in **[dry, redispersible form, packaged with other dry ingredients] [liquid-latex form for adding packaged dry-grout mix]**.

Colors: **[As indicated by manufacturer's designations] [Match Director’s Representative's samples] [As selected by Director’s Representative from manufacturer's full range]**.

* + - 1. STONE MATERIALS AND ACCESSORIES

Retain this article if stone facing is required. Performance criteria, preconstruction material testing, material quality, fabrication, and finish requirements are usually specified in Section 044200 "Exterior Stone Cladding." Replace first paragraph below with stone requirements if preferred.

* + - * 1. Stone facing for architectural precast concrete is specified in Section 044200 "Exterior Stone Cladding."

Anchors are generally supplied by stone fabricator or, in some cases, by precaster. Specify supplier. Anchors may be toe in, toe out, or dowels.

* + - * 1. Anchors: Stainless steel, ASTM A276, Type 304 or Type 316, of temper and diameter required to support loads without exceeding allowable design stresses.

Grommets are usually required if filling dowel holes with rigid epoxy.

Fit each anchor leg with neoprene grommet collar of width at least twice the diameter and of length at least five times the diameter of anchor.

Anchor hole filling is used to prevent water intrusion into stone and future discoloration at anchor locations. Retain one of two "Sealant Filler" paragraphs below for flexible filler.

Verify suitability of sealant in first "Sealant Filler" Paragraph below before retaining. Silicone sealants often stain porous, light-colored stone.

* + - * 1. Sealant Filler: Single-component, nonsag, neutral-curing, silicone sealant; Class 25, Use NT (nontraffic), and Use M (masonry) that complies with applicable requirements in Section 079200 "Joint Sealants" and that does not stain stone:

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

BASF Corporation.

GE Construction Sealants; Momentive Performance Materials Inc.

The Dow Chemical Company.

Tremco Incorporated.

Approved equivalent.

* + - * 1. Sealant Filler: Single-component, nonsag, urethane sealant; Class 25, Use T (traffic), and Use M (masonry) that complies with applicable requirements in Section 079200 "Joint Sealants" and that does not stain stone:

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

BASF Corporation.

Sika Corporation.

Tremco Incorporated.

Approved equivalent.

* + - * 1. Epoxy Filler: ASTM C881, 100 percent solids, sand-filled nonshrinking, nonstaining of type, class, and grade to suit application.

Elastomeric Anchor Sleeve: 1/2 inch long, Type A durometer hardness of 60, ASTM D2240.

* + - * 1. Bond Breaker: **[Preformed, compressible, resilient, nonstaining, nonwaxing, closed-cell polyethylene foam pad, nonabsorbent to liquid and gas, 1/8 inch thick] [Polyethylene sheet, ASTM D4397, 6 to 10 mils thick]**.
      1. INSULATED PANEL ACCESSORIES

Retain this article if insulated, architectural precast concrete panels are required. Retain insulation material in "Molded-Polystyrene Board Insulation," "Extruded-Polystyrene Board Insulation," or "Polyisocyanurate Board Insulation" Paragraph below; if using more than one type, identify location of each on Drawings.

* + - * 1. Molded-Polystyrene (EPS) Board Insulation: ASTM C578, **[Type XI, 0.70 lb/cu. ft.] [Type I, 0.90 lb/cu. ft.] [Type VIII, 1.15 lb/cu. ft.] [Type II, 1.35 lb/cu. ft.] [Type IX, 1.80 lb/cu. ft.]; [square] [ship-lap]** edges; with thickness of **<Insert dimension>**.
        2. Extruded-Polystyrene (XPS) Board Insulation: ASTM C578, **[Type X, 1.30 lb/cu. ft.] [Type IV, 1.55 lb/cu. ft.] [Type VI, 1.80 lb/cu. ft.] [Type VII, 2.20 lb/cu. ft.] [Type V, 3.00 lb/cu. ft.]; [square] [ship-lap]** edges; with thickness of **<Insert dimension>**.
        3. Polyisocyanurate Board Insulation: ASTM C591, **[Type I, 1.8 lb/cu. ft.] [Type II, 2.5 lb/cu. ft.] [Type III, 3.0 lb/cu. ft.]** unfaced, with thickness of **<Insert dimension>**.

