Guide Specification

This Guide Specification is intended to be used as a basis for the development of an office master specification or in the preparation of specifications for a particular project. **In either case this Guide Specification must be edited to fit the conditions of use.** Particular attention should be given to the deletion of inapplicable provisions or inclusion of appropriate requirements. Coordinate the specifications with the information shown on the contract drawings to avoid duplication or conflicts.

Shaded portions are Notes to the Specification Writer.

SECTION 034100

STRUCTURAL PRECAST CONCRETE AND
STRUCTURAL PRECAST CONCRETE WITH COMMERCIAL ARCHITECTURAL FINISH

This Section uses the term "Architect." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions. Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the performance criteria, materials, production, and erection of structural precast and precast, prestressed concrete for the entire project. The work performed under this Section includes all labor, material, equipment, related services, and supervision required for the manufacture and erection of the structural precast and precast, prestressed concrete work shown on the Contract Drawings.

Adjust list below to suit Project. Delete paragraph below if not listing type of units.

B. This Section includes the following:

1. Hollow-core slab units.
2. Beams, columns, double tees.
3. Walls.
4. Spandrels.
5. Insulated, precast concrete units.
6. **<Insert other applicable units>**

C. Related Sections include the following:

List below only products and construction that the reader might expect to find in this Section but are specified elsewhere. Other sections of the specifications not referenced below, shall also apply to the extent required for proper performance of this work. Some items such as precast, prestressed wall panels could be included in either this section or the section "Architectural Precast Concrete," depending on the desired finish and tolerance expectation.

1. Division 3 Section "Architectural Precast Concrete."
2. Division 3 Section "Cast-in-Place Concrete" for installing connection anchors in concrete and structural topping.
3. Division 3 Section "Precast Post-Tensioned Concrete" for connecting precast units.
4. Division 3 Section "Cementitious Floor Underlayment" for floor and roof deck fill.
5. Division 4 Section "Unit Masonry Assemblies" for inserts or anchorages required for slab connections.
6. Division 5 Section "Structural Steel" for structural steel framing and for furnishing and installing connections attached to structural steel framing.
7. Division 5 Section "Metal Fabrications" for furnishing and installing loose hardware items.
8. Division 7 Section "Through Penetration Firestopping Systems" for joint filler materials for fire-resistance-rated construction.
9. Division 7 Section "Water Repellents" for water-repellent finish treatments.
10. Division 7 Section "Sheet Metal Flashing and Trim" for flashing receivers and reglets.
11. Division 7 Section "Joint Sealants" for elastomeric joint sealants and sealant backings between slab edges at exposed underside of floor and roof members and/or perimeter of members.
12. Division 7 Section "Roof and Deck Insulation" for insulation to meet energy code.
13. Division 9 Section "Carpet and Carpet Cushion" for covering on flooring members.
14. Division 9 Section "Exterior Paints."

1.3 DEFINITION

Retain paragraph below if a reference sample has been preapproved by Architect and is available for review.

A. Reference Sample: Sample of approved structural precast concrete color, finish and texture, preapproved by Architect.

1.4 PERFORMANCE REQUIREMENTS

Retain this Article if delegating design responsibility for structural precast concrete units to fabricator. AIA Document A201 requires Owner or Architect to specify performance and design criteria.

A. Structural Performance: Provide structural precast concrete units and connections capable of withstanding design loads within limits and under conditions indicated on Drawings.

1. Loads: As indicated.

Retain paragraph above if design loads are shown on Drawings; retain paragraph and applicable subparagraphs below if including design loads here. Revise requirements below to suit Project, and add other performance and design criteria, if applicable.

B. Structural Performance: Provide structural precast concrete units and connections capable of withstanding the following design loads within limits and under conditions indicated:

For members that are to receive concrete topping, state whether all superimposed dead and live loads on precast, prestressed members do or do not include the weight of the concrete topping. It is best to list the live load, superimposed dead load, topping weight, and weight of the member, all as separate loads. Where there are two different live loads (e.g., roof level of a parking structure) indicate how they are to be combined. Show hanging utility support loads in addition to loads indicated on drawings.

Most precast, prestressed concrete is cast in continuous steel forms. Therefore, connection devices on the formed surfaces must be contained within the member since penetration of the form is impractical.

Camber will generally occur in prestressed concrete members having eccentricity of the stressing force. If camber considerations are important, check with local prestressed concrete manufacturer to secure estimates of the amount of camber and of camber movement with time and temperature change. Design details must recognize the existence of camber and camber movement in connection with:

1. Closures to interior non-load bearing partitions.
2. Closures parallel to prestressed concrete members (whether masonry, windows, curtain walls or others) must be properly detailed for camber.
3. Floor slabs receiving cast-in-place topping. The elevation of top of floor and amount of concrete topping must allow for camber of prestressed concrete members.

Designing for cambers less than obtained under normal design practices is possible, but this usually requires the addition of tendons or non-prestressed steel reinforcement and practice should be checked with the local manufacturer.

1. Basic Ground Snow Load: **<Insert applicable snow loads.>**
2. Dead Loads: **<Insert applicable dead loads.>**
3. Live Loads: **<Insert applicable live loads.>**
4. Concrete Topping Weight: **<Insert applicable weight.>**
5. Wind Loads: **<Insert applicable wind loads or wind-loading criteria, positive and negative for various parts of the building as required by applicable building code or ASCE 7, including basic wind speed, importance factor, exposure category, and pressure coefficient.>**
6. Seismic Loads: **<Provide seismic loads or insert applicable seismic design data including seismic performance category, importance factor, use group, seismic design category, seismic zone, site classification and site coefficient.>**

Indicate locations here or on Drawings if different movements are anticipated for different building elements. If deflection limits stricter than ACI 318 (ACI 318M) are required, the limits must be specified.

7. Design framing system 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. Member deflections shall meet the limits of ACI 318 (ACI 318M).

Differential values in first subparagraph below are applicable to members exposed to the sun on one face. Insert the temperature range to suit local conditions. Temperature data is available from National Oceanic and Atmospheric Administration at www.ncdc.noaa.gov.

8. Thermal Movements: Provide for thermal movements noted.

   a. The precast system design shall consider the maximum seasonal climatic temperature change.
   b. In-plane thermal movements of individual members directly exposed to the sun shall consider a temperature range of <**Insert temperature range**>.
   c. Member and connection design shall consider through thickness thermal gradients as appropriate.

Delete subparagraph below if fire resistance rating is not required. Fire ratings are generally a code requirement and are dependent on many factors. When required, fire-rated products should be clearly identified on the design drawings.

9. Fire Resistance Rating: Provide components to meet the following fire ratings:

   a. Roof: **<Insert rating>**
   b. Floors: **<Insert rating>**
   c. Columns: **<Insert rating>**
   d. Exterior Walls: **<Insert rating>**
   e. **<Insert additional elements or special occupancy separations>**

Retain subparagraph below only if stone faced precast concrete are used on project.

10. Stone to Precast Anchorages: Provide anchors, as determined through Owner's or stone supplier testing in numbers, types and locations as required to satisfy the performance criteria specified, but not less than the following.

    a. Minimum Anchorage Requirement: Not less than 2 anchors per unit of less than 2 sq.ft. (0.19 sq. m) in area and 4 anchors per unit of less than 12 sq. ft. (1.1 sq. m) in area and for units larger than 12 sq. ft. (1.1 sq. m) in area, provide anchors spaced not more than 24 inches (600 mm) o.c. both horizontally and vertically, all located a minimum of 6 inches (150 mm) from stone edge.

Delete subparagraph below if precast units are not used in parking structure to resist impact load. Local code requirements vary on impact loads, and the loads must be specified.

11. Vehicular Impact Loads: <**Insert applicable load and load location**>

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Retain quality control records and certificates of compliance for 5 years or period of warranty, whichever is greater.

B. Design Mixes: For each precast concrete mixture. Include compressive strength and water-absorption tests, if required.

C. Erection Drawings: Detail fabrication and installation of structural precast concrete units. Indicate member locations, plans, elevations, dimensions, shapes, cross sections, openings, extent and location of each finish, connections, support conditions and types of reinforcement, including special reinforcement.

Delete subparagraphs below not applicable to Project.

