

SECTION 03410 - PRECAST / PRESTRESSED CONCRETE PRODUCTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Work Includes: Precast, prestressed structural concrete components as shown on the Drawings, specified herein, and needed for complete and proper installation, including:
 - 1. Design not shown on the contract drawings,
 - 2. Erection drawings and Production drawings,
 - 3. Inspection and testing ,
 - 4. Fabrication of specified precast concrete components,
 - 5. Handling, storage and protection of precast concrete components,
 - 6. Transportation of precast concrete components to erection site,
 - 7. Erection of precast concrete components including all bearing pads, base plates, inserts, clamps, nuts, bolts, storage, protection and other necessary appurtenances, and other hardware items for connections between cast-in-place concrete and precast components and tolerances for the placement of these components.

- B. Work Excludes:
 - 1. Installation of round openings less than 12 inches in diameter or rectangular openings having a minimum dimension less than 10 inches.
 - 2. Independent inspection and testing of work.
 - 3. Cast-in-place concrete
 - 4. Steel reinforcement and embedded items in cast-in-place concrete

- C. Related Sections
 - 1. 02350 Piles and Caissons
 - 2. 02500 Paving and Surfacing
 - 3. 02700 Sewerage and Drainage
 - 4. 03300 Cast-In-Place Concrete
 - 5. 03700 Concrete Restoration and Cleaning
 - 6. 04200 Unit Masonry
 - 7. 07180 Water Repellants
 - 8. 07500 Membrane Roofing
 - 9. 07900 Joint Sealers
 - 10. 09900 Painting

1.02 REFERENCES

- A. Precast Concrete Institute
 - 1. PCI MNL 116-85 Manual for Quality Control For Plants and Production of Precast Prestressed Concrete Products
 - 2. PCI MNL 120-99 Design Handbook, 5th Edition

- B. American Concrete Institute
 - 1. ACI 318-99 Building Code Requirements for Reinforced Concrete

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C. American Society of Testing and Materials:

1. ASTM A 185-94 Steel Welded Wire Fabric, Plain for Concrete Reinforcement
2. ASTM A 615-94 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
3. ASTM A 706-92b Low Alloy Steel Deformed Bars for Concrete Reinforcement
4. ASTM C 33-93 Concrete Aggregates
5. ASTM C 94-94 Ready Mixed Concrete
6. ASTM C 150-94 Portland Cement
7. ASTM C 260-94 Air-Entraining Admixtures for Concrete
8. ASTM C 330-93 Lightweight Aggregates for Structural Concrete
9. ASTM C 494-92 Chemical Admixtures for Concrete
10. ASTM C 618-94a Fly Ash and Raw or Calcified Natural Pozzolan for Use as Mineral Admixture in Portland Cement Concrete
11. ASTM C 989-93 Ground Granulated Blast Furnace Slag for Use in Concrete and Mortars
12. ASTM C 1107-97 Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

D. Other Standards:

1. AWS D1.1 Structural Welding Code – Steel
2. ACI CPI-90 Technician Workbook for ACI Certification of Concrete Field Testing Technician - Grade 1
3. AASHTO Standard Specification for Highway Bridges

1.03 DESIGN REQUIREMENTS

A. General:

1. Precast Components: The manufacturer shall complete the design, including calculations and detailing, for all precast components specified on the Contract Drawings. Design shall be based on preliminary design criteria and conditions provided on the Drawings and in the Specifications. The manufacturer shall perform the complete design assuring that the manufacturing, transportation and erection process are compatible with the Contract Drawings and Specifications.
2. Erection: The manufacturer's designer shall consider erection of the precast components including calculations and details for guying, staying, and shoring all precast components to assure structural stability during the construction stage and before all permanent structural connections are completed. Provide in the erection plan for removal, replacement, and relocation of guying, bracing, and shoring before all permanent precast structural connections are completed. The manufacturer's registered professional engineer shall retain responsibility for the erection design.
3. Design of precast components and connections shall be prepared under the direct supervision of the manufacturer's professional engineer.

B. Design Criteria:

1. Design loads:
 - a. All dead and live loads specified on the Contract Drawings
 - b. All other loads specified for components, where applicable
 - c. Initial handling and erection stress limits
2. All precast components and connections to non-precast elements shall be designed in accordance with the PCI Design Handbook.

