

GREAT LAKES CAST STONE

STANDARD SPECIFICATIONS

Section 04720 governs the specifications for the manufacture of cast stone.

Great Lakes Cast Stone complies with the following specifications.

This specification encompasses basic requirements for Cast Stone, a refined architectural concrete building unit manufactured to simulate natural cut stone, used in unit masonry applications. Cast Stone is a masonry product, used as an architectural feature, trim, ornament or facing for buildings or other structures. Great Lakes Cast Stone used the standards of the Cast Stone Institute.

GLCS standard will exceed minimum requirements for compressive strength and weathering qualities essential for normal installations as a suitable replacement for natural cut limestone, brownstone, sandstone, bluestone, granite, slate, keystone, travertine and other natural building stones and equals or exceeds the standards of the Cast Stone Institute.

1. PART 1 - GENERAL

1.1 SECTION INCLUDES - Architectural Cast Stone

- A. Scope - Cast Stone shown on architectural drawings and as described in this specification.
Manufacturer shall furnish Cast Stone covered by this specification.

1.2 RELATED SECTIONS

- A. Section - 01 33 00 - Submittal Procedures
- B. Section - 04 05 13 - Masonry Mortaring
- C. Section - 04 05 16 - Masonry Grouting
- D. Section - 04 05 19 - Masonry Anchorage and Reinforcing
- E. Section - 04 20 20 - Unit Masonry
- F. Section - 07 90 00 - Joint Protection

1.3 REFERENCES

- A. ACI 318 - Building Code Requirements for Reinforced Concrete
- B. ASTM A 185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
- C. ASTM A 615/A 615M - Standard Specification for Deformed and Plain Billet - Steel Bars for Reinforced Concrete.
- D. ASTM C 33 - Standard Specification for Concrete Aggregates
- E. ASTM C 150 - Standard Specification for Portland Cement
- F. ASTM C 595 - Blended Cement
- G. ASTM C 1157 - Hydraulic Cement
- H. ASTM C 173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volume Method
- I. ASTM C 231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
- J. ASTM C 260 - Standard Specification for Air-Entrained Admixtures for Concrete
- K. ASTM C 270 - Standard Specification for Mortar for Unit Masonry
- L. ASTM C 426 - Standard Test Method for Linear Shrinkage of Concrete Masonry Units
- M. ASTM C 494/C 494M - Standard Specification for Chemical Admixtures for Concrete
- N. ASTM C 618 - Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
- O. ASTM C 666 - Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
- P. ASTM C 979 - Standard Specification for Coloring Pigments for Integrally Pigmented Concrete
- Q. ASTM C 989 - Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete
- R. ASTM C 1116 - Standard Specification for Fiber Reinforced Concrete and Shotcrete
- S. ASTM C 1194 - Standard Test Method for Compressive Strength of Architectural Cast Stone
- T. ASTM C 1195 - Standard Test Method for Absorption of Architectural Cast Stone
- U. ASTM C 1364 - Standard Specification for Architectural Cast Stone
- V. ASTM D 2244 - Standard Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates

Cast Stone Institute® Technical Manual (Current Edition)

1.4 DEFINITIONS

- A. Cast Stone - a refined architectural concrete building unit manufactured to simulate natural cut stone, used in Division 4 masonry applications.
 - 1. Dry Cast - manufactured from zero slump concrete
 - a. Vibrant Dry Tamp (VDT) casting method: Vibratory ramming of earth moist, zero-slump concrete against a rigid mold until it is densely compacted.
 - b. Machine casting method: Manufactured from earth moist, zero-slump concrete compacted by machinery using vibration and pressure against a mold until it becomes densely consolidated.
 - 2. Wet Cast - manufactured from measurable slump concrete
 - a. Wet casting method: manufactured from measurable slump concrete and vibrated into a mold until it becomes densely consolidated.
 - 3. Specifier Note: Slump, manufacturing method, and apparatus shall be selected by the manufacturer and not specified by the purchaser.

