PART 1 - GENERAL

1.1 DESCRIPTION

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 contract drawings.

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. PreCast pre-stressed structural building elements: Section 03 41 33, PRECAST STRUCTURAL PRETENSIONED CONCRETE.
D. Mortar: Section 04 05 13, MASONRY MORTARING // Section 04 05 16, MASONRY GROUTING //
E. Masonry Facing: Section 04 20 00, UNIT MASONRY.
F. Cast Stone Facing: Section 04 72 00, CAST STONE MASONRY.
G. Insulation for Insulated Panels: Section 07 21 13, THERMAL INSULATION.
H. Sealants and Caulking: Section 07 92 00, JOINT SEALANTS.
I. Size, type and color of aggregate for exposed aggregate finish and matrix color: Section 09 06 00, SCHEDULE FOR FINISHES.
J. Ceramic Tile Facing: Section 09 30 13, CERAMIC TILING.
K. Repair of abraded galvanized and painted surfaces: Section 09 91 00, PAINTING.

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. // Assumes responsibility for engineering units to comply with performance requirements. A Comprehensive Engineering Analysis shall be 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.

3. Has sufficient production capacity to produce required units without delaying the work.

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 //.

2. // An erector with a minimum of 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. Submits Erectors Post Audit Declaration. //
   b. // The basis of the audit is the PCI MNL 127. //

C. 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.

D. Sample Panels: After sample approval and before fabricating units, produce a minimum of two sample panels approximately // 1.5 sq. m. (16 sq. ft.) // in size for review by Resident Engineer. Incorporate full scale details of architectural features, finishes, textures, and transitions in the sample panels. Approved sample panel may be used for mockup and range sample.

1. Locate panels where indicated or, if not indicated, as directed by Resident Engineer.

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, maintain one sample panel at the manufacturer’s plant and one 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.

E. Range Samples: After sample panel approval and before production of units, produce a minimum of three samples, approximately 1.5 sq. m. (16 sq. ft.) in size, representing anticipated range of color and texture on project’s units. Following range sample acceptance by the Resident Engineer, maintain samples at the manufacturer’s plant as color and texture acceptability reference.

F. Mockups: After sample approval but before production of units, construct full sized mockups to verify selections made under sample Submittals 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 accepted 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 Resident Engineer.
   2. Notify Resident Engineer in advance of dates and times when mockups will be constructed.
   3. Obtain Resident Engineer’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.

G. 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 drawings, 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, applicable to types of units indicated.
   2. Limit deflection of precast members as follows:
      Vertical live load – Span / 360.
      Wind load – Floor to floor height times 0.0025.
   3. Design for handling, transportation and erection stresses.
4. // 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, 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. ft.). //

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

C. Thermal Movements: Provide for in-plane thermal movements resulting from annual ambient temperature changes of // 27 deg C (80 deg F) // Insert temperature //. Use other values, greater or smaller, whenever justified by climatic conditions at the project site.

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

1.5 SUBMITTALS

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

B. Design Mixes: For each 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 intent 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: Provide calculations // signed and sealed // certified // by the qualified professional engineer responsible for the product design. 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 // 300 by 300 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 and professional engineer: List of completed projects with project names and addresses, names and addresses of Resident Engineers and owners, and other information specified.

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

J. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements.
   1. Concrete materials.
   2. Reinforcing materials and prestressing tendons.
   3. Admixtures.
   5. Structural-steel shapes and hollow structural sections.
   6. Insulation
   7. Facing units.
   8. Anchors.
1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Product handling requirements of PCI MNL 117 shall be followed 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.

1.7 WARRANTY

A. Warranty of precast concrete work, including anchorage, joint treatment and related components to be free from defects in materials and workmanship, including cracking and spalling.
B. After erection, completed work will be weathertight, subject to terms of Article “Warranty of Construction” FAR clause 52.246-21, except warranty period is extended to five years.

