

SECTION 03450

PLANT-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.
 - d. .
- 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.
 4. 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: Company; address, City, ST 00000. ASD. Tel: (000) 000-0000. Fax: (000) 000-0000. Email: _____ www. _____
- 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:

SECTION 04720

ARCHITECTURAL CAST STONE

1. PART 1 - GENERAL

1.1. SECTION INCLUDES - Architectural cast stone.

- A. Scope - All labor, materials and equipment to provide the cast stone shown on architectural drawings and as described in this specification.
 1. Manufacturer shall furnish cast stone covered by this specification.
 2. Installing contractor shall unload, store, furnish all anchors, set, patch, clean and seal (optional) the cast stone as required.

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 – 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 173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volume Method.
- G. ASTM C 231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- H. ASTM C 260 - Standard Specification for Air-Entrained Admixtures for Concrete.
- I. ASTM C 270 - Standard Specification for Mortar for Unit Masonry.
- J. ASTM C 426 – Standard Test Method for Linear Shrinkage of Concrete Masonry Units
- K. ASTM C 494/C 494M - Standard Specification for Chemical Admixtures for Concrete.
- L. ASTM C 618 – Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
- M. ASTM C 666 – Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
- N. ASTM C 979 - Standard Specification for Coloring Pigments for Integrally Pigmented Concrete.
- O. ASTM C 989 – Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete.
- P. ASTM C 1194 - Standard Test Method for Compressive Strength of Architectural Cast

Stone.

- Q. ASTM C 1195 - Standard Test Method for Absorption of Architectural Cast Stone.
- R. ASTM C 1364 - Standard Specification for Architectural Cast Stone.
- S. ASTM D 2244 – Standard Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
- T. Cast Stone InstituteSM Technical Manual (Current Edition)

1.4. DEFINITIONS

- A. Cast Stone - a refined architectural concrete building unit manufactured to simulate natural cut stone, used in unit masonry applications.
 - 1. Dry Cast Concrete Products – 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.
 - 2. Wet Cast Concrete Products – manufactured from measurable slump concrete.
 - a. Wet casting method: manufactured from measurable slump concrete and consolidated into a mold.

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 previously made cast stone.
- 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 location.

1.6. QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Manufacturer shall have sufficient plant facilities to produce the shapes, quantities and size of cast stone required in accordance with the project schedule.
 - 2. Manufacturer must be a producing member of the Cast Stone Institute and/or an Architectural Precast Association Certified Plant with a minimum of five years history of manufacturing cast stone of similar units.
- 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.

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 (45 Mpa) min. for products at 28 days.
 - 2. Absorption - ASTM C 1195: 6% max. by the cold water method, or 10% maximum by the boiling method for products at 28 days.
 - 3. Air Content – ASTM C173 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 666: The Cumulative Percentage Weight Loss 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 (1) 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 (3) 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 (3) 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 gray, 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. (37 mm).
 2. Welded Wire Fabric: ASTM A 185 where applicable for wet cast units.
- H. 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 exposed to view surfaces shall have a fine-grained texture similar to natural stone, with no air voids in excess of 1/32 in. (0.8 mm) and the density of such voids shall be less than 3 occurrences per any 1 in.² (25 mm²) and not obvious under direct daylight illumination at a 5 ft (1.5m) distance.
- C. Units shall exhibit a texture approximately equal to the approved sample when viewed under direct daylight illumination at a 10 ft (3 m) 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 (6 m) 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 non corrosive where faces exposed to weather are covered with less than 1.5 in. (38 mm) 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. Mold 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. (3 mm) from approved dimensions.
- B. Length of units shall not deviate by more than length/ 360 or $\pm 1/8$ in. (3 mm), whichever is greater, not to exceed $\pm 1/4$ in. (6 mm).
 - 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. (3 mm), 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. (3 mm), on unformed sides of unit, 3/8 in. (9 mm) maximum deviation.

2.7. PRODUCTION QUALITY CONTROL

- A. Testing.
 - 1. Test compressive strength and absorption from specimens selected at random from plant production.
 - 2. Samples shall be taken and tested from every 500 (14 m³) cubic feet of product produced.
 - 3. Perform tests in accordance ASTM C 1194 and C 1195.
 - 4. New and existing mix designs shall be tested for strength and absorption compliance prior to producing units.

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. Do not set unacceptable units.

3.2. SETTING TOLERANCES

- A. Set stones 1/8 in. (3 mm) or less, within the plane of adjacent units.
- B. Joints, plus - 1/16 in. (1.5 mm), minus - 1/8 in. (3 mm).