Retain connectors from "Wythe Connectors" Paragraph below.

* + - * 1. Wythe Connectors: **[Glass-fiber-reinforced vinylester connectors] [Polypropylene pin connectors] [Stainless steel pin connectors] [Bent galvanized reinforcing bars or galvanized welded wire trusses] [Epoxy-coated carbon-fiber grid] [Fiberglass trusses]** manufactured to connect wythes of precast concrete panels.
      1. CONCRETE MIXTURES
         1. Prepare design mixtures for each type of precast concrete required.

Use a single design mixture for units with more than one major face or edge exposed.

Where only one face of unit is exposed use either a single design mixture or separate mixtures for face and backup.

Retain first paragraph below if fly ash, ground granulated blast-furnace slag, or metakaolin and silica fume are permitted. Revise percentages to suit Project. White silica fume is available.

* + - * 1. Limit use of fly ash and ground granulated blast-furnace slag to 20 percent of portland cement by weight; limit metakaolin and silica fume to 10 percent of portland cement by weight.
        2. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at architectural precast concrete fabricator's option.
        3. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 or PCI MNL 117 when tested according to ASTM C1218.

Architectural precast concrete units may be manufactured with a separate architectural face mixture and a structural backup mixture. Face and backup mixtures should have similar shrinkage and expansion coefficients. Similar water-cementitious materials ratios and cement-aggregate ratios are recommended by PCI to limit bowing or warping. Retain first option in "Normal-Weight Concrete Mixtures" Paragraph below if lightweight backup concrete mix is required; second option if normal-weight face and backup mixtures are required; third option if full-depth, normal-weight mixture is required; or fourth option if choice of normal-weight face and backup mixtures or full-depth mixtures is fabricator's option.

* + - * 1. Normal-Weight Concrete Mixtures: Proportion **[face mixtures] [face and backup mixtures] [full-depth mixture] [face and backup mixtures or full-depth mixtures, at fabricator's option]** by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:

Retain "Compressive Strength (28 Days)" Subparagraph below or revise to suit Project. Higher-strength mixtures may be available; verify availability with fabricators.

Compressive Strength (28 Days): 5000 psi minimum.

Water-cementitious materials ratio of 0.40 to 0.45 is usual for architectural precast concrete. Lower ratios may be possible with use of high-range water reducers. Revise ratio in "Maximum Water-Cementitious Materials Ratio" Subparagraph below to suit Project.

Maximum Water-Cementitious Materials Ratio: 0.45.

Water absorption indicates susceptibility to weather staining. PCI states that limits in "Water Absorption" Paragraph below are suitable for average exposures. Different parts of a single panel cannot be produced with different absorptions. Verify that fabricators can produce units with lower water absorption because special consolidation techniques to increase concrete density are required.

* + - * 1. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to ASTM C642, except for boiling requirement.

Lightweight backup mixtures must be compatible with normal-weight face mixtures to minimize bowing or warping. Retain "Lightweight Concrete Backup Mixtures" Paragraph below if required or as an option if satisfactory durability and in-service performance are verified by fabricator. Coordinate with option retained in "Normal-Weight Concrete Mixtures" Paragraph above.

* + - * 1. Lightweight Concrete Backup Mixtures: Proportion mixtures by either laboratory trial batch or field test data methods according to ACI 211.2, with materials to be used on Project, to provide lightweight concrete with the following properties:

Retain "Compressive Strength (28 Days)" Subparagraph below or revise to suit Project. Higher-strength mixtures may be available; verify availability with fabricators.

Compressive Strength (28 Days): 5000 psi.

Increase or decrease weight in "Unit Weight" Subparagraph below to suit Project. Coordinate with lightweight-aggregate supplier and architectural precast concrete fabricator. Lightweight concretes with lightweight and normal-weight aggregate in mixture are usually heavier than unit weight below.

