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.

Boxed portions are Notes to the Specification Writer.

STRUCTURAL PRECAST CONCRETE SECTION 034100
STRUCTURAL PRECAST CONCRETE WITH COMMERICAL
ARCHITECTURAL (CA) 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 of the contract. 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the performance criteria, materials, design, production, and erection of structural precast and precast, prestressed concrete with a commercial architectural (CA) finish 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 members.

B. This Section includes the following with a commercial architectural (CA) finish:

1. Hollow-core slab and wall units.
2. Beams, columns, double tees.

3. Walls, spandrels.
4. Insulated, precast concrete units.
5. **<Insert other applicable members>**

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. Section 03300 "Cast-in-Place Concrete" for installing connection anchors and reinforcing steel in concrete and structural topping.
2. Section 03416 "Precast Post-Tensioned Concrete" for connecting precast units.
3. Section 03450 "Architectural Precast Concrete."
4. Section 03500 "Cementitious Floor Underlayment" for floor and roof deck fill.
5. Section 04810 "Unit Masonry Assemblies" for inserts or anchorages required for slab connections.
6. Section 04851 "Dimension Stone Cladding" for stone facing.
7. Section 05120 "Structural Steel" for furnishing and installing connections attached to structural-steel framing.
8. Section 05500 "Metal Fabrications" for furnishing and installing loose hardware items.
9. Section 07190 "Water Repellents" for water-repellent finish treatments.
10. Section 07220 "Roof and Deck Insulation" for insulation to meet energy code.
11. Section 07620 "Sheet Metal Flashing and Trim" for flashing receivers and reglets.
12. Section 07841 "Through-Penetration Firestop Systems" for joint filler materials for fire-resistance-rated construction.
13. Section 07920 "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.
14. Section 09680 "Carpet and Carpet Cushion" for covering on flooring members.
15. Section 09910 "Exterior Paints."

1.3 DEFINITION

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

A. Design 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 members to contractor. AIA Document A201 requires Owner or Architect to specify performance and design criteria.

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

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 members 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 fabricator 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. Dead Loads: **<Insert dead loads.>**
2. Live Loads: **<Insert live loads.>**
3. Roof Loads: **<Insert roof loads>**

4. Basic Ground Snow Load: **<Insert snow loads.>**
5. Rain Loads: **<Insert rain loads.>**
6. Concrete Topping Thickness: **<Insert thickness.>**
7. Wind Loads: **<Insert wind loads or wind-loading criteria, positive and negative for various parts of the building as required by applicable building code or ASCE/SEI 7, including basic wind speed, importance factor, exposure category, and pressure coefficient.>**
8. Seismic Loads: **<Insert seismic design data including seismic performance category, importance factor, use group, seismic design category, seismic zone, site classification, site coefficient and drift criteria.>**

Precast concrete specific load may include blast loads.

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

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.

10. Design structural precast concrete 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. Maintain structural precast concrete deflections within 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.

11. 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 connection design shall consider through thickness thermal gradients as appropriate.

Retain subparagraph below if fire resistance rating is required. Fire ratings depend on occupancy and building construction type, and are generally a building code requirement. When required, fire-rated products should be clearly identified on the design drawings.

12. 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 veneer-faced precast concrete members are used on project.

13. Stone to Precast Concrete Anchorages: Provide anchors, as determined through Owner's or Stone supplier testing, in numbers, types and locations required to satisfy specified performance criteria.

Retain subparagraph below if precast concrete members are used in parking structure to resist impact load. Local codes may have requirements that vary from those listed. SUVs and other similar vehicles may dictate greater loads applied slightly higher above the floor or ramp surface.

14. Vehicular Impact Loads: Design spandrel beams acting as vehicular barriers for passenger cars to resist a single load of **(6,000 lb [26.7 kN]) <Insert load>** service load applied horizontally in any direction to the spandrel beam, with anchorages or attachments capable of transferring this load to the structure. Design spandrel beams, assuming the load to act at a height of 18 in (457 mm) and 27 in (686 mm) above the floor or ramp surface on an area not to exceed 1 ft^2 (0.093 m^2).

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Retain quality control records and certificates of compliance for 5 years after completion of structure.

B. LEED Submittals

Retain subparagraph below if recycled content is required for LEED-NC Credits MR 4.1 and MR 4.2. An alternative method of complying with Credit MR 4.1 and MR 4.2 requirements is to retain requirement in Division 01 SECTION "Sustainable Design Requirements" that gives Contractor the option and responsibility for determining how Credit MR 4.1 and MR 4.2 requirements will be met.

1. Product Data for Credit MR 4.1 **[and Credit MR 4.2]**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer (post-industrial) recycled content per unit of product.

   a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.

b. Indicate relative dollar value of recycled content product to total dollar value of product included in project.
c. If recycled content product is part of an assembly, indicate the percentage of recycled content product in the assembly by weight.
d. If recycled content product is part of an assembly, indicate relative dollar value of recycled content product to total dollar value of assembly.

2. Product Data for Credit MR 5.1 **[and Credit MR 5.2]** For local and regional material extracted/harvested and manufactured within a 500 mile radius from the project site.

a. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
b. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
c. Indicate dollar value of product containing local/regional materials; include materials cost only.
d. Where product components are sourced or manufactured in separate locations, provide location information for each component. Indicate the percentage by weight of each component per unit of product.

Retain subparagraph below if environmental data is required in accordance with Table 1 of ASTM E 2129. Concrete is relatively inert once cured. Admixtures, form release agents, and sealers may emit VOCs, especially during the curing process; however, virtually all emissions are eliminated before enclosing the building.

3. Include MSDS product information showing that materials meet any environmental performance goals such as biobased content.
4. For projects using FSC certified formwork, include chain-of-custody documentation with certification numbers for all certified wood products.
5. For projects using reusable formwork, include data showing how formwork is reused.