1. Indicate separate face and backup mix locations.
2. Indicate welded connections by AWS standard symbols and show size, length, and type of each weld. Detail loose and cast-in hardware, lifting and erection inserts, connections, and joints.
3. Indicate locations and details of anchorage devices to be embedded in or attached to structure or other construction.
4. Indicate plans and/or elevations showing member locations with all openings larger than 10 in (250 mm) shown and located.
5. Indicate location of each structural precast concrete unit by same identification mark placed on unit.
6. Indicate relationship of structural precast concrete members to adjacent materials.
7. Indicate locations and details of thin, half and full brick units and joint treatment.
8. Indicate locations and details of stone facings, stone anchors, and joint widths.
9. Estimated cambers for floor slabs receiving cast-in-place topping.
10. Indicate shim sizes and grouting sequence.
11. Design Modifications: If design modifications are proposed to meet performance requirements and field conditions, notify the Architect immediately and submit design calculations and drawings. Do not adversely affect the appearance, durability or strength of units when modifying details or materials. Maintain the general design concept when altering size of units and alignment.

D. Provide handling procedures, sequence of erection, and bracing plan.

Retain paragraph below if retaining "Performance Requirements" Article. Delete or modify if Architect/Engineer of Record assumes or is required by law to assume design responsibility.

E. Comprehensive engineering design signed and sealed by a professional engineer responsible for its preparation and registered in the state in which the project is located.

Retain paragraph and subparagraphs below if finishes, colors, and textures of Commercial Architectural (CA) panels are preselected, specified, or scheduled. Coordinate with sample panels and range samples in "Quality Assurance" Article.

F. Samples: Reference samples for initial verification of design intent, approximately 12 by 12 by 2 inches (300 by 300 by 50 mm), representative of finishes, colors, and textures of exposed surfaces of structural precast concrete panels.

1. When back face of precast concrete unit is to be exposed, show samples of the workmanship, color, and texture of the concrete.

Retain subparagraph below if samples of thin brick facings are required.

2. Samples for each thin or half brick unit required, showing the full range of color and texture expected. Supply sketch of each corner or special shape with dimensions. Include sample showing color and texture of joint treatment.

Retain subparagraph below if thin or half brick facings are used and joints are grouted.

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

Retain paragraph below if procedures for welder certification are retained in "Quality Assurance" Article.

G. Welding Certificates: Copies of certificates for welding procedure specifications (WPS) and personnel.

Manufacturer should have a minimum of 2 years of production experience in structural precast concrete work comparable to that shown and specified, in not less than three projects of similar scope with the Owner or Architect determining the suitability of the experience.

H. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include list of completed projects with project names and addresses, names and addresses of architects, engineers and owners, and other information specified.

Delete test reports below if not required.

I. Material Test Reports: From a qualified testing agency indicating and interpreting test results of the following for compliance with requirements indicated:

Retain paragraph above or below.

J. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements.

Retain list below with either paragraph above. Edit to suit Project.

1. Concrete materials.
2. Reinforcing materials and prestressing tendons.
3. Admixtures.
4. Bearing pads.
5. Structural-steel shapes and hollow structural sections.
6. Thin, half or full brick units.
7. Stone anchors.

1.6 QUALITY ASSURANCE

Erector should have a minimum of 2 years of experience in structural precast concrete work comparable to that shown and specified in not less than three projects of similar scope with the Owner or Architect determining the suitability of the experience. The inclusion of erection in the precast concrete contract should be governed by local practices. See PCI's website www.pci.org for current listing of PCI-Qualified Erectors.

A. Erector Qualifications: A precast concrete erector Qualified by the Precast/Prestressed Concrete Institute (PCI) prior to beginning work at the jobsite. Submit a current Certificate of Compliance furnished by PCI designating qualification in **[Category S1 (Simple Structural Systems) for horizontal decking members and single-lift wall panels] [Category S2 (Complex Structural Systems) for load-bearing members].**

Retain paragraph below if PCI-Qualified Erector is not available in Project location. Basis of the audit is PCI MNL 127, "PCI Erector's Manual – Standards and Guidelines for the Erection of Precast Concrete Products."

B. Erector Qualifications: A precast concrete erector who has retained a PCI Certified Field Auditor, at erector's expense, to conduct a field audit of a project in the same category as this Project prior to start of erection. Submits Erectors' Post Audit Declaration.

C. Fabricator Qualifications: A firm that complies with the following requirements and is experienced in producing structural precast concrete units similar to those indicated for this Project and with a record of successful in-service performance.

1. Assumes responsibility for engineering structural precast concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

Delete first subparagraph above and below if Contractor is not required to engage the services of a qualified professional engineer and if submission of a comprehensive engineering analysis is not retained in "Submittals" Article.

2. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of structural precast concrete that are similar to those indicated for this Project in material, design, and extent.

Affix the suffix A to the product group and category, e.g., C3A, if the structural product requires the application of an architectural finish produced by a manufacturer with special architectural qualifications. Structural precast products must meet the requirements of PCI Manual, MNL-116. These products should not be expected to meet the requirements of MNL-117 for architectural precast concrete products. However, the structural products may have the application of architectural finishes included in the provisions of MNL-116. Manufacturers that have certified architectural qualifications to apply these finishes have the suffix A added to their certification listing.

3. Participates in PCI's Plant Certification program **[at the time of bidding]** and is designated a PCI-certified plant for Group C or CA, Category **[C1 or C1A – Precast Concrete Products (no prestressed reinforcement)] [C2 or C2A – Prestressed Hollow-Core and Repetitive Products] [C3 or C3A – Prestressed Straight-Strand Structural Members] [C4 or C4A - Prestressed Deflected-Strand Structural Members]**
4. Has sufficient production capacity to produce required units without delaying the Work.

Delete subparagraph below if fabricators are not required to be registered with and approved by authorities having jurisdiction. List approved fabricators in Part 2 if required.

5. Is registered with and approved by authorities having jurisdiction.

Retain first paragraph below if quality assurance testing in addition to that provided by the PCI Certification Program is required. Testing agency is normally engaged by Owner.

D. Testing Agency Qualifications: An independent testing agency, **[acceptable to authorities having jurisdiction]** qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

E. Design Standards: Comply with ACI 318 (ACI 318M) and the design recommendations of PCI MNL 120, "PCI Design Handbook – Precast and Prestressed Concrete," applicable to types of structural precast concrete units indicated.

F. Quality-Control Standard: For manufacturing procedures and testing requirements and quality control recommendations for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Concrete Products."

1. Comply with camber and dimensional tolerances of PCI MNL 135, "Tolerance Manual for

Precast and Prestressed Concrete Construction."

Retain paragraph below to allow drawing details based on one manufacturer's product to establish requirements. Exact cross section of precast, prestressed concrete members may vary from producer to producer, permissible deviations in member shape from that shown on the contract drawings might allow more competition. Revise below to identify specific proprietary system or indicate on Drawings. Correlate with Division 1 requirements.

G. Product Options: Drawings indicate size, profiles and dimensional requirements of precast concrete units and are based on the specific types of units indicated. Other fabricators' precast concrete units complying with requirements may be considered. Refer to Division 1 Section "Substitutions."

Delete paragraph below if no welding is required. Retain "Welding Certificates" Paragraph in "Submittals" Article if paragraph below is retained. AWS states that welding qualifications remain in effect indefinitely unless welding personnel have not welded for more than six months or there is a specific reason to question their ability.

H. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel"; and AWS D1.4, "Structural Welding Code – Reinforcing Steel."

Retain paragraph below if fire-rated units or assemblies are required. Select either PCI MNL 124 or ACI 216.1/TMS 0216.1 or retain both if acceptable to authorities having jurisdiction.

I. Fire Resistance: Where indicated, provide structural precast concrete units whose fire resistance meets the prescriptive requirements of the governing code or has been calculated according to **[PCI MNL 124, "Design for Fire Resistance of Precast Prestressed Concrete,"] [ACI 216.1/TMS 0216.1, "Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies,"]** and is acceptable to authorities having jurisdiction.

PCI recommends review of preproduction sample panels to establish the range of acceptable finish, color, and texture to be expected. Revise size and number of sample panels in paragraph below to suit Project.

J. Sample Panels: After sample approval and before fabricating CA precast concrete units, produce sample panels to establish the approved range of selections made under sample Submittals. Produce a minimum of **[2] <Insert number>** sample panels approximately **[16 sq. ft. (1.5 sq. m)] <Insert size>** in area and incorporating full scale details of architectural features to demonstrate the expected range of finish, color, and texture variations.