Unit Weight: Calculated equilibrium unit weight of 115 lb/cu. ft., plus or minus 3 lb/cu. ft., according to ASTM C567.

* + - * 1. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 117.
        2. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.
      1. MOLD FABRICATION
         1. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing and detensioning operations. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.

Delete form liners in subparagraph below unless needed to produce exposed surface finish.

Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during concrete placement. Coat form liner with form-release agent.

* + - * 1. Maintain molds to provide completed architectural precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.

Form joints are not permitted on faces exposed to view in the finished work.

Retain one option in "Edge and Corner Treatment" Subparagraph below; indicate details on Drawings or revise description to add dimensions. Sharp edges or corners of precast concrete units are vulnerable to chipping.

Edge and Corner Treatment: Uniformly [chamfered] [radiused].

* + - 1. THIN-BRICK FACINGS

Retain this article if using thin-brick facings on architectural precast concrete units.

* + - * 1. Place form liner templates accurately to provide grid for thin-brick facings. Provide solid backing and supports to maintain stability of liners while placing thin bricks and during concrete placement.
        2. Securely place thin-brick units face down into form liner pockets and place concrete backing mixture.

Delete first two paragraphs below if joint cavities are filled with concrete instead of using mortar or pointing grout.

* + - * 1. Completely fill joint cavities between thin-brick units with sand-cement mortar, and place precast concrete backing mixture while sand-cement mortar is still fluid enough to ensure bond.

Retain first paragraph below if grouting is required. Delete if joints remain as cast.

* + - * 1. Mix and install pointing grout according to ANSI A108.10. Completely fill joint cavities between thin-brick units with pointing grout, and compress into place without spreading grout onto faces of thin-brick units. Remove excess grout immediately to prevent staining of thin brick.

Retain joint profile from options in subparagraph below or revise to suit Project. Joint shapes are listed in order of decreasing weathertightness according to BIA Technical Note 21C.

Tool joints to a **[slightly concave] [V-]**shape when pointing grout is thumbprint hard.

* + - * 1. Clean faces and joints of thin-brick facing.
      1. STONE FACINGS

Retain this article if stone facing is required.

* + - * 1. Accurately position stone facings to comply with requirements and in locations indicated on Shop Drawings. Install anchors, supports, and other attachments indicated or necessary to secure stone in place. Keep concrete reinforcement a minimum of 3/4 inch from the back surface of stone. Use continuous spacers to obtain uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.

"Stone to Precast Anchorages" Subparagraph below is based on anchorage requirement in the Uniform Code for slab-type exterior veneer panels not more than 20 sq. ft. in area; revise anchor spacing if required.

Stone to Precast Anchorages: Provide anchors in numbers, types and locations required to satisfy specified performance criteria, but not more than 24 inches o.c. around perimeter of stone facing panels with a minimum of four anchors per panel.

Retain one of two options in paragraph below if sealing dowel holes. Use sealant if flexible filler is required; use epoxy if rigid filler is required.

* + - * 1. Fill anchor holes with **[sealant filler and install anchors] [epoxy filler and install anchors with elastomeric anchor sleeve at back surface of stone]**.

Retain one of two subparagraphs below. PCI recommends that no bonding between stone facing and precast concrete to minimize bowing, cracking, and staining of stone.

Install minimum 0.006-inch- thick polyethylene sheet to prevent bond between back of stone facing and concrete substrate and to ensure no passage of precast matrix to stone surface.

Install 1/8-inch polyethylene-foam bond breaker to prevent bond between back of stone facing and concrete substrate and to ensure no passage of precast matrix to stone surface. Maintain minimum projection requirements of stone anchors into concrete substrate.

* + - 1. FABRICATION
         1. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1 and AWS C5.4, "Recommended Practices for Stud Welding."

Coordinate first paragraph below with Section 055000 "Metal Fabrications" for furnishing and installing loose hardware items.