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3. All precast components shall have a minimum reinforcing in accordance with ACI 318. Analysis of prestressed components shall include a check of the shear reinforcing requirements at 0.1L, 0.2L, 0.25L and 0.3L, where L is the component length.
4. Modifications: All proposed modifications to the drawing and specifications shall be submitted To the Architect and Engineer with complete design calculations and drawing.
5. The manufacturer shall provide for round openings having a minimum diameter of 12 inches and square/rectangular openings having a minimum dimension of 10 inches or larger. The location of openings shall be shown on the Drawings. Other openings shall be located and field drilled (or cut) by the trade requiring them after precast components have been erected. Locations of all field cut openings shall be reviewed and approved by the manufacturer prior to drilling or cutting.
6. Lifting devices shall be designed and cast into the components to ensure safe and efficient handling. Lifting devices shall be so arranged that they do not have to be removed; or, if they must be removed, they shall be arranged so that they are readily removed and any planned depressions in the concrete can be readily filled.
7. Lift loops and erection inserts shall be located so they are not objectionable in the completed structure with a minimum concrete or grout cover as specified in ACI 318 and the PCI Design Handbook. Inserts located in areas exposed to view shall be recessed and patched with non-shrink, non-staining grout to match surrounding concrete, or cover and protect in an approved manner.
8. Where cast-in-place pour strips are used, connections between beams and double tees shall be recessed or made on the underside of the flange. Connections made on the topside of the flange shall be protected by a deck waterproof sealant or made with stainless steel hardware and welding.

1.04 SUBMITTALS

- A. Design calculations and drawing specified in Section 1.03, Design Requirements
- B. Concrete Mix Design: The manufacturer shall submit sources and proportions of all constituent materials, and mixture characteristics for all designs of Portland cement concrete. Submit manufacturer's laboratory or field data documenting required strength in accordance with ACI 318. Separate design is required for each strength and class of concrete. Data for each mix shall include the following:
 1. Mix identification
 2. Specified strength
 3. Intended Use
 4. Method used to determine mix proportions
 5. Gradation of fine and coarse aggregates and combined gradation.
 6. Sources of all constituent materials
 7. Proportions of all constituent materials
 8. Ratio of water to cementitious materials
 9. Design slump with tolerance
 10. Air content
 11. Certification of chloride content
 12. Design unit weight

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- C. Concrete Test Reports: Submit monthly test reports during production of precast components. Reports shall be made in accordance with PCI MNL 116. Reports showing 28-day compressive strength tests representing concrete placed in components shall be submitted to the Architect.
- D. Erection Drawings: Shall be prepared showing:
1. Member piece marks.
 2. Plans and/or elevations locating and defining all precast components.
 3. Sections and details showing connections, embedded items and their relation to the structure.
 4. Joints and openings between members and between members and structure.
 5. Description of all loose, embedded and field hardware.
 6. Field installed anchor location drawings.
 7. Shipping and handling requirements.
 8. All dead, live and other applicable loads in the design.
 9. Expansion joint details

Production shop drawings: Submit, for review purposes only, drawings and calculations providing the following information: (Only representative/typical details of each element will be provided)

1. Plan and/or elevation view of each component
 2. Sections and details to indicate quantities and location of reinforcing steel, anchors, inserts and all embedded items. Catalogue and design data on all inserts, bearing plates, anchors, and embedded items.
 3. Lifting and erection devices. Catalogue and design data for all materials required to erect precast components for information purposes.
 4. Dimension and finishes.
 5. Prestress for strands and concrete strengths.
 6. Estimated cambers.
 7. Methods for storage and transportation.
- F. Samples: Furnish 12 inch by 12-inch samples as required by the Architect. Upon approval of the samples for finish and color, the Architect will inspect one full size component at the manufacturer's plant no later than 5 days after manufacturers request. Provide representative detail such as returns, edges, repairs and finished life point patching or plastic caps. Upon approval of the first run of components, they shall become the identified standard, and may be used in the structure.
- G. Approvals: Erection shall not proceed without approval of the Engineer of the appropriate drawing and design calculations.

1.05 QUALITY ASSURANCE

- A. Manufacturer qualifications
1. The manufacturer shall have a minimum of 5 years proven experience in the design and manufacture of precast concrete and prestressed components, and having adequate finances, equipment, plant and skilled personnel to expeditiously design, detail, fabricate and install the work as required by the Drawings and Specifications.
 2. The Manufacturer shall be a producer/member of the P.C.I. Plant Certification Program at the date of bid submittal.