3.3. JOINTING

- A. Joint size:
 - 1. At stone/brick joints 3/8 in. (9.5 cm).
 - 2. At stone/stone joints in vertical position 1/4 in. (6 mm) (3/8 in. (9.5 mm) optional).
 - 3. Stone/stone joints exposed on top 3/8 in. (9.5 mm).
- 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. (18 mm) 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. Protect units and surrounding masonry prior to cleaning.
- C. Saturate all units prior to applying an approved masonry cleaner.
- D. Consult with manufacturer for appropriate cleaners.

3.7. INSPECTION AND ACCEPTANCE

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

SECTION 03490

GLASS-FIBER REINFORCED PRECAST CONCRETE

PART 4 GENERAL

4.1 SECTION INCLUDES

- A. Plant-cast, glass-fiber-reinforced precast concrete panels.
- B. Embedded hardware and anchors.
- C. Loose connection hardware.
- D. Integrated steel support framing.

4.2 RELATED SECTIONS

- A. Section 03300 - Cast-in-Place Concrete: Building structural frame.
- B. Section 04800 – Unit Masonry: Back-up masonry.
- C. Section 05120 - Structural Steel: Building structural frame.
- D. Section 05400 - Cold-Formed Metal Framing: Structural stud members.
- E. Section 07190 - Water Repellent Coating.
- F. Section 07600 - Metal flashings.
- G. Section 07840 - Firestopping: Fire barrier seal between units and edge of floor slab.
- H. Section 07900 - Joint Sealers: Application of backer rods or bond breakers and joint sealers.

4.3 REFERENCES

- A. ASTM A 27/A 27M – Standard Specification for Steel Castings, Carbon for General Application.
- B. ASTM A 36/A 36M – Standard Specification for Carbon Structural Steel.
- C. ASTM A 47/A 47M – Standard Specification for Ferritic Malleable Iron Castings.

- D. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip) on Iron and Steel Hardware.
- E. ASTM A 108 – Standard Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality.
- F. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- G. ASTM A 283/A 283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
- H. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
- I. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- J. ASTM A 513 - Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
- K. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- L. ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- M. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members.
- N. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
- O. ASTM C 33 - Standard Specification for Concrete Aggregates.
- P. ASTM C 150 - Standard Specification for Portland Cement.
- Q. ASTM C 260 - Standard Specification for Air-Entraining Admixtures for Concrete.
- R. ASTM C 494/C 494M - Standard Specification for Chemical Admixtures for Concrete.
- S. ASTM C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
- T. ASTM C 979 - Standard Specification for Pigments for Integrally Colored Concrete.
- U. ANSI - American Iron and Steel Institute (AISI), Specification for the Design of Cold-Formed Steel Structural Members
- V. AWS D1.1 - Structural Welding Code - Steel.
- W. AWS D1.3 - Structural Welding Code - Sheet Steel.
- X. AWS D1.4 - Structural Welding Code - Reinforcing Steel.

- Y. PCI MNL-117 – Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products.
- Z. PCI MNL-128 – Recommended Practice for Glass Fiber Reinforced Concrete Panels.
- AA. PCI MNL-130 – Manual for Quality Control for Plants and Production of Glass Fiber Reinforced Concrete Products.
- BB. SSPC 2 – Hand Tool Cleaning.
- CC. SSPC 3 – Power Tool Cleaning.
- DD. SSPC Paint 20 - Zinc-Rich Primers (Type I - Inorganic and Type II - Organic).
- EE. SSPC Paint 25 - Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II
- FF. CIELAB - International Commission of Illumination, 1976 Standards.

4.4 SYSTEM DESCRIPTION

- A. System: Plant fabricated glass-fiber-reinforced precast concrete panels consisting of face mix, back-up mix, steel support frame attached via pins, gravity anchors and flex anchors, steel connections for panel attachment to structure, and other inclusions for attachments to panels.
- B. Design Requirements: Design glass-fiber-reinforced precast concrete panels and shapes under the supervision of a professional engineer and in accordance with procedures of PCI MNL-128, Recommended Practices for Glass Fiber Reinforced Concrete Panels using property data generated from the manufacturer's actual production.
- C. Performance Requirements:
 1. Provide glass-fiber-reinforced precast concrete panels and panel frames capable of withstanding gravity, wind, seismic, and erection design loads as well as the effects of thermal and moisture-induced volume changes, according to load factors and combinations established in PCI MNL 128.
 2. Design Loads: As indicated.
 3. Design framing systems to withstand design loads with lateral deflections no greater than 1/240 of the wall height.
 4. Provide for movement of framing members without damage or overstressing, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 100 degrees F.