1. Locate panels where indicated or, if not indicated, as directed by Architect.
2. 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.
3. Maintain sample panels at the manufacturer's plant in an undisturbed condition as a standard for judging the completed Work.

4. Demolish and remove sample panels when directed.

Delete paragraph and subparagraphs below if sample panels above will suffice and the 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.

K. Mockups: Before fabricating CA precast concrete panels, construct full sized mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and set quality standards for materials and execution. Mockup to be representative of the finished work in all respects including **[glass, aluminum framing, sealants] <Insert construction>** and precast concrete complete with all anchors, connections, flashings, and joint fillers as accepted on the final shop drawings. Build mockups to comply with the following requirements, using materials indicated for the completed work:

Revise or delete subparagraphs below to suit Project.

1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
2. Notify Architect in advance of dates and times when mockups will be constructed.
3. Obtain Architect's approval of mockups before starting fabrication.
4. In presence of Architect, damage part of an exposed face for each finish, color, and texture, and demonstrate materials and techniques proposed for repairs to match adjacent undamaged surfaces.
5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Demolish and remove mockups when directed.

Retain subparagraph below if mockups are erected as part of building rather than separately and the intention is to make an exception to the default requirement in Division 1 Section, "Quality Requirements" for demolishing and removing mockups.

7. Approved mockups may become part of the completed Work if undamaged at the time of Substantial Completion.

Delete paragraph below if mockup above is to be used for Testing Mockup or if testing is not required.

L. Testing Mockup: Provide a single full sized mockup for testing to the extent shown or indicated to simulate the precast and window wall assembly. Refer to Division 8 WINDOW AND CURTAIN WALLS for requirements applicable to testing structural precast concrete systems in conjunction with windows and window wall.

Delete below if Work of this Section is not extensive or complex enough to justify a preinstallation conference. If retaining, coordinate with Division 1.

M. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.7 PRODUCT STORAGE, DELIVERY AND HANDLING

A. Store units with adequate dunnage and bracing and protect units to prevent contact with soil, staining, and to prevent cracking, distortion, warping or other physical damage.

B. Store units, unless otherwise specified, with dunnage across full width of each bearing point.

C. Place stored units so identification marks are clearly visible, and units can be inspected.

D. Deliver all structural precast concrete units in such quantities and at such times to assure compliance with the schedule and proper setting sequence to ensure continuity of installation.

E. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses which would cause cracking or damage.

F. Place dunnage of even thickness between each unit.

G. Lift and support units only at designated points shown on the Shop Drawings.

1.8 SEQUENCING

Coordination and responsibility for supply of items to be placed on or in the structure to allow placement of precast concrete units depends on type of structure and varies with local practice. Clearly specify responsibility for supply and installation of hardware. If not supplied by precast concrete fabricator, supplier should be listed and requirements included in related trade sections. When the building frame is structural steel, erection hardware welded to the steel frame should be supplied and installed as part of the structural steel. Ensure that type and quantity of hardware items to be cast into precast concrete units for use of other trades are specified or detailed in Contract Drawings and furnished to fabricator, with instructions, in a timely manner in order not to delay the Work.

A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 – PRODUCTS

2.1 FABRICATORS

Delete this Article unless naming fabricators. See PCI's magazine "Ascent" or its Web site www.pci.org for current PCI-certified plant listings.

A. Available Fabricators: Subject to compliance with requirements, fabricators offering products that may be incorporated into the Work include, but are not limited to, the following:

Retain above for nonproprietary or below for semiproprietary specification. If above is retained, include procedure for approval of other fabricators in Instructions to Bidders. Refer to Division 1 Section "Product Requirements."

B. Fabricators: Subject to compliance with requirements, provide products by one of the following:

1. **<Insert fabricators' names and product designations for acceptable manufacturers.>**

2.2 MOLD MATERIALS

A. Molds: Rigid, dimensionally stable, nonabsorptive material, warp and buckle free, that will provide continuous and true precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and capable of producing required finish surfaces.

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

Delete below if not using form liners. Form liners may be used to achieve a special off-the-form finish or to act as a template for thin or half brick facings. Revise to add description if particular form liner is selected.

B. Form Liners: Units of face design, texture, arrangement, and configuration **[indicated] [to match those used for precast concrete design reference sample].** Provide solid backing and form supports to ensure that form liners remain in place during concrete placement. Use with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.

Retain paragraph below if surface retarder is applied to molds to help obtain exposed aggregate finish.

C. Surface Retarder: Chemical set retarder capable of temporarily delaying hardening of newly placed concrete mixture to depth of reveal specified.

2.3 REINFORCING MATERIALS

Revise or delete paragraphs and subparagraphs below to suit steel reinforcement requirements. If retaining Part 1 "Performance Requirements" Article, consider reviewing selections with fabricators.

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) or Grade 40 (Grade 300), deformed.

Retain paragraph below for reinforcement that is welded or if added ductility is sought.

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

Retain galvanized reinforcement in paragraph below where corrosive environment or severe exposure conditions justify extra cost. The presence of chromate film on the surface of the galvanized coating is usually visible as a light yellow tint on the surface. ASTM B 201 describes a test method for determining the presence of chromate coatings.

C. Galvanized Reinforcing Bars: **[ASTM A 615/A 615M, Grade 60 (Grade 420) or Grade 40 (Grade 300)] [ASTM A 706/A 706M],** deformed bars, ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized and chromate wash treated after fabrication and bending.

Consider using epoxy coated reinforcement where corrosive environment or severe exposure conditions justify extra cost. In first paragraph below, retain ASTM A 775/A 775M for a bendable coating; retain ASTM A 934/A 934M for a non-bendable coating.

D. Epoxy-Coated Reinforcing Bars: **[ASTM A 615/A 615M, Grade 60 (Grade 420) or Grade 40 (Grade 300)] [ASTM A 706/A 706M],** deformed bars, **[ASTM A 775/A 775M]** or **[ASTM A 934/A 934M]** epoxy coated.

E. Steel Bar Mats: ASTM A 184/A 184M, fabricated from **[ASTM A 615/A 615M, Grade 60 (Grade 420) or Grade 40 (Grade 300)] [ASTM A 706/A 706M],** deformed bars, assembled with clips.

F. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from **[as-drawn] [galvanized and chromate wash treated]** steel wire into flat sheets.

G. Deformed-Steel Welded Wire Fabric: ASTM A 497/A 497M, flat sheet.

H. Epoxy-Coated-Steel Welded Wire Fabric: ASTM A 884/A 884M, Class A coated, **[plain] [deformed]**, flat sheet, **[Type 1 bendable coating] [Type 2 non-bendable coating].**

2.4 PRESTRESSING TENDONS

Retain this Article if precast concrete units will be prestressed, either pretensioned or post-tensioned. ASTM A 416/A 416M establishes low-relaxation strand as the standard.

A. Prestressing Strand: ASTM A 416/A 416M, Grade 250 (Grade 1720) or Grade 270 (Grade 1860), uncoated, 7-wire, low-relaxation strand or ASTM A 886/A 886M, Grade 270 (Grade 1860), indented, 7-wire, low-relaxation strand (including supplement).

B. Unbonded Post-tensioning Strand: ASTM A 416/A 416M with corrosion inhibitor conforming to ASTM D 1743, Grade 270 (Grade 1860), 7-wire, low-relaxation strand with polypropylene conduit

sheath.

C. Prestressing Strand: ASTM A 910/A 910M, Grade 270 (Grade 1860), uncoated, weldless, 2-and 3-wire, low relaxation strand.

D. Post-tensioning Bars: ASTM A 722, uncoated high strength steel bar.

2.5 CONCRETE MATERIALS

Delete materials below not required. Revise to suit Project.

A. Portland Cement: ASTM C 150, Type I or III.

Select Portland cement color from options in subparagraph below. Gray cement alone can produce significant color variations. Mixing with white cement will improve color uniformity of gray cement. White cement has greater color consistency than gray cement and should be used for light colors. For darker colors, the variation of gray cement will have less effect on the final color.

1. For surfaces exposed to view in finished structure, use **[gray] [and] [white]**, same type, brand, and mill source throughout the precast concrete production.

Delete subparagraph below if only gray cement is selected in paragraph above. Retain below if face mix uses white cement but gray cement will be permitted in backup mix.

