

SECTION 03 45 00
PRECAST ARCHITECTURAL CONCRETE

SPEC WRITER NOTE: Delete between // // if not applicable to project. Also delete any other item or paragraph not applicable in the section and renumber the paragraphs.

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section includes the performance criteria, materials, production, and erection of architectural precast concrete cladding // and load bearing // units. The work performed under this section includes all labor, material, equipment, related services, and supervision required for the manufacture and erection of the architectural precast concrete work shown on the construction documents.

1.2 RELATED WORK

- A. Section 01 45 29, TESTING LABORATORY SERVICES: Materials testing and inspection during construction.
- B. //Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS: Sustainable Design Requirements. //
- C. Section 03 30 00, CAST-IN-PLACE CONCRETE: Concrete.
- D. Section 03 41 33, PRECAST STRUCTURAL PRETENSIONED CONCRETE: Precast pre-stressed structural building elements.
- E. Section 04 05 13, MASONRY MORTARING: Mortar.
- F. //Section 04 05 16, MASONRY GROUTING: Grout. //
- G. Section 04 20 00, UNIT MASONRY: Masonry Facing.
- H. Section 04 72 00, CAST STONE MASONRY: Cast Stone Facing.
- I. Section 07 21 13, THERMAL INSULATION: Insulation for Insulated Panels.
- J. Section 07 92 00, JOINT SEALANTS: Sealants and Caulking.
- K. Section 09 06 00, SCHEDULE FOR FINISHES: Size, Type and Color of Aggregate for Exposed Aggregate Finish and Matrix Color.
- L. Section 09 91 00, PAINTING: Repair of Abraded Galvanized and Painted Surfaces.

1.3 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm that complies with PCI MNL 117 and the following requirements and is experienced in producing units similar to those indicated for this Project and with a record of successful in-service performance:
1. //Provide engineering units to comply with performance requirements.
Furnish Comprehensive Engineering Analysis, performed by a Professional

Structural Engineer registered in the state of the project with a minimum of 5 years experience in providing engineering services of the kind indicated. //

2. Participates in PCI's Plant Certification program at the time of bidding and is designated a PCI-certified plant for Group A, Category A1- Architectural Cladding and Load Bearing Units. Submit PCI certification.
3. Fabricator must have a minimum of three (3) years' experience in Precast Architectural Concrete work comparable to that shown and specified in not less than three (3) projects of similar scope // with the Government determining the suitability of experience //.

B. Erector Qualifications:

1. A precast concrete erector Qualified by the Precast/Prestressed Concrete Institute (PCI) prior to beginning work at the project site. Submit a current Certificate of Compliance furnished by PCI designating qualification in // Category A (Architectural Systems) for non-load-bearing members // // Category S2 (Complex Structural Systems) for load-bearing members //. Submit qualifications.
2. //An erector with a minimum of two (2) years of experience who has completed architectural precast concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance and who meets the following requirements: //
 - a. //Retains 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. Submit Erectors Post Audit Declaration. //
 - b. //The Basis of the Audit: PCI MNL 127. //

C. Testing Laboratory Accreditation Requirements: Construction materials testing laboratories must be accredited by a laboratory accreditation authority. Submit a copy of the Certificate of Accreditation and Scope of Accreditation.

D. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 117.

E. //Sample Panels: Before fabricating units, produce a minimum of two (2) sample panels approximately 1.5 sq. m. (16 sq. feet) in size for review by the Contracting Officer Representative (COR). Incorporate full scale details of architectural features, finishes, textures, and transitions in

the sample panels. Approved sample panel will be used for mockup and range sample.

1. Locate panels where indicated or, if not indicated, as directed by COR.
 2. Damage part of an exposed-face surface for each finish, color, and texture, and demonstrate adequacy of repair techniques proposed for repair of surface blemishes.
 3. After acceptance of repair technique by COR, maintain one (1) sample panel at the manufacturer's plant and one (1) at the project site in an undisturbed condition as a standard for judging the completed work.
 4. When back face of precast concrete unit is to be exposed, show samples of the workmanship, color, and texture of the backup concrete as well as the facing.
 5. Demolish and remove sample panels only when directed by COR. //
- F. //Range Samples: After sample panel approval and before production of units for installation, produce a minimum of three (3) samples, approximately 1.5 sq. m. (16 sq. feet) in size, representing anticipated range of color and texture of project. Following range sample acceptance by the COR, maintain samples at the manufacturer's plant and the Project site as color and texture acceptability reference.//
- G. //Mockups: After // sample panel // // and range sample // approval but before production of units, construct full sized mockups to verify selections and to demonstrate aesthetic effects and qualities of materials and execution. Mockup to be representative of the finished work in all respects including glass, aluminum framing, sealants and architectural precast concrete complete with all anchors, connections, flashings, and joint fillers as approved on the final shop drawings. Build mockups to comply with the following requirements, using materials indicated for the completed work:
1. Build mockups in the location and of the size indicated or, if not indicated, as directed by COR.
 2. Notify COR in advance of dates and times when mockups will be constructed.
 3. Obtain COR's approval of mockups before starting fabrication.
 4. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 5. Demolish and remove mockups when directed by COR.//
- H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01, GENERAL REQUIREMENTS.

1.4 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide units and connections capable of withstanding: the design criteria specified on the construction documents, self-weights and weights of materials supported or attached, for the conditions indicated.
1. Design Standards: Comply with ACI 318/ACI 318M and the design recommendations of PCI MNL 120 and PCI MNL 122 applicable to types of units indicated.
 2. Limit deflection of precast members as follows:
 - a. Vertical live load - $\text{Span} / 360$.
 - b. Wind load - $\text{Height} / 400$.
 3. //Parking Garage Vehicular Impact Loads: Design spandrel units acting as vehicular barrier for passenger cars to resist a single load of 26.7 kN (6,000 pounds) service load and 44.5 kN (10,000 pounds) ultimate load applied horizontally in any direction, with anchorages or attachments capable of transferring this load to the structure. For design of these units, assume the load to act at a height of 460 mm (18 inches) above the floor or ramp surface on an area not to exceed 0.09 sq. m. (1 sq. feet). //
 4. //Physical Security Life Safety Protected Facilities:
 - a. Precast concrete panels to meet or exceed the design and construction standards as provided in the Physical Security Design Manual for VA Facilities: Life Safety Protected.
 - 1) Blast Resistance: Design level threat //W1, W2// located at the standoff distance, but not greater than //GP1, GP2//. Submit calculations for review and approval prepared by qualified blast consultant, with a minimum of 5 years experience in design of blast resistant systems. The magnitudes of the design threats //W1, W2// //GP1,GP2// are defined in the Physical Security Design Standards Data Definitions which is a document separate from the referenced VA Security Design Manual. The Physical Security Design Standards Data Definitions are on a need to know basis by the blast/structural engineer performing the blast design on VA projects. It is the responsibility of the engineer of blast resistant system to request and obtain the Physical Security Design Data Standard Data Definitions from the VA Office of Construction and Facilities Management (CFM). Any associated delays or increased costs due to failure to obtain this information will be borne by the contractor //

5. //Physical Security Mission Critical Facilities:

a. Precast concrete panels to meet or exceed the design and construction standards as provided in the Physical Security Design Manual for VA Facilities: Mission Critical Facilities.