* + - * 1. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing architectural precast concrete units to supporting and adjacent construction.
        2. Cast-in reglets, slots, holes, and other accessories in architectural precast concrete units as indicated on the Contract Drawings.

Retain first paragraph below if applicable.

* + - * 1. Cast-in openings larger than 10 inches in any dimension. Do not drill or cut openings or prestressing strand without Director’s Representative's approval.
        2. Reinforcement: Comply with recommendations in PCI MNL 117 for fabricating, placing, and supporting reinforcement.

Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcing exceeds limits specified in ASTM A775, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.

Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.

Place reinforcing steel and prestressing strands to maintain at least 3/4-inch minimum concrete cover. Increase cover requirements for reinforcing steel to 1-1/2 inches when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.

Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.

* + - * 1. Reinforce architectural precast concrete units to resist handling, transportation, and erection stresses and specified in-place loads.

Retain first paragraph below for precast, prestressed architectural concrete units. Option to prestress may be left to fabricator if objective is to aid handling and to control cracking of units during installation.

* + - * 1. Prestress tendons for architectural precast concrete units by either pretensioning or post-tensioning methods. Comply with PCI MNL 117.

Revise release or post-tensioning strength in first subparagraph below to an actual compressive strength if required. Concrete strength in the range of 2500 to 4000 psi at release does not appreciably affect bond transfer length.

Delay detensioning or post-tensioning of precast, prestressed architectural concrete units until concrete has reached its indicated minimum design release compressive strength as established by test cylinders cured under same conditions as concrete unit.

Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat-cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.

If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.

Protect strand ends and anchorages with bituminous, zinc-rich, or epoxy paint to avoid corrosion and possible rust spots.

* + - * 1. Comply with requirements in PCI MNL 117 and requirements in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

Retain first paragraph below if a separate face mixture is required or is Contractor's option.

* + - * 1. Place face mixture to a minimum thickness after consolidation of the greater of 1 inch or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover specified.
        2. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete units.

Place backup concrete mixture to ensure bond with face-mixture concrete.

* + - * 1. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 117.

Place self-consolidating concrete without vibration according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants." Ensure adequate bond between face and backup concrete, if used.

* + - * 1. Comply with PCI MNL 117 for hot- and cold-weather concrete placement.
        2. Identify pickup points of architectural precast concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each architectural precast concrete unit on a surface that does not show in finished structure.
        3. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.
        4. Discard and replace architectural precast concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 117 and Director’s Representative's approval.
      1. INSULATED PANEL CASTING

Retain this article if integrally insulated panels are required.

* + - * 1. Cast, screed, and consolidate bottom concrete wythe supported by mold.
        2. Place insulation boards abutting edges and ends of adjacent boards. Insert wythe connectors through insulation holes, and consolidate concrete around connectors according to connector manufacturer's written instructions.
        3. Ensure bottom wythe and insulation layer are not disturbed after bottom wythe reaches initial set.
        4. Cast, screed, and consolidate top wythe to meet required finish.
        5. Maintain temperature below 150 deg F in bottom concrete wythe.
      1. FABRICATION TOLERANCES
         1. Fabricate architectural precast concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.

Retain paragraph above or first paragraph below. PCI MNL 117 product tolerances, referenced above and listed below, are standardized throughout the industry.

* + - * 1. Fabricate architectural precast concrete units to shapes, lines, and dimensions indicated so each finished unit complies with the following product tolerances:

Overall Height and Width of Units, Measured at the Face Exposed to View: As follows:

10 feet or under, plus or minus 1/8 inch.

10 to 20 feet, plus 1/8 inch, minus 3/16 inch.

20 to 40 feet, plus or minus 1/4 inch.

Each additional 10 feet, plus or minus 1/16 inch.

Overall Height and Width of Units, Measured at the Face Not Exposed to View: As follows:

10 feet or under, plus or minus 1/4 inch.

10 to 20 feet, plus 1/4 inch, minus 3/8 inch.