4.5 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Submit manufacturer's data sheets on each product to be used, including:
 1. Preparation instructions and recommendations.
 2. Storage and handling requirements and recommendations.
 3. Installation methods.

- C. Shop Drawings: Indicate dimensions, cross-sections and edge details; metal framing details, location, size and type of reinforcement, including reinforcement necessary for safe handling and erection; and connection details, and relationship to adjacent materials:
 - 1. Design calculations demonstrating compliance with indicated loading conditions and showing flexural ultimate strengths assumed for design, stamped by a structural professional engineer registered in the location of the project.
 - 2. Layout, dimensions, and identification of each panel segment corresponding to installation sequence.
 - 3. Location and details of anchorage devices embedded in panels and shapes, and connection details to building.

- D. Samples:
 - 1. Selection Samples: For each finish product specified, two complete sets of color sample, minimum size 6 inches (150 mm) square, representing manufacturer's full range of available colors and patterns for the exposed face of panels.
 - 2. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns for the exposed face of panels.
 - 3. Do not start fabrication until samples are approved.

- E. Maintain plant records and quality control program during production of units. Make records and access to plant available to Architect upon request.

- F. Submit certificates of compliance for the following:
 - 1. Admixtures.
 - 2. Reinforcing Steel.
 - 3. Portland Cement: Identify the cement brand name, type, mill location, quantity to be used, size of lot represented by quality control sample, lot number, and destination of shipment.
 - 4. Glass Fibers: Submit evidence that glass composition, Portland cement matrix, or both have been designed for glass-fiber reinforced precast concrete panel applications.

4.6 QUALITY ASSURANCE

- A. Perform Work in accordance with PCI MNL 128, Recommended Practice for Glass Fiber Reinforced Concrete Panels

- B. Manufacturer Qualifications: Provide panels and shapes only from a manufacturer who has demonstrated capability to produce products of the quality and scope required for this project, and with not less than 5 years of successful experience in manufacturing glass-fiber reinforced precast concrete panels and shapes and who is certified in one or more of the following programs:
 - 1. Certified Participant in the Architectural Precast Association's Plant Certification Program for GFRC.
 - 2. Designated PCI-Certified Plant for Group G, Glass Fiber Reinforced Concrete by PCI's Plant Certification Program
 - 3. Retains licensed Professional Engineer for plant and record inspection indicating production, testing and quality control methods comply with PCI MNL-130, Manual for Quality Control: Glass Fiber Reinforced Concrete.

- C. Installer Qualifications: A firm which has specialized in erection of glass-fiber reinforced precast concrete panels or architectural precast concrete items similar to those required on

this project for not less than 5 years and who is acceptable to manufacturer of glass-fiber reinforced precast concrete panels.

- D. Welder Qualifications: Use welders who have been qualified in accordance with AWS D1.1 and AWS D1.4 within the last year.
- E. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
 - 1. Finish areas designated by Architect.
 - 2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
 - 3. Refinish mock-up area as required to produce acceptable work.

4.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver units to the project site palletized, safely wrapped, packed and labeled and retain until erected.
- B. Store materials in a dry location off the ground, and in such a manner to prevent damage or intrusion of foreign matter.
- C. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses or damage.
- D. Store units to protect them from contact with soil, staining, and from physical damage.
- E. Place stored units so that identification marks are easily readable.

PART 5 PRODUCTS

5.1 MANUFACTURERS

- A. Acceptable Manufacturer: Company; address, City, ST 00000. ASD. Tel: (000) 000-0000. Fax: (000) 000-0000. Email: _____ www. _____
- B. Substitutions: Not permitted.
- C. Requests for substitutions will be considered in accordance with provisions of Section 01600.

5.2 MATERIALS

- A. Aggregates:
 - 1. Back-up Mix: Washed and dried silica sand or other sand having a history of successful use in glass-fiber-reinforced precast concrete panel construction; passing through a No. 20 sieve.
 - 2. Facing Mix: Fine and course aggregate for face mix shall conform to ASTM C 33 except for gradation. Aggregates shall be clean, hard, strong, durable, inert, and free of staining and deleterious materials. Provide aggregate in colors and sizes as required to achieve the panel finish texture and colors indicated on the Drawings.