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

D. Shop (Erection) Drawings:

1. Detail fabrication and installation of structural precast concrete units including connections at member ends and to each adjoining member.
2. Indicate locations, plan views, elevations, dimensions, shapes, and cross sections of each unit, openings, support conditions and types of reinforcement, including special reinforcement.
3. Indicate aesthetic intent including joints, rustications or reveals, and extent and location of each surface finish.

4. Indicate details at building corners.

Retain subparagraphs below applicable to Project.

5. Indicate separate face and backup mixture locations.
6. Indicate welded connections by AWS standard symbols. Show size, length, and type of each weld.
7. Detail loose and cast-in hardware, lifting and erection inserts, connections, and joints.
8. Indicate locations, tolerances and details of anchorage devices to be embedded in or attached to structure or other construction.
9. Include and locate openings larger than 10 in (250 mm). Where additional structural support is required for openings include header design.
10. Coordinate and indicate openings and inserts required by other trades.
11. Indicate location of each structural precast concrete member by same identification mark placed on unit.
12. Indicate relationship of structural precast concrete members to adjacent materials.
13. Indicate locations and details of thin, half and full brick units and joint treatment.
14. Indicate locations and details of stone veneer-facings, stone anchors, and joint widths.
15. Indicate areas receiving toppings and magnitude of topping thickness.
16. Indicate estimated cambers for floor slabs receiving cast-in-place topping.
17. Indicate multiple wythe connection devices.
18. Indicate shim sizes and grouting sequence.
19. Design Modifications: If design modifications are proposed to meet performance requirements and field conditions, notify the Architect and submit design calculations and Shop Drawings. Do not affect the appearance, durability or strength of members when modifying details or materials. Maintain the general design concept when altering size of members and alignment.

E. Provide handling procedures, erection sequences, and for special conditions provide temporary bracing and shoring 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.

F. Comprehensive engineering design signed and sealed by a qualified professional engineer responsible for its preparation licensed in **<insert the jurisdiction 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.

G. Samples: Design 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 members.

1. When back face of precast concrete member is to be exposed, include Samples illustrating workmanship, color, and texture of the concrete.

Retain subparagraph below if samples of brick facings are required.

2. Samples for each thin, half, or full brick unit required, showing the full range of color and texture expected. Include Sample showing color, geometry and texture of joint treatment.

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

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

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For **[installer] [fabricator] [testing agency]** 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 and owners, and other information specified.

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

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

Retain test reports paragraph below if submittal is required.

C. Material Test Reports for aggregates: From an accredited testing agency, indicating and interpreting test results for compliance with requirements indicated.

Retain paragraph below to require submittal of material certificates from manufacturers.

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

Edit to suit Project.

1. Cementitious materials.
2. Reinforcing materials and prestressing tendons.
3. Admixtures.
4. Bearing pads.
5. Structural-steel shapes and hollow structural sections.
6. Insulation.
7. Clay product units and accessories.
8. Stone anchors.
9. Other components specified in Contract Documents with applicable standards.

Retain paragraph below if Contractor is responsible for field quality-control testing. Retain option if Contractor is responsible for special inspections.

E. Field quality-control test **[and special inspections]** reports.

1.7 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 the PCI website at www.pci.org for current listing of PCI-Qualified and Certified Erectors. Retain one of two "Erector Qualifications" paragraphs below if qualifying 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].**

B. Erector Certification: A precast concrete erector with erecting organization and all erecting crews Certified and designated, prior to beginning work at project site, by PCI's Certificate of Compliance to erect **[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 or Certified 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,"* and *PCI MNL-132 Erection Safety-For Precast and Prestressed Concrete.*

C. 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.

D. 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.

Retain subparagraph above and below if fabricator is 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 licensed 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.

Select the product group and category with the suffix A, e.g., C3A, if the structural product requires the application of an architectural finish produced by a fabricator with special architectural qualifications. Structural precast members must meet the requirements of PCI Manual, MNL-116. These members should not be expected to meet the requirements of MNL-117 for architectural precast concrete products. However, the structural members may have the application of architectural finishes included in the provisions of MNL-116. Fabricators 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 members without delaying the Work.
5. Certification shall be maintained throughout the production of the precast concrete units. Production shall immediately stop if at any time the fabricator's certification is revoked, regardless of the status of completion of contracted work. Production will not be allowed to re-start until the necessary corrections are made and certification has been re-established. In the event certification(s) can not be re-established in a timely manner, causing project delays, the fabricator, at no

additional cost, will contract out the remainder of the units to be manufactured at a PCI certified plant.

Retain subparagraph below if fabricators are required to be registered with and approved by authorities having jurisdiction. List approved fabricators in Part 2 if required.

6. 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, if required, is normally engaged by Owner.

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

F. 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 members indicated.

G. Quality-Control Standard: For manufacturing procedures and testing requirements and quality control recommendations for types of members 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 fabricator'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.

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

Retain paragraph below if shop or field welding is required. If retaining, also retain "Welding Certificates" paragraph in "Submittals" Article. 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.

I. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel"; AWS D1.4/D1.4M, "Structural Welding Code – Reinforcing Steel"; and AWS D1.6/D1.6M "Structural Welding Code-Stainless".

Retain paragraph below if fire-rated members 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.

J. Fire Resistance: Where indicated, provide structural precast concrete members whose fire resistance satisfy the fire resistance ratings of the Contract Documents and 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 units for CA precast concrete members to establish the range of acceptable finish, color, and texture to be expected. Revise number and size of sample units in paragraph below to suit Project.

K. Sample Units: After sample approval and before fabricating CA precast concrete members, with **[architectural finish] [thin-brick facing] [stone facing],** produce sample units to establish the approved range of selections made under sample Submittals. Produce a minimum of **[2] <Insert number>** sample units approximately **[16 ft.^{2} (1.5 m^2)] <Insert size>** in area. Incorporate full scale details of architectural features, finishes, textures and transitions in sample units.