1) Blast Resistance: Design level vehicle threat (W1) located at the standoff distance, but not greater than GP2. Submit calculations for review and approval prepared by qualified blast consultant, with a minimum of 5 years experience in design of blast resistant systems. The magnitudes of the design threats W1 and GP2 are defined in the Physical Security Design Standards Data Definitions which is a document separate from the referenced VA Security Design Manual. The Physical Security Design Standards Data Definitions are on a need to know basis by the blast/structural engineer performing the blast design on VA projects. It is the responsibility of the engineer of blast resistant system to request and obtain the Physical Security Design Data Standard Data Definitions from the VA Office of Construction and Facilities Management (CFM). Any associated delays or increased costs due to failure to obtain this information will be borne by the contractor//

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

SPEC WRITER NOTE: Use other values, greater or smaller, whenever justified by climatic conditions for project site.

C. Thermal Movements: Provide for in-plane thermal movements resulting from annual ambient temperature changes of // 49 // // // degrees C (// 120 // // // degrees F).

D. Calculated Fire-Test-Response Characteristics: Where indicated, provide units whose fire resistance has been calculated according to PCI MNL 124.

1.5 SOURCE QUALITY CONTROL

A. Quality-Control Testing: Test and inspect precast concrete according to Section 01 45 29, TESTING LABORATORY SERVICES and PCI MNL 117 requirements respectively. If using self-consolidating concrete also test and inspect according to PCI TR-6.

B. Testing: When determined by the COR that there is evidence that the concrete strength of precast concrete units may be deficient, employ an

independent testing agency at Contractor's expense to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to PCI MNL 117:

1. Submit test results in writing on the same day that tests are performed, with copies to COR, Contractor, and precast concrete fabricator. Include the information required in Section 01 45 29, TESTING LABORATORY SERVICES and the following:
 - a. Identification mark and type of precast concrete units represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.
- C. Defective or Damaged Work: Units that do not comply with acceptability requirements, including concrete strength, manufacturing tolerances, and color and texture range are unacceptable. Chipped, spalled or cored units may be repaired, if repaired units match the visual mock-up. The COR will reject units that do not match the accepted samples and visual mock-up. Remove unacceptable units from the site and replace with precast concrete units that comply with requirements.

1.6 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. //Sustainable Design Submittals, as described below:
 1. //Postconsumer and preconsumer recycled content as specified in PART 2 - PRODUCTS.// //
- C. Design Mixes: For each concrete mix along with compressive strength and water-absorption tests.
- D. Shop (Erection) Drawings: Detail fabrication and installation of units.
 1. Indicate member locations with distinctive marks that match marks placed on the panels. Provide plans, elevations, dimensions, corner details, shapes, cross sections and relationships to adjacent materials.
 2. Indicate aesthetic characteristics including joints, reveals, and extent and location of each surface finish.
 3. Indicate separate face and backup mix locations, and thicknesses. Indicate locations, extent and treatment of dry joints if two-stage casting is proposed.
 4. Indicate welded connections by AWS standard symbols. Detail loose and cast-in hardware, and connections.

5. Indicate locations, tolerances and details of anchorage devices to be embedded in or attached to structure or other construction.
6. Indicate sequence of erection.
7. //Indicate locations and details of facing materials, anchors, and joint widths.//
8. //Design Modifications:
 - a. If design modifications are necessary to meet the performance requirements and field conditions, submit design calculations and drawings. Do not adversely affect the appearance, durability or strength of units when modifying details or materials and maintain the general design concept. //
- E. //Comprehensive Engineering Analysis: Submit calculations // signed and sealed // by a Professional Structural Engineer responsible for the product design who is registered in the state where the work is located. Show governing panel types, connections, and types of reinforcement, including special reinforcement. Indicate design criteria and loads. Indicate the location, type, magnitude and direction of all imposed loadings from the precast system to the building structural frame. //
- F. Samples: Design reference samples for initial verification of design intent, approximately // 305 by 305 by 50 mm (12 by 12 by 2 inches) //, representative of finishes, color, and textures of exposed surfaces of units.
- G. //Samples for each facing unit required, showing the full range of color and texture expected. Supply sketch of each corner or special shape with dimensions. Supply sample showing color and texture of joint treatment. //
- H. Welding Certificates: Copies of certificates for welding procedure specifications (WPS) and personnel.
- I. Qualification Data for fabricator, erector, and professional engineer: List of completed projects with project names and addresses, names and addresses of COR and owners, and PCI Certification documentation.
- J. Testing laboratory accreditations.
- K. Material Test Reports: From an accredited testing agency indicating and interpreting test results of the following for compliance with requirements indicated:
 1. Concrete strengths and mix designs.
- L. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements.
 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. Facing units.
- 8. Anchors.

- M. Description of stone anchor shear and tensile test assembly.
- N. Certificate of Compliance.
- O. Erectors Post Audit Declaration.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Comply with product handling requirements of PCI MNL 117 at the plant and project site.
- B. Deliver all units to the project site in such quantities and at such times to assure compliance with the agreed project schedule and proper setting sequence so as to limit unloading units temporarily on the ground.
- C. Lift and support units only at designated points shown on the shop drawings.
- D. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.
- E. Store units with adequate dunnage and bracing, and protect units to prevent contact with soil to prevent staining, and to prevent cracking, distortion, warping, and other physical damage. Place stored units so identification marks are clearly visible for inspection.

1.8 WARRANTY

- A. Construction Warranty: Comply with FAR clause 52.246-21 "Warranty of Construction".