- B. Portland Cement: ASTM C 150, Type I, II or III. Use the same type, brand and color of portland cement for all panels and shapes. Color shall be as required to obtain the panel facing color indicated.
- C. Admixtures:
 - 1. Air-entraining admixtures, ASTM C 260. ASTM C260, ASTM C494, ASTM C618 or acrylic thermoplastic copolymer dispersion conforming to PCI MNL-130, Appendix E.
 - 2. Polymer Compound: Conform to requirements of PCI MNL-128, Appendix L.
- D. Coloring Agent: ASTM C 979; shall have no adverse effects to glass-fiber-reinforced precast concrete panel set and strength; shall be stable at high temperature; and shall be sunlight fast and alkali-resistant. Color shall be as required to obtain panel facing color selected.
- E. Water for Mixing Concrete: Use potable water.
- F. Glass Fiber: Conforming to PCI MNL-130, Appendix D and specifically designed to be compatible with the aggressive alkaline environment of portland cement based composites or fibers with a history of successful use in portland cement based composites that has been modified to be compatible with the fiber.
- G. Anchors and Loose Attachment Hardware:
 - 1. Structural Steel: ASTM A 36/A 36M.
 - 2. Cold Drawn Wire:
 - 3. Anchor Bolts: ASTM A 325.
 - 4. Pipe: ASTM A 500 Grades A or B.
 - 5. Tube Steel: ASTM A 500 Grade A or B.
 - 6. Carbon-Steel Rods: ASTM A 108, cold drawn.
 - 7. Carbon-Steel Plate: ASTM A 283/A 283M.
 - 8. Malleable-Steel Castings: ASTM A 47/A 47M.
 - 9. Carbon-Steel Castings: ASTM A 27/A27M, Grade 60-30.
 - 10. Finish: Galvanized in accordance with ASTM A 153/A 153M.
- H. Panel Frame Materials:
 - 1. Cold-Formed Steel Framing: Manufacturer's standard C-shaped steel studs, complying with AISI "Specification for the Design of Cold-Formed Steel Structural Members," minimum uncoated steel thickness of 0.0538 inch (1.37mm) of web depth indicated, with stiffened flanges, V-shaped steel track, and of the following steel sheet:
 - a. Metallic-Coated Steel Sheet: ASTM A 653/A653M, structural-steel sheet, of grade required by structural performance of framing and with zinc coating thickness of:
 - 1) G60 (Z180).
 - 2) G90 (Z275).
 - b. Painted, Nonmetallic-Coated Steel Sheet: ASTM A1011/A1011M hot rolled or ASTM A1008/ A1008M cold rolled; nonmetallic coated according to ASTM A 1003/ A 1003M; of grade required by structural performance of framing.
 - 2. Hollow Structural Sections: Steel tubing, ASTM A500, Grade B, or ASTM A513. Finish hollow structural sections with wall thickness less than 3/16 inch (4.76 mm) as follows:
 - a. Organic Zinc-Rich Primer: SSPC-Paint 20 on surfaces prepared to comply with SSPC-SP6/NACE No.3, "Commercial Blast Cleaning."
 - b. Primer: SSPC-Paint 25 on surfaces prepared to comply with SSPC-SP 2, Hand Tool Cleaning," or better.
 - 3. Steel Channels and Angles: ASTM A36/ A36M, finished as follows:

- a. Organic Zinc-Rich Primer: SSPC-Paint 20 on surfaces prepared to comply with SSPC-SP6/NACE No.3, "Commercial Blast Cleaning."
 - b. Primer: SSPC-Paint 25 on surfaces prepared to comply with SSPC-SP 2, "Hand Tool Cleaning," or better.
- I. Form Materials: Provide form materials that will produce panels having the profile, dimensions and tolerances indicated. Use release agents which are compatible with finish specified and joint sealants proposed for use.
 - J. Mixes: Portland cement, water, glass fibers and sand mixed in proportions determined in accordance with PCI MNL-128.

