SECTION 03450 - PLANT-PRECAST ARCHITECTURAL CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Precast architectural concrete units (Voided Wall Panels).
2. Simulated-brick-faced, precast architectural concrete units (Solid or Voided Wall Panels).

B. Related Sections include the following:

1. Division 7 Section "Water Repellents" for water-repellent finish treatments.
2. Division 7 Section "Sheet Metal Flashing and Trim" for flashing receivers and reglets.
3. Division 7 Section "Joint Sealants" for elastomeric joint sealants and sealant backings.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide precast architectural concrete units and connections capable of withstanding design loadings indicated within limits and under conditions required.

B. Engineering Responsibility: Engage a fabricator who assumes undivided responsibility for engineering structural precast concrete units by employing a qualified Specialty Structural Engineer (SSE) engineer to prepare design calculations, fire-resistance calculations, shop drawings, and other structural data.

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contact and Division 1 Specification Sections.

B. Product data and instructions for manufactured materials and products.

1. Certification by paint and curing compound manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

C. Shop drawings prepared by or under the supervision of a qualified Specialty Structural Engineer (SSE) detailing fabrication and installation of precast concrete units. Indicate member dimensions and cross-sections; locations, sizes, and types of reinforcement, including special reinforcement; and lifting devices necessary for handling and erection. Final submittal shall be signed and sealed by the SSE.

1. Indicate layout and dimensions, and identify each precast concrete unit corresponding to sequence and procedure of installation. Indicate welded connections and joints, including accessories and construction at openings in precast units.

2. Indicate locations and details of anchorage devices that are to be embedded in other construction. Furnish templates, if required, for accurate placement.

D. Structural analysis design data and design computations for precast elements sealed and signed by the Specialty Structural Engineer.

E. Samples, approximately 12 by 12 by 2 inches, to illustrate quality of finishes, colors, and textures of exposed precast concrete units.

F. Design mixes for each concrete mix. Submit revised mix proportions when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

G. Corrosion inhibitor manufacturer's test data and method used to determine the plastic and hardened concentration of the active component of the inhibitor.

H. Test reports as required by provisions of this Section.

1. Steel producer's certificates of mill analysis, tensile tests, and bend tests.
2. Specifications, and installation instructions for proprietary reinforcing materials, welded and mechanical splices, reinforcement accessories, and mechanical or chemical anchors.
3. Laboratory test reports for concrete materials and mix design test.
4. Materials certificates in lieu of material laboratory test reports when permitted by Engineer. Material certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.
5. Concrete tests as follows:
   a) Hardened concrete chloride ion content.
   b) Hardened concrete air-void parameters.
   c) Shrinkage tests.
6. Current certification of welders.
7. Batch plant quality control compression and air content tests.

I. Precaster shall provide casting schedule to Engineer with first shop drawing submittal.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer/Erector who has completed structural precast concrete work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Fabricator Qualifications: Firm experienced in producing structural precast concrete units similar to those indicated for this Project and with a record of successful in-service performance as well as sufficient production capacity to produce required units without delaying the Work. Fabricator must participate in the Precast/Prestressed Concrete Institute's (PCI) Plant Certification Program and be designated a PCI Certified Plant for product Group A, Category A1 – Architectural Cladding and Load Bearing Unit Certification.

C. Specialty Structural Engineer Qualifications: A professional engineer legally authorized to practice in the State of Maine and experienced in providing engineering services of the kind indicated that have resulted in the installation and successful in-service performance of precast concrete units and systems similar to this Project in material, design, and extent.

D. Testing Agency Qualifications: To qualify for acceptance, an independent testing agency must demonstrate to Engineer's satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM C 1077 and ASTM E 329, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.

E. PCI Design Standard: Comply with recommendations of PCI MNL-120 "PCI Design Handbook—Precast and Prestressed Concrete" applicable to types of structural precast concrete units indicated.

F. PCI Quality-Control Standard: Comply with requirements of PCI MNL-116 "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products," including manufacturing and testing procedures, quality-control recommendations, and camber and dimensional tolerances for types of units required.

G. PCI Tolerance Manual: Comply with requirements of PCI MNL-135 "Tolerance Manual for Precast and Prestressed Concrete Construction."