1.9 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of specification to extent referenced. Publications are referenced in text by basic designation only.
- B. ASTM International (ASTM):
 - A27/A27M-20.....Standard Specification for Steel Castings, Carbon, for General Application
 - A36/A36M-19.....Standard Specification for Carbon Structural Steel
 - A47/A47M-99(2018)e1.....Standard Specification for Ferritic Malleable Iron Castings
 - A108-18.....Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished

A123/A123M-17.....Standard Specifications for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

A153/A153M-16a.....Standard Specifications for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

A184/A184M-19.....Standard Specification for Welded Deformed Steel Bar mats for Concrete Reinforcement

A240/A240M-20.....Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and For General Applications

A276/A276M-17.....Standard Specification for Stainless Steel Bars and Shapes

A283/A283M-18.....Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

A307-14e1.....Standard Specifications for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength

A416/A416M-18.....Standard Specification for Low-alloy, Seven-Wire Steel Strand for Prestressed Concrete

A500/A500M-20.....Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

A563-15.....Standard Specification for Carbon and Alloy Steel Nuts

A563M-07 (R2013).....Carbon and Alloy Steel Nuts (Metric)

A572/A572M-18.....Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

A615/A615M-20.....Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement

A666-15.....Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar

A675/A675M-14 (2019).....Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties

A706/A706M-16.....Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement

A767/A767M-19.....Standard Specification for Zinc Coated (Galvanized) Steel Bars for Concrete Reinforcement

A775/A775M-19.....Standard Specification for Epoxy Coated Steel
Reinforcing Bars

A780/A780M-20.....Standard Practice for Repair of Damaged and
Uncoated Areas of Hot-Dip Galvanized Coatings

A884/A884M-19.....Standard Specification for Epoxy-Coated Steel Wire
and Welded Wire Fabric for Reinforcement

A934/A934M-19.....Standard Specification for Epoxy-Coated
Prefabricated Steel Reinforcing Bars

A1064/A1064M-18a.....Standard Specification for Carbon-Steel Wire and
Welded Wire Reinforcement, Plain and Deformed, for
Concrete

B633-19.....Standard Specification for Electrodeposited
Coatings of Zinc on Iron and Steel

C33/C33M-18.....Standard Specification for Concrete Aggregates

C40/C40M-20.....Standard Test Method for Organic Impurities in
Fine Aggregate for Concrete

C144-18.....Standard Specification for Aggregate for Masonry
Mortar

C150/C150M-20.....Standard Specification for Portland Cement

C260/C260M-10a (2016)....Standard Specification for Air Entraining
Admixtures for Concrete

C330/C330M-17a.....Standard Specification for Lightweight Aggregates
for Structural Concrete

C373-18.....Standard Test Methods for Determination of Water
Absorption and Associated Properties by Vacuum
method for Pressed Ceramic Tiles and Glass Tiles
and Boil Method for Extruded Ceramic Tiles and
Non-tile Fired ceramic Whiteware Products

C494/C494M-19.....Standard Specification for Chemical Admixtures for
Concrete

C618-19.....Standard Specification for Coal Fly Ash and Raw or
Calcined Natural Pozzolan for Use in Concrete

C881/C881M-20.....Standard Specification for Epoxy Resin Base
Bonding Systems for Concrete

C920-18.....Standard Specification for Elastomeric Joint
Sealants

C979/C979M-16.....Standard Specification for Pigments for Integrally
Colored Concrete

- C989/C989M-18a.....Standard Specification for Slag Cement for Use in Concrete and Mortars.
- C1017/C1017M-13e1.....Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
- C1107/1107M-20.....Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
- C1218/C1218M-20.....Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
- C1240-20Standard Specification for Silica Fume Used in Cementitious Mixtures
- C1354/C1354M-15.....Standard Test Method for Strength of Individual Stone Anchorages in Dimension Stone
- D412-16.....Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
- D2240-15e1.....Standard Test Method for Rubber Property—Durometer Hardness
- D4397-16.....Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
- E165/E165M-18.....Standard Practice for Liquid Penetrant Testing for General Industry
- E488/E488M-18.....Standard Test Methods for Strength of Anchors in Concrete Elements
- E709-15.....Standard Guide for Magnetic Particle Testing
- F436/F436M-19.....Standard Specification for Hardened Steel Washers, Inch and Metric Dimensions
- F593-17.....Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
- F844-07a (R2013).....Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
- F3125/F3125M-19e1.....Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120ksi (830MPa) and 150ksi (1040MPa) Minimum Tensile Strength, Inch and Meter Dimensions
- C. American Concrete Institute (ACI):
- 211.1-91 (R2009).....Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete

- 211.2-98 (R2004).....Standard Practice for Selecting Proportions for
Structural Lightweight Concrete
- 318/318R-19.....Building Code Requirements for Structural
Concrete and Commentary
- D. American Association of State Highway and Transportation Officials
(AASHTO):
- AASHTO LRFD-2017.....LRFD Bridge Design Specifications, U.S., 8th
Edition
- AASHTO M251-06.....Elastomeric Bearings
- E. American Welding Society (AWS):
- C5.4-93.....Recommended Practices for Stud Welding
- D1.1/D1.1M-20.....Structural Welding Code - Steel
- D1.4-18.....Structural Welding Code - Steel Reinforcing Bars
- F. American National Standards Institute (ANSI):
- A108/A118/A136-19.....Installation of Ceramic Tile
- A137.1-19.....Ceramic Tile
- G. Precast/Prestressed Concrete Institute (PCI):
- Architectural Precast Concrete - Color and Texture Selection Guide
- MNL-117-13.....Quality Control for Plants and Production of
Architectural Precast Concrete Products
- MNL-120-17.....Design Handbook - Precast and Prestressed Concrete
- MNL-122-07.....Architectural Precast Concrete
- MNL-124-11.....Design for Fire Resistance of Precast Prestressed
Concrete
- MNL-127-99.....Erector's Manual - Standards and Guidelines for
the Erection of Precast Concrete Products
- MNL-135-00.....Tolerance Manual for Precast and Prestressed
Concrete Construction
- TR-6-15-E.....Guidelines For The Use of Self-Consolidating
Concrete In Precast/Prestressed Concrete
- H. Military Specifications (MIL. Spec):
- MIL-C882E-89.....Cloth, Duck, Cotton or Cotton-Polyester Blend
Synthetic Rubber, Impregnated, and Laminated, Oil
Resistant
- I. Department of Veterans Affairs:
- Physical Security Design Manual for VA // Life Safety// // Mission
Critical// Protected Facilities-January 2015

PART 2 - PRODUCTS

SPEC WRITER NOTE: Make material requirements agree with applicable requirements specified in the referenced Applicable Publications. Update and specify only that which applies to the project.