1.5 SUBMITTAL PROCEDURES

- A. Comply with Section 01 33 00 – Submittal Procedures
- B. Samples: Submit pieces of the Cast Stone that are representative of the general range of finish and color proposed to be furnished for the project.
- C. Test results: Submit manufacturers test results of Cast Stone previously made by the manufacturer.
- D. Shop Drawings: Submit manufacturers shop drawings including profiles, cross-sections, reinforcement, exposed faces, arrangement of joints (optional for standard or semi-custom installations), anchoring methods, anchors (if required), annotation of stone types and their location.
- E. Warranty: Submit Cast Stone Institute® Member Limited Warranty.
- F. Certification: Submit valid Cast Stone Institute® Plant Certification.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Cast Stone shall be produced in a plant certified by the Cast Stone Institute®.
 - 2. Manufacturer shall have sufficient plant facilities to produce the shapes, quantities and size of Cast Stone required in accordance with the project schedule.
 - 3. Manufacturer shall submit a written list of projects similar in scope and at least three (3) years of age, along with owner, architect and contractor references.
- B. Standards: Comply with the requirements of the Cast Stone Institute® Technical Manual and the project specifications. Where a conflict may occur, the contract documents shall prevail.
- C. Mock-up (Optional) Provide full size unit(s) for use in construction of sample wall. The approved mock-up shall become the standard for appearance and workmanship for the project.
- D. Warranty Period: 10 years.

2. PART 2 - PRODUCTS

2.1 ARCHITECTURAL CAST STONE

- A. Comply with ASTM C 1364
- B. Physical properties: Provide the following:
 - 1. Compressive Strength – ASTM C 1194: 6,500 psi minimum for products at 28 days.
 - 2. Absorption – ASTM C 1195: 6% maximum by the cold water method, or 10% maximum by the boiling method for products at 28 days.
 - 3. Air Content – ASTM C 173 or C 231, for wet cast product shall be 4-8% for units exposed to freeze-thaw environments. Air entrainment is not required for VDT products.
 - 4. Freeze-thaw – ASTM C 1364: The CPWL shall be less than 5% after 300 cycles of freezing and thawing.
 - 5. Linear Shrinkage – ASTM C 426: Shrinkage shall not exceed 0.065%.
- C. Job site testing – One sample from production units may be selected at random from the field for each 500 cubic feet (14 m³) delivered to the job site.
 - 1. Three field cut cube specimens from each of these samples shall have an average minimum compressive strength of not less than 85% with no single specimen testing less than 75% of design strength as allowed by ACI 318.

2. Three field cut cube specimens from each of these samples shall have an average maximum cold-water absorption of 6%.
3. Field specimens shall be tested in accordance with ASTM C 1194 and C 1195.

2.2 RAW MATERIALS

- A. Portland cement – Type I or Type III, white and/or grey, ASTM C 150.
- B. Coarse aggregates - Granite, quartz or limestone, ASTM C 33, except for gradation, and are optional for the VDT casting method.
- C. Fine aggregates - Manufactured or natural sands, ASTM C 33, except for gradation.
- D. Colors - Inorganic iron oxide pigments, ASTM C 979 except that carbon black pigments shall not be used.
- E. Admixtures- Comply with the following:
 1. ASTM C 260 for air-entraining admixtures.
 2. ASTM C 494/C 495M Types A - G for water reducing, retarding, accelerating and high range admixtures.
 3. Other admixtures: Integral water repellents and other chemicals, for which no ASTM Standard exists, shall be previously established as suitable for use in concrete by proven field performance or through laboratory testing.
 4. ASTM C 618 mineral admixtures of dark and variable colors shall not be used in surfaces intended to be exposed to view.
 5. ASTM C 989 granulated blast furnace slag may be used to improve physical properties. Tests are required to verify these features.
- F. Water – Potable
- G. Reinforcing bars:
 1. ASTM A 615/A 615M: Grade 40 or 60 steel galvanized or epoxy coated when cover is less than 1.5 in.
 2. Welded Wire Fabric: ASTM A 185 where applicable for wet cast units.
- H. Fiber reinforcement (optional): ASTM C 1116
- I. All anchors, dowels and other anchoring devices and shims shall be standard building stone anchors commercially available in a non-corrosive material such as zinc plated, galvanized steel, brass, or stainless steel Type 302 or 304.