2. Standard gray Portland cement may be used for nonexposed backup concrete.

B. Supplementary Cementitious Materials

Select mineral or cementitious admixtures from four paragraphs below. Where appearance is an important factor, it is recommended that fly ash and gray silica fume not be permitted for exposed exterior surfaces. White silica fume is available.

1. Fly Ash Admixture: ASTM C 618, Class C or F.
2. Metakaolin Admixture: ASTM C 618, Class N.
3. Silica Fume Admixture: ASTM C 1240 with optional chemical and physical requirements.
4. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

Revise class of aggregate in paragraph below to suit Project. ASTM C 33 limits deleterious substances in coarse aggregate depending on climate severity and in-service location of concrete. Severe (S) weathering classifications range from Class 1S for protected substructure, beam, and column elements, and floor slabs to be given coverings, to Class 5S for exposed architectural concrete. Moderate (M) weathering classifications similarly range from Classes 1M to 5M. There are two negligible (N) weathering classifications. Class 1N is for slabs subject to abrasion, bridge decks, floors, sidewalks, and pavements; Class 2N is for other concrete. PCI MNL 116 established stricter limits on deleterious substances for fine and coarse aggregates.

C. Normal-Weight Aggregates: Except as modified by PCI MNL 116, ASTM C 33, with coarse, non-reactive aggregates complying with **Class [4S] [4M] [5S] [5M]**. Provide and stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for entire Project.

Revise subparagraph below and add descriptions of selected coarse- and fine-face aggregate colors, sizes, and sources if required.

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

Retain one option from first subparagraph below or insert gradation and maximum aggregate size if known. Fine and coarse aggregates are not always from same source.

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

2. Face-Mix Fine Aggregates: Selected, natural or manufactured sand of a material compatible with coarse aggregate to match selected sample finish.

Delete paragraph below when architectural requirements dictate that face-mix be used throughout.

D. Backup Concrete Aggregates: ASTM C 33 or C 330.

Lightweight aggregates in a face mix 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 the face mix, lightweight aggregates in the backup mix are not recommended due to bowing potential.

E. Lightweight Aggregates: Except as modified by PCI MNL 116, ASTM C 330 with absorption less than 11 percent.

Delete first paragraph below if coloring admixture is not required. Add color selection if known.

F. Coloring Admixture: ASTM C 979, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable and non-fading.

G. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with ASTM C 1602/C 1602M and chemical limits of PCI MNL 116.

Delete paragraph below if air entrainment is not required. Air entrainment should be required to increase resistance to freezing and thawing where environmental conditions dictate.

H. Air Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

I. 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.

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

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing Admixture: ASTM C 1017/C 1017M.
7. Corrosion Inhibiting Admixture: ASTM C 1582/C 1582M

2.6 STEEL CONNECTION MATERIALS AND ACCESSORIES

Edit this Article to suit Project. Add other materials as required.

A. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M

B. Carbon-Steel Headed Studs: ASTM A 108, Grades 1010 through 1020, cold finished and bearing the minimum mechanical properties for studs as indicated under PCI MNL 116, Table 3.2.3.; AWS D1.1, Type A or B, with arc shields.

C. Carbon-Steel Plate: ASTM A 283/A 283M.

D. Malleable Iron Castings: ASTM A 47/A 47M. Grade 32510 or 35028.

E. Carbon-Steel Castings: ASTM A 27/A 27M, Grade U-60-30 (Grade 415-205).

F. High-Strength, Low-Alloy Structural Steel: ASTM A 572/A 572M

G. Carbon-Steel Structural Tubing: ASTM A 500, Grade B or C.

H. Wrought Carbon-Steel Bars: ASTM A 675/A 675M, Grade 65 (Grade 450).

I. Deformed-Steel Wire or Bar Anchors: ASTM A 496 or ASTM A 706/A 706M.

ASTM A 307 defines the term “studs” to include stud stock and threaded rods.

J. Carbon-Steel Bolts and Studs: ASTM A 307, Grade A or C (ASTM F 568M, Property Class 4.6) carbon-steel, hex-head bolts and studs; carbon-steel nuts (ASTM A 563/A 563M, Grade A);

and flat, unhardened steel washers (ASTM F 844).

High-strength bolts are seldom used since concrete creep and crushing of concrete during bolt tightening reduce effectiveness. ASTM A 490/A 490M bolts should not be galvanized.

K. High-Strength Bolts and Nuts: ASTM A 325/ A 325M or ASTM A 490/ A 490M, Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, (ASTM A 563/A 563M) and hardened carbon-steel washers (ASTM F 436/F 436M).

Retain paragraph and subparagraph below if galvanized finish is required. Revise locations of galvanized items if required. Field welding should generally not be permitted on galvanized elements, unless the 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.

L. Zinc-Coated Finish: For exterior steel items and items indicated for galvanizing, apply zinc coating by **[hot-dip process according to ASTM A 123/A 123M, after fabrication, or ASTM A 153/A 153M, as applicable] [electrodeposition according to ASTM B 633, SC 3, Type 1]**.

1. 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.
2. 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-21035A or SSPC-Paint 20.

Retain paragraph below when more protection than a paint finish is required, but galvanizing is not required.

M. Galvanizing Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20. Comply with manufacturer's requirements for surface preparation.

Retain paragraph below if paint finish is required. Revise locations of priming, if required. MPI 79 (FS TT-P-664) in first option below provides some corrosion protection, while SSPC-Paint 25, without topcoating, provides minimal corrosion protection.

N. Shop-Primed Finish: Prepare surfaces of nongalvanized steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 1 followed by 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.

Select material from options in paragraph below or add another material to suit Project. Coordinate with counterflashing materials and details.

O. Reglets: **[PVC extrusions.] [Stainless steel, Type 302] [Copper] [Reglets and flashing are specified in Division 7 Section "Sheet Metal Flashing and Trim."]** felt or fiber filled.

P. Accessories: Provide clips, hangers, plastic or steel shims, and other accessories required to install structural precast concrete units.

Q. Welding Electrodes: Comply with AWS standards.

2.7 STAINLESS-STEEL CONNECTION MATERIALS

Delete this Article if not required. Use when resistance to staining merits extra cost in parking structures or other severe environments.

A. Stainless-Steel Plate: ASTM A 666, Type 304, of grade suitable for application.

B. Stainless-Steel Bolts and Studs: ASTM F 593, alloy 304 or 316, hex-head bolts and studs; stainless-steel nuts; and flat, stainless-steel washers.

1. Lubricate threaded parts of stainless steel bolts with an anti-seize thread lubricant during assembly.

C. Stainless-Steel Headed Studs: ASTM A 276, with minimum mechanical properties for studs as indicated under MNL 116, Table 3.2.3.

2.8 BEARING PADS

Delete this Article if not applicable. Choice of bearing pad can usually be left to fabricator; coordinate selection with structural engineer if required for bearing loads and rotation requirements.

A. Provide one of the following bearing pads for structural precast concrete units [**as recommended by precast fabricator for application]:**

1. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 50 to 70 Shore A durometer according to ASTM D 2240, minimum tensile strength 2250 psi (15.5 MPa) per ASTM D 412.
2. Random-Oriented, Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. Surface hardness of 70 to 90 Shore A durometer. Capable of supporting a compressive stress of 3000 psi (20.7 MPa) with no cracking, splitting or delaminating in the internal portions of the pad. Test one specimen for each 200 pads used in the Project.
3. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer. Surface hardness of 80 to 100 Shore A durometer. Conforming to Division II, Section 18.10.2 of AASHTO Standard

Specifications for Highway Bridges, or Military Specification, MIL-C-882E.

4. Frictionless Pads: Polytetrafluoroethylene (PTFE), glass-fiber reinforced, bonded to stainless or mild-steel plates, of type required for in-service stress.

Plastic pads are widely used with hollow-core slabs. Compression stress in use is not normally over a few hundred psi and proof testing is not considered necessary. No standard guide specifications are available.

5. High-Density Plastic: Multimonomer, nonleaching, plastic strip capable of supporting construction loads with no visible overall expansion.

Limit use of tempered hardboard pads to dry, low-stress applications, such as interior hollow-core slabs. High-density plastic pads can also be used.

6. Hardboard: AHA A135.4, Class 1, tempered hardboard strips, smooth on both sides.

2.9 GROUT MATERIALS

Add other proprietary grout systems to suit Project. Show locations of each grout here or on Drawings if retaining more than one type. Sand-cement grout in paragraph below is commonly used in keyed joints between hollow-core floor and roof units. Indicate required strengths on Contract Drawings.