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- B. Engineering qualifications
 - 1. The manufacturer shall show evidence of an in-house engineering department managed by a registered professional engineer.
 - 2. The manufacturer's professional engineer shall hold current professional engineering registration in the state where the components are to be permanently erected. In the event the manufacturer's professional engineer is not registered in the state where the components are to be permanently erected, the manufacturer shall contract with a professional engineer registered in the state where the components are to be permanently erected to perform the required design and engineering work.
- C. Erector qualifications: Shall have been regularly engaged for a period not less than 5 years in the erection of precast components similar to those required for this project.
- D. Welder qualifications: Certified in accordance with AWS D1.1
- E. Concrete testing:
 - 1. Unless otherwise directed by the Engineer, concrete testing shall be performed by the manufacturer in accordance with PCI MNL 116-85. If directed and paid for by the owner, testing shall be performed by an independent testing and inspection agency. If inspection discloses improper workmanship or inferior material, any subsequent inspection or test deemed necessary by the Architect shall be at no cost to the Owner.
 - 2. All testing shall be performed by ACI Concrete Field Testing Technician Grade 1 in accordance with ACI CPI
- F. Engineers Inspection: The Engineer may elect to visit the manufacturer's plant to inspect and approve methods of control of the concrete mixes, component fabrication and curing methods, and approve first run production components no later than five days after the manufacturer's request. Access to the manufacturing facility shall be provided to the Engineer, Architect, Owner and the Owner's representative.

1.06 HANDLING, STORAGE, PROTECTION AND TRANSPORTATION

- A. Components shall not to shipped until the compressive strength of test specimens representing the component have developed a compressive strength of 80% of the specified compressive strength or until the component can safely support the superimposed dead load of other precast components, whichever is greater.
- B. Precast components shall be lifted and supported during manufacturing and yard handling only at the lifting and supporting points or both, as shown on the shop drawings and with appropriate lifting devices.
- C. Precast components shall be stored in a manner to minimize cracking, distortion, warping, staining, or other physical damage. Components shall be stored on properly cushioned supports to protect the edges.
- D. Units shall not be placed in contact with earth or other staining influences or to rest on corners.
- E. All holes and reglets shall be protected against water and ice in freezing weather.
- F. Precast components shall be delivered to the project site in such quantities and at such times to assure continuous operations. Components shall be transported with proper equipment, methods and with qualified personnel.

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1.07 WARRANTY

A. The Manufacturer shall provide the following warranty:

“We (name of Manufacturer or Subcontractor) do, hereby, warrant that the precast units are in accordance with the contract documents and any authorized modification thereto, and will be free of spalls or show evidence of visible cracking beyond accepted industry standards, splitting, deformation, or loosening resulting from inferior materials or workmanship by this trade for a period of one (1) year effective from the date of the substantial completion of the precast erection. Precast units showing such defects will be repaired or replaced and made acceptable at no expense to the Owner.”

PART 2. PRODUCTS

2.01 MATERIALS

A. Cementitious Materials

1. Portland Cement: ASTM C 150, Type I or III
2. Fly Ash: ASTM C 618, Except the L.O.I. shall not exceed 3.0%
3. Ground Granulated Blast Furnace Slag: ASTM C 989
4. Architectural Cement: Cement meeting the requirements of ASTM C 150 or a blend of a cement meeting the requirements of ASTM C 150 and blended with fly ash, ground granulated blast furnace slag and/or silica fume to match the Owner's control sample.

B. Aggregates

1. Normal Weight Aggregates: ASTM C33. Provide aggregates from a single source for architecturally finished concrete. Local aggregates not complying with ASTM C 33, but which have shown by special test or actual service to produce concrete of adequate strength and durability, may be used when acceptable to the Engineer.
2. Lightweight Aggregates: ASTM C 330

C. Admixtures:

1. Air-Entraining Admixture: ASTM C 260
2. Water reducing admixtures: ASTM C 494. Use in strict compliance with manufacturer's directions. Admixtures to increase cement dispersion, or provide increased workability for low slump concrete, may be used subject to Architect's acceptance. Use amounts as recommended by admixture manufacturer for climatic conditions prevailing at time of placing. Adjust quantities of admixtures as required to maintain quality control.

D. Reinforcing Steel:

1. Billet steel: ASTM A 615, Grade 60K.
2. Low alloy steel reinforcing should conform to ASTM A 706 when welding reinforcement, Grade 60K, for welding.
3. Welded wire mesh shall conform to ASTM A 185, or ASTM A 497, Grade 60K, Plain.

