

SECTION 03 45 00  
PRECAST ARCHITECTURAL CONCRETE

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. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Concrete: Section 03 30 00, CAST-IN-PLACE CONCRETE.
- C. Mortar: Section 04 05 13, MASONRY MORTARING.
- D. Grout: Section 04 05 16, MASONRY GROUTING.
- E. Masonry Facing: Section 04 20 00, UNIT MASONRY.
- F. Sealants and Caulking: Section 07 92 00, JOINT SEALANTS.

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 qualified professional engineer who is legally qualified to practice in jurisdiction where Project is located, and who is experienced in providing engineering services of the kind indicated.
  - 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. 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:

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. ft.) in size for review by 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. 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:
    - Vertical live load -  $\text{Span} / 360$ .
    - 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 lbs.) service load and 44.5 kN (10,000 lbs.) ultimate load applied horizontally in any direction, with anchorages or attachments capable of transferring this load to the structure. For design of these units consider two loading conditions, the first assuming the load to act at a height of 460 mm (18 inches) and the second assuming the load to act at a height of 685 mm (27 inches) above the floor or ramp. In both cases the load is assumed to act on the surface on an area not to exceed 0.09 sq. m. (1 sq. ft.).
- 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.

C. Thermal Movements: Provide for in-plane thermal movements resulting from annual ambient temperature changes of 38degrees C (101 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. Design Mixes: For each concrete mix along with compressive strength and water-absorption tests.
- C. 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: 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.
- D. Comprehensive Engineering Analysis: Submit calculations signed and sealed by a qualified professional 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.

- E. 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.
- F. 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.
- G. Welding Certificates: Copies of certificates for welding procedure specifications (WPS) and personnel.
- H. 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.
- I. Testing laboratory accreditations.
- J. 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.
- K. 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.
- L. Certificate of Compliance.
- M. 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-13 .....Steel Castings, Carbon, for General Application
  - A36/A36M-14 .....Carbon Structural Steel
  - A47/A47M-99(R2014) ...Ferritic Malleable Iron Castings
  - A108-13 .....Steel Bar, Carbon and Alloy, Cold-Finished
  - A123/A123M-13 .....Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

- A153/A153M-09 .....Zinc Coating (Hot-Dip) on Iron and Steel  
Hardware
- A184/A184M-06e1(R2011) Fabricated Deformed Steel Bar Mats for  
Concrete Reinforcement
- A240/A240M-14.....Chromium and Chromium-Nickel Stainless  
Steel Plate, Sheet, and Strip for Pressure  
Vessels and For General Applications
- A276-13a .....Stainless Steel Bars and Shapes
- A283/A283M-13 .....Low and Intermediate Tensile Strength Carbon  
Steel Plates
- A307-14 .....Carbon Steel Bolts and Studs, 60 000 PSI  
Tensile Strength
- A325-14 .....Structural Bolts, Steel, Heat Treated,  
120/105 ksi Minimum Tensile Strength
- A325M-14 .....Structural Bolts, Steel, Heat Treated,  
120/105 ksi Minimum Tensile Strength (Metric)
- A416/A416M-12a .....Steel strand, Uncoated Seven-Wire for  
Prestressed Concrete
- A490-14a .....Structural Bolts, Alloy Steel, Heat Treated,  
150 ksi Minimum Tensile Strength
- A490M-14a .....Structural Bolts, Alloy Steel, Heat Treated,  
150 ksi Minimum Tensile Strength (Metric)
- A500/A500M-13 .....Cold-Formed Welded and Seamless Carbon Steel  
Structural Tubing in Rounds and Shapes
- A563-07(R2014) .....Carbon and Alloy Steel Nuts
- A563M-07(R2013) .....Carbon and Alloy Steel Nuts (Metric)
- A572/A572M-13a .....High-Strength Low-Alloy Columbium-Vanadium  
Structural Steel
- A615/A615M-14 .....Deformed and Plain Billet-Steel Bars for  
Concrete Reinforcement
- A666-10 .....Annealed or Cold-Worked Austenitic Stainless  
Steel Sheet, Strip, Plate, and Flat Bar
- A675/A675M-14 .....Steel Bars, Carbon, Hot-Wrought, Special  
Quality, Mechanical Properties