1. Locate units where indicated in Contract Documents 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 repairs of surface blemishes.
3. After acceptance of repair technique, maintain one sample unit at the fabricator's plant and one at the Project site in an undisturbed condition as a standard for judging the completed Work.
4. Demolish and remove sample units when directed.

PCI recommends production of finish and texture range samples when color and texture uniformity of CA units concerns could be an issue, Architect or fabricator has not had previous experience with the specified mixture and finish, or a large project has multiple approving authorities

L. Range Sample Units: After sample units approval and before fabricating structural precast concrete CA units, produce a minimum of **[three][five] <Insert number>**samples, approximately **(16 ft^2 [1.5 m^2]) <Insert number>** in area,

representing anticipated range of each color and texture on Project's units. Maintain samples at the fabricator's plant as color and texture acceptability reference.

Retain paragraph and subparagraphs below if sample units above will not suffice and the added expense of mockups is required. If retaining, indicate location, size, and other details of mockups on Drawings or by inserts. Revise wording if only one mockup is required.

M. Mockups: After sample panel approval but before production of structural precast concrete units, with **[architectural finish] [thin-brick facing] [stone facing],** construct full-sized mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution. Mockups to be representative of the finished work in all respects including [**sealants]** <**Insert construction**> and precast concrete complete with anchors, connections, 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 in Contract Documents or, if location is 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 of precast concrete members.
4. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
5. 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 Section 01400, "Quality Requirements" for demolishing and removing mockups.

6. Approved mockups may become part of the completed Work if undamaged at the time of Substantial Completion.
7. Approval of mockups does not constitute approval of deviations from the Contract Documents unless such deviations are specifically approved by Architect in writing.

Delete paragraph below if mockup above is to be used for Testing Mockup or if testing is not required. If retaining paragraph and subparagraph below, determine where preconstruction testing will be specified and include requirements in that Section. Requirements in paragraph below are limited to building a preconstruction testing mockup at a testing agency's facility.

N. Preconstruction Testing Mockup: Provide a full-size mockup of precast concrete indicated on Drawings for preconstruction testing. Refer to Division **[01] [08] <Insert**

Division number> Section "<**Insert Section title**>" for preconstruction testing requirements.

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

1. Build preconstruction testing mockup as indicated on Drawings including **[sealants,] <Insert construction>** and precast concrete complete with anchors, connections, and joint fillers.
2. Build preconstruction testing mockup at testing agency facility.

Delete below if Work of this Section is not extensive or complex enough to justify a preinstallation conference. If retaining, coordinate with Division 01.

O. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**to comply with requirements in Section 01310 "Project Management and Coordination."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver all structural precast concrete members in such quantities and at such times to assure compliance with the agreed upon project schedule and setting sequence to ensure continuity of installation.

B. Handle and transport members in a manner to avoid excessive stresses that could cause cracking or other damage.

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

D. Unless otherwise specified or shown on Shop Drawings, store members with dunnage across full width of each bearing point.

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

F. Place dunnage of even thickness between each member.

G. Lift and support members only at designated points indicated on the Shop Drawings.

1.9 SEQUENCING

Coordination and responsibility for supply of items to be placed on or in the structure to allow placement of precast concrete members 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. Ensure that type and quantity of hardware items to be cast into precast concrete members for use by 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 locations, setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 – PRODUCTS

2.1 FABRICATORS

Retain this Article if naming fabricators. See PCI's Web site www.pci.org for current PCI-certified plant listings.

A. Fabricators: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [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 01 Section "Product Requirements."

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

1. **[Insert in separate subparagraphs, fabricators: names and product designations for acceptable manufacturers.>**

2.2 FORM MATERIALS

A. Forms: Rigid, dimensionally stable, nonabsorptive material, warp and buckle free, that will provide precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required surface finishes.

1. Form-Release Agent: Commercially produced form-release agent that will not bond with, stain or affect hardening of 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 manufacturer's recommended form-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 forms to help obtain exposed aggregate finish.

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

2.3 REINFORCING MATERIALS

Retain first paragraph below if recycled content is required for LEED-NC or LEED C1 Credits MR 4.1 and MR 4.2. USGBC allows a default value of 25 percent to be used for steel, without documentation; higher percentages can be claimed if they are supported by appropriate documentation**.** Reinforcing bars made by the electric arc furnace process contain a total of 100 percent recovered steel of which 67 percent is post-consumer.

A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than **[25] [60] <Insert number>** percent.

Select one or more paragraphs in this Article to suit steel reinforcement requirements. Indicate locations of each type of reinforcement here or on Drawings. If retaining Part 1 "Performance Requirements" Article, consider reviewing selections with fabricators.

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

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

C. 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.

D. Galvanized Reinforcing Bars: **[ASTM A 615/A 615M, Grade 60 (Grade 420)] [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 epoxy coating; retain ASTM A 934/A 934M for a non-bendable epoxy coating.

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

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

Select one or more of the paragraphs below to suit steel reinforcement requirements. If retaining Part 1 "Performance Requirements" Article, consider reviewing selections with fabricators.

G. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, or ASTM A 1064/A 1064M, fabricated from **[as-drawn] [galvanized and chromate wash treated]** steel wire into flat sheets.

H. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, or ASTM A 1064/A 1064M, flat sheet.

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

J. Supports: Use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.

2.4 PRESTRESSING TENDONS

Retain this Article if precast concrete members 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, Grade 270 (Grade 1860), 7-wire, low-relaxation strand with corrosion inhibitor conforming to ACI 423.7, with polypropylene tendon sheathing. Include anchorage devices.

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/A 722M, uncoated high strength steel bar.

2.5 CONCRETE MATERIALS

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

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

Select portland cement color from options in subparagraph below. 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 pastel colors. For darker colors, the variations of gray cement will have less effect on the final color hue.