A. Sand-Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144, or ASTM C 404, with minimum water required for placement and hydration.

Retain first paragraph below if nonshrink grout is required or if cement-grout shrinkage could cause structural deficiency. For critical installations, field installation procedures should be developed and the manufacturer's instructions should be followed. Non-ferrous grouts with a gypsum base should not be exposed to moisture. Ferrous grouts should not be used where possible staining would be undesirable or where the grout is not confined. Non-shrink grouts are normally not used or required in the keyed joints between hollow-core floor and roof systems.

B. Nonshrink Grout: Premixed, packaged ferrous and non-ferrous aggregate shrink-resistant grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, Grade A of consistency suitable for application with a 30-minute working time.

C. Epoxy-resin grout: Two-component mineral-filled epoxy-resin: ASTM C881/C881M of type, grade, and class to suit requirements.

2.10 THIN AND HALF BRICK UNITS AND ACCESSORIES

Retain this Article if specifying thin veneer brick-faced precast concrete panels. Brick should be selected prior to bid. Type TBX brick units feature the tightest dimensional tolerances but may be too dimensionally variable to fit securely within form liner templates. If full-size brick units are required, use Division 4 Section "Unit Masonry Assemblies."

A. Thin or Half Brick Units: ASTM C 216, Type FBX or ASTM C 1088, Grade Exterior, Type TBX, **[not less than 1/2 inch (13 mm)] [3/4 inch (19 mm)] [1 inch (25 mm)]** thick with a tolerance of plus or minus 1/16 inch (1.59 mm) and as follows:

Select from first five subparagraphs below for face sizes with equivalent metric dimensions. Verify availability of sizes.

1. Face Size: Standard, 2-1/4 inches (57 mm) high by 8 inches (203 mm) long.
2. Face Size: Modular, 2-1/4 inches (57 mm) high by 7-1/2 to 7-5/8 inches (190 to 194 mm) long.
3. Face Size: Engineer Modular, 2-3/4 to 2-13/16 inches (70 to 71 mm) high by 7-1/2 to 7-5/8 inches (190 to 194 mm) long.
4. Face Size: Closure Modular, 3-1/2 to 3-5/8 inches (89 to 92 mm) high by 7-1/2 to 7-5/8 inches (190 to 194 mm) long.
5. Face Size: Utility, 3-1/2 to 3-5/8 inches (89 to 92 mm) high by 11-1/2 to 11-5/8 inches (292 to 295 mm) long.
6. **[Where indicated to "match existing,"]** provide face brick matching color, texture, and face size of existing adjacent brickwork.

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

Select from subparagraphs above face sizes with equivalent metric dimensions or from subparagraphs below for products manufactured to metric face sizes. If retaining below, verify availability of sizes.

7. Face Size: Metric modular, 57 mm high by 190 mm long.
8. Face Size: Metric engineer, 70 mm high by 190 mm long.
9. Face Size: Metric closure, 90 mm high by 190 mm long.
10. Face Size: Metric utility, 90 mm high by 290 mm long.

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

11. Special Shapes: Include corners, edge corners, and end edge corners.

Brick units with higher rates of absorption than values in first subparagraph below should be wetted before placing concrete to improve bond. Before retaining subparagraph, verify that thin brick selected complies with requirements.

12. Initial Rate of Absorption: Less than 30g/30 sq. in. (30g/194 sq. cm.) per minute when tested per ASTM C 67.

13. Efflorescence: Provide brick that has been tested according to ASTM C 67 and rated "not effloresced."

Delete subparagraph below if surface-colored brick is not used.

14. Surface Coloring: Brick with surface coloring, other than flashed or sand-finished brick, shall withstand 50 cycles of freezing and thawing per ASTM C 67 with no observable difference in applied finish when viewed from 10 feet (3 m).

Options in subparagraph below are examples of descriptive requirements for appearance where a proprietary specification cannot be used. Edit to suit Project or delete if brick is specified by product name.

15. Face Color and Texture: **[Match Architect's samples] [Medium brown, wire cut] [Full-range red, sand molded] [Gray, velour].**

Retain first subparagraph below, deleting inapplicable descriptions if required. Include keyback or dovetail configuration, if necessary for adequate bond.

16. Back Surface Texture: Scored, combed, wire roughened, ribbed, keybacked or dovetailed.
17. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

Retain subparagraph above for nonproprietary or subparagraph below for semiproprietary Specification. Refer to Division 1 Section "Materials and Equipment."

18. Products: Subject to compliance with requirements, provide one of the following:

    a. **<Insert manufacturers' names and product designations for acceptable face brick.>**

Refer to American National Standards Institute (ANSI) A 137.1 for the commonly available sizes and shapes, physical properties, the basis for acceptance and methods of testing.

B. Glazed and Unglazed Ceramic Tile Units: ANSI A 137.1 **[not less than 3/8 inch (10 mm)]**

1. Body of glazed tile shall have a water absorption of less than 3 percent using ASTM C373.
2. Manufacturer shall warrant materials as frost-resistant.
3. Glazed units shall conform to ASTM C126.

C. Architectural Terra Cotta Units: Conform to requirements of Architectural Terra Cotta Institute.

Retain paragraph below if mortar setting brick unit joints before placing precast concrete mix.

D. Setting Mortar: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144. Mix at ratio of 1 part cement to 4 parts sand, by volume, with minimum water required for

placement.

Delete paragraph and subparagraphs below if not filling brick unit joints with pointing grout after precast concrete panel production.

E. Latex-Portland Cement Pointing Grout: ANSI A118.6 and as follows:

Select one or both types of grout from first two subparagraphs below.

1. Dry-grout mixture, factory prepared, of portland cement, graded aggregate, and dry, redispersible, ethylene-vinyl-acetate additive for mixing with water; uniformly colored.
2. Commercial portland cement grout, factory prepared, with liquid styrene-butadiene rubber or acrylic-resin latex additive; uniformly colored.
3. Colors: **[As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range]**.

F. Setting Systems

Retain subparagraphs below if thin brick, ceramic tile, or full brick will be laid after casting of panel.

1. Thin brick and Ceramic Tile Units: **[Dry-Set Mortar: ANSI A118.1] [Latex-Portland Cement Mortar: ANSI A 118.4**]
2. Full Brick Units: Dovetail Slots: Type 304 stainless steel, not less than 0.5 mm thick, felt or fiber filled. Use Wire Anchors: ASTM A 82 or B 227, Grade 30HS not less than 3/16 inch (W2.8) in diameter and hooked on one end and looped through a 7/8 in. (22 mm) wide, 12-gage (2.68 mm) steel sheet bent over the wire with dovetail on other end.

2.11 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 Division 4 Section "Dimension Stone Cladding." Replace first paragraph below with stone requirements, if preferred.

A. Stone facing for structural precast concrete is specified in Division 4 Section "Dimension Stone Cladding."

1. Tolerance of length and width of +0, -1/8 inch (+0, -3mm).

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

B. Anchors: Stainless steel, ASTM A 666, Type 304, of temper and diameter required to support loads without exceeding allowable design stresses.

Grommets will usually be required if filling dowel holes with rigid epoxy.

1. Fit each anchor leg with 60 durometer neoprene grommet collar of width at least twice the diameter and of length at least five times the diameter of the anchor.

C. Sealant Filler: ASTM C 920, low-modulus, multicomponent, nonsag urethane sealant complying with requirements in Division 7 Section "Joint Sealants" and that is nonstaining to stone substrate.

Dowel hole filling is used to prevent water intrusion into stone and future discoloration at anchor locations. Retain paragraph above for a flexible filler or paragraph below for a rigid filler.

D. Epoxy Filler: ASTM C 881/C 881M, 100 percent solids, non-shrinking, non -staining of type, class, and grade to suit application.

E. Bond Breaker: **[Preformed, compressible, resilient, nonstaining, nonwaxing, closed-cell polyethylene foam pad, nonabsorbent to liquid and gas, 1/8 inch (3.2 mm) thick] [Polyethylene sheet, ASTM D4397, 6 to 10 mil (0.15 to 0.25 mm) thick]**

2.12 INSULATED PANEL ACCESSORIES

If insulated structural precast concrete panels are required, retain one or more of the following insulation paragraphs. State the required thickness for each type of insulation allowed to achieve the desired minimum aged R-value.