H. ACI Publications: Comply with the following ACI Publications applicable to types of structural precast concrete units indicated:

1. ACI 301 "Specifications for Structural Concrete of Buildings."
2. ACI 318 (ACI 318M) "Building Code Requirements for Reinforced Concrete."

I. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code—Steel" and AWS D1.4 "Structural Welding Code—Reinforcing Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

J. Product Options: The drawings indicate size, profiles, and dimensional requirements of precast concrete units and are based on the specific types of units indicated. Other fabricators' precast concrete units with equal performance characteristics may be considered. Revisions to Bay dimensions and depth of units not permitted. Refer to Division 1 Section "Products and Substitutions."

K. Sample Panels: Before fabricating precast architectural concrete units, produce sample panels to establish the approved range of selections made under sample Submittals. Produce a minimum of 3 sets of full-thickness sample panels, approximately 48 inches long by 48 inches high, to demonstrate the expected range of finish, color, and texture variations.

1. Locate panels where indicated or, if not indicated, as directed by Engineer.
2. In presence of Engineer, damage part of an exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair of surface blemishes to match adjacent undamaged surfaces.
3. Maintain sample panels during construction in an undisturbed condition as a standard for judging the completed Work.
4. Demolish and remove samples panels when directed.

L. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings."

1.6 DELIVERY STORAGE AND HANDLING

A. Deliver precast concrete units to Project site in such quantities and at such times to ensure continuity of installation. Store and handle units at Project site to prevent cracking, distorting, warping, staining, or other physical damage, and so that markings are visible.

B. Lift and support units only at designated lifting or supporting points as shown on final shop drawings.

C. Deliver anchorage items that are to be embedded in other construction before starting such work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

1.7 SEQUENCING

A. Supply 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.

1.8 WARRANTY

A. Submit a written warranty by the fabricator/installer stating that the work is in conformance with Contract Documents and shall be free of defects in materials and workmanship for a period of 5 years from the date of substantial completion and agreeing to replace or repair defective materials and workmanship to “like-new” conditions at no additional cost to the owner.

PART 2 – PRODUCTS

2.1 FABRICATORS

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

1. Blakeslee Prestress Inc., Branford, CT
2. J.P. Carrara & Sons, Inc., Middlebury, VT

2.2 FORMWORK

A. Forms: Provide forms and, where required, form facing materials of metal, plastic, wood, or another acceptable material that is non-reactive with concrete and will produce required finish surfaces and interior void spaces.

B. Accurately construct forms, mortar-tight, of sufficient strength to withstand pressures due to concrete placing operations, temperature changes, and for prestressed, pretensioning, and detensioning operations. Maintain formwork to provide complete precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified in PCI MNL 116.

C. Unless forms for plant-manufactured prestressed concrete units are stripped prior to detensioning, design forms so that stresses are not included in precast units due to deformation of concrete under prestress or movement during detensioning.

D. Form Liners: Units of face design, texture, arrangement, and configuration indicated.

1. Form liner for brick shall be used to position brick in proper coursing. Place form liner templates accurately to provide grid for thin brick facings. Use "Brick Snap" carriers to form tooled joint, Manufactured by Scott System, Inc; or equal as approved by the Engineer.

2.3 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615, Grade 60 deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706, Grade.

C. Galvanized Reinforcing Bars: ASTM A 767, Class II, 2 oz./sq. ft. zinc, hot-dip galvanized.

D. Epoxy-Coated Reinforcing Bars: ASTM A 775.

E. Steel Wire: ASTM A 82, plain, cold drawn.

F. Steel-Welded Wire Fabric: ASTM A 185, plain, cold drawn.

G. Deformed-Steel Welded Wire Fabric: ASTM A 497, cold drawn.

H. Supports for Reinforcement: Provide supports for reinforcement, including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing, complying with CRSI recommendations.

1. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provided supports with legs that are protected with plastic (CRSI, Class 1) or stainless steel (CRSI, Class 2).