2.3 COLOR AND FINISH

- A. Match sample on file in architect's office.
- B. All surfaces intended to be exposed to view shall have a fine-grained texture similar to natural stone, with no air voids in excess of 1/32 in. and the density of such voids shall be less than 3 occurrences per any 1 in.² and not obvious under direct daylight illumination at a 5 ft distance.
- C. Units shall exhibit a texture approximately equal to the approved sample when viewed under direct daylight illumination at a 10 ft distance.
 1. ASTM D 2244 permissible variation in color between units of comparable age subjected to similar weathering exposure.
 - a. Total color difference – not greater than 6 units.
 - b. Total hue difference – not greater than 2 units.
- D. Minor chipping resulting from shipment and delivery shall not be grounds for rejection. Minor chips shall not be obvious under direct daylight illumination from a 20-ft distance.
- E. The occurrence of crazing or efflorescence shall not constitute a cause for rejection.
- F. Remove cement film, if required, from exposed surfaces prior to packaging for shipment.

2.4 REINFORCING

- A. Reinforce the units as required by the drawings and for safe handling and structural stress.
- B. Minimum reinforcing shall be 0.25 percent of the cross section area.
- C. Reinforcement shall be noncorrosive where faces exposed to weather are covered with less than 1.5 in. of concrete material. All reinforcement shall have minimum coverage of twice the diameter of the bars.
- D. Panels, soffits and similar stones greater than 24 in. (600 mm) in one direction shall be reinforced in that direction. Units less than 24 in. (600 mm) in both their length and width dimension shall be non-reinforced unless otherwise specified.
- E. Welded wire fabric reinforcing shall not be used in dry cast products.

2.5 CURING

- A. Cure units in a warm curing chamber approximately 100°F (37.8°C) at 95 percent relative humidity for approximately 12 hours, or cure in a 95 percent moist environment at a minimum 70°F (21.1°C) for 16 hours after casting. Additional yard curing at 95 percent relative humidity shall be 350 degree-days (i.e. 7 days @ 50°F (10°C) or 5 days @ 70°F (21°C)) prior to shipping. Form cured units shall be protected from moisture evaporation with curing blankets or curing compounds after casting.

2.6 MANUFACTURING TOLERANCES

- A. Cross section dimensions shall not deviate by more than $\pm 1/8$ in. from approved dimensions.
- B. Length of units shall not deviate by more than length/ 360 or $\pm 1/8$ in., whichever is greater, not to exceed $\pm 1/4$ in.
 - 1. Maximum length of any unit shall not exceed 15 times the average thickness of such unit unless otherwise agreed by the manufacturer.
- C. Warp, bow or twist of units shall not exceed length/ 360 or $\pm 1/8$ in., whichever is greater.
- D. Location of dowel holes, anchor slots, flashing grooves, false joints and similar features – On formed sides of unit, 1/8 in., on unformed sides of unit, 3/8 in. maximum deviation.

2.7 PRODUCTION QUALITY CONTROL

- A. Testing
 - 1. Test compressive strength and absorption from specimens taken from every 500 cubic feet of product produced.
 - 2. Perform tests in accordance ASTM C 1194 and C 1195.
 - 3. Have tests performed by an independent testing laboratory every six months.
 - 4. New and existing mix designs shall be tested for strength and absorption compliance prior to producing units.
 - 5. Retain copies of all test reports for a minimum of two years.

2.8 DELIVERY, STORAGE AND HANDLING

- A. Mark production units with the identification marks as shown on the shop drawings.
- B. Package units and protect them from staining or damage during shipping and storage.
- C. Provide an itemized list of product to support the bill of lading.

3. PART 3 - EXECUTION

3.1 EXAMINATION

- A. Installing contractor shall check Cast Stone materials for fit and finish prior to installation. Unacceptable units shall not be set.

3.2 SETTING TOLERANCES

- A. Comply with Cast Stone Institute® Technical Manual.
- B. Set stones 1/8 in. or less, within the plane of adjacent units.
- C. Joints, plus - 1/16 in., minus - 1/8 in.