A. Expanded Polystyrene Board Insulation: Rigid, cellular polystyrene thermal insulation complying with ASTM C578 formed by expansion of polystyrene base resin with **[square edges] [shiplap edges]** and thickness of **< Insert dimension>**.

B. Extruded-Polystyrene Board Insulation: Rigid, cellular polystyrene thermal insulation complying with ASTM C 578 formed from polystyrene base resin by an extrusion process using HCFCs as blowing agents with **[square edges] [shiplap edges]** and thickness of **<Insert dimension>**.

C. Polyisocyanurate Board Insulation: Rigid, cellular polyisocyanurate thermal insulation complying with ASTM C 591 formed by using HCFCs as blowing agents with **[square edges] [shiplap edge**s] and thickness of **<Insert dimension>**.

Select wythe connectors from paragraph below.

D. Wythe Connectors: **[Glass-fiber connectors] [Vinyl-ester polymer connectors] [Polypropylene pin connectors] [Stainless-steel pin connectors] [Bent galvanized reinforcing bars] [Galvanized welded wire trusses] [Galvanized bent wire connectors] [Cylindrical metal sleeve anchors]** manufactured to connect wythes of precast concrete panels.

2.13 CONCRETE MIXES

A. Prepare design mixes for each type of concrete required.

Delete subparagraph below if fly ash, blast furnace slag, or silica fume are not permitted. Revise percentage to suit Project.

1. Limit use of fly ash to 25 percent replacement of portland cement by weight and granulated blast-furnace slag to 40 percent of portland cement by weight; metakaolin and silica fume to 10 percent of portland cement by weight.

B. Design mixes may be prepared by a qualified independent testing agency or by qualified precast plant personnel at structural precast concrete fabricator's option.

C. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 (ACI 318M) or PCI MNL 116 when tested in accordance with ASTM C 1218/C 1218M.

Structural precast concrete units may be manufactured with a separate "architectural" face mix and a "structural" backup mix. Face and backup mixes should have similar shrinkage and expansion coefficients. Similar water-cementitious materials ratios and cement-aggregate ratios are recommended to limit bowing or warping.

D. Normal-Weight Concrete Face and Backup Mixes: Proportion mixes 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 subparagraph below or revise to suit Project. Higher-strength mixes may be available; verify availability with fabricators.

1. Compressive Strength (28 Days): minimum 5000 psi (34.5 MPa).
2. Release Strength: as required by design.

A maximum water-cementitious materials ratio of 0.40 to 0.45 is usual for structural precast concrete. Lower ratios may be possible with use of high-range water reducers. Revise ratio as required to suit Project.

3. Maximum Water-Cementitious Materials Ratio: 0.45.

Lightweight backup mixes are not recommended with normal-weight face mixes due to bowing or warping potential. Retain lightweight concrete backup mixes if required or as an option if satisfactory durability and in-service performance are verified by fabricator.

E. Lightweight Concrete: Proportion mixes 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 subparagraph below or revise to suit Project. Higher-strength mixes may be available; verify with fabricators.

1. Compressive Strength (28 Days): minimum 5000 psi (34.5 MPa).
2. Release Strength: as required by design.

Increase or decrease unit weight in subparagraph below to suit Project. Coordinate with lightweight-aggregate supplier and structural precast concrete fabricator. Lightweight concretes with lightweight and normal-weight aggregate in mix will usually be heavier than unit weight below.

3. Unit Weight: Calculated equilibrium unit weight of 115 lb/cu.ft. (1842 kg/cu.m), plus or minus 3 lb/cu.ft. (48 kg/cu.m), according to ASTM C 567.

F. 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 116.

G. When included in design mixes, add other admixtures to concrete mixes according to manufacturer's written instructions.

H. Concrete Mix Adjustments: Concrete mix design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

2.14 FORM FABRICATION

A. Form: Accurately construct forms, mortar tight, of sufficient strength to withstand pressures due to concrete-placement and vibration operations and temperature changes and for prestressing and detensioning operations. Coat contact surfaces of forms 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.

1. 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.

B. Maintain forms to provide completed structural precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.

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

Select one option from subparagraph below; show details on Drawings or revise description to add dimensions. Sharp edges or corners of precast concrete units are vulnerable to chipping.

1. Edge and Corner Treatment: Uniformly **[chamfered] [radiused]** or as built in on standard forms.

2.15 THIN AND HALF BRICK FACINGS

Retain this Article if using thin or half brick facings on structural precast concrete units.

A. Place form liner templates accurately to provide grid for brick facings. Provide solid backing and supports to maintain stability of liners while placing bricks and concrete placement.

B. Securely place brick units face down into form liner pockets and place precast concrete backing mix.

Retain first two paragraphs and delete subparagraph below if bonding back of brick directly to concrete instead of using mortar.

C. Completely fill joint cavities between brick units with sand-cement mortar, and place precast concrete backing mix while sand-cement mortar is still fluid enough to ensure bond.

Retain subparagraph below if grouting is required. Delete if joints will remain fully recessed as cast.

D. Mix and install grout according to ANSI A 108.10. Completely fill joint cavities between brick units with grout, and compress into place without spreading grout onto faces of brick units. Remove excess grout immediately to prevent staining of brick.

Select joint profile from options in subparagraph below or revise to suit Project. Joints are placed in order of decreasing weather tightness according to BIA Technical Note 21C. PCI recommends grout materials and installation follow ANSI standards for ceramic tiles.

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

E. Clean faces and joints of brick facing.

2.16 STONE FACINGS

Retain this Article if stone facing is required. Refer to Division 4 Section "Dimensional Stone Cladding" for precast veneer.

A. Clean stone surfaces before placing in molds to remove soil, stains, and foreign materials.

Use cleaning methods and materials recommended by the stone supplier.

B. Accurately position stone facings to comply with requirements and in locations indicated on Shop Drawings. Install spring clips, anchors, supports, and other attachments indicated or necessary to secure stone in place. Orient stone veining in direction indicated on Shop Drawings. Keep reinforcement a minimum of 3/4 inch (19 mm) 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. Ensure no passage of concrete matrix to stone surface.

C. See Division 7 Section "Joint Sealants" for furnishing and installing sealant backings and sealant into stone-to-stone joints and stone-to-concrete joints. Apply a continuous sealant bead along both sides and top of precast panels at the stone/precast interface using the bond breaker as a joint filler backup. Do not seal panel bottom edge.

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

1. Fill anchor holes with low modulus polyurethane sealant filler and install anchors.
2. Fill anchor holes with epoxy filler and install anchors with 1/2 inch (13 mm) long 60 durometer elastomeric sleeve at the back surface of the stone.

Retain one of two subparagraphs below. PCI recommends preventing bond between stone facing and precast concrete to minimize bowing, cracking, and staining of stone.

3. Install 6 to 10 mil (0.15 to 0.25 mm) polyethylene sheet to prevent bond between back of stone facing and concrete substrate.
4. Install 1/8 inch (3 mm) polyethylene-foam bond breaker to prevent bond between back of stone facing and concrete substrate. Maintain minimum projection requirements of stone anchors into concrete substrate.

PCI recommends anchor spacing be determined prior to bidding. Retain below if precaster is to test stone anchors for shear and tension. ASTM E488 is preferred as ASTM C1354 does not include the influence of the precast concrete backup.

D. Stone Anchor Shear and Tensile Testing: Engage a certified testing laboratory acceptable to the Architect to evaluate and test the proposed stone anchorage system. Test for shear and tensile strength of proposed stone anchorage system in accordance with ASTM E 488 or ASTM C 1354 modified as follows:

1. Prior to testing, submit for approval a description of the test assembly (including pertinent data on materials), test apparatus and procedures.
2. Test 12-by-12 inch (300 by 300 mm) samples of stone affixed to testing apparatus through proposed anchorages. Provide 2 sets of 6 stone samples; one set for shear load testing and the other set for tensile load testing.
3. Test stone anchors of the sizes and shapes proposed for the installation.

a. Test the assembly to failure and record the test load at failure. Record the type of failure, anchor pull-out or stone breakage, and any other pertinent information, in accordance with the requirements of ASTM E 488. In addition, submit load deflection curves of each test assembly.

E. Minimum Anchor Spacing: Anchor spaced not less than 6 inches (152 mm) from an edge with not more than 24 to 30 inches (610 to 760 mm) between anchors depending on the local building code.