5.3 FABRICATION

- A. Fabricate panels in general compliance with PCI MNL-128 and MNL-130.
- B. Molds:
 - 1. Rigid and constructed of materials that will result in finished products conforming to the profiles, dimensions and tolerances indicated on the Drawings.
 - 2. Release agents; apply and use according to manufacturer's instructions.
- C. Proportioning and Mixing:
 - 1. Carefully measure mix constituents in a manner to achieve the desired mix proportions.
 - 2. Meter the glass fiber and cement slurry to the spray head at rates to achieve the desired mix proportion and glass content. Check rates in accordance with standard procedures described in PCI MNL-128.
 - 3. Maintain cleanliness of equipment and working procedures at all times.
- D. Hand Spray Application:
 - 1. Spray apply a mist coat consisting of the matrix without fiber. Applied coating not to exceed 1/8 inch thick in order to avoid an unreinforced surface.
 - 2. Spray or place face mix in thickness shown on shop drawings.
 - 3. Spray-up main body of material before the mist coat has set.
 - 4. Apply by spraying such that uniform thickness and distribution of glass fiber and cement matrix is achieved during the application process.
 - 5. Consolidate by rolling or such other techniques as necessary to achieve complete encapsulation of fibers and compaction.
 - 6. Control thickness by using a pin gauge or other approved method. Perform a minimum of 2 measurements per 5 square feet of panel surface with at least 3 measurements per panel.
 - 7. Perform hand forming of intricate details, incorporate formers or infill material, and overspray before the material has achieved its initial set so as to insure complete bonding.
- E. Inserts and Embedments:
 - 1. Properly embed inserts in built up homogeneous glass-fiber reinforced precast concrete panel bosses to develop their strength. Waste material or overspray is not acceptable to encapsulate inserts or for bonding pads.
 - 2. Test inserts to establish test data and reduce test values by the appropriate safety factors to determine connection strength to be used in design.
 - 3. Rigid embedded items bonded to the glass-fiber reinforced precast concrete panel shall not create undesirable restraint to volume changes.

- F. Panel Frame Fabrication:
1. Fabricate panel frames and accessories plumb, square, true to line, and with components securely fastened in accordance with design requirements.
 - a. Fabricate panel frames using jigs or templates.
 - b. Cut cold-formed metal framing members by sawing or shearing; do not torch cut.
 - c. Fasten cold-formed metal framing members by welding. Comply with AWS D1.3 requirements and procedure for welding, appearance and quality of welds, and methods used in correcting welding work.
 - d. Fasten framing members of hollow structural sections, steel channels, or steel angles by welding. Comply with AWS D1.1 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - e. Weld flex, gravity, and seismic anchors to panel frames.
 2. Reinforce, stiffen, and brace framing assemblies, if necessary, to withstand handling, delivery, and erection stresses. Lift fabricated assemblies in a manner that prevents damage or significant distortion.
 3. Galvanizing Repair: Touch up accessible damaged galvanized surfaces according to ASTM A 780.
- G. Finish of Exposed Faces: Panel faces shall be free of honeycombs, form marks, concrete droppings or other blemishes that would telegraph through the panel. Provide a finish surface free of laitance, grease, form release treatments, efflorescence, curing compounds or other foreign material that would adversely affect bonding of any subsequent coating.
1. Color and texture of exposed face surfaces shall match Architect's design reference panel.
 2. Color and texture of exposed face surfaces shall match _____.
 3. Color and texture of exposed face surfaces shall match one of the manufacturers standard finishes as selected by the Architect.
- H. Dimensional Tolerances of Finished Units: Provide in accordance with PCI MNL-117 and PCI MNL-128.
- I. Cover: Provide embedded anchors, inserts, and other sprayed in items with sufficient anchorage and embedment for design requirements.
- J. Curing:
1. Immediately after the completion of spraying of the panel, cure panels using a method to ensure sufficient strength for removing the units from the form.
 2. After initial curing, remove panel from form and place in a controlled curing environment.
 3. An acrylic thermoplastic copolymer dispersion may be used as a curing admixture. Only copolymers shown to eliminate the need for moist curing through independent laboratory test data shall be used.
- K. Panel Identification:
1. Mark each glass-fiber reinforced precast concrete panel to correspond to identification mark on shop drawings for panel location.
 2. Mark each glass-fiber reinforced precast concrete panel with date on which it was cast.
 3. Apply markings on surface that will not be exposed in the finished construction.

5.4 SOURCE QUALITY CONTROL

- A. Independent Testing:
 - 1. Allow Owner's testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities.
 - 2. Cooperate with Owner's testing agency and provide samples of materials and concrete mixes as may be requested for additional testing and evaluation.
 - 3. Test glass-fiber reinforced precast concrete panel units in accordance with PCI MNL-130.

- B. Plant Testing:
 - 1. Test glass-fiber reinforced precast concrete panel units in accordance with PCI MNL-130.
 - 2. Perform testing by an independent testing agency capable of performing the specified tests. Submit copies to the Architect and designated authorities.