1. For surfaces exposed to view in finished structure, use **[gray] [or] [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 mixture uses white cement but gray cement will be permitted in backup mixture.

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

B. Supplementary Cementitious Materials

Prior to selecting mineral or cementitious materials from four subparagraphs below consult local fabricators. These materials may affect concrete appearance, set times and cost. 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: ASTM C 618, Class C or F with maximum loss on ignition of 3%.
2. Metakaolin: ASTM C 618, Class N.
3. Silica Fume: 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.

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

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

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

Retain one option 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-Mixture 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-mixture be used throughout.

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

Lightweight aggregates in a face mixture are not recommended in cold or humid climates (if exposed to the weather) unless their performance has been verified by tests or records of previous satisfactory usage in similar environments. If normalweight aggregates are used in the face mixture, 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.

Retain first paragraph below if coloring admixture is required. Add color selection if known.

F. Coloring Admixture: ASTM C 979, synthetic or natural mineral-oxide pigments or liquid coloring admixtures, temperature stable and nonfading.

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

Retain paragraph below if air entrainment is 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 with low levels of volatile organic compounds (VOC) 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. Water-Reducing and Accelerating Admixture ASTM C494/C 494M, Type E.
5. High Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
6. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
7. Plasticizing Admixture for Flowable Concrete: ASTM C 1017/C 1017M.
8. Corrosion Inhibiting Admixture: ASTM C 1582/C 1582M

2.6 STEEL CONNECTION MATERIALS

Edit this Article to suit Project. Add other materials as required. Select steel with high percentage of post-consumer recycled content.

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, AWS D1.1/D1.1M, Type A or B, with arc shields and with the minimum mechanical properties of PCI MNL 116, Table 3.2.3.

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

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

E. Carbon-Steel Castings: ASTM A 27/A 27M, Grade 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/A 500M, 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 used for friction-type connections between steel members and are not recommended between steel and concrete because 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 A193/A193M, Grade B5 or B7, 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).

Structural plate and shape steel connection hardware enclosed in wall cavities is provided uncoated in non corrosive environments. Protection is required by painting or galvanizing on steel connection hardware when the corrosive environment is high or when connections are exposed to exterior weather conditions. Retain paragraph below if shop-primed finish is required. Indicate locations of priming, if required. MPI 79 in first option below provides some corrosion protection while SSPC-Paint 25, without top-coating, provides minimal corrosion protection. The need for protection from corrosion will depend on the actual conditions to which the connections will be exposed to in service. Indicate locations of each finish. Select coatings that do not contain toxic chemicals and with less than 250 g/l VOCs.

L. Shop-Primed Finish: Prepare surfaces of nongalvanized steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3 and shop-apply **[lead- and chromate-free, rust –inhibitive primer, complying with performance requirements in MPI 79] [SSPC-Paint 25]** according to SSPC-PA 1.

Retain paragraph and subparagraph below if galvanized finish is required. Indicate 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.

M. 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, ASTM A 153/A 153M, or ASTM F 2329 as applicable]**

[electrodeposition according to ASTM B 633, SC 3, Type 1 or 2 and for bolts F 1941 and F 1941M].

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 content and 2.5 times phosphorous content to 0.09 percent.
2. Galvanizing Repair Paint: Zinc paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035B or SSPC-Paint 20.

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

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

2.7 STAINLESS-STEEL CONNECTION MATERIALS

Retain this Article if required. Use when corrosion resistance merits extra cost in parking structures or other high moisture or corrosive environments.

A. Stainless-Steel Plate: ASTM A 666, Type 304, Type 316, or Type 201, 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 AND OTHER ACCESSORIES

Retain this Article if 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 members **[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 according to ASTM D2240. 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.
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 according to ASTM D 2240. Conforming to Division II, Section 18.10.2 of AASHTO LRFD Bridge Design Specifications or Military Specification, MIL-C-882E.
4. Frictionless Pads: Polytetrafluoroethylene (PTFE), glass-fiber reinforced, bonded to stainless or mild-steel plates, or random-oriented, fiber-reinforced elastomeric pads, 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 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.

Select material from options in paragraph below or add another material to suit Project. Coordinate with counterflashing materials and details. It is preferable to use surface mounted reglets to avoid misalignment of reglets from unit to unit.

B. Reglets: **[PVC extrusions.] [Stainless steel, Type 304] [Copper] [Reglets and flashing are specified in Section 07620 "Sheet Metal Flashing and Trim."]** felt or fiber filled face opening of slots covered.

C. Erection Accessories: Provide clips, hangers, high density plastic or steel shims, and other accessories required to install structural precast concrete members.

D. Welding Electrodes: Comply with AWS standards for steel type and/or alloy being welded.

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 members. 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. Mix at ratio of 1 part cement to 2 ½ to 3 parts sand, by volume, with minimum water required for placement and hydration. Water-soluble chloride ion content of grout less than 0.06 percent chloride ion by weight of cement when tested in accordance with ASTM C 1218/C 1218M.

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 members.

B. Nonshrink Grout: Premixed, prepackaged 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 for drypack and Grades B and C for flowable grout and of consistency suitable for application with a 30-minute working time. Water-soluable chloride ion content of grout less than 0.06 percent chloride ion by weight of cement when tested in accordance with ATM C1218/C1218M.

C. Epoxy-resin grout: Two-component mineral-filled epoxy-resin: ASTM C 881/C 881M of type, grade, and class to suit requirements.

2.10 CLAY PRODUCT UNITS AND ACCESSORIES

Retain this Article if specifying thin brick-faced precast concrete members which require brick units with tighter dimensional tolerances than ASTM C 1088 or ASTM C 216, Type FBX. TBX or FBX brick units may be too dimensionally variable to fit securely within form liner templates. For economy, brick patterns should minimize cutting of brick. Select thin brick manufacturer and product prior to bid or establish cost allowance. If full-size brick units are required, delete this article and refer to Section 04810 "Unit Masonry Assemblies." The listed characteristics for thin brick units are included in PCI "Standard for Thin Brick". Verify availability of sizes and color.