3.3 JOINTING

- A. Joint size:
 - 1. At stone/brick joints 3/8 in.
 - 2. At stone/stone joints in vertical position 1/4 in. (3/8 in. optional).
 - 3. Stone/stone joints exposed on top 3/8 in.
- B. Joint materials:
 - 1. Mortar, Type N, ASTM C 270.
 - 2. Use a full bed of mortar at all bed joints.
 - 3. Flush vertical joints full with mortar.
 - 4. Leave all joints with exposed tops or under relieving angles open for sealant.
 - 5. Leave head joints in copings and projecting components open for sealant.
- C. Location of joints:
 - 1. As shown on shop drawings.
 - 2. At control and expansion joints unless otherwise shown.

3.4 SETTING

- A. Drench units with clean water prior to setting.
- B. Fill dowel holes and anchor slots completely with mortar or non-shrink grout.
- C. Set units in full bed of mortar, unless otherwise detailed.
- D. Rake mortar joints 3/4 in. in for pointing.
- E. Remove excess mortar from unit faces immediately after setting.
- F. Tuck point unit joints to a slight concave profile.

3.5 JOINT PROTECTION

- A. Comply with requirements of Section 07 90 00.
- B. Prime ends of units, insert properly sized backing rod and install required sealant.

3.6 REPAIR AND CLEANING

- A. Repair chips with touchup materials furnished by manufacturer.
- B. Saturate units to be cleaned prior to applying an approved masonry cleaner.
- C. Consult with manufacturer for appropriate cleaners.

3.7 INSPECTION AND ACCEPTANCE

- A. Inspect finished installation according to Cast Stone Institute® Technical Bulletin #36.
- B. Do not field apply water repellent until repair, cleaning, inspection and acceptance is completed.

3.8 WATER REPELLENT (OPTIONAL)

- A. Apply water repellent in accordance with Cast Stone Institute® Technical Bulletin #35 or water repellent manufacturer's directions.

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Great Lakes Cast Stone's Precast Architectural Concrete Standard Specifications

Section 03450 governs the specifications for the manufacturing of precast. Great Lakes Cast Stone complies with the following specifications.

Section 03450 PRECAST ARCHITECTURAL CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Architectural precast concrete wall panels.
- B. Architectural precast concrete lintels, sills, copings, and trim.
- C. Architectural precast concrete pavers.
- D. Supports, anchors, and attachments.
- E. Perimeter and intermediate joint seals.
- F. Grouting under panels.

1.2 RELATED SECTIONS

- A. Section 03300 - Cast-in-Place Concrete: Building structural frame.
- B. Section 03380 - Post Tensioned Concrete: Building structural frame.
- C. Section 03410 - Plant-Precast Structural Concrete: Building structural frame.
- D. Section 03470 - Tilt-Up Precast Concrete: Building structural frame.
- E. Section 03415 - Precast Concrete Hollow Core Planks: Building structural floor.
- F. Section 05120 - Structural Steel: Building structural frame.
- G. Section 07620 - Flashing and Sheet Metal.
- H. Section 07900 - Joint Sealers.
- I. Section 04720 – Architectural Cast Stone

1.3 REFERENCES

- A. American Concrete Institute.
 - 1. ACI 211.1 - Normal, Heavy Weight, and Mass Concrete, Practice for Selecting Proportions; 1991.
 - 2. ACI 318 - Building Code Requirements for Reinforced Concrete; 2002.