2.1 MOLD MATERIALS

- A. Molds: Rigid, dimensionally stable, nonabsorptive material, warp and buckle free, that will provide continuous and true precast concrete surfaces within fabrication tolerances indicated; non-reactive with concrete and suitable for producing required finishes:
 - 1. Mold-Release Agent: Commercially produced 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.
- B. //Form Liners: Units of face design, texture, arrangement, and configuration indicated. Provide solid backing and form supports to ensure that form liners remain in place during concrete placement. Use with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.//

2.2 REINFORCING MATERIALS

- A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (Grade 420), deformed.
- B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than // 30 // // // percent.
- C. Weldable Reinforcing Bars: ASTM A706/A706M, deformed.
 - 1. //Galvanized Reinforcing Bars: ASTM A767/A767M, Class II zinc coated, hot-dip galvanized and chromate wash treated after fabrication and bending. //
 - 2. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M.
 - 3. Steel Bar Mats: ASTM A184/A184M, assembled with clips.
 - a. Plain-Steel Welded Wire Reinforcement: ASTM A1064/A1064M, fabricated from // as-drawn // // galvanized and chromate wash treated // steel wire into flat sheets.
 - b. Deformed-Steel Welded Wire Reinforcement: ASTM A1064/A1064M, flat sheet.
- D. Epoxy-Coated-Steel Welded Wire Reinforcement: ASTM A884/A884M Class A coated, plain on flat sheet, Type 1 bendable coating.

- E. //Prestressing Strand: ASTM A416/A416M, Grade 270 (Grade 1860), uncoated, 7-wire, low-relaxation strand. //
- F. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 117.

2.3 CONCRETE MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or III.
 - 1. For surfaces exposed to view in finished structure, use // gray // // white //, same type, brand, and mill source throughout the precast concrete production.
 - 2. //Standard gray Portland cement may be used for non-exposed backup concrete. //
- B. Supplementary Cementitious Materials for unexposed surfaces (backup concrete) only.
 - 1. Fly Ash Admixture: ASTM C618, Class C or F with maximum loss on ignition of 3 percent.
 - 2. Metakaolin Admixture: ASTM C618, Class N.
 - 3. Silica Fume Admixture: ASTM C1240 with optional chemical and physical requirement.
 - 4. Ground Granulated Blast-Furnace Slag: ASTM C989/C989M, Grade 100 or 120.
- C. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C33/C33M, with coarse aggregates complying with Class 5S. Provide and stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for entire project.
 - 1. Face-Mix Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match selected finish sample.
 - a. Gradation: // Uniformly graded // // Gap graded // // To match design reference sample //.
 - b. //Hard durable // // quartz // // marble // // granite // // siliceous stone // // aggregate // // // carefully graded from coarse to fine in proportions required to match approved samples. //
 - c. //Eliminate off color material from exposed aggregate. //
 - 2. Face-Mix Fine Aggregates: Selected, natural or manufactured sand of the same material as coarse aggregate, unless otherwise approved by COR.
 - a. //Test sand for color value in accordance with ASTM C40/C40M. Sand producing darker than specified color standard is unacceptable.//

- b. //Clean washed white sand. //
- c. //Special fine aggregate produced by crushing exposed coarse aggregate used for finish // A // // B // // as specified //. //
- D. //Lightweight Coarse Aggregate: Except as modified by PCI MNL 117, ASTM C330/C330M, with absorption less than 11 percent and free from expanded clay. //
- E. Unexposed Surface (Backup) Concrete Aggregates: ASTM C33/C33M // or ASTM C330/C330M //.
- F. Admixtures: Admixtures containing calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture are not permitted.
 - 1. Coloring Admixture: ASTM C979/C979M, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable and non-fading.
 - 2. Air Entraining Admixture: ASTM C260, certified by manufacturer to be compatible with other required admixtures.
 - 3. Water-Reducing Admixture: ASTM C494/C494M, Type A.
 - 4. Retarding Admixture: ASTM C494/C494M, Type B.
 - 5. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
 - 6. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
 - 7. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
 - 8. Plasticizing Admixture for Flowable Concrete: ASTM C1017/C1017M.
- 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 117.

2.4 STEEL CONNECTION MATERIALS

- A. Carbon-Steel Shapes and Plates: ASTM A36/A36M except silicon (Si) content in the range of 0 to 0.03percent or 0.15 to 0.25 percent for materials to be galvanized. Steel with chemistry conforming to the formula $Si + 2.5P \leq 0.09$ is also acceptable.
- B. Carbon-Steel Headed Studs: ASTM A108, Grades 1018 through 1020, cold finished and bearing the minimum mechanical properties for studs as indicated under PCI MNL 117, Table 3.2.3.
 - 1. Make welds in accordance with AWS D1.1/D1.1M, Type A or B, with arc shields.
- C. Carbon-Steel Plate: ASTM A283/A283M.
- D. Malleable Iron Castings: ASTM A47/A47M. Grade 32510.
- E. Carbon-Steel Castings: ASTM A27/A27M, Grade U-60-30 (Grade 415-205).

- F. High-Strength, Low-Alloy Structural Steel: ASTM A572/A572M except silicon (Si) content in the range of 0 to 0.03 or 0.15 to 0.25 percent for materials to be galvanized. Steel with chemistry conforming to the formula $Si + 2.5P \leq 0.09$ is also acceptable.
- G. Carbon-Steel Structural Tubing: ASTM A500/A500M, Grade B.
- H. Wrought Carbon-Steel Bars: ASTM A675/A675M, Grade 65 (Grade 450).
- I. Deformed-Steel Wire or Bar Anchors: ASTM A1064/A1064M or ASTM A706/A706M.
- J. Carbon-Steel Bolts and Studs: ASTM A307, Grade A, carbon-steel, hex-head bolts and studs; carbon-steel nuts ASTM A563M (A563), Grade A; and flat, unhardened steel washers complying with ASTM F844.
- K. High-Strength Bolts and Nuts: ASTM F3125/F3125M), Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, complying with ASTM A563M (A563) and hardened carbon-steel washers complying with ASTM F436M (F436).
- L. Finish: For exterior steel items and items indicated for galvanizing, apply zinc coating by // hot-dip process according to ASTM A123/A123M, after fabrication, or ASTM A153/A153M, as applicable //
// electrodeposition according to ASTM B633, SC 3, Type 1 //.
- 1. Galvanizing Repair Paint: High-zinc-dust-content paint with minimum 2 mils (0.002 inch) dry film containing not less than 94 percent zinc dust by weight, and complying with SSPC-Paint 20.
- M. Welding Electrodes: Provide materials that comply with requirements of AWS D1.1/D1.1M. Submit product data on welding electrodes and rods.