2. For epoxy-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire or all-plastic bar supports.

2.4 PRESTRESSING TENDONS

A. Prestressing Strand: ASTM A 416, Grade 250 or 270, uncoated, 7-wire, low-relaxation strand.

2.5 CONCRETE MATERIALS

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

1. Use only one brand and type of cement throughout Project, unless otherwise acceptable by Engineer.

2. All exterior precast elements to use white portland cement, unless specified otherwise by Engineer.

B. Fly Ash: ASTM C 618, Class C or F.

C. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

D. Silica Fume: ASTM C 1240, amorphous silica.

E. Normal-Weight Aggregates: ASTM C 33, Class 5S. Provide aggregates from a single source.

F. Water: Potable.

G. Admixtures, General: Provide admixtures for concrete that contain not more that 0.1 percent chloride ions by mass of portland cement or cementitious material.

H. Air-Entraining Admixture: ASTM C260, certified by manufacturer to be compatible with other required admixtures.

I. Water-Reducing Admixture: ASTM C 494, Type A.

J. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.

K. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.

L. Water-Reducing and Retarding Admixture: ASTM C 494 Type D.

M. Corrosion Inhibiting Admixture: ASTM C 494, Type C, 30 ±2 percent calcium nitrite by weight.

2.6 STEEL CONNECTION MATERIALS AND FINISHES

A. Steel Shapes and Plates: ASTM A 36.

B. Malleable Iron Castings: ASTM A 47.

C. **Stainless Steel Bolts and Studs: ASTM F593, alloy 304 or 316, hex-head bolts and studs; stainless-steel nuts; and flat, stainless steel washers.**

D. High-Strength Bolts and Nuts: ASTM A 325, Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, hardened carbon-steel washers.

E. Welded Headed Studs: AWS D1.1, Type B headed studs, cold-finished carbon-steel bars.

F. Deformed-Steel Wire Bar Anchors: ASTM A 496.

G. Welding Electrodes: Comply with AWS standards.

H. Accessories: Provide clips, hangers, shims, and other accessories required to install precast concrete units.

I. Inserts and Coil Rods:

1. Provide sizes as shown on drawings and/or as required by SSE design.
2. Yield strength: 65,000 psi minimum.
3. Galvanizing: Electrodeposited zinc coating, ASTM B 633, Service Condition 1, Type III.

J. Hot-Dip Galvanized Finish: For exterior steel items and items indicated for galvanizing, apply zinc coating by the hot-dip process, complying with the following requirements:

1. ASTM A 123 for galvanizing rolled, pressed, and forged shapes, plates, bars and strips.
2. ASTM A 153 for galvanizing iron and steel hardware.

K. Shop-Primed Finish: Prepare surfaces of interior steel items, except those with galvanized finish or those surfaces to be embedded in concrete, according to requirements of SSPC-SP 3 and shop-apply primer according to SSPC-PA 1.

1. Primer: Fast-curing, lead- and chromate-free, VOC-conforming, universal modified-alkyd primer with good resistance to normal atmospheric corrosion, complying with performance requirements of FS TT-P-664.

2.7 GROUT MATERIALS

A. Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 404. 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 silca sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and a 30-minute working time.

C. Epoxy Grout: ASTM C 881, 2-component epoxy resin, of type, grade, and class to suit requirements.

2.8 MOLD FABRICATION

A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing operations.

1. Simulated brick form liners:
   a) Place form liners accurately to provide finished surface texture to simulate brick.
   b) Face Size: Modular, 2-1/4 inches high by 7-1/2 to 7-5/8 inches long.
   c) Special Shapes: Include corners, edge corners, and end edge corners.
2. Maintain molds to provide completed precast architectural concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.
3. Edge and Corner Treatment: Uniformly radiused.

2.9 ANCHOR ITEMS

A. Slots and inserts for anchoring masonry and mechanical items shall be of standard manufacture, of types required to engage with anchors to be furnished and installed under other section of specifications, and shall be subject to review by Engineer.

B. Dovetail slots shall be 20 gage, 1 inch size, galvanized steel, installed as directed at points where masonry abuts or faces concrete.

C. Flashing reglets, masonry anchors, and other accessories are specified in Division 4.

2.10 CONCRETE MIXES

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

1. Limit use of fly ash and silica fume to not exceed, in aggregate, 25 percent of the portland cement by weight.
2. Provide a minimum of 35 percent Ground Granulated Blast-Furnace Slag in all mixes.