20 to 40 feet, plus or minus 3/8 inch.

Each additional 10 feet, plus or minus 1/8 inch.

Total Thickness or Flange Thickness: Plus 1/4 inch, minus 1/8 inch.

Rib Thickness: Plus or minus 1/8 inch.

Rib to Edge of Flange: Plus or minus 1/8 inch.

Distance between Ribs: Plus or minus 1/8 inch.

Variation from Square or Designated Skew (Difference in Length of the Two Diagonal Measurements): Plus or minus 1/8 inch/72 inches or 1/2 inch total, whichever is greater.

Length and Width of Block-outs and Openings within One Unit: Plus or minus 1/4 inch.

Location and Dimension of Block-outs Hidden from View and Used for HVAC and Utility Penetrations: Plus or minus 3/4 inch.

Dimensions of Haunches: Plus or minus 1/4 inch.

Haunch Bearing Surface Deviation from Specified Plane: Plus or minus 1/8 inch.

Difference in Relative Position of Adjacent Haunch Bearing Surfaces from Specified Relative Position: Plus or minus 1/4 inch.

Bowing: Plus or minus L/360, maximum 1 inch.

Local Smoothness: 1/4 inch/10 feet.

Warping: 1/16 inch/12 inches of distance from nearest adjacent corner.

Tipping and Flushness of Plates: Plus or minus 1/4 inch.

Dimensions of Architectural Features and Rustications: Plus or minus 1/8 inch.

* + - * 1. Position Tolerances: For cast-in items measured from datum line location, as indicated on Shop Drawings.

Weld Plates: Plus or minus 1 inch.

Inserts: Plus or minus 1/2 inch.

Handling Devices: Plus or minus 3 inches.

Reinforcing Steel and Welded Wire Reinforcement: Plus or minus 1/4 inch where position has structural implications or affects concrete cover; otherwise, plus or minus 1/2 inch.

Reinforcing Steel Extending out of Member: Plus or minus 1/2 inch of plan dimensions.

Tendons: Plus or minus 1/4 inch, vertical; plus or minus 1 inch, horizontal.

Location of Rustication Joints: Plus or minus 1/8 inch.

Location of Opening within Panel: Plus or minus 1/4 inch.

Location of Flashing Reglets: Plus or minus 1/4 inch.

Location of Flashing Reglets at Edge of Panel: Plus or minus 1/8 inch.

Reglets for Glazing Gaskets: Plus or minus 1/8 inch.

Electrical Outlets, Hose Bibs: Plus or minus 1/2 inch.

Location of Bearing Surface from End of Member: Plus or minus 1/4 inch.

Allowable Rotation of Plate, Channel Inserts, and Electrical Boxes: 2-degree rotation or 1/4 inch maximum over the full dimension of unit.

Position of Sleeve: Plus or minus 1/2 inch.

Location of Window Washer Track or Buttons: Plus or minus 1/8 inch.

Retain "Thin-Brick-Faced Architectural Precast Concrete Units" Paragraph below if thin-brick-faced architectural units are used.

* + - * 1. Thin-Brick-Faced Architectural Precast Concrete Units: Restrict the following misalignments to 2 percent of number of thin bricks in a unit.

Alignment of Mortar Joints:

Jog in Alignment: 1/8 inch.

Alignment with Panel Centerline: Plus or minus 1/8 inch.

Variation in Width of Exposed Mortar Joints: Plus or minus 1/8 inch.

Tipping of Individual Thin Bricks from the Panel Plane of Exposed Thin-Brick Surface: Plus 0 inch; minus 1/4 inch less than or equal to depth of form liner joint.

Exposed Thin-Brick Surface Parallel to Primary Control Surface of Panel: Plus 1/4 inch; minus 1/8 inch.

Individual Thin-Brick Step in Face from Panel Plane of Exposed Thin-Brick Surface: Plus 0 inch; minus 1/4 inch less than or equal to depth of form liner joint.

Retain "Stone Veneer-Faced Architectural Precast Concrete Units" Paragraph below if stone veneer-faced architectural precast units are used.