A. Thin Brick Units: Thickness, not less than ½ in. (12.7 mm), nor more than 1 in. (25.4 mm) thick, with an overall tolerance of plus 0 in, minus $^{1}/_{16}$ in. (+0 mm, -1.59 mm) for any unit dimension 8 in. (203.2 mm) or less and an overall tolerance of plus 0 in.,

minus $^{3}/_{32}$ in. (+0 mm, -2.38 mm) for any unit dimension greater than 8 in. (203.2 mm) measured according to ASTM C 67.

1. Face Size Modular, 2 ¼ in. (57.15 mm) high by 7 $^{5}/_{8}$ in. (193.68 mm) long.
2. Face Size Norman, 2 ¼ in. (57.15 mm) high by 11 $^{5}/_{8}$ in. (295.28 m m) long.
3. Face Size Closure Modular, 3 $^{5}/_{8}$ in. (92.08 mm) high by 7 $^{5}/_{8}$ in. (193.68 mm) long.
4. Face Size Utility, 3 $^{5}/_{8}$ in. (92.08 mm) high by 11 $^{5}/_{8}$ in. (295.28 mm) long.
5. Face Size: **<Insert dimension>**.

If approving a color range for brick, view 100 square feet (9.3 m^2) of loose bricks or a completed building. Edit to suit Project or delete if brick is specified by product name.

6. Face Size, Color, and Texture: **[Match Architect's samples] [Match existing color, texture, and face size of adjacent brickwork]**

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

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

7. Special Shapes: Include corners, edge corners, and end edge corners.
8. Cold Water Absorption at 24 Hours: Maximum 6 percent when tested per ASTM C 67.
9. Efflorescence: Tested according to ASTM C 67 and rated "not effloresced."
10. Out of Square: Plus or minus $^{1}/_{16}$ in. (± 1.59 mm) measured to nearest 1/32 in. (1mm) according to ASTM C 67.
11. Warpage: Consistent plane of plus 0 in, minus $^{1}/_{16}$ in. (+0 mm, -1.59 mm) measured to nearest 1/32 in. (1mm).
12. Variation of Shape from Specified Angle: Plus or minus 1 degree measured to nearest 1 degree using a protractor graduated in ½ degree (30 minute) division.
13. Tensile Bond Strength: Not less than 150 psi (1.0Mpa) when tested per modified ASTM E 488. Epoxy steel plate with welded rod on a single brick face for each test.
14. Freezing and Thawing Resistance: No detectable deterioration (spalling, cracking, or chafing) when tested in accordance with ASTM C 666.
15. Modulus of Rupture: Not less than 250 psi (1.7Mpa) when tested in accordance with ASTM C 67.
16. Chemical Resistance: Provide brick that has been tested according to modified ASTM C 650 and rated "not affected."

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

17. 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 20 ft (6 m).

Retain first subparagraph below, deleting inapplicable descriptions if required.

18. Back Surface Texture: scored, combed, wire roughened, ribbed, keybacked, or dovetailed.
19. 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 01 Section "Materials and Equipment."

20. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [products that may be incorporated into the work include, but are not limited to, the following]**:

    a. **<Insert in separate subparagraphs, manufacturers' name and product name or designation.>**

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 ceramic tile units.

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: Comply with requirements of the manufacturer of the selected Architectural Terra Cotta for the application indicated.

Retain paragraph below if mortar setting clay product unit joints before placing precast concrete mixture.

D. Sand-Cement 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.

Retain paragraph and subparagraphs below if filling brick unit joints with pointing grout after precast concrete member production.

E. Latex-Portland Cement Pointing Grout: ANSI A118.6 (included in ANSI A 108.1) 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]**.
4. Tool joints to a slightly concave shape when pointing grout is thumbprint hard.

F. Setting Systems

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

1. Thin brick and Ceramic Tile Units: **[Dry-Set Mortar: ANSI A118.1 (included in ANSI A 108.1)] [Latex-Portland Cement Mortar: ANSI A 118.4 (included in ANSI A 108.1)]**
2. Full Brick Units: Install **[Galvanized] [Type 304 stainless steel]** dovetail slots in precast concrete: not less than $^{3}/_{16}$ in. (0.5 mm) thick, felt or fiber filled or cover face opening of slots. Attach brick units with 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 Section 04851 "Dimension Stone Cladding." Replace first paragraph below with stone requirements, if preferred.

A. Stone facing for structural precast concrete is specified in Section 04851 "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 fabricator. Specify supplier. Anchors may be toe-in, toe-out, or dowels.

B. Anchors: Stainless steel, ASTM A 666, Type 304 or Type 316, of temper and diameter required to support loads without exceeding allowable design stresses.

Retain subparagraph below if rigid epoxy filler is specified. Grommets will usually be required if filling dowel holes with rigid epoxy.

1. Fit each anchor leg with 60 durometer, ASTM D 2240, neoprene grommet collar of width at least twice the diameter of the anchor and a length at least five times the diameter of the anchor.

C. Sealant Filler: ASTM C 920, low-modulus, multicomponent, nonsag polyurethane or silicone sealant complying with requirements in Section 07920 "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, sand-filled 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 members are required, retain one or more of the following insulation paragraphs. Specify the required thickness for each insulation type allowed to achieve the desired aged R-value. CFCs, HCFCs and other ozone-depleting substances should not be used or released during manufacture of insulation.