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

C. Submit written reports and test data to Engineer of each proposed mix for concrete at least 15 days prior to start of Work; for mixes requiring tests for chloride ion content, shrinkage, air-void parameters, etc., allow sufficient time for review of results and retesting. Failure to allow time for required testing shall not be a cause for claim of delay. Do not begin concrete production until proposed mix designs have been reviewed by Engineer.

D. Design mixes to provide normal weight concrete with the following properties and as indicated on drawings.

1. Concrete for all portions of structure shall be proportioned to withstand sulfates and other chemically aggressive solutions.
2. Proportion concrete to resist destructive exposure with a maximum water cementitious rate = 0.40
   a) Aggressive environment.
   b) Freezing/thawing
   c) Chloride exposures
3. Chloride ion content no greater than 0.06 percent by weight of cement.
4. Hardened concentrate shall have a target air void spacing factor of 0.0080 in. Specific surface (surface area of air voids) target shall be 600 in^2 per cubic inch of air-void volume. Number of air voids/ in. shall be 1-1/2 to 2 times numerical value of entrained air content percentage, as determined by ASTM C 457. Concrete mixes not meeting these values may require adjustments unless accepted in writhing by Engineer.
5. Shrinkage/length of change of standard specimen per ASTM C 457 target 0.04% at 28 days.

E. Air Entrainment:

1. See General Notes on drawings for total air content (percent by volume).
2. Permissible variation from specified total air content: plus or minus 1-1/2 percent.

F. Corrosion inhibiting admixture: Include calcium nitrite corrosion inhibiting admixture in concrete for double Tee Units. Include as an alternate as indicated in Structural General Notes. Dosage shall be determined by the manufacturer to inhibit active corrosion at the reinforcing level to 9.9 pounds of chlorides per cubic yard of concrete, but no less than 2 gallons per cubic yard.

G. Provide back-up data (30 test data), standard deviation computation, computation of required concrete strength (always higher than specified strength) along with verification (trial batch records or 10 test series) that design mix provides the required strength.

H. Include the following information for each concrete mix design:

1. Each mix design shall include mix identification designation (Unique for each mix submitted) and statement of intended use for the mix, i.e. “Mix A-Walls”, etc.
2. Method used to determine proposed mix design (ACI 318, Articles 5.2 and 5.3).
3. Graduation of fine and coarse aggregates.
4. Proportions of all ingredients including all admixtures added either at time of batching or at job site.
5. Water/cementitious materials ratio.
6. Slump, ASTM C 143.
7. Air Content:
   a) Of freshly mixed concrete by pressure method, ASTM C 231, or volumetric method, ASTM C 173.
8. Unit Weight of concrete, ASTM C 138.
9. Strength at 28 days, ASTM C 39.
10. Data (30 test data) and standard deviation computation, per ACI 318.5.3.2. Cylinder tests are the average of 2 cylinder breaks. These cylinder tests shall be for concrete with a specified strength no more than 1000 psi more or less than the specified strength for this concrete, and shall use the same cement, admixtures, and aggregate sources. The tests shall be no older than 6 months from the present time. The computations shall include the average strength value, the standard deviation, and the computations for the required average strength.
11. Verification that design mix provides the required average strength. This shall consist of at least 10 tests (average of 2 cylinders) for field experience method, and strength/water-cement ratio curves for trial batch method. For the field experience method, tests shall be no more than 8 months old and shall represent concrete made with a mix having the same proportions and materials/sources as that proposed. For test result populations less than 30, the spread in time for the cylinders shall not be less than 45 days. The population used for documentation of average strength may be the same as that used for determining the required average strength, so long as the provision s of materials and maturity are satisfied.
12. Submit tests (4 tests) to document chloride ion content of mix.
    a) Total water soluble chloride ion content of mix including all constituents shall not exceed 0.06 chloride ions by weight of cement for prestressed concrete and 0.15% for reinforced concrete. Test to determine chloride ion content shall conform to Federal Highway Administration Report No. FHWA-RD-77-85, “Sampling and Testing for Chloride Ion in Concrete” or AASHTO Method 260.
    b) Concrete chloride ion content shall be determined by Mix Designer prior to mix use. Cast and test 4 samples from current production of a similar concrete mix to that proposed for superstructure. Sample and test to be no later than 2 months old.
13. Submit tests (3 Tests) to document shrinkage (Length Change of Concrete).

a) Determine length change of hardened concrete test specimens in accordance with ASTM C 157, except as noted below. Existing test data from previous project may be acceptable, so long as it is no older than 6 months.

b) Test specimens shall be moist cured, including period in molds for 7 days. Store specimens in air for a period of 28 days.

c) Utilize concrete materials and mix proportions submitted for use in post-tensioned floor slab and beam.

d) Report length change of specimens after periods of air drying after curing of 4, 7, 14, and 28 days.

e) Target Value: Target average length change at 28 days is 0.04%.