* + - * 1. Stone Veneer-Faced Architectural Precast Concrete Units:

Tolerances in "Variation in Cross-Sectional Dimensions," "Variation in Joint Width," and "Variation in Plane between Adjacent Stone Units (Lipping)" subparagraphs below are generally appropriate for smooth-finished stone. Retain, delete, or revise below to suit Project.

Variation in Cross-Sectional Dimensions: For thickness of walls from dimensions indicated: Plus or minus 1/4 inch.

Variation in Joint Width: 1/8 inch in 36 inches or a quarter of nominal joint width, whichever is less.

Revise or delete "Variation in Plane between Adjacent Stone Units (Lipping)" Subparagraph below for natural-cleft, thermal, and similar finishes.

Variation in Plane between Adjacent Stone Units (Lipping): 1/16-inch difference between planes of adjacent units.

* + - 1. FINISHES
         1. Exposed faces shall be free of joint marks, grain, and other obvious defects. Corners, including false joints shall be uniform, straight, and sharp. Finish exposed-face surfaces of architectural precast concrete units to match approved **[design reference sample] [sample panels] [mockups]** and as follows:

This article presumes Director’s Representative has preapproved one or more design reference samples. Include complete description of design reference sample here. If preapproving fabricators, coordinate with "Manufacturers" Article. Revise if multiple samples are approved.

Design Reference Sample: **<Insert description and identify fabricator and code number of sample>**.

Retain first subparagraph below if required. If retaining, revise and add reference number; PCI publishes numbered, color photographs of 428 precast concrete finishes; see PCI's Web site, www.pci.org. Add reference number combinations if more than one finish is required.

PCI's "Architectural Precast Concrete - Color and Texture Selection Guide," of plate numbers indicated.

Retain type of finish from first nine finish subparagraphs below if needed. If more than one finish is required, add locations to finish descriptions or indicate on Drawings. Add more-detailed descriptions of finishes outlined below if greater definition, such as light, medium, or deep, is required. See PCI MNL 117 for more information on finishes. An as-cast finish generally results in a mottled surface or non-uniform finish.

As-Cast Surface Finish: Provide surfaces to match approved sample for acceptable surface, air voids, sand streaks, and honeycomb.

Textured-Surface Finish: Impart by form liners or inserts.

Bushhammer Finish: Use power or hand tools to remove matrix and fracture coarse aggregates.

Exposed-Aggregate Finish: Use chemical retarding agents applied to concrete forms and washing and brushing procedures to expose aggregate and surrounding matrix surfaces after form removal.

Abrasive-Blast Finish: Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.

Acid-Etched Finish: Use acid and hot-water solution, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces. Protect hardware, connections, and insulation from acid attach.

Honed Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.

Polished Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.

Sand-Embedment Finish: Use selected stones placed in a sand bed in bottom of mold, with sand removed after curing.

Thin-Brick Facing: See "Thin-Brick Facings" Article.

Stone Facing: See "Stone Facings" Article.

Retain one of first two paragraphs below if applicable. Revise second paragraph to float finish or light-broom finish if smooth, steel-trowel finish is unnecessary.

* + - * 1. Finish exposed **[top] [back]** surfaces of architectural precast concrete units to match face-surface finish.
        2. Finish exposed **[top] [back]** surfaces of architectural precast concrete units with smooth, steel-trowel finish.

Revise finish in paragraph below to light-broom stippled, or float finish if necessary. Upgrade to smooth, steel-trowel finish if surface is in contact with materials requiring a smooth finish.

* + - * 1. Finish unexposed surfaces of architectural precast concrete units with as cast finish.
      1. SOURCE QUALITY CONTROL

Retain "Quality-Control Testing" Paragraph below if establishing a minimum standard of plant testing and inspecting. PCI MNL 117 mandates source testing requirements and a plant "Quality Systems Manual." PCI certification also ensures periodic auditing of plants for compliance with requirements in PCI MNL 117.