3. ACI 533R - Guide for Precast Concrete Wall Panels; 1993.

B. ASTM International.

1. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel; 2001
2. ASTM A 47/A 47M - Standard Specification for Ferritic Malleable Iron Castings; 1999.
3. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products; 2002.
4. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot Dip) on iron and Steel Hardware; 2002.
5. ASTM A 185 - Standard Specification for Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement; 2001.
6. ASTM A 283/A 283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2000.
7. ASTM A 307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength; 2002.
8. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2002.
9. ASTM A 325M - Standard Specification for High Strength Bolts for Structural Steel Joints; 2000
10. ASTM A 416/A 416M - Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete; 1999.
11. ASTM A 496 - Standard Specification for Steel Wire, Deformed, for Concrete; 2001.
12. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2001a.
13. ASTM A 563 - Standard Specification for Carbon and Alloy Nuts; 2000.
14. ASTM A 572/A 572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel; 2001.
15. ASTM A 615/A 615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 2001b.
16. ASTM A 767/A 767M - Standard Specification for Zinc-Coated (Galvanized) Bars for Concrete Reinforcement; 2000b.
17. ASTM A 934/A 934M - Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars; 2001.
18. ASTM C 33 - Standard Specification for Concrete Aggregates; 2002a.
19. ASTM C 39/C 39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2001.
20. ASTM C 150 - Standard Specification for Portland Cement; 2002a.
21. ASTM C 260 - Standard Specification for Air-Entraining Admixtures for Concrete; 2001.
22. ASTM C 330 - Standard Specification for Lightweight Aggregates for Structural Concrete; 2002b.
23. ASTM C 404 - Standard Specification for Aggregates for Masonry Grout; 1997.
24. ASTM C 494/C 494M - Standard Specification for Chemical Admixtures for Concrete; 1999a.
25. ASTM C 642 - Standard Test Method for Density, Absorption, and Voids in Hardened Concrete; 1997.
26. ASTM C 979 - Standard Specification for Pigments for Integrally Colored Concrete; 1999.
27. ASTM C 1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2002.
28. ASTM C 1240 - Standard Specification for Use of Silica Fume as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar and Grout; 2003.
29. ASTM D 412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension; 1998a.
30. ASTM F 593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs; 2002.

- C. American Welding Society.
 - 1. AWS D1.1/D1.3M - Structural Welding Code; 2003.
 - 2. AWS D1.4 - Structural Welding Code - Reinforcing Steel; 1998.
- D. Cement and Concrete Reference Laboratory (CCRL).
- E. Concrete Reinforcing Steel Institute (CRSI).
 - 1. CRSI - Manual of Standard Practice; 2001.
- F. Department of Defense (DOD).
 - 1. DOD P-21035A - Galvanizing Repair Specification.
- G. Precast/Prestressed Concrete Institute.
 - 1. PCI MNL-117 - Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products; 1996.
- H. Steel Structures Painting Council (SSPC).
 - 1. SSPC Paint 20 - Zinc-Rich Primers (Type I, Inorganic, and Type II, Organic); 2002.
 - 2. SSPC Paint 25 - Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II; 1997.
- I. American Institute of Steel Construction (AISC).

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Submit product data for manufactured materials and products.
- C. Shop Drawing:
 - 1. Show in-place location, manufacturing details, plans, elevations, anchorages, reinforcement, connection details and methods, dimensions, finishes, relationships to adjacent materials, and erection and placement.
 - 2. Show identification marks, coordinated to Shop Drawings, and date of manufacture on all units to facilitate hauling and erection.
 - 3. Setting diagrams, templates, instructions and directions as required for installation.
- D. Engineering Calculations: Engineering calculations as required sealed by an engineer licensed to practice in (project state).
- E. Mix Design(s): Proposed concrete mix design for each type and color of concrete mix required including backup mix.
- F. Material Test Reports: Submit material certificates signed by manufacturer for concrete materials, reinforcing materials, admixtures, and similar items.
- G. Certifications:
 - 1. Manufacturer's certification from APA, PCI, or applicable municipal certifications.
 - 2. Welder's AWS certification. Submit for each welder.
- H. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors, textures, and patterns.
- I. Verification Samples: For each finish product specified, two samples, approximately 12 inches (300 mm) square, representing actual product, color, texture, and patterns.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications.
 - 1. Firm shall have a minimum of five years experience in producing units similar to those required for this Project, with sufficient production capacity to produce and deliver required units without causing delay in Work.
 - 2. Fabricating plant shall be certified by one of the following:
 - a. Architectural Precast Association (APA).
 - b. Precast/Prestressed Concrete Institute (PCI), Group A1.
 - c. Or Equal Certification Program.
- B. Installer's Qualifications: Installer shall have a record of at least five years of successful installation of units similar to those required for this Project.
- C. Welder's Qualifications: Provide certification that welders to be employed in the Work are certified by AWS and applicable local building officials, and have been re-certified in the last 12 months.
- D. Mock-Up: Provide a mock-up for evaluation of surface finishes and workmanship.
 - 1. Provide initial production units for job-site assembly with other materials for approval. Coordinate type and location of mock-ups with project requirements. Accepted units will be used as the standard for acceptance of production units. Remove and replace units which are not accepted.
 - 2. Do not proceed with remaining work until workmanship, color, and finish are approved by Architect.
 - 3. Refinish mock-up area as required to produce acceptable work.
 - 3. Incorporate accepted mockup as part of Work.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store and handle precast in strict compliance with manufacturer's instructions and recommendations and industry standards Protect from damage. Lift and support units only at designated lifting points as shown on approved Shop Drawings.
- B. Deliver units to the Project site in such quantities and at such times to ensure continuity of installation.
- C. Handle precast units to position, consistent with their shape and design. Lift and support only from support points.
- D. Provide 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. Blocking and Lateral Support During Transport and Storage: Clean, non-staining, without causing harm to exposed surfaces. Provide temporary lateral support to prevent bowing and warping.
- F. Protect units to prevent staining, chipping, or spalling of concrete.
- G. Mark units with date of production in location not visible to view when in final position in structure.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Great Lakes Cast Stone Inc., 711 Beaver Road, Girard, PA 16417
Tel: (814) 402-1055, Fax: (814) 402-1120. Email: info@greatlakescaststone.com
Website: www.greatlakescaststone.com