14. Submit 3 tests of hardened air-void system parameters as determined by microscopical examination per ASTM C 457.

I. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows, with a tolerance of plus or minus 1-1/2 percent:

1. Air Content: 6 percent for 1-inch maximum aggregate.

2. Air Content: 7 percent for ½ inch maximum aggregate.

J. Other Admixtures: Use water-reducing, high-range water-reducing, water-reducing and accelerating, or water-reducing and retarding admixtures according to manufacturer's directions.

K. Concrete-Mix Adjustments: Concrete-mix design adjustments may be proposed when characteristics of materials, project conditions, weather, test results, or other circumstances warrant.

2.11 FABRICATION

A. Formwork: Accurately construct forms, mortar tight, of sufficient strength to withstand pressures due to concrete placing operations, temperature changes, and for pretensioning and detensioning operations. Maintain formwork to provide completed precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified in PCI MNL-116.

1. Coat surfaces of forms with bond-breaking compound before reinforcement is placed. Provide commercial-formula, form-coating compounds that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces requiring bond or adhesion. Apply in compliance with manufacturer's instructions.

2. Unless forms for precast, prestressed concrete units are stripped prior to detensioning, design forms so that stresses are not induced in precast units due to deformation of concrete under prestress or movement during detensioning.

B. Built-In Anchorages: Accurately position built-in anchorage devices and secure to formwork. Locate anchorages where they do not affect the position of the main reinforcement or placing of concrete.

C. Cast-in reglets, slots, holes, and other accessories in precast architectural concrete units to receive windows, cramps, dowels, reglets, waterstops, flashings, and other similar work as indicated.

D. Reinforcement: Comply with the recommendations of CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

E. The admixture supplier shall certify the admixture conformance to all requirements specified herein. The contractor shall submit written certification to the Engineer prior to or with the submission of the concrete mix design.

1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete.

2. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcement by metal chairs, runners, bolsters, spacers and hangers, as required.

3. Place reinforcement to obtain at least the minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

4. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least on full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuos laps in either direction.

F. Pretensioing: Pretension tendons for precast, prestressed concrete either by single-strand tensioning method or multiple-strand tensioning method. Comply with PCI MNL-116 requirements.

G. Concrete Mixing: Comply with requirements and with ASTM C 94. Following concrete batching, no additional water may be added.

H. Concrete Placement: Place concrete in a continuos operation to prevent seams or planes of weakness from forming in precast units. Comply with requirements of ACI 304R for measuring, mixing, transporting, and placing concrete.

1. Thoroughly consolidate placed concrete by internal and externals vibration without dislocating or damaging reinforcement and built-in terms. Use equipment and procedures complying with ACI 309R.

2. Comply with ACI 306R procedures for cold-weather concrete placement.

3. Comply with ACI 305R procedures for hot-weather concrete placement.

I. Identify pickup points of precast concrete units and orientation in structure with permanent markings, complying with markings indicated on final shop drawings. Imprint casting date on each precast unit on a surface that will not show in the finished structure.

J. Cure concrete according to the requirements of PCI MNL-116 by moisture retention without heat or by accelerated heat curing, using low-pressure live steam or radiant heat and moisture.

K. Delay detensioning prestressed concrete units until concrete has attained at least 70 percent of it s compressive strength as established by test cylinders cured under the same conditions as the concrete.

1. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.

2. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat-cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.

L. Finish formed surfaces of precast concrete as indicated for each type of unit, and as follows:

1. Unless noted otherwise, provide a Standard Finish: Normal plant-run finish produced in forms that impart a smooth finish to concrete. Small surface holes caused by air bubbles, normal color variations, and form joint marks, and minor chips and spalls will be tolerated. Major or unsightly imperfections, as judged by the Engineer, honeycombs, or structural defects as judged by the Structural Engineer, are not permitted.