* + - * 1. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL 117 requirements. If using self-consolidating concrete, also test and inspect according to PCI TR-6, ASTM C1610, ASTM C1611, ASTM C1621, and ASTM C1712.

Retain first paragraph below if required. PCI certification may be acceptable to authorities having jurisdiction without further monitoring of plant quality-control and testing program by Director’s Representative.

* + - * 1. Director’s Representative will employ an independent testing agency to evaluate architectural precast concrete fabricator's quality-control and testing methods.

Allow Director’s Representative's testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with Director’s Representative's testing agency and provide samples of materials and concrete mixtures as may be requested for additional testing and evaluation.

* + - * 1. Strength of precast concrete units is considered deficient if units fail to comply with ACI 318 requirements for concrete strength.

Review testing and acceptance criteria with structural Director’s Representative. In "Testing" Paragraph below, add criteria for load tests if required.

* + - * 1. Testing: If there is evidence that strength of precast concrete units may be deficient or may not comply with ACI 318 requirements, precaster will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C42 and ACI 318.

A minimum of three representative cores shall be taken from units of suspect strength, from locations directed by Director’s Representative.

Test cores in an air-dry condition.

PCI's recommendations in first subparagraph below are more stringent than ACI's.

Strength of concrete for each series of three cores is considered satisfactory if average compressive strength is equal to at least 85 percent of 28-day design compressive strength and no single core is less than 75 percent of 28-day design compressive strength.

Report test results in writing on same day that tests are performed, with copies to Director’s Representative, Contractor, and precast concrete fabricator. Test reports include the following:

Project identification name and number.

Date when tests were performed.

Name of precast concrete fabricator.

Name of concrete testing agency.

Identification letter, name, and type of precast concrete unit(s) represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.

* + - * 1. Patching: If core test results are satisfactory and precast concrete units comply with requirements, clean and dampen core holes and solidly fill with precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.
        2. Defective Units: Discard and replace recast architectural concrete units that do not comply with acceptability requirements in PCI MNL 117, including concrete strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to Director’s Representative's approval. Director’s Representative reserves the right to reject precast units that do not match approved samples, sample panels, and mockups. Replace unacceptable units with precast concrete units that comply with requirements.

1. EXECUTION
   * + 1. EXAMINATION
          1. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, bearing surface tolerances, and other conditions affecting performance of the Work.
          2. Do not install precast concrete units until supporting cast-in-place concrete has attained minimum allowable design compressive strength and supporting steel or other structure is structurally ready to receive loads from precast concrete units.
          3. Proceed with installation only after unsatisfactory conditions have been corrected.
       2. INSTALLATION
          1. Install clips, hangers, bearing pads, and other accessories required for connecting architectural precast concrete units to supporting members and backup materials.
          2. Erect architectural precast concrete level, plumb, and square within specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment of units until permanent connections are completed.

Install temporary steel or plastic spacing shims as precast concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.

Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.

Remove projecting lifting devices and grout fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.

Unless otherwise indicated, maintain uniform joint widths of 3/4 inch.

* + - * 1. Connect architectural precast concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.

Do not permit connections to disrupt continuity of roof flashing.

* + - * 1. Welding: Comply with applicable requirements in AWS D1.1 and AWS D1.4 for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.

Protect architectural precast concrete units and bearing pads from damage by field welding or cutting operations, and provide noncombustible shields as required.

Welds not specified shall be continuous fillet welds, using no less than the minimum fillet as specified by AWS.

Retain one of first two subparagraphs below.

Clean weld-affected metal surfaces with chipping hammer followed by brushing, and apply a minimum 4.0-mil- thick coat of galvanized repair paint to galvanized surfaces according to ASTM A780.

Clean weld-affected metal surfaces with chipping hammer followed by brushing, and reprime damaged painted surfaces.

Visually inspect welds and remove, reweld, or repair incomplete and defective welds.

* + - * 1. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.

Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot.