B. Substitutions: Not permitted.

C. Requests for substitutions will be considered in accordance with provisions of Section 01600.

2.2 APPLICATIONS/SCOPE

- A. Design units to withstand design loads as calculated in accordance with applicable code, and erection forces. Calculate structural properties of units in accordance with ACI 318.
1. Wind Loads.
 2. Seismic forces.
 3. Building dynamics, thermal, live, impact or concentrated loads, structural deflection, story drift.

2.3 MATERIALS

A. Concrete Materials:

1. Portland Cement: Complying with ASTM C 150, Type I or III, white or gray colors to achieve desired finish colors. Use only one brand, type, and color from the same mill. Gray cement may be used for non-exposed backup mixes.
2. Aggregates: Complying with ASTM C 33, gradation may differ to achieve desired finish characteristics. Select coarse and fine aggregate colors and screen sizes to match approved sample(s). Verify that adequate supply, from one pit or quarry, for each type of aggregate is available for the entire Project. If possible obtain entire aggregate supply prior to starting Work, or have aggregate supply held in reserve by aggregate supplier.
3. Lightweight aggregate: Complying with ASTM C 330.
4. Water: Potable. Clean, clear, and free from deleterious amounts of salts, acids, alkalies, organic materials, oils, detergents, or other matter that may interfere with color, curing, or strength of concrete.
5. Admixtures: Select to be compatible in specified mix.
 - a. Air Entraining: Complying with ASTM C 260.
 - b. Water Reducing: Complying with ASTM C 494, Type A, B, C, For G.
 - c. Silica Fume: Complying with ASTM C 1240, for cement replacement for high performance concrete.
 - d. Coloring Agent: Complying with ASTM C 979, compatible with other concrete materials.
 - e. Other constituents: Integral water repellents and other chemicals for which no ASTM standard exists, shall be previously established as suitable for use in concrete or shall be shown by test or experience not to be detrimental to the concrete.

B. Formwork:

1. Provide forms with acceptable form facing materials that are non-reactive with concrete or form release agents and will produce required finish surfaces.
2. Construct and maintain forms to produce precast concrete units of shapes, lines, and dimensions indicated, within specified tolerances.

C. Reinforcing Materials:

1. Reinforcing Bars: Complying with ASTM A 615/A 615M, Grade 40 or 60, unless otherwise required to meet structural requirements.
2. Galvanized Reinforcing Bars: Complying with ASTM A 767/A 767M, hot-dip galvanized; use where concrete cover is less than 1-1/2 inches.

3. Epoxy Coated Reinforcing Bars: Complying with ASTM A 934; use in special applications where indicated.
4. Steel Welded Wire Fabric: Complying with ASTM A 185, plain, cold drawn.
5. Pre-Stressing Tendons: Complying with ASTM A 416/A 416M, Grade 250 or 270, uncoated, 7 wire, low relaxation strand.