1.8 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of specification to extent referenced. Publications are referenced in text by basic designation only.
B. American Society for Testing and Materials (ASTM):
   A27/A27M-10 ........... Steel Castings, Carbon, for General Application
   A36/A36M-08 ........... Carbon Structural Steel
   A47/A47M-99(R2009) .. Ferritic Malleable Iron Castings
   A82-07 ................. Steel Wire, Plain, for Concrete Reinforcement
   A108-07 ............ Steel Bar, Carbon and Alloy, Cold-Finished
   A123/A123M-09 ...... Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
   A153/A153M-09 ....... Zinc Coating (Hot-Dip) on Iron and Steel Hardware
   A167-99(R2009) ...... Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
   A184/A184M-06 ...... Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
   A185-07 ............ Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
   A276-10 ............ Stainless Steel Bars and Shapes
   A283/A283M-03(R2007) Low and Intermediate Tensile Strength Carbon Steel Plates
A307-10 .......... Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
A325/A325M-10 .... Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
A416/A416M-10 .... Steel strand, Uncoated Seven-Wire for Prestressed Concrete
A490/A490M-10 .... Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
A496-07 .......... Steel Wire, Deformed, for Concrete Reinforcement
A497-07 .......... Steel Welded Wire Reinforcement, Deformed, for Concrete
A500-10 .......... Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
A563/A563M-07 .... Carbon and Alloy Steel Nuts
A572/A572M-07 .... High-Strength Low-Alloy Columbium-Vanadium Structural Steel
A615/A615M-09 .... 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-03(R2009) Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
A706/A706M-09 .... Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
A767/A767M-09 .... Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
A775/A775M-07 .... Epoxy-Coated Steel Reinforcing Bars
A780-09 .......... Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
A884/A884M-06 .... Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement
A934/A934M-07 .... Epoxy-Coated Prefabricated Steel Reinforcing Bars
B227-10 .......... Hard-Drawn Copper-Clad Steel Wire
B633-07 .......... Electrodeposited Coatings of Zinc on Iron and Steel
C33-11 .......... Concrete Aggregates
C40-04 .......... Organic Impurities in Fine Aggregate for Concrete
C150-09 .......... Portland Cement
C260-10 .......... Air-Entraining Admixtures for Concrete
C330-09 .......... Lightweight Aggregates for Structural Concrete
C373-88 (R2006) ... Test Method for Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware Products
C494/C494M-10 .......... Chemical Admixtures for Concrete
C618-08 .............. Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
C881/C881M-10 ...... for Epoxy-Resin-Base Bonding Systems for Concrete
C979-10 ............. Pigments for Integrally Colored Concrete
C989-10 ............ Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
C1017/C1017M-07 ..... Chemical Admixtures for Use in Producing Flowing Concrete
C1107-08 ........... Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
C1218/C1218M-99 (R2008) Test Method for Water-Soluble Chloride in Mortar and Concrete
C1240-10 .......... Silica Fume Used in Cementitious Mixtures
D412-06 ............. Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
D2240-05 (R2010) .... Test Method for Rubber Property—Durometer Hardness
F436/F436M-10 ...... Hardened Steel Washers
F568M-07 ........... Carbon and Alloy Steel Externally Threaded Metric Fasteners
F593-02 (R2008) ...... Stainless Steel Bolts, Hex Cap Screws, and Studs
F844-07 ........... 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 318-11 .......... Building Code Requirements for Structural Concrete

D. American Association of State Highway and Transportation Officials
   AASHTO LRFD-2010 .... LRFD Bridge Design Specifications, U.S., 3rd Edition
   AASHTO M251-06 ...... Elastomeric Bearings

E. Precast/Prestressed Concrete Institute (PCI):
   MNL-117-96 ........ Quality Control for Plants and Production of Architectural Precast Concrete Products
   MNL-120-04 .......... Design Handbook—Precast and Prestressed Concrete
   MNL-124-08 ........ 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

F. Military Specifications (MIL. Spec):
   MIL-C882E-89 ......... Cloth, Duck, Cotton or Cotton-Polyester Blend
                      Synthetic Rubber, Impregnated, and Laminated, Oil Resistant.

G. Structural Steel Painting Council (SSPC):

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 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.

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. 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.
2.3 CONCRETE MATERIALS

A. Portland Cement: ASTM C150, 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.
   4. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.

C. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C33, 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 Resident Engineer.
   a. Test sand for color value in accordance with ASTM C40. 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 // specified. //
D. Lightweight Coarse Aggregate: Except as modified by PCI MNL 117, ASTM C330, with absorption less than 11 percent and free from expanded clay. //
E. Unexposed Surface (Backup) Concrete Aggregates: ASTM C33 // or C330 //.
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, 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 0.03% or 0.15 to 0.25% for materials to be galvanized. Steel with chemistry conforming to the formula Si + 2.5P < 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.; AWS D1.1, 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 ≤ 0.09 is also acceptable.

G. Carbon-Steel Structural Tubing: ASTM A500, Grade B.

H. Wrought Carbon-Steel Bars: ASTM A675/A675M, Grade 65 (Grade 450).

I. Deformed-Carbon Wire or Bar Anchors: ASTM A496 or ASTM A706/A706M.

J. Carbon-Steel Bolts and Studs: ASTM A307, Grade A (ASTM F568M, Property Class 4.6) carbon-steel, hex-head bolts and studs; carbon-steel nuts (ASTM A563/A563M, Grade A); and flat, unhardened steel washers (ASTM F844).

K. High-Strength Bolts and Nuts: ASTM A325/A325M or ASTM A490/A490M, Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, (ASTM A563/A563M) and hardened carbon-steel washers (ASTM F436/F436M).

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 dry film containing not less than 94 percent zinc dust by weight, and complying with SSPC-Paint 20.

M. Welding Electrodes: Comply with AWS standards.

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: Prefomed, 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.

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 LFRD, 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.


B. Reglets: Stainless steel, ASTM A167, 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. 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, 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, 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 FACING UNITS AND ACCESSORIES

A. Refer to the related specification for facing units and facing accessories.

B. Epoxy Anchor Hole Filler: ASTM C881, 100 percent solids, sand-filled nonshrinking, non-staining of type, class, and grade to suit application.