For slip-critical connections, use one of the following methods to assure proper bolt pretension:

Turn-of-Nut: According to RCSC's "Specification for Structural Joints Using ASTM A325 or A 490 Bolts."

Calibrated Wrench: According to RCSC's "Specification for Structural Joints Using ASTM A325 or A 490 Bolts."

Twist-off Tension Control Bolt: ASTM F3125, Grade 1852.

Direct-Tension Control Bolt: ASTM F3125, Grade 1852.

For slip-critical connections, use method and inspection procedure approved by Director’s Representative and coordinated with inspection agency.

In "Grouting or Dry-Packing Connections and Joints" Paragraph below, revise locations and extent of grouting if required.

* + - * 1. Grouting or Dry-Packing Connections and Joints: Grout connections where required or indicated. Retain flowable grout in place until hard enough to support itself. Alternatively, pack spaces with stiff dry-pack grout material, tamping until voids are completely filled. Place grout and finish smooth, level, and plumb with adjacent concrete surfaces. Promptly remove grout material from exposed surfaces before it affects finishes or hardens. Keep grouted joints damp for not less than 24 hours after initial set.
      1. ERECTION TOLERANCES
         1. Erect architectural precast concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 117, Appendix I.

Retain paragraph above or paragraph below. Usually retain above unless tolerances for Project deviate from PCI recommendations. PCI MNL 117 erection tolerances are referenced above and listed below.

* + - * 1. Erect architectural precast concrete units level, plumb, square, and in alignment, without exceeding the following noncumulative erection tolerances:

Plan Location from Building Grid Datum: Plus or minus 1/2 inch.

Plan Location from Centerline of Steel: Plus or minus 1/2 inch.

Top Elevation from Nominal Top Elevation: As follows:

Exposed Individual Panel: Plus or minus 1/4 inch.

Non-Exposed Individual Panel: Plus or minus 1/2 inch.

Exposed Panel Relative to Adjacent Panel: 1/4 inch.

Non-Exposed Panel Relative to Adjacent Panel: 1/2 inch.

Support Elevation from Nominal Support Elevation: As follows:

Maximum Low: 1/2 inch.

Maximum High: 1/4 inch.

Maximum Plumb Variation over the Lesser of Height of Structure or 100 Feet: 1 inch.

Plumb in Any 10 Feet of Element Height: 1/4 inch.

Maximum Jog in Alignment of Matching Edges: 1/4 inch.

Joint Width (Governs over Joint Taper): Plus or minus 1/4 inch.

Maximum Joint Taper: 3/8 inch.

Joint Taper in 10 Feet: 1/4 inch.

Maximum Jog in Alignment of Matching Faces: 1/4 inch.

Differential Bowing or Camber, as Erected, between Adjacent Members of Same Design: 1/4 inch.

Opening Height between Spandrels: Plus or minus 1/4 inch.

* + - 1. FIELD QUALITY CONTROL
         1. Special Inspections: Director’s Representative will engage a special inspector and a qualified testing agency to perform tests and inspections in accordance with the requirements of BDC 406 Summary of Special Inspections and BDC 406.1 Statement of Special Inspections and as directed by the Code Compliance Manager.
      2. REPAIRS

Blemishes occurring after delivery are normally repaired before final joint sealing and cleaning as weather permits.

* + - * 1. Repair architectural precast concrete units if permitted by Director’s Representative. Director’s Representative reserves the right to reject repaired units that do not comply with requirements.

Precast concrete manufacturer should develop appropriate repair mixtures and techniques during production sample approval process.

* + - * 1. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet.
        2. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A780.

Retain last paragraph above if using galvanized anchors, connections, and other items; retain first paragraph below if items are prime painted.

* + - * 1. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.
        2. Remove and replace damaged architectural precast concrete units when repairs do not comply with requirements.
      1. CLEANING
         1. Clean surfaces of precast concrete units exposed to view.
         2. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.
         3. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.

Perform cleaning procedures, if necessary, according to precast concrete fabricator's recommendations. Protect other work from staining or damage due to cleaning operations.

Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 034500