2. At columns, and exposed faces of spandrels and shear walls not formed by form liners provide a medium sandblast finish, as approved by the Engineer.

3. At form liner surfaces Grade B Finish: Fill air pockets and holes greater than ¼ inch in diameter with sand-cement past matching color of adjacent surfaces. Grind smooth from offsets or fins greater than 1/8 inch.

M. Finish unformed surfaces by trowel, unless otherwise indicated. Consolidate concrete, bring to proper level with straightedge, float, and trowel to a smooth, uniform finish.

1. Apply scratch finish to precast concrete units that will receive concrete topping after installation. Following initial strike-off, transversely scarify surface to provide ridges approximately ¼ inch deep.

2.12 FABRICATION TOLERANCES

A. Product Tolerances: Fabricate precast structural concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished unit complies with PCI MNL 116 product tolerances.

B. Fabricate precast architectural concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished panel complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.

C. Position Tolerances: For cast-in items measured from datum line locations, as indicated on Shop Drawings.

1. Weld Plates: Plus or minus 1 inch.

2. Inserts: Plus or minus ½ inch.

3. Handling Devices: Plus or minus 3 inches.

4. Reinforcing Steel and Welded Wire Fabric: Plus or minus ¼ inch where position has structural implications or affects concrete cover; otherwise, plus or minus ½ inch.

5. Reinforcing Steel Extending out of Member: Plus or minus ½ of plan dimensions.

6. Tendons: Plus or minus ¼ inch, vertical; plus or minus 1 inch, horizontal.

7. Location of Rustication Joints: Plus or minus 1/8 inch.

8. Flashing Reglets: Plus or minus ¼ inch.

2.13 FINISHES

A. Finish exposed-face surfaces of precast architectural concrete units to match approved sample panels and mockups and as follows:

1. Smooth-Surface Finish: Provide surfaces free of pockets, sand streaks, and honeycombs with uniform color and texture.

B. Finish exposed back surfaces of precast architectural concrete units by smooth, steel-trowel finish.

C. Finish unexposed surfaces of precast architectural concrete units by float finish.

2.14 SOURCE QUALITY CONTROL

A. The Owner will employ an independent testing agency to evaluate precast fabricator's quality control and testing methods.

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

B. Quality-Control Testing: The contractor shall perform all testing and inspection of precast concrete as specified herein, and in accordance with PCI MNL-116 requirements. Refer to section 3.3.

C. Strength of precast concrete units will be considered potentially deficient when precast concrete units fail to comply with requirements, including the following:

1. Fail to meet compressive-strength test requirements.
2. Reinforcement, and pretensioning and detensioning tendons of prestressed concrete do not conform to fabrication requirements.
3. Concrete curing and protection of precast units against extremes in temperature fail to meet requirements.
4. Precast units are damaged during handling and erecting.

D. Testing: When there is evidence that the strength of precast concrete units may be deficient or may not meet requirements, the Owner will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42.

1. A minimum of 3 representative cores will be taken form precast concrete units of suspect strength, from locations directed by Engineer.
2. Cores will be tested, following immersion in water, in a wet condition per ACI 301 when precast concrete units will be wet under service conditions.
3. Cores will be tested in an air-dry condition per ACI 301 when precast concrete units will be dry under service conditions.
4. Strength of concrete for each series of 3 cores will be considered satisfactory if the average compressive strength is at least 85 percent of the 28-day design compressive strength and no core compressive strength is less than 75 percent of the 28-day design compressive strength.

5. Test results will be made in writing on the same day that tests are made, with copies to Engineer, Contractor, and precast fabricator. Test reports will include the Project identification name and number, date, name of precast concrete fabricator, name of concrete testing agency; identification letter, name and type of precast concrete unit or units represented by core tests; design compressive strength, compressive strength at break and type of break, corrected for length-diameter ration, and direction of applied load to core with respect to horizontal plane of concrete as placed.

E. Patching: Where core test results are satisfactory and precast concrete units meet requirements, solidly fill core holes with patching mortar and finish to match adjacent concrete surfaces.