- A706/A706M-14 .....Low-Alloy Steel Deformed and Plain Bars for  
Concrete Reinforcement
- A767/A767M-09 .....Zinc-Coated (Galvanized) Steel Bars for  
Concrete Reinforcement
- A775/A775M-07b(R2014) Epoxy-Coated Steel Reinforcing Bars
- A780/A780M-09 .....Repair of Damaged and Uncoated Areas of Hot-  
Dip Galvanized Coatings
- A884/A884M-14 .....Epoxy-Coated Steel Wire and Welded Wire  
Fabric for Reinforcement
- A934/A934M-13 .....Epoxy-Coated Prefabricated Steel Reinforcing  
Bars
- A1064/A1064M-14 .....Carbon-Steel Wire and Welded Wire  
Reinforcement, Plain and Deformed, for  
Concrete
- B633-13 .....Electrodeposited Coatings of Zinc on Iron and  
Steel
- C33/C33M-13 .....Concrete Aggregates
- C40/C40M-11 .....Organic Impurities in Fine Aggregate for  
Concrete
- C144-11 .....Aggregate for Masonry Mortar
- C150/C150M-12 .....Portland Cement
- C260/C260M-10a .....Air-Entraining Admixtures for Concrete
- C330/C330M-14 .....Lightweight Aggregates for Structural  
Concrete
- C373-14a .....Test Method for Water Absorption, Bulk  
Density, Apparent Porosity, and Apparent  
Specific Gravity of Fired Whiteware Products
- C494/C494M-13 .....Chemical Admixtures for Concrete
- C618-12a .....Coal Fly Ash and Raw or Calcined Natural  
Pozzolan for Use as a Mineral Admixture in  
Concrete
- C881/C881M-14 .....for Epoxy-Resin-Base Bonding Systems for  
Concrete
- C920-14a .....Elastomeric Joint Sealants

- C979/C979M-10 .....Pigments for Integrally Colored Concrete
- C989/C989M-14 .....Ground Granulated Blast-Furnace Slag for Use  
in Concrete and Mortars
- C1017/C1017M-13 .....Chemical Admixtures for Use in Producing  
Flowing Concrete
- C1107/C1107M-14 .....Packaged Dry, Hydraulic-Cement Grout  
(Nonshrink)
- C1218/C1218M-99(R2008) Test Method for Water-Soluble Chloride  
in Mortar and Concrete
- C1240-14 .....Silica Fume Used in Cementitious Mixtures
- C1354/C1354M-09 .....Test Method for Strength of Individual Stone  
Anchorages in Dimension Stone
- D412-06a(R2013) .....Test Methods for Vulcanized Rubber and  
Thermoplastic Elastomers-Tension
- D2240-05(R2010) .....Test Method for Rubber Property-Durometer  
Hardness
- D4397-10 .....Polyethylene Sheeting for Construction,  
Industrial, and Agricultural Applications
- E165/E165M-12 .....Standard Practice for Liquid Penetrant  
Examination for General Industry
- E488/E488M-10 .....Strength of Anchors in Concrete Elements
- E709-14 .....Standard Guide for Magnetic Particle Testing
- F436-11 .....Hardened Steel Washers
- F436M-11 .....Hardened Steel Washers (Metric)
- F593-13a .....Stainless Steel Bolts, Hex Cap Screws, and  
Studs
- F844-07a(R2013) .....Washers, Steel, Plain (Flat), Unhardened for  
General Use

C. American Concrete Institute (ACI):

- ACI 211.1-91(R2009) ..Selecting Proportions for Normal, Heavyweight  
and Mass Concrete (Reapproved 2002)
- ACI 211.2-98(R2004) ..Selecting Proportions for Structural  
Lightweight Concrete

- ACI 318/318M-14 .....Building Code Requirements for Structural  
Concrete
- D. American Association of State Highway and Transportation Officials  
(AASHTO):
  - AASHTO LRFD-2014 .....LRFD Bridge Design Specifications, U.S., 7th  
Edition
  - AASHTO M251-06 .....Elastomeric Bearings
- E. American Welding Society (AWS):
  - C5.4-93 .....Recommended Practices for Stud Welding
  - D1.1/D1.1M(R2011) ....Structural Welding Code - Steel
  - D1.4/D1.4M .....Structural Welding Code - Reinforcing Steel
- F. American National Standards Institute (ANSI):
  - A108/A118/A136 .....Installation of Ceramic Tile
  - A137.1-12 .....Ceramic Tile
- G. Precast/Prestressed Concrete Institute (PCI):
  - Architectural Precast Concrete - Color and Texture Selection Guide
  - MNL-117-96 .....Quality Control for Plants and Production of  
Architectural Precast Concrete Products
  - MNL-120-10 .....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-6-03 .....Interim Guidelines for the Use of  
Self-Consolidating 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 Facilities-July 2007

PART 2 - PRODUCTS

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.