A. Expanded-Polystyrene Board Insulation: ASTM C 578, Type **[XI, 0.70 lb/ft^3(12kg/m^3)], [I, 0.90 lb/ft^3 (15kg/m^3)][VIII, 1.15 lb/ft^3(18kg/m^3)][II, 1.35 lb/ft^3(22kg/m^3)][IX, 1.80 lb/ft^3(29 kg/m^3)]**; **[square][ship-lap]** edges; with thickness of **<Insert dimension>**.

B. Extruded-Polystyrene Board Insulation: ASTM C 578, Type **[X, 1.30 lb/ft^3(21kg/m^3)][IV, 1.55 lb/ft^3(25 kg/m^3)][VI, 1.80 lb/ft^3(29 kg/m^3)][VII, 2.20 lb/ft^3(35 kg/m^3)][V, 3.00 lb/ft^3(48 kg/m^3)]; [square][ship-lap]** edges; with thickness of **<Insert dimension>**.

C. Polyisocyanurate Board Insulation: Rigid, cellular polyisocyanurate thermal insulation complying with ASTM C 591; Grade 1, or ASTM C 1289 Type **[I, 1.8 lb/ft^3(29kg/m^3)][II, 2.5 lb/ft^3 (40kg/m^3)][(III, 3.0 lb/ft^3(48kg/m^3)]**; square edged; unfaced; with thickness of **<Insert dimension>.**

Select wythe connectors from paragraph below.

D. Wythe Connectors: **[Glass-fiber in vinyl-ester polymer], [Polypropylene pin], [Stainless-steel pin], [Bent galvanized reinforcing bars] [Galvanized welded wire trusses], [Galvanized bent wire connectors] [Epoxy coated carbon fiber grid], [Fiberglass truss]** manufactured to connect wythes of precast concrete panels.
   1. Provide holes in insulation for connector placement at least 4 in. (100 mm) and no more than 12 in. (0.30m) from edges of member or openings.

2.13 CONCRETE MIXTURES

A. Prepare design mixtures for each type of precast concrete required or to match Architect's sample.

Retain subparagraph below if fly ash, blast furnace slag, or gray silica fume are permitted. Revise percentage to suit Project. Lower limits below apply to CA finishes.

   1. Limit use of fly ash to **[15 to 20] [35]** percent replacement of portland cement by weight; granulated blast-furnace slag to **[15 to 20] [50]** percent of portland cement by weight; and metakaolin and silica fume to 10 percent of portland cement by weight.

B. Design mixtures 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 members may be fabricated with a separate "architectural" face mixture and a "structural" backup mixture. Face and backup mixtures should have similar shrinkage and expansion coefficients. Similar water-cementitious materials ratios and cement-aggregate ratios are recommended to limit bowing or warping.

D. Normalweight Concrete Face and Backup Mixtures: Proportion mixtures by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normalweight 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): 5000 psi (34.5 Mpa) minimum.
   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 reducing admixtures. Revise ratio as required to suit Project.

3. Maximum Water-Cementitious Materials Ratio: 0.45.

Lightweight backup mixtures must be compatible with normalweight face mixtures to minimize bowing or warping. Retain paragraph below if required or as an option if satisfactory durability and in-service performance are verified by fabricator. Coordinate with selection of normalweight face mixture option above..

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

Retain subparagraph below or revise to suit Project. Higher-strength mixtures may be available; verify with fabricators.

1. Compressive Strength (28 Days): 5000 psi (34.5 Mpa) minimum.
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 combinations of lightweight and normalweight aggregate in mixture will usually be heavier than unit weight below.

3. Density (Unit Weight): Calculated equilibrium density of 115 lb/ft.^{3} (1842 kg/m^3), plus or minus 5 lb/ft.^{3} (80 kg/m^3) adjusted to plus or minus 3 lb./ft.^{3} (48 kg/ m^3), when tested in accordance with 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 mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.

H. Concrete Mixture Adjustments: Concrete mixture 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 members of shapes, lines, and dimensions indicated in Contract Documents, within fabrication tolerances specified.

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

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 during concrete placement.

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

C. Match appearance of sample units.

D. After stripping units, clean faces and joints of brick facing.

2.16 STONE VENEER FACINGS

Retain this Article if stone facing is required. Refer to Section 04851 “Dimension Stone Cladding”.

A. Accurately position stone facings to comply with requirements and in locations indicated on Shop Drawings. Install anchors, supports, and other attachments indicated or necessary to secure stone in place. Maintain projection requirements of stone anchors into concrete substrate. Orient stone veining in direction indicated on Shop

Drawings. Keep concrete 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.

B. See Section 07920 "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 members at the stone/precast concrete interface using the bond breaker as a joint filler backer. Do not seal 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 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) thick polyethylene sheet to prevent bond between back of stone facing and concrete substrate.
4. Install 1/8 inch (3 mm) thick polyethylene-foam bond breaker to prevent bond between back of stone facing and concrete substrate.

PCI recommends anchor spacing be determined prior to bidding. Retain below if fabricator 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.

C. Stone Anchor Shear and Tensile Testing: Engage accredited 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 each; 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 pullout or stone breakage, and any other pertinent information, in accordance with the requirements of ASTM E 488.

Retain subparagraph below and revise anchor spacing if required as a result of preconstruction

testing of stone anchors for shear and tension specified in Section 04851 "Dimension Stone Cladding."

D. Stone to Precast Concrete Anchorages: Provide anchors in numbers, types and locations required to satisfy specified performance criteria, but not less than two anchors per stone unit of less than 2 ft.^{2} (0.19 m^2) in area and four anchors per unit of less than 12 ft.^{2} (1.1 m^2) in area; and for units larger than 12 ft.^{2} (1.1 m^2) in area, provide anchors spaced not more than 24 in. (600 mm) on center both horizontally and vertically. Locate anchors a minimum of 6 in. (150 mm) from stone edge.