2.17 FABRICATION

When required for anchorage or lateral bracing to structural steel members, some methods of manufacturing hollow-core slabs preclude the use of anchors and inserts; Coordinate with other trades for installation of cast-in items.

A. 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. Do not relocate bearing plates in units unless approved by Architect.

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

Coordinate paragraph below with Division 5 Section "Metal Fabrications" for furnishing and installing loose hardware items.

B. Furnish loose steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast concrete units to supporting and adjacent construction.

C. Cast-in reglets, slots, holes, and other accessories in structural precast concrete units as indicated on Contract Drawings.

Delete first paragraph below if not applicable or if all openings are clearly detailed. Coordinate with other Specification Sections.

D. Cast-in openings larger than 10 inches (250 mm) in any dimension. Do not drill or cut openings or prestressing strand without Engineer's approval.

E. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.

1. 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 A 775/A 775M repair with patching material compatible with coating material. Epoxy coat bar ends after cutting.

2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Locate and support reinforcement by metal or plastic chairs, runners, bolsters, spacers, hangers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place according to PCI MNL 116.
3. Place reinforcing steel and prestressing tendon to maintain a minimum 3/4 –inch (19 mm) concrete cover. Increase cover requirements in accordance with ACI 318 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.
4. Install welded wire fabric in lengths as long as practicable. Offset laps of adjoining widths to prevent continuous laps in either direction.

F. Reinforce structural precast concrete units to resist handling, transportation, and erection stresses.

Delete paragraph and subparagraph below if precast prestressed concrete units are not required. Option to prestress may be left to fabricator if objective is to aid handling and to control cracking of units during installation.

G. Prestress tendons for structural precast concrete units by either pretensioning or post-tensioning methods. Comply with PCI MNL 116.

Revise release or post-tensioning strength in first subparagraph below to an actual compressive strength, if required. A release strength as low as 2500 psi (17.2 MPa) for post-tensioned components and 3000 psi (20.7 MPa) for pretensioned components is permitted.

1. Delay detensioning or post-tensioning of precast prestressed concrete units until concrete has reached its indicated minimum design release compressive strength as established by test cylinders cured under the same conditions as concrete member.
2. 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.
3. 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.

Retain the following subparagraph only when appearance of member ends is critical.

4. Recess strand ends and anchorages exposed to view a minimum of 1/2 inch (12 mm), fill with grout and sack rub surface.

Retain the following subparagraph only when exposed to severe environment.

5. Protect strand ends and anchorage exposed to severe environments with bitumastic, zinc -rich or epoxy paint.

H. Comply with requirements in PCI MNL 116 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 mix is required or is Contractor's option.

I. Place face mix to a minimum thickness after consolidation of the greater of 1 inch (25 mm) or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover.

1. Use only face mix for those units in which more than one major face (edge) is exposed.
2. Where only one face of unit is exposed and at the fabricator's option either of the following mix design/casting techniques may be used:

a. A single design mix throughout the entire thickness of panel.
b. Design mixes for facing and backup; using cement and aggregates for each type as indicated, for consecutive placement in the mold. Use cement and aggregate specified for facing mix. Use cement and aggregate for backup mix complying with criteria specified or as selected by the fabricator.

J. Place concrete in a manner to prevent seams or planes of weakness from forming in precast concrete units.

1. Place backup concrete to ensure bond with face mix concrete.

K. Thoroughly consolidate placed concrete by internal and/or external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing or entrapped air on surfaces. Use equipment and procedures complying with PCI MNL 116.

1. Place self-consolidating concrete without vibration in accordance with PCI TR-6 "Interim Guidelines for the Use of Self-Consolidating Concrete."

L. Comply with PCI MNL 116 procedures for hot and cold-weather concrete placement.

M. Identify pickup points of 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 precast concrete unit on a surface that will not show in finished structure.

N. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using live steam or radiant heat and moisture. Cure units until the compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

2.18 INSULATED PANEL CASTING

Delete this Article if integrally insulated panels are not required.

A. Cast and screed wythe supported by form.

B. Place insulation boards, abutting edges and ends of adjacent boards. Stagger end joints between rows to minimize cold joints. Stagger joints of insulation layers one-half board apart. Insert wythe connectors through insulation, and consolidate concrete around connectors according to connector manufacturer's written instructions.

C. Cast and screed top wythe and apply required finish.

2.19 FABRICATION TOLERANCES

Usually retain paragraph below unless tolerances for Project deviate from PCI recommendations. PCI MNL 116 or MNL 135 product tolerances are standardized throughout the industry. Revise product tolerances if additional costs of more exacting tolerances are justified.

A. Fabricate structural precast concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished unit complies with PCI MNL 116 or PCI MNL 135 product tolerances as well as position tolerances for cast-in items.

2.20 FINISHES

A. Commercial (Structural) Finishes

Select finish from one of four subparagraphs below. If more than one finish is required, create a finish schedule or describe locations in each precast concrete unit article. Finishes below are in ascending order of finish quality and cost. Insert other specific finish requirements to suit Project. Specify the minimum finish grade consistent with a product's application and the intended use of the structure. Consult precasters regarding the finishes appropriate for various products and cost effectiveness. Coordinate precast concrete finishes with required floor, ceiling, roof, and deck finishes or toppings.

Specify Commercial Grade when the product will not be visible in the completed structure, or when the function of the structure does not require an enhanced surface. This is essentially an "as cast" finish.

1. Commercial Grade: Remove large fins and protrusions and fill large holes. Rub or grind ragged edges. Faces are to be true, well-defined surfaces. Air holes, water marks, and color variations are acceptable. Allowable form joint offsets are limited to 3/16 in. (5mm).

Specify Standard Grade where products are exposed to view but the function of the structure does not require a special finish. The surface is suitable for an applied textured coating but not necessarily suitable for painting. This is the typical finish grade for all structural products.

2. Standard Grade: Normal plant-run finish produced in forms that impart a smooth finish to concrete. Surface holes smaller than 1/2 inch (13mm) caused by air bubbles, normal color variations, form joint marks, and minor chips and spalls are acceptable. Fill air holes greater than 1/4 inch (6 mm) in width that occur in high concentration (more than one per 2 in.^{2} [1300 mm^2]). Major or unsightly imperfections, honeycombs, or structural defects are not permitted. Allowable for joint offset limited to 1/8 inch (3 mm).

Specify Grade B Finish on visually exposed structural members such as columns or walls. Grade B Finish definition is primarily for surface finish. Color variations are acceptable.

3. Grade B Finish: Fill air pockets and holes larger than 1/4 inch (6 mm) in diameter with sand-cement paste matching color of adjacent surfaces. Fill air holes greater than 1/8 inch (3 mm) in width that occur in high concentration (more than one per 2 in.^{2} [1300 mm^2]). Grind smooth form offsets or fins larger than 1/8 inch (3 mm). Repair surface blemishes due to holes or dents in forms. Discoloration is permitted at form joints.

Specify Grade A Finish where surface will be painted (especially with a textured or "sand" paint); however, some surface blemishes will be visible. If a surface with fewer imperfections than allowed for "Grade A" is needed, specify the requirements as a "special finish." Requirements for Grade A Finish are not applicable to extruded products using zero-slump concrete in their process.

4. Grade A Finish: Repair and/or fill all surface blemishes with the exception of air holes 1/16 inch (2 mm) in width or smaller and form marks where the surface deviation is less than 1/16 inch (2 mm). Float-apply a neat cement-paste coating to exposed surfaces. Rub dried paste coat with burlap to remove loose particles. Discoloration is permitted at form joints. Grind smooth all form joints.

Specify the extent to which float or trowel marks, variations of texture, or other surface blemishes will be permitted. Require samples to establish acceptance criteria for any exposed finish. Revise finish below to light-broom or as-cast finish if float finish is unnecessary, or upgrade to smooth, steel-trowel finish.

B. Screed or float finish unformed surfaces. Strike off and consolidate concrete with vibrating screeds to a uniform finish, float finish, if required. Hand screed at projections. Normal color variations, minor indentations, minor chips, and spalls are permitted. No major imperfections, honeycombing, or defects are permitted.

Retain paragraph above or below. Screed or float finish above is standard; smooth steel-trowel finish below may also be achieved.

C. Smooth steel-trowel finish unformed surfaces. Consolidate concrete, bring to proper level with straightedge, float and trowel to a smooth, uniform finish.

If composite topping is required, retain subparagraph below.