E. Prestressing strand: Shall be uncoated seven (7) wire low relaxation strand ASTM A416, Grade 270K.

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F. Anchors and inserts

1. Structural steel shall be of new material conforming to ASTM A 36.
2. Bolts: ASTM A 307
3. Welded headed studs: AWS D1.1-Type B.
4. Deformed bar anchors: ASTM A496.
5. Mechanical splice for future expansion column and wall reinforcing anchorage: Splice Sleeve, Interlock.
6. Double tee flange-to-flange shear connectors: galvanized or stainless steel.
7. Rod anchor bars: high strength coil rod, or approved equal
8. Anchor finish:
 - a. Shop primer: Manufacturer's standards.
 - b. Hot dipped galvanized: ASTM A153.
 - c. Zinc Rich Coating: Self-curing, one component, standard brushing grade.
 - d. Cadmium plated: ASTM A165.

G. Forms

1. To be constructed of approved concrete, steel, wood or fiberglass reinforced plastic or high-density overlaid plywood to obtain the quality of the finish specified. Forms shall be designed to withstand vibration and anticipated lateral forces.
2. Forms shall be of such rigidity as to ensure sectional dimensions as outlined in MNL 116.
3. Parting Compound: Non-oil base

H. Grout

1. Cement Grout: Portland cement, ASTM C150, Type I and clean, natural sand, ASTM C404. Mix at ratio of 1.0 part cement to 3 parts sand, by volume, with minimum water required for placement and hydration.
2. Non-metallic, non-corrosive, non-staining product containing selected silica sands, Portland cement, shrinkage compensating materials, water-reducing admixtures, complying with ASTM C 1107.

I. Bearing Pads

1. Chloroprene (Neoprene): Conform to Division II, Section 25 of AASHTO Standard Specification for Highway Bridges.
2. Laminated fabric-rubber pads: Preformed, unused synthetic fibers and new unvulcanized rubber. Surface hardness of 80 Shore A durometer plus or minus 10 percent.
3. Expansion bearing pads: Assemblies consisting of lower and upper components. The upper component shall consist of a stainless steel support plate and a sheet of stainless (14 gage minimum) with a minimum 2B mill finish. It shall be larger than the lower element by at least ½ inch in each direction. The lower element shall consist of a bearing pad, a stainless support plate and a bonded contact layer of Teflon.

J. Concrete Mixes

1. General: Concrete mixes shall be proportioned to develop the required strength using either laboratory trial batch or field experience methods as specified in ACI 318, Chapter 5.
2. Freeze-thaw durability: Concrete exposed to freeze-thaw cycles shall be air entrained to produce a total air content in accordance with ACI 318, Chapter 4.
3. Compressive strength: The 28-day specified compressive strength of the concrete to be incorporated into each component shall be shown on the shop drawings. The minimum 28-day specified compressive strength for precast, prestressed components is 5,000 psi.

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4. Corrosion inhibition: The ratio of the water to cementitious materials shall not exceed 0.40 by weight.
5. Chloride content: The water soluble chloride ion content in concrete to be incorporated into prestressed components shall not exceed 0.06 percent by weight of cement. For all other components, the water soluble chloride ion content shall not exceed 0.15 percent by weight of cement.

2.03 MANUFACTURE

A. General

1. Concrete for the precast components shall be batched in accordance with ASTM C 94.
2. Precast components shall be fabricated in accordance with PCI MNL 116 and ACI 318
3. Forms shall be cleaned between casting. Parting compound shall be applied to forms to insure against discoloration and keep surface imperfections to a minimum.
4. When approved by the Engineer, limited warp is permitted to facilitate water drainage. Dimensional tolerances shall be in accordance with PCI MNL 116.
5. The minimum release compressive strength for prestressed components is 3,000 psi.
6. Components shall be cured after form removal in a moist condition and at a minimum temperature of 50 deg F until field molded specimens cured under similar conditions have developed a minimum compressive strength of 3,000 psi.
7. Lift loops and erection inserts shall be furnished cast as shown on the production drawings.
8. Components shall be identified with a number on back face or other exposed area that identifies the orientation of the component in its final position.
9. Coat exposed ends of prestressing strands in all prestressed components to protect against corrosion.