2.17 FABRICATION

Some methods of manufacturing hollow-core slabs preclude the use of anchors and inserts required for anchorage or lateral bracing to structural steel members. 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 members 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 Section 05500 "Metal Fabrications" for furnishing and installing loose hardware items.

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

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

Retain first paragraph below if 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 and 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 plastic tipped or corrosion resistant metal or plastic chairs, runners, bolsters, spacers, hangers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.
3. Place reinforcing steel and prestressing tendons to maintain at least ¾ in. (19 mm) minimum concrete cover. Provide cover requirements in accordance with ACI 318 (ACI 318M) 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 reinforcement in lengths as long as practicable. Lap adjoining pieces in accordance with ACI 318 (ACI 318M) and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.

F. Reinforce structural precast concrete members to resist handling, transportation, and erection stresses, and specified in-place loads, whichever governs.

Retain paragraph and subparagraph below if precast prestressed concrete members are 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 members by either pretensioning or post-tensioning methods. Comply with PCI MNL 116.

Revise release or post-tensioning strength in subparagraph below to an actual compressive strength, if required. Concrete strength in the range of 2500 psi (17.2 MPa) to 4000 psi (27.6 Mpa) at release does not appreciably affect bond transfer length.

1. Delay detensioning or post-tensioning of precast prestressed concrete members 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 inch (25 mm), fill with non-metallic, non-shrink mortar and sack rub surface. Coat or spray the inside pocket surfaces with a bonding agent before installing mortar.

Retain the following subparagraph only when not exposed to severe environment or view.

5. Protect strand ends and anchorage not exposed to view with bitumastic, zinc-rich or epoxy paint.

H. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

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

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

1. Use a single design mixture for those members 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 mixture design/casting techniques may be used:

a. A single design mixture throughout the entire thickness of member.
b. Design mixtures for facing and backup; using cement and aggregates for each type as appropriate, for consecutive placement in the form. Use cement and aggregate specified for facing mixture. Use cement and aggregate for backup mixture complying with specified criteria or as selected by the fabricator.

J. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete members.

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

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

1. Place self-consolidating concrete without vibration in accordance with PCI TR-6 "Interim Guidelines for the Use of Self-Consolidating Concrete." If face and backup concrete is used, ensure adequate bond between concrete mixtures.

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

M. Identify pickup points of precast concrete members and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast concrete member 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 members until compressive strength is high enough to ensure that stripping does not have an effect on the performance or appearance of final product.

2.18 INSULATED PANEL CASTING

Retain this Article if integrally insulated members are required.

A. Cast, screed and consolidate bottom concrete 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.

D. Maintain temperature below 150 deg. F (65 deg. C) in bottom cast concrete wythe.

2.19 FABRICATION TOLERANCES

Usually retain paragraph below unless tolerances for Project deviate from PCI recommendations. PCI 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 members of shapes, lines and dimensions indicated, so each finished member complies with 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 member 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 fabricators 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 fins and protrusions larger than 1/8 inch (3 mm) and fill holes with a diameter larger than ½ inch (13 mm). Rub or grind ragged edges. Faces shall 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 members.

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 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 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." Specify a sample panel for a Grade A Finish. Requirements for Grade A Finish are not applicable to extruded products using zero-slump concrete in their process.

4. Grade A Finish: Repair all surface blemishes and fill all air holes 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 members that will receive concrete topping after installation.

E. Commercial Architectural (CA) Finishes

1. Exposed faces shall be free of joint marks, grain, or other obvious defects. Corners, including false joints shall be uniform and straight. Finish exposed-face surfaces of structural precast concrete members 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 ”Fabricators” Article. Revise if multiple samples are approved.

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

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

b. PCI’s “Architectural Precast Concrete – Color and Texture Selection Guide,” of plate numbers indicated.

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.

c. As-Cast Surface Finish: Provide surfaces to match accepted sample or mockup units for acceptable surface air voids, sand streaks, and honeycombs.
d. Textured-Surface Finish: Impart texture by form liners or inserts to match accepted sample or mockup units for acceptable surface air voids, streaks, and honeycombs, with uniform color and texture.
e. Bushhammer Finish: Use power or hand tools to remove matrix and fracture coarse aggregates to match accepted sample or mockup units.
f. Exposed Aggregate Finish: Use chemical retarding agents applied to forms and washing and brushing procedures, to expose aggregate and surrounding matrix surfaces after form removal to match accepted sample or mockup units.
g. Abrasive-Blast Finish: Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces to match accepted sample or mockup units.
h. Acid-Etched Finish: Use acid and hot-water solution, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces to match accepted sample or mockup units. Protect hardware, connections and insulation from acid attack.
i. Honed Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures to match accepted sample or mockup units.
j. Polished Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures to match accepted sample or mockup units.
k. Sand-Embedment Finish: Use selected stones placed in a sand bed in bottom of form, with sand removed after curing to match accepted sample or mockup units.
l. Thin Brick Facings: Refer to "Thin Brick Facings" Article.
m. Stone Veneer Facings: Refer to "Stone Veneer Facings" Article.

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 a 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” and ASTM C 1611/C 1611M, ASTM C 1712, ASTM 1610/1610M, and ASTM C 1621/C 1621M.

Retain first paragraph and subparagraph below if 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 accredited 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 mixtures as may be requested for additional testing and evaluation.

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

Review testing and acceptance criteria with structural engineer. In first paragraph and subparagraph below, add criteria for load tests if required.

D. Testing: If there is evidence that strength of precast concrete members may be deficient or may not comply with ACI 318 (ACI 318M) requirements, fabricator shall 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 and ACI 318/ACI 318M.

1. Test results shall be reported in writing on the same day that tests are performed, with copies to Architect, Contractor, and precast concrete fabricator. Test reports shall 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 member(s) represented by core tests; design compressive strength; type of failure; actual 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 members comply with requirements, clean and dampen core holes and solidly fill with precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.

F. Acceptability: Structural precast concrete members 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 members may be repaired. The Architect reserves the right to reject any member if it does not match the accepted samples. Replace unacceptable units with precast concrete members that comply with requirements.

PART 3 – EXECUTION

3.1 PREPARATION

A. Furnish loose connection hardware and anchorage devices for precast concrete members to be embedded in or attached to the building structural frame or foundation before starting that Work. Provide locations, setting diagrams, templates and instructions for the proper installation of each anchorage device.

3.2 EXAMINATION

A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, bearing surface tolerances, and other conditions affecting precast concrete performance.

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

C. Contractor shall notify precast concrete erector that supporting cast-in-place concrete foundation and building structural framing has attained minimum allowable design compressive strength or supporting steel or other structure is structurally ready to receive loads from precast concrete members prior to proceeding with installation.

3.3 ERECTION

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

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

1. Install temporary steel or plastic spacing shims or bearing pads as precast concrete members are being erected. Surface 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 plastic patchcaps or sand-cement grout to fill voids within recessed lifting devices flush with surface of adjacent precast concrete surfaces when recess is exposed.
4. Unless otherwise indicated, provide for uniform joint widths of ¾ in. (19mm).

Retain subparagraph below if voids of hollow-core slabs are used for electrical raceways or mechanical ducts.

5. For hollow-core slab voids used as electrical raceways or mechanical ducts, align voids between units and tape butt joint at end of slabs.
6. Provide and install headers of structural-steel shapes for openings larger than one slab width according to hollow-core slab fabricator's written recommendations.

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

1. Disruption of roof flashing continuity by connections is not permitted; concealment within roof insulation is acceptable.

D. Welding: Comply with applicable AWS D1.1/D1.1M, AWS D1.4/D1.4M and AWS D1.6/D1.6M requirements for welding, welding electrodes, appearance of welds, quality of welds, and methods used in correcting welding work.

1. Protect structural precast concrete members and bearing pads from damage during field welding or cutting operations and provide noncombustible shields as required.
2. Welds not specified shall be continuous fillet welds, using not less than the minimum fillet as specified by AWS D1.1/D1.1M, D1.4/D1.4M or D1.6/D1.6M.
3. Clean-weld-affected metal surfaces with chipping hammer followed by brushing or power tool cleaning and then reprime damaged painted surfaces in accordance with manufacturer's recommendations.

Retain last subparagraph above or first subparagraph below.

4. For galvanized metal, clean weld affected metal surfaces with chipping hammer followed by brushing or power tool cleaning, and apply a minimum 0.004 inch (4 mil) thick coat of galvanized repair paint to galvanized surfaces in conformance with ASTM A 780/A 780M.
5. Visually inspect all welds critical to precast concrete 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 upset threads, thread locking compound or other approved means to prevent loosening of nuts after final adjustment.

1. Where slotted connections are used, verify bolt position and tightness at installation. For sliding connections, properly secure bolt but allow bolt to move within connection slot.
2. For slip critical connections, one of the following methods shall be used to assure proper bolt pretension:
   a. Turn-of-Nut – in accordance with AISC.
   b. Calibrated Wrench – in accordance with AISC.
   c. Twist-off Tension Control Bolt – meeting ASTM F 1852.
   d. Direct-Tension Control Bolt – meeting ASTM F 1852.
3. For slip critical connections, the method to be used and the inspection procedure to be used shall be approved by the Architect and coordinated with the inspection agency.

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

F. Grouting or Dry-Packing Connections and Joints: Indicate joints to be grouted and any critical grouting sequences on Shop (Erection) Drawings. Grout open spaces at keyways, connections and joints where required or indicated. Provide reinforcing steel where indicated. Retain flowable grout in place until it gains sufficient strength to support itself. Fill joints completely without seepage to other surfaces. Alternatively, pack spaces with stiff dry pack grout material, tamping until voids are completely filled. Place grout and finish smooth, level, and plumb with adjacent concrete surfaces. Promptly remove grout material from exposed surfaces before it affects finishes or hardens. Keep grouted joints damp for at least 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.

Retain subparagraph below when end grouting hollow-core slabs is required.

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

G. Field cutting of precast, prestressed concrete members 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 members.

H. Fasteners: Do not use drilled or power-actuated fasteners for attaching accessory items to precast, prestressed concrete members unless approved by Precast Engineer and Engineer of Record.

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 members level, plumb, square, 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 fabricator and acceptable to the Architect.

3.5 FIELD QUALITY CONTROL

Retain first option in paragraph below if Owner engages a special inspector. If authorities having jurisdiction permit Contractor to engage a special inspector, retain second option and retain option for submitting special inspection reports in Part 1 "Submittals" Article.

A. Special Inspections: **[Owner will engage][Contractor will engage]** a qualified special inspector to perform the following special inspections and prepare reports:

1. Erection of loadbearing precast concrete members.
2. **<Insert special inspections>**

Retain first paragraph below if field testing and inspecting are required, with or without paragraph above, to identify who shall perform tests and inspections. If retaining second option, retain requirement for field quality-control test reports in Part 1 "Submittals" Article.

B. Testing: Owner will engage accredited independent testing and inspecting agency to perform field tests and inspections and prepare reports.

1. Field welds will be subject to visual inspections and dye penetrant or magnetic particle testing in accordance with ASTM E 165 or ASTM E 1444. Testing agency shall be qualified in accordance with ASTM E543.
2. Testing agency will report test results promptly and in writing to Contractor and Architect.

C. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.

D. Additional testing and inspecting, at Erector'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 fabricator's plant. Defects

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

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

The precast concrete fabricator 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/A 780M.

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 members when repairs do not comply with specified requirements.

3.7 CLEANING

Specify whether erector or precaster does cleaning under the responsibility of General Contractor. Consider use of biodegradable, bio-based cleaning products.

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 members 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 adjacent 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