F. Dimensional Tolerances: Units having dimensions smaller or greater than required and not meeting tolerance limits may be subject to additional testing.

1. Precast units having dimensions greater than required will be rejected if the appearance of function of the structure is adversely affected or if larger dimensions interfere with other construction. Repair or remove and replace rejected units, as required, to meet construction conditions.

G. Defective Work: Precast concrete units that do not conform to requirements, including strength, manufacturing tolerances, and finishes, are unacceptable. Replace with precast concrete units that meet requirements.

PART 3 - PRODUCTS

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements including installation tolerances, true and level bearing surfaces, and other conditions affecting performance of precast concrete units. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Welding: Perform welding in compliance with AWS D1.1 and AWS D1.4, with qualified welders.

1. Protect precast concrete units and bearing pads from damage by field welding or cutting operations and provide noncombustible shields as required.

2. Repair damaged metal surfaces by cleaning and applying a coat of galvanizing repair paint to galvanized surfaces.

3. Repair damaged metal surfaces by cleaning and repriming damaged painted surfaces.

B. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed units, unless otherwise acceptable to Engineer.

C. Shore and brace precast concrete units to maintain location, stability, and alignment until permanent connections are installed.

D. Grouting Connections and Joints: After precast concrete units have been placed and secured, grout open spaces at keyways, connections, and joints. Provide forms or other acceptable method to 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, plumb and level with adjacent to concrete surfaces. Keep grouted joints damp for not less than 24 hours after initial set. Promptly remove grout material from exposed surfaces before it hardens.

3.3 ERECTION TOLERANCES

A. Erection Tolerances: Install structural precast units level, plumb, square, and true, without exceeding the recommended erection tolerances of PCI MNL-127 "Recommended Practice for Erection of Precast Concrete."

B. Install precast architectural concrete units level, plumb, square, true, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 117, Appendix I.

3.4 QUALITY CONTROL TESTING

A. General: The Contractor shall perform tests and submit test reports.

B. Sampling and testing for quality control during concrete placement shall include the following, unless directed otherwise by Engineer.

1. Sampling and Testing Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
    a) Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
    b) Air Content: ASTM C 173, volumetric method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.
    c) Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg. F. and below, when 80 deg. F. and above, and one test for each set of compressive-strength specimens.
    d) Compression Test Specimen: ASTM C 31; one set of six standard cylinders for each compressive-strength test, 8 standard cylinders for post-tensioned concrete unless otherwise directed. Mold and store cylinders laboratory-cured test specimens except when field-cured test specimens are required.
    e) Compressive-Strength Tests: ASTM C 39; one set for each day's pour exceeding 5 cu. yd. Plus additional sets for each 100 cu. yd. more than the first 25 cu. yd. of each concrete class placed in any one day.
        1) Make six cylinders per placement: 3 at beginning (labeled "A") and 3 at end of placement (labeled "B").
        2) Only 1 "A" and 1 "B" cylinder made for each placement need be cured per PCI MNL 116. Test these cylinders to verify concrete compressive strength at transfer of prestress.
        3) Other cylinders may be moist cured and tested at 28 days to verify design compressive strength of concrete.
        4) Discard remaining cylinders after 56 days upon acceptance in writing of Engineer.

C. Test results will be reported in writing to Engineer, on a weekly basis. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, concrete type and class, location or identification of concrete/pieces formed, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both transfer tests and 28-day tests.

D. Field Inspection: The Owner will employ a testing agency to inspect precast erection.

1. Inspect all precast concrete member bearing pad placements prior to placement of cast-in-place topping or cast-in-place washes. Report location of all bearing pads which do not meet placement tolerances.
2. Visually inspect all field welds.
3. Welds: Test 25% of all field fillet welds and 5% of all shop welds using magnetic particle method. One spot test per partial penetration weld using magnetic testing techniques or ultrasonic test methods. Bolted connections: visually inspect all connections. Check proper torque with calibrated torque wrench at minimum of 2 bolts of every connection.
4. Report location of all conditions which do not conform to contract requirements.

3.5 CLEANING

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

1. Wash and rinse according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations.
2. Due not use cleaning materials or processes that could change the appearance of exposed concrete finishes.

END SECTION 03450