2.5 STAINLESS-STEEL CONNECTION MATERIALS

- A. Stainless-Steel Plate: ASTM A666, Type 304, of grade suitable for application.
- B. Stainless-Steel Bolts and Studs: ASTM F593, alloy 304 or 316, hex-head bolts and studs; stainless-steel nuts; and flat, stainless steel washers. Lubricate threaded parts of stainless steel bolts with an anti-seize thread lubricant during assembly.
- C. Stainless-Steel Headed Studs: ASTM A276 and bearing the minimum mechanical properties for studs as indicated under PCI MNL 117, Table 3.2.3.

2.6 BEARING PADS AND OTHER ACCESSORIES

- A. Provide bearing pads for units as follows:
 - 1. Elastomeric Pads: AASHTO M251, 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 D2240, minimum tensile strength 15.5 MPa (2250 psi) per ASTM D412.

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 20.7 MPa (3000 psi) with no cracking, splitting or delaminating in the internal portions of the pad. Test one specimen for each 200 pads used in the project. Submit test results.
 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 D2240. Conforming to Division II, Section 18.10.2 of AASHTO LRFD, or MIL-C-882E.
 4. Frictionless Pads: Tetrafluoroethylene (teflon), glass-fiber reinforced, bonded to stainless or mild-steel plates, of type required for in-service stress.
 5. High-Density Plastic: Multimonomer, nonleaching, plastic strip.
- B. Reglets: Stainless steel, ASTM A240/A240M, Type 302 felt or fiber filled or cover face opening of slots.
- C. Vents and Weeps: Polyvinyl chloride plastic tubing, // 9.5 mm (3/8 inch) // // 4.7 mm (3/16 inch) // inside diameter.
- D. Provide sealant backings and sealant into stone-to-stone joints and stone-to-concrete joints in accordance with Section 07 92 00, JOINT SEALANTS.
- E. Accessories: Provide clips, hangers, plastic or steel shims, and other accessories required to install units.

2.7 GROUT MATERIALS

- A. Sand-Cement Grout: Portland Cement, ASTM C150/C150M, Type I, and clean, natural sand, ASTM C144, or ASTM C404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C1107/C1107M, Grade A for drypack and Grades B and C for flowable grout and of a consistency suitable for application within a 30-minute working time.
- C. Epoxy-resin grout: Two-component mineral-filled epoxy-resin: ASTM C881 of type, grade, and class to suit requirements.

2.8 //CLAY PRODUCT UNITS AND ACCESSORIES

- A. Thin Brick Units: PCI Standard, not less than 13 mm (1/2 inch), nor more than 25 mm (1 inch) thick, with an overall tolerance of plus 0 mm, minus

1.6 mm (+0 inch, -1/16 inch) for any unit dimension 203 mm (8 inch) or less and an overall tolerance of plus 0 mm, minus 2.4 mm (+0 inch, -3/32 inch) for any unit dimension greater than 203 mm (8 inch) measured according to ASTM C67.

1. //Face Size: Modular, 57 mm (2-1/4 inch) high by 190 mm (7-5/8 inch) long.//
2. //Face Size: Norman, 57 mm (2-1/4 inch) high by 290 mm (11-5/8 inch) long.
3. //Face Size: Closure Modular, 90 mm (3-5/8 inch) high by 190 mm (7-5/8 inch) long.//
4. //Face Size: Utility, 90 mm (3-5/8 inch) high by 290 mm (11-5/8 inch) long.//
5. Face Size, Color, and Texture: // //.
6. Special Shapes: Include corners, edge corners, and end edge corners.
7. Cold Water Absorption at 24 Hours: Maximum 6 percent when tested per ASTM C67.
8. Efflorescence: Tested according to ASTM C67 and rated "not effloresced."
9. Out of Square: Plus or minus 1.6 mm (1/16 inch) measured according to ASTM C67.
10. Warpage: Consistent plane of plus 0 mm, minus 1.6 mm (+0, -1/16 inch).
11. Variation of Shape from Specified Angle: Plus or minus 1 degree.
12. Tensile Bond Strength: Not less than 1.0 MPa (150 psi) when tested per modified ASTM E488/E488M. Epoxy steel plate with welded rod on a single brick face for each test.
13. Freezing the Thawing Resistance: No detectable deterioration (spalling, cracking, or chafing) when tested in accordance with ASTM C666/C666M Method B.
14. Modulus of Rupture: Not less than 1.7 MPa (250 psi) when tested in accordance with ASTM C67.
15. Chemical Resistance: Provide brick that has been tested according to ASTM C650 and rated "not affected."
16. Surface Coloring: Provide brick with surface coloring to withstand 50 cycles of freezing and thawing per ASTM C67 with no observable difference in.
17. Back Surface Texture: Scored, combed, wire roughened, ribbed, keybacked, or dovetailed.

- B. Sand-Cement Mortar: Portland cement, ASTM C150/C150M, Type I, and clean, natural sand, ASTM C144. Mix at ratio at 1 part cement to 4 parts sand, by volume, with minimum water required for placement.
- C. Latex-Portland Cement Pointing Grout: ANSI A108/A118/A136 and as follows:
 - 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. Color: // //.

2.9 STONE MATERIALS AND ACCESSORIES

- A. Fabricate stone units in sizes, types and shapes to comply with requirements as indicated on contract documents.
 - 1. Tolerance of length and width of +0, -3 mm (+0, -1/8 inch).
- B. Anchors: Stainless steel, ASTM A666, Type 304, of temper and diameter required to support loads without exceeding allowable design stresses.
 - 1. Fit each anchor leg with 60 durometer neoprene grommet collar with a 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 C920, low-modulus, multicomponent, nonsag polyurethane or silicone sealant complying with requirements in Section 07 92 00, JOINT SEALANTS and that is nonstaining to stone substrate.
- D. Epoxy Filler: ASTM C881/C881M, 100 percent solids, sand-filled non-shrinking, non-staining of type, class, and grade to suit application.
- E. Bond Breaker: // Preformed, compressible, resilient, non-staining, non-waxing, closed-cell polyethylene foam pad, nonabsorbent to liquid and gas, 3 mm (1/8 inch) thick. // // Polyethylene sheet, ASTM D4397, 0.15 mm to 0.25 mm (6 to 10 mil) thick. //

2.10 INSULATED PANEL ACCESSORIES

- A. A. Expanded-Polystyrene Board Insulation: ASTM C578, Type //(XI, 12 kg per cubic meter (0.70 lb. per cubic feet))// //(I, 15 kg per cubic meter (0.90 lb. per cubic ft.))// //(VIII, 18 kg per cubic meter (1.15 lb. per cubic feet))// //(II, 22 kg per cubic meter (1.35 lb. per cubic feet))// //(IX, 29 kg per cubic meter (1.80 lb. per cubic feet))//; //square// //ship-lap// edges, with thickness of // //.
- B. Extruded-Polystyrene Board Insulation: ASTM C578, Type, //(X, 21 kg per cubic meter (1.30 lb. per cubic feet))// //(IV, 25 kg per cubic meter

(1.55 lb. per cubic feet))// // (VI, 29 kg per cubic meter (1.80 lb. per cubic feet))// // (VII, 35 kg per cubic meter (2.20 lb. per cubic feet))// // (V, 48 kg per cubic meter (3.0 lb. per cubic feet))//; //square// //ship-lap// edges, with thickness of // //.