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.

1. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M.

C. Epoxy-Coated-Steel Welded Wire Reinforcement: ASTM A884/A884M Class A coated, plain on flat sheet, Type 1 bendable coating.

D. Prestressing Strand: ASTM A416/A416M, Grade 270 (Grade 1860), uncoated, 7-wire, low-relaxation strand.

E. 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, same type, brand, and mill source throughout the precast concrete production.

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.
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. Select aggregate and cement combination to match as closely as possible with the color of exposed cast in place concrete.

D. 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.
- E. 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 0.03% or 0.15 to 0.25% 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% 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 A325M (A325) or ASTM A490M (A490), 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.
  - 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: Multimer, nonleaching, plastic strip.
- B. Reglets: Stainless steel, ASTM A240/A240M, Type 302 felt or fiber filled or cover face opening of slots.
- C. Provide sealant backings and sealant into stone-to-stone joints and stone-to-concrete joints in accordance with Section 07 92 00, JOINT SEALANTS.
- D. 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. Match color and texture of Face Brick specified in Section 04 20 00.

1. Face Size: Modular, 57 mm (2-1/4 inch) high by 190 mm (7-5/8 inch) long.
2. Special Shapes: Include corners, edge corners, and end edge corners.
3. Cold Water Absorption at 24 Hours: Maximum 6% when tested per ASTM C67.
4. Efflorescence: Tested according to ASTM C67 and rated "not effloresced."
5. Out of Square: Plus or minus 1.6 mm (1/16 inch) measured according to ASTM C67.
6. Warpage: Consistent plane of plus 0 mm, minus 1.6 mm (+0, -1/16 inch).
7. Variation of Shape from Specified Angle: Plus or minus 1 degree.
8. 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.
9. Freezing the Thawing Resistance: No detectable deterioration (spalling, cracking, or chafing) when tested in accordance with ASTM C666/C666M Method B.
10. Modulus of Rupture: Not less than 1.7 MPa (250 psi) when tested in accordance with ASTM C67.
11. Chemical Resistance: Provide brick that has been tested according to ASTM C650 and rated "not affected."

12. Surface Coloring: Provide brick with surface coloring to withstand 50 cycles of freezing and thawing per ASTM C67 with no observable difference in.

13. 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: Match color used for face brick under Section 04 20 00.

## 2.9 CONCRETE MIXES:

A. Prepare design mixes to match COR's sample for each type of concrete required.

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. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to PCI MNL 117.
- F. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content as follows.
- G. Total air content for various sizes of coarse aggregate for normal weight concrete.

Nominal Maximum Size of Aggregate mm (inch)	Total Air Content, Percent, by Volume	
	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

- H. 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.

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 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. 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.
- G. Place concrete in a continuous operation. Comply with requirements in PCI MNL 117.
- H. 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.
- I. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat, accelerated heat curing using low-pressure live steam, or radiant heat and moisture. To produce concrete of uniform appearance, consistent and uniform curing conditions shall be provided.
- J. Repair damaged units to meet acceptability requirements of PCI MNL 117 and the COR.

- K. Reinforce architectural precast concrete units to resist handling, transportation and erection stresses, and specified in-place loads, whichever governs.
  - L. 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.
  - M. 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).
    - 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.
  - N. 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.
  - O. Comply with PCI MNL 117 procedures for hot- and cold-weather concrete placement.
- 3.4 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.

B. 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.

3.5 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 sample panels 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.

B. Finish exposed top, bottom, and back surfaces of units to match face-surface finish.

3.6 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.

### 3.7 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. Setting: Where shown, fill joints with cement mortar specified in Section 04 05 13, MASONRY MORTARING.

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.
- E. 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.
- F. 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.
- 3.8 ERECTION TOLERANCES:
- A. Erect units level, plumb, square, true, and in alignment without exceeding the erection tolerances of PCI MNL 117, Appendix I.
- 3.9 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 five 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.

### 3.10 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.

### 3.11 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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