- C. Acceptability of Appearance:
 - 1. Finished construction in place shall present a uniform, pleasing appearance when viewed in good typical lighting with the naked eye at a distance of 10 feet and shall show no imperfections at a distance of 20 feet.
 - 2. The range of total acceptable color (lightness, color saturation and hue) variation shall not exceed CIELAB 3.0 provided that the difference in hue alone does not exceed CIELAB 1.0 as defined by the International Commission of Illumination, 1976 Standards.

PART 6 EXECUTION

6.1 EXAMINATION

- A. Check placement of structural support system to assure a true and level surface for attachment of panels. Do not begin construction until discrepancies that could adversely affect installation of panels have been corrected.

- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

6.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.

- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

6.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

- B. Setting:
 - 1. Lift glass-fiber reinforced precast concrete panel units with suitable lifting devices at points provided by the manufacturer.
 - 2. Set glass-fiber reinforced precast concrete panel units level, plumb, square and true within the allowable tolerances.
 - 3. Site cutting of panels is not permitted.

- C. Supports and Bracing: Provide temporary supports and bracing required to maintain position, stability, and alignment as units are being permanently connected.
- D. Fastening:
 1. Fasten glass-fiber reinforced precast concrete panel units in place by bolting or welding or both as shown on erection drawings.
 2. Field welding shall be done by qualified welders using equipment and materials compatible with the base material.
 3. Use non-combustible shields during welding operations to protect adjacent Work.
- E. Tolerances of Erected Units:
 1. Tolerances for location of glass-fiber reinforced precast concrete panel units shall be noncumulative and as listed below. For erection tolerances not listed below, those listed in PCI MNL 117 shall apply.
 2. Face width of joint:
 - a. Panel dimension 10 feet or less plus 3/16 inch.
 - b. Panel dimension 10 to 20 feet plus 3/16 inch, minus 1/4 inch.
 - c. Panel dimension greater than 20 feet plus 1/4 inch, minus 5/16 inch
 3. Warpage: Maximum permissible warpage of one corner out of plane of the other three shall be 1/16 inch per foot of distance from the nearest adjacent corner or 1/8 inch total after installation.
 4. Bowing: Not over L/360, where L is the panel length.

6.4 PATCHING AND CLEANING

- A. Patch and clean panels using methods and materials in accordance with manufacturer's instructions.
- B. Patching blemishes using a patching mixture matching the color and texture of surrounding surface.
- C. Use extreme care to prevent damage to panel surfaces and to adjacent materials. Provide protection of adjacent surfaces if required.
- D. Surface must be thoroughly rinsed with clean water immediately after using cleaner.

6.5 FIELD TESTS AND INSPECTION

- A. Quality Control Program: Panel manufacturer shall have an established quality control program in effect at the plant or shall employ an independent testing laboratory approved by the Architect to monitor glass content, spray rate, physical properties and curing period and conditions.
- B. Sampling and Testing:
 1. Prepare test specimens and use test procedures in accordance with PCI MNL-128, Chapter 8 and Appendix A.
 2. Prepare a minimum of 2 test boards per work shift until a production uniformity acceptable to the quality control personnel has been achieved. At such time frequency may be reduced to one board per work shift.
 3. For each board determine glass content by the washout test, flexural ultimate strength and flexural yield strength.
 4. Glass content shall be considered satisfactory if within minus 0.5 and plus 1.0 percent, by weight, of the glass content in the design mix.

5. Flexural yield strength shall be considered satisfactory if both of the following requirements are met.
 - a. The average of all sets of 3 consecutive strength tests equal or exceed assumed ultimate flexural strength for design purposes.
 - b. No individual test (average of 6 coupons) fall below required assumed ultimate flexural strength for design purposes by more than 10 percent.
6. Submit reports giving proportions, test results, inspection results, unit identification numbers and casting date for each work shift.

C. Rejection:

1. Panels in place may be rejected for any one of the following product defects or installation deficiencies:
 - a. Non-repairable damage incurred during construction operations.
 - b. Ragged or irregular edges.
 - c. Visible form joints or irregular surfaces.
 - d. Panels not conforming to tolerance requirements.
 - e. Foreign material embedded in the face.
 - f. Visible repairs.
 - g. Cracks visible at a distance of 10 feet.
 - h. Panels do not meet design strength requirements.

6.6 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

6.7 SCHEDULE

- A. Item:

END OF SECTION