D. Connection Materials:

1. Steel Shapes and Plates: Complying with ASTM A 36/A 36M.
2. Malleable Iron Castings: Complying with ASTM A 47/A 47M.
3. Carbon Steel Plates: Complying with ASTM A 283/A 283M.
4. High Strength, Low Alloy Structural Steel: Complying with ASTM A 572.
5. Carbon Steel Structural Tubing: Complying with ASTM A 500, Grade B.
6. Anchor Bolts: Complying with ASTM A 307, carbon steel or ASTM A 325 (ASTM A325M), high strength; bolts nuts, and washers.
7. Welded Headed Studs: Complying with AWS D1.1/D1.3M, Type B.
8. Deformed Steel Wire Bar Anchors: Complying with ASTM A 496.
9. Stainless Steel Plate: Complying with ASTM F 593, Type 304 or Type 316; bolts and studs, nuts and washers. Note that selection of stainless steel will result in increased costs.
10. Finish for Steel Connection Materials:
 - a. Hot-dip galvanize steel exposed to weather in final assembly complying with ASTM A 123/A 123M or ASTM A 153/A 153M.
 - b. Shop Prime Remaining Steel Shapes: Complying with SSPC Paint 25.
 - c. Anchor Bolts, Nuts, Washers, Cadmium Plated: Complying with ASTM A 563, Grade C.
 - d. Hot-dip galvanize setting bolts or projecting steel in masonry applications complying with ASTM A 153/A 153M.
 - e. Galvanizing Repair Paint: Complying with DOD P-21035A or SSPC Paint 20.
 - f. Welding Electrodes: Comply with AWS Standards.

E. Bearing Pads: Elastomeric pads, complying with ASTM D 412.

F. Grout Materials:

1. Cement Grout: Cement complying with ASTM C 150; sand complying with ASTM C 404; proportions 1:2.5 by volume, minimum water for placement and hydration.
2. Non-Shrink Grout: Complying with ASTM C 1107.
3. Epoxy Grout: Consult Suppliers.

2.4 MIXES

A. Design mixes for each type of concrete specified shall be prepared by an independent testing agency or by an architectural precast manufacturing plant at precast manufacturer's option. Proportion mixes by either testing agency trial batch or field test data methods in accordance with ACI 211.1, using materials to be used on the Project, to provide concrete with properties as follows:

1. Concrete Density: Normal weight.
2. Concrete Density: Lightweight.
3. Compressive Strength: 5,000 psi (35 MPa) when tested in accordance with ASTM C 39/C 39M.
4. Maximum water cement ratio 0.40 at point of placement.
5. Add air-entrainment admixture to result in air content at point of placement complying with ACI 533R requirements.
6. Water absorption maximum 6% (by weight) when tested in accordance with ASTM C 642.

2.5 MANUFACTURING

A. General:

1. Fabricate precast concrete units with manufacturing and testing procedures, quality control recommendations, and dimensional tolerances as specified in PCI MNL-117 or ACI 533R, unless more stringent requirements are shown or specified.
2. Fabricate units straight, smooth and true to size and shape, with exposed edges and corners precise and square, unless otherwise indicated.

B. Cast openings larger than 10 inches (254 mm) in any dimension according to locations shown on Shop Drawings. Smaller holes may be field cut when approved by Architect.

C. Reinforcement: Comply with CRSI Manual of Standard Practice, PCI MNL-117, or ACI 533R recommendations. Reinforce architectural precast concrete units to resist handling, transportation, and erection stresses, and to comply with specified performance criteria.

D. Pretension tendons for units in compliance with PCI MNL-117 or ACI 533R.

E. Cast-in Items: Provide embedded anchors, inserts, steel shapes, and lifting devices as shown on reviewed Shop Drawings. Window connections are best made by field drilled inserts. Firmly hold cast items in place by jigs, strongbacks, or other approved means.

F. Comply with PCI MNL-117 or ACI 533R requirements for measuring, mixing, transporting, and placing concrete. Place facing mix to a thickness of the greater of 1 inch (26 mm) or 1.5 times the maximum aggregate size. Place back-up concrete to ensure bond with face concrete.

G. Consolidate concrete using equipment and procedures complying with PCI MNL-117 or ACI 533R.

H. Permanently mark units with pick-up points as shown on reviewed Shop Drawings. Imprint casting date and piece mark on a surface to be concealed from view in the finished structure.

I. Cure concrete in accordance with PCI MNL-117 or ACI 533R requirements.

J. Discard units that are warped, cracked, broken, spalled, stained, or otherwise defective unless repairs are approved by the Architect and meet specified requirements. Refer to ACI-533R for product finish requirements unless otherwise shown or specified.