B. Welding

1. Welding shall be performed in accordance with AWS D12.1 and AWS D1.1.
2. Manufacturer shall furnish fit up plates or angles to compensate for deviations, alignment or location of inserts.
3. Welding shall not reduce cross-section of concrete reinforcement and cause tearing at end of the weld and progressive failure.

C. Finishes

1. Precast concrete exposed surface finishes shall match approved samples.
2. The vertical face of the exterior spandrels and exterior wall panels shall be cast to provide an architectural finish as designated by the architectural drawings and the Owner's control sample.
3. Double tees shall have a normal, plant run finish on the underside resulting from casting against approved forms using good industry practice, and an unformed surface with the designated finish.
4. Wall panels, spandrels, and columns to have the specified trowel, broom or float finish on the unformed surface.
5. Unless otherwise specified, non-formed surfaces of double tees and inverted tee beams shall have a swirl, or broom finish parallel with the length of the tee.
6. Exterior precast components required to have an architectural finish shall be as specified by the Architect.

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PART 3. EXECUTION

3.01 ERECTION

A. Erection Equipment and Safety

1. The erection contractor shall be responsible for safe erection and comply with applicable local and state safety regulations. Components shall be lifted by means of suitable lifting devices at points provided by the manufacturer.
2. The erection contractor shall be responsible for becoming familiar with the Contract drawings, specifications and erection drawings.
3. Each component shall be safely and adequately secured in position by positive mechanical connections.
4. Temporary bracing shall be sufficient to brace work adequately.
5. Connections are to be completed as erection progresses.
6. Erection equipment shall not be bent, twisted, warped or damaged in any way. All wire ropes for cranes or lifting bars shall be of full sections -- not bent, twisted, kinked, torn or stretched. The lifting capacity of all lifting beams, platforms and trusses shall be posted.

B. SITE ACCESS

1. General Contractor shall be responsible for providing suitable access to the building, proper drainage and firm, level bearing for the hauling and erection equipment to operate under its own power.
2. General Contractor shall make provisions as required for placement and accurate alignment of anchor bolts, plates or dowels in column footings, grade beams and other field placed supporting members.

C. INSTALLATION

1. The manufacturer shall perform a field pre-erection survey prior to erection of precast members. Any discrepancies shall be reported to the contractor as soon as they are discovered for correction prior to start of precast erection.
2. Work shall be executed by workmen skilled in this trade, set work plumb, true and square with joints parallel and uniform, all in accordance with the approved erection drawings. Shims and bearing plates shall be accurately placed.
3. Components shall be anchored in final position by bolting and/or welding as shown on drawings. All field welding must be done by certified welders in accordance with AWS D12.1. Complete grouting and packing as shown.
4. Clean up: At the completion of the work, and at other such times directed by the Engineer, all rejected and surplus materials, rubbish and apparatus shall be removed from the project site.

D. ALIGNMENT

1. Components shall be properly aligned and leveled as required by the shop drawings. Variations between adjacent components shall be reasonably leveled out by jacking, loading or any other feasible method as recommended by the manufacturer and acceptable to the Engineer.
2. Components shall be erected as shown on the contract and shop drawings in conformance with PCI Committee Report "Tolerances for Precast and Prestressed Concrete", PCI Journal, Vol. 30, #1, January-February, 1985.

3.02 FIELD WELDING

- ##### **A. Field welding shall be performed by certified welders using equipment and materials compatible with the base materials.**

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3.03 CLEAN UP

- A. As work progresses, all excess or foreign materials which would become difficult to remove from finished surfaces, or which would harden on finished surfaces shall be removed.
- B. On completion of the work, all surplus materials, tools, equipment and debris, leaving the building in a clean condition shall be removed to the satisfaction of the Owner.
- C. Final cleaning of all material is the responsibility of the general contractor/construction manager of the project.

3.04 INSPECTION AND ACCEPTANCE OF WORK

- A. Final acceptance and acceptance of erected precast components shall be made by the architect to verify conformance with plans and specifications.
- B. Components incorporating concrete that has failed to meet strength requirements of plans and specifications when evaluated in accordance with ACI 318 shall be cored as directed by the Architect. Unit may be rejected and replaced at the Architect's discretion after the core test. The costs of these tests shall be borne by this subcontractor.
- C. Damaged or discolored components shall be replaced, patched or refinished as directed by the Engineer. Cracks greater than 0.007 inches wide and broken edges shall be repaired. The repair procedure shall be approved by the Engineer.

END OF SECTION