2.9 INSULATED PANEL ACCESSORIES

A. Refer to related specifications for insulation.

2.10 CONCRETE MIXES

A. Prepare design mixes to match Resident Engineer’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. Design mixes shall be 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 (ACI 318M) or PCI MNL 117 when tested in accordance with ASTM C1218/C1218M.
D. 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.
E. Lightweight Concrete 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/cu.m (115 lb/cu.ft.), plus or minus 48 kg/cu.m (3 lb/cu.ft.), according to ASTM C567.
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 an air content complying with PCI MNL 117.
H. When included in design mixes, add other admixtures to concrete mixes according to manufacturer’s written instructions.

2.11 MOLD FABRICATION

A. Molds: Accurately construct and maintain molds, mortar tight, within fabrication tolerances and of sufficient strength to withstand pressures due to concrete-placement and vibration operations and temperature changes and for prestressing and detensioning operations.
   1. Form joints are not permitted on faces exposed to view in the finished work.
   2. Edge and Corner Treatment: Uniformly chamfered radiused.
3. //Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during placing of concrete.//

4. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.

2.12 SETTING FACING UNITS

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

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

C. Clean faces and joints of brick facing.

2.13 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. Accurately position for attachment of loose hardware and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

Weld headed studs and deformed bar anchors used for anchorage.

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. Cast-in reglets, slots, holes, and other accessories in units as indicated.

D. Cast-in openings larger than 250 mm (10 inches) in any dimension. Do not drill or cut openings or reinforcing without approval of Resident Engineer.

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 full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.
F. Prestress tendons for units by pretensioning methods. Comply with PCI MNL 117.
   1. Protect strand ends and anchorages with // bituminous //, zinc-rich // or epoxy paint // to prevent corrosion and rust spots.
G. Mix concrete according to PCI MNL 117 and requirements in this Section. 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 to prevent seams or planes of weakness from forming in precast concrete units. 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 // or by accelerated heat curing using low-pressure live steam // or radiant heat and moisture //.
K. Repair damaged units to meet acceptability requirements of PCI MNL 117 and the Resident Engineer.

2.14 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.

2.15 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) < 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) < depth of form liner joint.

2.16 FINISHES

A. Panel faces shall be free of joint marks, grain, and other obvious defects. Corners, including false joints shall be uniform, straight and sharp. Finish exposed-face surfaces of 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 excessive 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 // // 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.

2.17 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: If there is evidence that the concrete strength of precast concrete units may be deficient, Precaster will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to PCI MNL 117:

1. Test results will be made in writing on the same day that tests are performed, with copies to Resident Engineer, Contractor, and precast concrete fabricator. Test reports will include the information required in Section 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 Resident Engineer reserves the right to reject any unit if it does not match the
accepted samples and visual mock-up. Replace unacceptable units with precast concrete units that comply with requirements.

PART 3 - EXECUTION

3.1 PREPARATION

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

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 / or supporting steel / or other structure is structurally ready to receive loads from precast /.

3.2 ERECTION

A. Erect 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 / 19mm (3/4 inch) / Insert Width /.

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 and/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 applicable requirements for welding.
a. Protect units and bearing pads from damage by field welding or cutting operations and provide noncombustible shields as required.
b. Welds not specified shall be continuous fillet welds, using not less than the minimum fillet as specified by AWS.
c. Clean weld affected metal surfaces and apply a minimum 100 µm (0.004 inch) thick coat of galvanized repair paint to galvanized surfaces in conformance with ASTM A780.
d. Visually inspect all welds critical to precast connections. Visually check all welds for completion and remove, reweld or repair all defective welds.

3. At bolted connections, use 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. Retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.

C. Attachments: Upon approval of Resident Engineer, 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 1220 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.
Rake out joints 25 mm (1-inch) deep for pointing or sealants.
Joints required to have only sealant: Kept free of mortar for full depth.
4. Remove wedges, spacers, or other appliances which are likely to cause staining from joints.
5. 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. // Use same material and color sand used in fabrication of precast concrete elements when specified in Section 09 06 00, SCHEDULE FOR FINISHES. //
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.

3.3 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: Use PCI tolerances above. Insert additional or stricter tolerances if required.

3.4 FIELD QUALITY CONTROL
A. Refer to Section 01 45 29, TESTING LABORATORY SERVICES.
B. Testing agency will report test results promptly and in writing to Contractor and Resident Engineer.
C. Repair or remove and replace work that does not comply with specified requirements.
D. Additional testing and inspecting, at Contractor’s expense, will be performed to determine compliance of corrected work with specified requirements.

3.5 REPAIRS
A. Repairs will be permitted provided structural adequacy of units and appearance are not impaired.
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 m (20 feet).
C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A780.
D. Remove and replace damaged units when repairs do not meet requirements.

3.6 CLEANING

A. Clean all 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.