D. Apply roughened surface finish in accordance with ACI 318 (ACI 318M) to precast concrete units that will receive concrete topping after installation.

E. Commercial (Structural) Architectural (CA) Finishes

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

This Article presumes Architect has preapproved one or more design reference samples. Include complete description of design reference sample here. If preapproving manufacturers, coordinate with "Manufacturers" Article. Revise if multiple samples are approved.

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

Select type of architectural finish from subparagraphs below for CA units. Indicate on Drawings which members require special finish. 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 is required, such as (light), (medium), or (deep). Remove matrix to a maximum depth of one-third the average diameter of coarse aggregate but not more than one-half the diameter of smallest sized coarse aggregate. See PCI MNL 116 for more information on special finishes. Review sample of special finishes prior to bidding.

b. Smooth-Surface Finish: Provide surfaces free of excessive air voids, sand streaks, and honeycombs, with uniform color and texture.
c. Textured-Surface Finish: Impart by form liners to provide surfaces free of excessive air voids, streaks, and honeycombs, with uniform color and texture.
d. Bushhammer Finish: Use power or hand tools to remove matrix and fracture coarse aggregates.
e. Retarded Finish: Use chemical retarding agents applied to forms and washing and brushing procedures to expose aggregate and surrounding matrix surfaces after form removal.
f. Abrasive-Blast Finish: Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.
g. 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 attack.
h. Honed Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
i. Polished Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
j. Sand-Embedment Finish: Use selected stones placed in a sand bed in bottom of form, with sand removed after curing.

2.21 SOURCE QUALITY CONTROL

Always retain paragraph below because it establishes the minimum standard of plant testing and inspecting. PCI MNL 116 mandates source testing requirements and plant "Quality Systems Manual." PCI certification also ensures periodic auditing of plants for compliance with requirements in PCI MNL 116.

A. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL 116 requirements. If using self-consolidating concrete also test and inspect according to PCI TR-6 "Interim Guidelines for the Use of Self-Consolidating Concrete."

Delete first paragraph and subparagraph below if not required. PCI certification may be acceptable to authorities having jurisdiction without further monitoring of plant quality-control and testing program by Owner.

B. In addition to PCI Certification, Owner will employ an independent testing agency to evaluate structural precast concrete fabricator's quality-control and testing methods.

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

C. Precast concrete units will be considered deficient if units fail to comply with ACI 318 (ACI 318M) strength requirements.

Review testing and acceptance criteria with structural engineer. Add criteria for load tests if required.

D. Testing: If there is evidence that strength of precast concrete units may be deficient or may not comply with ACI 318 (ACI 318M) 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 C 42/C 42M.

1. A minimum of three representative cores will be taken from units of suspect strength, from locations directed by Architect.
2. Cores will be tested in an air-dry condition or if units will be wet under service conditions, test cores, after immersion in water, in a wet condition.
3. Strength of concrete for each series of 3 cores will be considered satisfactory if the average compressive strength is equal to at least 85 percent of the 28-day design compressive strength and no single core is less than 75 percent of the 28-day design compressive strength.
4. Test results will be made in writing on the same day that tests are performed, with copies to Architect, Contractor, and precast concrete fabricator. Test reports will include the following:

   a. Project identification name and number.
   b. Date when tests were performed.
   c. Name of precast concrete fabricator.
   d. Name of concrete testing agency.
   e. 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.

E. 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 mix that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.

F. Defective Work: Structural precast concrete units that do not comply with acceptability requirements in PCI MNL 116, including concrete strength, manufacturing tolerances, and color and texture range are unacceptable. Chipped, spalled or cracked units may be repaired. The Architect reserves the right to reject any unit if it does not match the accepted samples. Replace unacceptable units with precast concrete units that comply with requirements.

PART 3 – EXECUTION

3.1 PREPARATION

A. Deliver anchorage devices that are embedded in or attached to the building structural frame or foundation before start of such work. Provide locations, setting diagrams, and templates for the proper installation of each anchorage device.

3.2 EXAMINATION

A. Examine supporting structure or foundation and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 ERECTION

A. Install loose clips, hangers, bearing pads,and other accessories required for connecting structural precast concrete units to supporting members and backup materials.

B. Erect precast concrete level, plumb and square within the specified allowable tolerances. Provide temporary structural framing, supports and bracing as required to maintain position, stability, and alignment of units until permanent connections are completed.

1. Install temporary steel or plastic spacing shims or bearing pads as precast concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
3. Remove projecting lifting devices and use sand-cement grout to fill voids within recessed lifting devices flush with surface of adjacent precast concrete surfaces when recess is exposed.
4. Provide and install headers of cast-in-place concrete or structural-steel shapes for openings larger than one slab width according to hollow-core slab unit fabricator’s written recommendations.

C. Connect structural precast concrete units in position by bolting, welding, grouting, or as otherwise indicated on approved Erection Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and/or grouting is completed.

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

1. Protect structural precast concrete units and bearing pads from damage by field welding or cutting operations and provide noncombustible shields as required.
2. Clean weld affected metal surfaces with chipping hammer followed by brushing, and apply a minimum 0.004 inch (100 µm) thick coat of galvanized repair paint to galvanized surfaces in conformance with ASTM A 780.

Retain last subparagraph above or first subparagraph below.

3. Clean weld affected metal surfaces with chipping hammer followed by brushing, and reprime damaged painted surfaces in accordance with manufacturer's recommendations.
4. Visually inspect all welds critical to precast connections. Visually check all welds for completion and remove, reweld or repair all defective welds, if services of AWS-certified welding inspector are not furnished by Owner.

E. At bolted connections, use lock washers or other approved means to prevent loosening of nuts after final adjustment.

1. Where slotted connections are used, check bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot. For friction connection, apply specified bolt torque and check 25 percent of bolts at random by calibrated torque wrench.

In paragraph below revise locations and extent of grouting if required.

F. Grouting or Dry Packing Connections and Joints: Erection drawings shall indicate joints to be grouted and any critical grouting sequences. Grout open spaces at keyways, connections and joints where required or indicated. Retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces. Fill joints completely without seepage to other 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. Trowel top of grout joints on roofs smooth to prevent any unevenness that might interfere with placing of, or cause damage, to insulation and roofing. Finish transitions due to different surface levels not steeper than 1 to 12.

Delete subparagraph below when end grouting hollow-core slabs is not required.

2. At Slab Ends (where shown on Drawings): Provide suitable end cap or dam in voids as required.

Delete subparagraph below when voids of hollow-core slabs are not used for electrical raceways or mechanical ducts.

3. For areas where slab voids are to be used as electrical raceways or mechanical ducts provide a taped butt joint at end of slabs, making sure the voids are aligned.

G. Field cutting of precast units is not permitted without approval of the Engineer.

Paragraph below refers to fastening under the control of precast concrete erector. Coordinate with and repeat warning in other Sections if additional construction will be fastened to precast, prestressed concrete units.

H. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed concrete units unless approved by Engineer.

3.4 ERECTION TOLERANCES

Review tolerances in PCI MNL 135. Consult structural engineer and precast concrete fabricators and erectors and revise paragraph below if other tolerances are needed.

A. Erect structural precast concrete units level, plumb, square, true, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135. Level out variations between adjacent members by jacking, loading, or any other feasible method as recommended by the manufacturer and acceptable to the Architect.

3.5 FIELD QUALITY CONTROL

Retain this Article if field testing and inspecting are required. Revise paragraph below if Contractor engages agency.

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections.

B. Field welds will be subject to visual inspections and non-destructive testing in accordance with ASTM E 165 or ASTM E 709.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Repair or remove and replace work that does not comply with specified requirements.

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

3.6 REPAIRS

Production chips, cracks, and spalls should have been corrected at manufacturer's plant. Defects occurring after delivery are normally repaired before final joint sealing and cleaning.

A. Repairs will be permitted provided structural adequacy, serviceability and durability of units and appearance are not impaired.

The precast concrete manufacturer should develop appropriate repair mixtures and techniques during the production sample approval process for CA finishes.

B. 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 (6 m).

C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A 780.

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

D. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.

E. Remove and replace damaged structural precast concrete units that cannot be repaired.

3.7 CLEANING

Specify whether erector or precaster does cleaning under the responsibility of General Contractor.

A. Clean mortar, plaster, fireproofing, weld slag, and any other deleterious material from concrete surfaces and adjacent materials immediately.

B. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.

1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's recommendations. Protect other work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 034100