- C. Polyisocyanurate Board Insulation: Rigid, cellular Polyisocyanurate thermal insulation complying with ASTM C591; Grade 1, Type //(I, 29 kg per cubic meter (1.8 lb. per cubic feet))// //(II, 40 kg per cubic meter (2.5 lb. per cubic feet))// //(III, 48 kg per cubic meter (3.0 lb. per cubic feet))//; square edged; unfaced; with thickness of // //.

2.11 CONCRETE MIXES

- A. Prepare design mixes to match COR's sample for each type of concrete required.
1. Limit use of // fly ash and granulated blast-furnace slag to 20 percent replacement of Portland cement by weight; // // metakaolin and silica fume to 10 percent of Portland cement by weight //.
- B. Provide design mixes prepared by a qualified independent testing agency or by qualified precast plant personnel at fabricator's option.
- C. Limit water-soluble chloride ions to the maximum percentage by weight of cement permitted by ACI 318/318M or PCI MNL 117 when tested in accordance with ASTM C1218/C1218M.
- D. Normal Weight Concrete Face and Backup Mixtures: Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:
1. Compressive Strength (28 Days): 34.5 MPa (5000 psi).
 2. Maximum Water-Cementitious Materials Ratio: 0.45.
 3. Release strength as required by design.
- E. //Lightweight Concrete Back-Up Mixes: Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.2, with materials to be used on Project, to provide lightweight concrete with the following properties: //
1. //Compressive Strength (28 Days): 34.5 MPa (5000 psi). //
 2. //Unit Weight: Calculated equilibrium unit weight of 1842 kg per cubic meter (115 lb. per cubic feet), plus or minus 48 kg per cubic m (3 lb. per cubic feet), according to ASTM C567/C567M. //
 3. //Release strength as required by design.//
- F. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to PCI MNL 117.

- G. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having air content as follows.
- H. Total air content for various sizes of coarse aggregate for normal weight concrete.

Total Air Content, Percent, by Volume		
Nominal Maximum Size of Aggregate mm (inch)	Severe Exposure	Moderate Exposure
Less than 9 (3/8)	9	7
9 (3/8)	7-1/2	6
13 (1/2)	7	5-1/2
19 (3/4)	6	5
25 (1)	6	5
38 (1-1/2)	5-1/2	4-1/2

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

PART 3 - EXECUTION

3.1 MOLD FABRICATION

- A. Molds: Construct and maintain molds, mortar tight, within fabrication tolerances and of sufficient strength to withstand pressures due to concrete-placement, vibration operations, and temperature changes and for prestressing and detensioning operations.
1. Form joints are not acceptable on faces exposed to view in the finished work.
 2. Edge and Corner Treatment: Uniformly // chamfered // // radiused //.

3.2 THIN BRICK FACINGS

- 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. Match appearance of sample panel(s).
- C. Securely place brick units face down into form liner pockets and place concrete backing mixture.
- D. After stripping units, clean faces and joints of brick facing.

3.3 STONE VENEER FACINGS

- A. 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 reinforcement a minimum of 19 mm (3/4 inch) from the back surface of stone. Provide 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 precast concrete matrix to stone surface.

- B. Apply a continuous sealant bead along both sides and top of precast concrete panels at the stone/precast concrete interface using the bond breaker as a joint filler backer. Do not seal panel bottom edge.
1. Fill anchor holes with low modulus polyurethane sealant filler and install anchors.
 2. Fill anchor holes with epoxy filler and install anchors with minimum 13 mm (1/2 inch) long, 60 durometer elastomeric sleeve at the back surface of the stone.
 3. Install 0.15 to 0.25 mm (6 to 10 mil) thick polyethylene sheet to prevent bond between back of stone facing and concrete substrate.
 4. Install 3 mm (1/8 inch) thick polyethylene-foam bond breaker to prevent bond between back of stone facing and concrete substrate.
- C. Stone Anchor Shear and Tensile Testing: Engage accredited testing laboratory acceptable to the COR to evaluate and test the proposed stone anchorage system. Test for shear and tensile strength of proposed stone anchorage system in accordance with ASTM E488/E488M or ASTM C1354/C1354M 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 305 by 305 mm (12 by 12 inches) samples of stone affixed to testing apparatus through proposed anchorages. Provide two (2) sets of six (6) stone samples each. One (1) 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 E488/E488M.
- D. Stone to Precast Concrete Anchorages: Provide anchors in numbers, types and locations required to satisfy specified performance criteria, but not less than two (2) anchors per stone unit of less than 0.19 sq. m

(2 sq. feet) in area and four (4) anchors per unit of less than 1.1 sq. m (12 sq. feet) in area; and for units larger than 1.1 sq. m (12 sq. feet) in area, provide anchors spaced not more than 610 mm (24 inches) on center both horizontally and vertically. Locate anchors a minimum 152 mm (6 inches) from stone edge.

3.4 FABRICATION

- A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Position anchors 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.
1. Weld headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4.
- B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing units to supporting and adjacent construction.
- C. Provide cast-in reglets, slots, holes, and other accessories in units as indicated on contract documents.
- D. Provide cast-in openings larger than 254 mm (10 inches) in any dimension. Do not drill or cut openings or reinforcing without approval of COR.
- E. Reinforcement: Comply with recommendations in PCI MNL 117 for fabrication, placing, and supporting reinforcement.
1. Place reinforcing steel and prestressing strand to maintain at least 19 mm (3/4 inch) minimum concrete cover. Increase cover requirements for reinforcing steel to 38 mm (1-1/2 inches) when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete.
 2. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one (1) full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.
 3. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcing exceeds limits specified in ASTM A775/A775M, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.

4. Accurately position, support, and secure reinforcement against displacement during concrete- placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
- F. Prestress tendons for units by pretensioning methods. Comply with PCI MNL 117.
1. Protect strand ends and anchorages with // bituminous //, // zinc-rich // // epoxy // paint to prevent corrosion and rust spots.
 2. Delay detensioning or post-tensioning of precast, prestressed architectural precast concrete units until concrete has reached its indicated minimum design release compressive strength as established by test cylinders cured under the same conditions as concrete member.
 3. 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.
 4. If concrete has been heat cured, detension while concrete is still warm and moist.
- G. Mix concrete according to PCI MNL 117 and requirements in PART 2. After concrete batching, no additional water may be added.
1. At the fabricator's option either of the following mix design/casting techniques may be used:
 - a. A single design mix throughout the entire thickness of panel.
 - b. Design mixes for facing and backup; using cement and aggregates for each type as indicated, for consecutive placement in the mold. Use cement and aggregate specified for facing mix, use cement and aggregate for backup mix complying with criteria specified as selected by the fabricator.
- H. Place concrete in a continuous operation. Comply with requirements in PCI MNL 117.
1. //Place backup concrete to ensure bond with face mix concrete. //
 2. //Place self-consolidating concrete without vibration in accordance with PCI TR-6. //
- I. Identify pickup points of units and orientation in structure with permanent markings, complying with markings indicated on shop drawings. Imprint or permanently mark casting date on each unit on a surface that will not show in finished structure.
- J. Cure concrete, according to requirements in PCI MNL 117, by // moisture retention without heat // // accelerated heat curing using low-pressure live steam // // radiant heat and moisture //.

- K. Repair damaged units to meet acceptability requirements of PCI MNL 117 and the COR.
- L. Reinforce architectural precast concrete units to resist handling, transportation and erection stresses, and specified in-place loads, whichever governs.
- M. Comply with requirements in PCI MNL 117 and requirements in this section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.
- N. Place face mixture to a minimum thickness after consolidation of the greater of 25 mm (1 inch) or 1.5 times the nominal maximum aggregate size, but not less than the minimum reinforcing cover of // 19 mm (3/4 inch) // // 38 mm (1-1/2 inches) //.
 - 1. Use a single design mixture for those units in which more than one major face (edge) is exposed.
 - 2. Where only one (1) face of unit is exposed, at the fabricator's option, either of the following mixture design/casting techniques may be used:
 - a. A single design mix throughout the entire thickness of panel.
 - b. Separate mixtures for face and backup concrete; using cement and aggregates for each type as appropriate, for consecutive placement in the mold. Use cement and aggregate specified for face mixture. Use cement and aggregate for backup mixture complying with specified criteria or as selected by the fabricator.
- O. Thoroughly consolidate placed concrete by internal or external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 117.
 - 1. Place self-consolidating concrete without vibration in accordance with PCI TR-6.
- P. Comply with PCI MNL 117 procedures for hot- and cold-weather concrete placement.

3.5 INSULATED PANEL CASTING

- A. Cast and screed supported wythe over mold.
- B. Place insulation boards, abutting edges and ends of adjacent boards. Insert wythe connectors through insulation, and consolidate concrete around connectors according to connector manufacturer's written instructions.
- C. Cast and screed top wythe to meet required finish.

3.6 FABRICATION TOLERANCES

- A. Fabricate units straight and true to size and shape with exposed edges and corners precise and true so each finished unit complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.
1. //Additional Position Tolerances: For cast-in items measured from datum line location, as indicated on shop drawings. //
 - a. //Location of Bearing Surface from End of Member: Plus or Minus 6 mm (1/4 inch). //
 - b. //Position of Sleeve: Plus or Minus 13 mm (1/2 inch). //
 - c. //Location of Window Washer Track or Buttons: Plus or Minus 3 mm (1/8 inch). //
- B. Fabricate architectural trim units such as sills, lintels, coping, cornices, quoins, medallions, bollards, benches, planters, and pavers, with tolerances meeting PCI MNL 135.
- C. Brick-Faced Architectural Precast Concrete Units.
1. Alignment of mortar joints:
 - a. Jog in Alignment: 3 mm (1/8 inch).
 - b. Alignment with Panel Centerline: Plus or Minus 3 mm (1/8 inch).
 2. Variation in Width of Exposed Mortar Joints: Plus or Minus 6 mm (1/4 inch).
 3. Tipping of Individual Bricks from the Panel Plane of Exposed Brick Surface: Plus 1.5 mm (1/16 inch); Minus 6 mm (1/4 inch) \leq depth of form liner joint.
 4. Exposed Brick Surface Parallel to Primary Control Surface of Panel: Plus 6 mm (1/4 inch); Minus 3 mm (1/8 inch).
 5. Individual Brick Step in Face from Panel Plane of Exposed Brick Surface: Plus 1.5 mm (1/16 inch); Minus 6 mm (1/4 inch) \leq depth of form liner joint.
- D. Stone Veneer-Faced Architectural Precast Concrete Units:
1. Variation in Cross-Sectional Dimensions: For thickness of walls from dimensions indicated: Plus or minus 6 mm (1/4 inch).
 2. Variation in Joint Width: 3 mm in 914 mm (1/8 inch in 36 inches) or a quarter of nominal joint width, whichever is less.
 3. Variation in Plane between Adjacent Stone Units (Lipping): 1.6 mm (1/16 inch) difference between planes of adjacent units.

3.7 FINISHES

- A. Provide exposed panel faces free of joint marks, grain, and other obvious defects. Corners, including false joints to be uniform, straight and

sharp. Finish exposed-face surfaces of units to match approved // design reference sample // // sample panels // // mockups // and as follows:

1. PCI's "Architectural Precast Concrete -Color and Texture Selection Guide," of plate numbers indicated.
 2. As-Cast Surface Finish: Provide surfaces free of excessive air voids, sand streaks, and honeycombs.
 3. Textured-Surface Finish: Impart by form liners to provide surfaces free of air voids, sand streaks, and honeycombs, with uniform color and texture.
 4. Bushhammer Finish: Use power and hand tools to remove matrix and fracture coarse aggregates.
 5. Exposed Aggregate Finish: Use chemical retarding agents applied to concrete forms and washing and brushing procedures to expose aggregate and surrounding matrix surfaces after form removal.
 6. Abrasive-Blast Finish: Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.
 7. Acid-Etched Finish: Use acid and hot-water solution, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces. Protect hardware, connections and insulation from acid attack.
 8. Honed Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
 9. Polished Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
 10. Sand-Embedment Finish: Use selected stones placed in a sand bed in bottom of mold, with sand removed after curing.
- B. Finish exposed // top // // , bottom // // , and back // surfaces of units to match face-surface finish.
- C. Finish unexposed surfaces // top // // , bottom // // , and back // of units by smooth steel-trowel finish.
- D. Finish unexposed surfaces of units by float finish.

3.8 ERECTION PREPARATION

- A. Deliver anchorage devices that are embedded in or attached to the building structural frame or foundation before start of such work. Furnish locations, setting diagrams, and templates for the proper installation of each anchorage device.
- B. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, true and level

bearing surfaces, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

- C. Do not install units until supporting // cast-in-place concrete building structural framing has attained minimum allowable design strength // // supporting steel or other structure is structurally ready to receive loads from precast //.

3.9 ERECTION

- A. Erect units level, plumb and square within the specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment of units until permanent connections are completed.
1. Install temporary steel or plastic spacing shims or bearing pads as precast concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
 2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
 3. Remove projecting lifting devices and use sand-cement grout to fill voids within recessed lifting devices flush with surface of adjacent precast concrete surfaces when recess is exposed.
 4. Unless otherwise shown provide for uniform joint widths of // 19 mm (3/4 inch) // // //.
- B. Connect units in position by bolting, welding, grouting, or as otherwise indicated on approved Erection Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting or grouting are completed.
1. Disruption of roof flashing continuity by connections is not permitted; concealment within roof insulation is acceptable.
 2. Welding: Comply with and AWS D1.1/D1.1M and AWS D1.4/1.4M requirements for welding, welding electrodes, appearance of welds, and methods used in connecting welding work.
 - a. Protect units and bearing pads from damage by field welding or cutting operations and provide noncombustible shields as required.
 - b. When welds are not specified, provide continuous fillet welds, using not less than the minimum fillet as specified by AWS.
 - c. Clean weld affected metal surfaces and apply a minimum 2 mils (0.002 inch) dry thickness coat of galvanized repair paint to galvanized surfaces in conformance with ASTM A780/A780M.

- d. Visually inspect welds critical to precast connections. Visually check welds for completion and remove, reweld or repair defective welds.
- 3. At bolted connections, provide lock washers, tack welding, or other acceptable means to prevent loosening of nuts after final adjustment.
 - a. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot. For friction connection apply specified bolt torque and check 25 percent of bolts at random by calibrated torque wrench.
- 4. Grouting Connections: Grout connections where required or indicated on shop (erection drawings). Retain flowable grout in place until strong enough to support itself. Pack spaces with stiff 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.
- C. Attachments: Upon approval of COR, precast pre-stressed products may be drilled or "shot" for fasteners or small openings, provided reinforcing or pre-stressing steel is not damaged or cut.
 - 1. Should spalling occur, repair according to this specification section.
- D. Venting and Weeps: Where precast concrete panels form the outer wythe of cavity wall construction, vent the cavity wall.
 - 1. Use polyvinyl chloride plastic tubing to vent the cavity.
 - 2. Place plastic vent tubes "tilted down and out" in horizontal and vertical joints.
 - 3. Space vent tubes in accordance with shop drawings, but not less than two vents per panel or approximately 1219 mm (4 feet) on centers.
- E. Setting: Where shown, fill joints with cement mortar specified in // Section 04 05 13, MASONRY MORTARING // // Section 04 05 16, MASONRY GROUTING //.
 - 1. Clean surfaces forming beds and other joints for precast concrete panels of dust, dirt, and other foreign matter, and wet thoroughly to prevent suction before precast concrete, elements are set.
 - 2. Set precast element level and true to line with uniform joints filled completely with mortar.
 - 3. Rake out joints 25 mm (1-inch) deep for pointing or sealants.
 - 4. Joints required to have only sealant to be kept free of mortar for full depth.

5. Keep exposed faces of precast concrete elements free of mortar.
 6. Remove wedges, spacers, or other appliances which are likely to cause staining from joints.
 7. Where parging is shown, parge back of elements solid with mortar. Apply parging without skips or holidays.
- F. Pointing: Wash and brush clean, leaving joints free from loose mortar, dust and other foreign material.
1. Carefully point with a slightly concave joint.
 2. Mortar for pointing as specified in // Section 04 05 13, MASONRY MORTARING // // Section 04 05 16, MASONRY GROUTING //. Provide same material and color sand used in fabrication of precast concrete elements.
- G. Sealing of Joints: Where shown and where required to make work watertight: clean, dry and seal joints between precast concrete elements and between precast elements and adjoining materials as specified in Section 07 92 00, JOINT SEALANTS.

SPEC WRITER NOTE: Insert additional or stricter erection tolerances if required.

3.10 ERECTION TOLERANCES

- A. Erect units level, plumb, square, true, and in alignment without exceeding the erection tolerances of // PCI MNL 117, Appendix I // // //.

SPEC WRITER NOTE: If load bearing precast is not used in project delete the following paragraph.

3.11 FIELD QUALITY CONTROL

- A. //Special Inspections: Contractor engaged qualified special inspector approved by COR is to perform the following special inspections and prepare reports:
1. Erection of loadbearing precast concrete members.//
- B. Testing Agency: Contractor engaged qualified testing agency approved by COR is to perform tests and inspections and prepare test reports.
- C. Visually inspect field welds and test according to ASTM E165 or to ASTM E709.
- D. Report test results directly from testing agency within // // days after testing and in writing to Contractor and COR.
- E. As directed by COR, repair, or remove and replace work that does not comply with specified requirements.

- F. Perform additional testing and inspecting, at no additional cost, to determine compliance of corrected work with specified requirements.

3.12 REPAIRS

- A. When permitted by COR, repair damaged units.
- 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 6.1 m (20 feet).
- C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A780/A780M.
- D. Remove and replace damaged units when repairs do not meet requirements.
- E. Repair damaged units to meet acceptability of PCI MNL 117.
- F. Wire brush, clean, and paint damaged prime painted components with the same type of shop primer.

3.13 CLEANING:

- A. Clean surfaces of precast concrete to be exposed to view, as necessary, prior to shipping.
- B. Clean mortar, plaster, fireproofing, weld slag, and any other deleterious material from concrete surfaces and adjacent materials immediately.
- C. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
 - 1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's recommendations. Clean soiled precast concrete surfaces with detergent and water, using stiff fiber brushes and sponges, and rinse with clean water. Protect other work from staining or damage due to cleaning operations.
 - 2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

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