K. Manufacturing Tolerances: Fabricate to tolerances listed in PCI MNL-117 or ACI 533R.

2.6 FINISHES

A. Finish exposed surfaces or units to match Architect's design reference sample.

B. Finish exposed surfaces or units to match APA and PCI "Architectural Precast Concrete-Color and Texture Selection Guide" of Plate Numbers Indicated.

C. Finish exposed surfaces or units in accordance with the following:

1. Smooth surface finish free from pockets, sand streaks, honeycomb, with uniform color and texture. State whether bugholes less than 5/8 inch (16 mm) in diameter are acceptable.
2. Textured surface finish from form liners or inserts.
3. Machine textured finish, using power or hand tools to remove matrix and fracture coarse aggregate.

4. Retarded finish, using chemical retarding agents applied to forms, with washing and brushing procedures to expose aggregate and surrounding matrix.
 5. Abrasive blast finish, using abrasive grit, equipment, application and cleaning procedures to expose aggregate and surrounding matrix.
 6. Acid etched finish using acid solution and application techniques to expose aggregate and surrounding matrix.
 7. Honed or Polished finish using mechanical abrasion, followed by filling and rubbing procedures.
 8. Sand embedment finish, using selected coarse aggregate placed in a sand bed in the bottom of the mold, with sand removed after removal from the mold.
 9. Applied material finish, using selected ceramic or natural stone materials, specified in Section 04400.
- D. Finish Exposed Back Surface of Units:
1. To match face surface of units.
 2. By smooth, steel trowel finish.

E. Finish unexposed surfaces of units by float finish or as-cast form finish.

2.7 SOURCE QUALITY CONTROL

- A. Inspect and test architectural precast concrete in accordance with PCI MNL-117 or ACI 533R.
- B. The Owner may retain an independent Testing Laboratory to evaluate manufacturer's quality control and testing methods. Testing Laboratory shall be certified by CCRL or similar National authority. Manufacturer shall allow Testing Laboratory access to all operations pertinent to the Project.
- C. Defective Work: Discard units that do not conform to requirements as shown or specified. Replace with units which meet requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Field Dimensions: Furnish field dimensions to manufacturer as required.
- C. Examine substrates and conditions for compliance with requirements for installation, tolerances, true and level bearing surfaces, and other conditions affecting performance of architectural precast concrete units.
- D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- E. Do not install units until supporting structure has been completed and has attained minimum allowable design compressive strength.

3.2 ERECTION

- A. Erect units using personnel experienced and trained in placement and securing of precast concrete units.
- B. Lift and handle precast using lift points and embeds as shown on approved shop drawings.

- C. Erect level, plumb, and true to line. Do not allow cumulative dimensional errors to develop.
 - 1. Adjustments such as shimming which would place additional stress on units shall not be permitted.
 - 2. Adhere to dimensional tolerances in accordance with PCI recommendations.
- D. Erect and secure in a manner to prevent damage to units or units in place.
- E. Erection Tolerances. Erect within tolerances listed in PCI MNL-117 Appendix I or ACI 533R.
- F. Joint Sealants: As specified in Section 07900.
- G. Where two stage joint seal is required, sequence with sealant application to ensure that sealant, gaskets, and similar items required for interior side seal are installed concurrently with installation of precast units.

3.3 CLEANING

- A. Clean exposed surfaces of units after erection if soiled or stained.
 - 1. Wash and rinse according to architectural precast concrete manufacturer's recommendations. Protect other work from damage while cleaning.
 - 2. Do not use cleaning materials or methods that change the appearance of architectural precast concrete finishes. Test clean a small area to verify adequacy and safety of materials and methods.
 - 3. Leave in condition for application of water repellents specified in Section 07190.

3.4 PROTECTION

- A. Subsequent trades to Protect finished surfaces from soiling or damage.
- B. Touch-up, repair or replace damaged products before Substantial Completion.
 - 1. Repair exposed surfaces of units to match color, texture, and uniformity of surrounding units.
 - 2. Remove and replace damaged units when repairs do not meet requirements.

3.5 SCHEDULE

- A. Item: