

## SECTION 034100 – PRECAST STRUCTURAL CONCRETE – PLANT CAST

### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes structural precast concrete units, plant cast, including the following:
  - 1. Hollow-core slab units.
  - 2. Steel header members.
  - 3. Steel connection plates and brackets.
  - 4. Grouting and anchor bolting and welding.
- B. Related Sections: The following sections contain requirements that relate to this section.
  - 1. Division 1 Section “Structural Special Inspection.”
  - 2. Division 3 Section “Cast-in-Place Concrete.”
  - 3. Division 5 Section “Structural Steel Framing.”

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Engineer, fabricate, and install structural precast concrete units to withstand design loadings indicated within limits and under conditions required.
  - 1. The design of precast-prestressed hollow core slabs shall be in accordance with the latest recommendations of the PCI and ACI building code requirements.
  - 2. Manufacturer shall use contract drawing information indicating depth and loading of member to design precast-prestressed hollow core slabs.
- B. Engineering Responsibility: Engage a fabricator who uses a qualified professional engineer to prepare design calculations, shop drawings, and other structural data.

#### 1.4 SUBMITTALS

- A. General: Furnish submittals in quantity, format, and other Conditions of the Contract and as specified in Division 1 of the Project Manual.
- B. Product data and instructions for manufactured materials and products.
  - 1. Certification by paint and curing compound manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
- C. Shop drawings detailing fabrication and installation of precast concrete units. Indicate member dimensions and cross-sections; locations, sizes, and types of reinforcement, including special reinforcement; estimated camber; and lifting devices necessary for handling and erection.

1. Include an erection plan indicating layout and dimensions, and identifying each precast concrete unit corresponding to sequence and procedure of installation. Indicate welded connections by AWS standard symbols. Detail loose, cast-in, and field hardware, inserts, connections, and joints, including accessories and construction at openings in precast units. Show all openings required for mechanical, plumbing, and other penetrations 12" which are to be cast into precast members.
  2. Indicate locations and details of anchorage devices that are to be embedded in other construction. Furnish templates, if required, for accurate placement.
  3. Shop drawings shall be signed and sealed by the qualified professional engineer, registered in the State of Kentucky, responsible for their preparation.
  4. To the extent structural precast unit design considerations are indicated as fabricator's responsibility, include structural analysis data signed and sealed by the qualified professional engineer, registered in the State of Kentucky, responsible for their preparation. The calculations will be reviewed for design intent only. Engineering and detailing shall be solely the responsibility of the manufacturer and the professional engineer responsible for their preparation.
  5. Computer generated electronic structural construction document files (ACAD) will be made available to the Contractor. The Contractor will be required to sign the Engineer's standard release of liability form and pay a handling fee of \$50.00 per drawing prior to receiving the drawing files. Rules for use of said files shall be as defined in the CRSI "Code of Standard Practice" Sections 4.19 and 6.4.1.
  6. Shop drawing resubmittals are reviewed for conformance with review marks only. Any changes or questions originating on a resubmittal shall be clearly clouded.
- D. Material test reports from a qualified independent testing agency evidencing compliance with requirements of the following based on comprehensive testing of current materials:
1. Concrete materials.
  2. Reinforcing materials.
  3. Prestressing strands.
  4. Admixtures.
  5. Bearing pads.
- E. Material certificates in lieu of agency test reports, when permitted by Architect, signed by fabricator certifying that each material item complies with requirements.

## 1.5 QUALITY ASSURANCE

- A. **Installer Qualifications:** Engage an experienced Installer who has completed structural precast concrete work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. **Fabricator Qualifications:** Firm experienced in producing structural precast concrete units similar to those indicated for this Project and with a record of successful in-service performance as well as sufficient production capacity to produce required units without delaying the Work.
1. Fabricator must participate in the Precast/Prestressed Concrete Institute's (PCI) Plant Certification Program and be designated a PCI Certified Plant.
- C. **Professional Engineer Qualifications:** A professional engineer who is legally authorized to practice in the State of Kentucky and who is experienced in providing engineering services

of the kind indicated that have resulted in the installation and successful in-service performance of precast concrete units similar to this Project in material, design, and extent.

- D. Testing Agency: Owner may engage an independent testing agency to perform shop inspections and tests and to provide test reports. Manufacturer shall provide testing agency with access to places where structural precast concrete units are being fabricated so inspection and testing can be accomplished. Correction of deficiencies and additional testing to determine compliance of corrected work will be performed at Contractor's expense.
- E. PCI Design Standard: Comply with recommendations of PCI MNL-120 "PCI Design Handbook – Precast and Prestressed Concrete" applicable to types of structural precast concrete units indicated.
- F. PCI Quality-Control Standard: Comply with requirements of PCI MNL-116 "Manual for Quality Control Plants and Production of Precast and Prestressed Concrete Products," including manufacturing and testing procedures, quality-control recommendations, and camber and dimensional tolerances for types of units required.
- G. ACI Publications: Comply with the following ACI publications applicable to types of structural precast concrete units indicated:
  - 1. ACI 301 "Specifications for Structural Concrete for Buildings."
  - 2. ACI 318 (ACI 318M) "Building Code Requirements for Reinforced Concrete."
  - 3. ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures."
  - 4. ACI 525 "Minimum Requirements for Thin-Section Precast Concrete Construction."
- H. Welding Standards: Comply with applicable provisions of the following American Welding Society publications:
  - 1. AWS D1.1 "Structural Welding Code – Steel."
  - 2. AWS D12.1 "Recommended Practices for Welding Reinforcing Steel, Metal Inserts, and Connections in Reinforced Concrete Construction."
- J. General Contractor and Precast Concrete Supplier shall coordinate and be responsible for installing all openings larger than 12" through precast members required for mechanical, plumbing, or other penetrations. Openings shown on structural drawings are for reference only and shall not be considered completely accurate in size, spacing, or quantity.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver precast concrete units to Project site in such quantities and at such times to ensure continuity of installation. Store units at Project site to prevent cracking, distorting, warping, staining, or other physical damage, and so that markings are visible.
- B. Lift and support units only at designated lifting or supporting points as shown on final shop drawings.
- C. Deliver anchorage items that are to be embedded in other construction before starting such work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

- D. Provide temporary lateral support during erection to prevent bowing and warping. Blocking and supports shall be clean, non-staining, and shall not prevent uniform curing of exposed surfaces.

## PART 2 – PRODUCTS

### 2.1 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Steel-Welded Wire Fabric: ASTM A 185, welded steel wire fabric in sheets.
- C. Supports for Reinforcement: Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Use supports complying with CRSI recommendations.
  - 1. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs that are protected with plastic (CRSI, Class 1) or stainless steel (CRSI, Class 2).

### 2.2 PRESTRESSING TENDONS

- A. Prestressing Strand: ASTM A 416, Grade 250 or 270, uncoated, 7-wire, stress-relieved.

### 2.3 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I or Type III.
  - 1. Use only one brand and type of cement throughout Project, unless otherwise acceptable to Architect.
- B. Fly Ash: ASTM C 618, Class C or F.
- C. Silica Fume: ASTM C 1240, amorphous silica.
- D. Normal-Weight Aggregates: ASTM C 33, Class 5S. Provide aggregates from a single source.
- E. Water: Potable.
- F. Admixtures, General: Provide admixtures for concrete that contain not more than 0.05 percent chloride ions.
- G. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
- H. Water-Reducing Admixture: ASTM C 494, Type A.
- I. High-Range, Water-Reducing Admixture: ASTM C 494, Type F or Type G.
- J. Water-Reducing, Accelerating Admixture: ASTM C 494, Type E.

- K. Water-Reducing, Retarding Admixture: ASTM C 494, Type D.

## 2.4 CONNECTION MATERIALS AND FINISHES

- A. Steel Shapes and Plates: ASTM A 36.
- B. Welded Headed Studs: AWS D1.1, Type B headed studs, cold-finished carbon-steel bars.
- C. Accessories: Provide clips, hangers, shims, and other accessories required to install precast concrete units.
- D. Shop-Primed Finish: Prepare surfaces of interior steel items, except those surfaces to be embedded in concrete, according to requirements of SSPC-SP 3 and shop-apply primer according to SSPC-PA 1.
  - 1. Primer: Fast-curing, lead- and chromate-free, VOC-conforming, universal modified-alkyd primer with good resistance to normal atmospheric corrosion, complying with performance requirements of FS TT-P-664.

## 2.5 BEARING PADS

- A. Provide bearing pads for precast concrete units as follows:
  - 1. High-Density Plastic: Multimonomer, nonleaching, plastic strip.

## 2.6 GROUT MATERIALS

- A. Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2 ½ parts sand, by volume, with minimum water required for placement and hydration. Compressive strength of 3500 psi: 28 day strength or greater.

## 2.7 CURING MATERIALS

- A. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type I, Class B.
  - 1. Provide material that has a maximum volatile organic compound (VOC) rating not to exceed those allowable by jurisdictional regulations.

## 2.8 CONCRETE MIXES

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use an independent testing agency acceptable to Architect or qualified precast manufacturing plant personnel for preparing and reporting proposed mix designs. Trial batch and field experience tests shall have been performed within 12 months of submittal date.
  - 1. Limit use of fly ash to less than or equal to 25 percent of cement content by weight.
- B. Normal-Weight Concrete: Provide normal-weight concrete with the following properties:
  - 1. Compressive Strength (28-Day): 5000 psi (34.5 MPa).

2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.40.
- C. Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1-1/2 percent within the following limits:
  1. Concrete not exposed to freezing, thawing, or hydraulic pressure: 2 to 4 percent air.
- D. Other Admixtures: Use water-reducing, high-range water-reducing, water-reducing and accelerating, or water-reducing and retarding admixtures, as required, according to manufacturer's directions.
- E. Concrete-Mix Adjustments: Concrete-mix design adjustments may be requested by precaster when characteristics of materials, project conditions, weather, test results, or other circumstances warrant as accepted by Architect. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Architect before using in the work.

## 2.9 FABRICATION

- A. Formwork: Accurately construct forms, mortar tight, of sufficient strength to withstand pressures due to concrete placing operations, temperature changes, and for pretensioning and detensioning operations. Maintain formwork to provide completed precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified in PCI MNL-116.
  1. Coat surfaces of forms with bond-breaking compound before reinforcement is placed. Provide commercial-formula, form-coating compounds that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces requiring bond or adhesion. Apply in compliance with manufacturer's instructions.
  2. Unless forms for precast, prestressed concrete units are stripped prior to detensioning, design forms so that stresses are not induced in precast units due to deformation of concrete under prestress or movement during detensioning.
- B. Built-In Anchorages: Accurately position built-in anchorage devices and secure to formwork. Locate anchorages where they do not affect the position of the main reinforcement or placing of concrete. Do not relocate bearing plates in units, unless acceptable to Architect.
- C. Cast-in openings larger than 12 inches in diameter or 12 inches square according to final shop drawings. Other smaller holes may be field cut by trades requiring them, as acceptable to Architect. Trades field cutting holes shall locate holes so as to not cut prestressing tendons.
- D. Reinforcement: Comply with the recommendations of CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
  1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete.

2. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcement by metal chairs, runners, bolsters, spacers and hangers, as required.
  3. Place reinforcement to obtain at least the minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
  4. Install welded wire fabric in lengths as long as practical. Lap adjoining pieces at least one full mesh and lace splices with wire.
- E. Pretensioning: Pretension tendons for precast, prestressed concrete either by single-strand tensioning method or multiple-strand tensioning method. Comply with PCI MNL-116 requirements.
- F. Concrete Mixing: Comply with requirements and with ASTM C 94. Following concrete batching, no additional water may be added.
- G. Concrete Placement: Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast units. Comply with requirements of ACI 304R for measuring, mixing, transporting, and placing concrete.
1. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items. Use equipment and procedures complying with ACI 309R.
  2. Comply with ACI 306R procedures for cold-weather concrete placement.
  3. Comply with ACI 305R procedures for hot-weather concrete placement.
- H. Identify pickup points of precast concrete units and orientation in structure with permanent markings, complying with markings indicated on final shop drawings. Imprint casting date on each precast unit on a surface that will not show in the finished structure.
- I. Cure concrete according to the requirements of PCI MNL-116 by moisture retention without heat or by accelerated heat curing, using low-pressure live steam or radiant heat and moisture.
- J. Delay detensioning prestressed concrete units until concrete has attained at least 70 percent of its compressive strength as established by test cylinders cured under the same conditions as the concrete.
1. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.
  2. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat-cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.
- K. Finish formed surfaces of precast concrete as indicated for each type of unit as follows:
1. Standard Finish: Normal plant-run finish produced in forms that impart a smooth finish to concrete. Small surface holes caused by air bubbles, normal color variations, and form joint marks, and minor chips and spalls will be tolerated. Major or unsightly imperfections, honeycombs, or structural defects are not permitted.

- L. Finish unformed surfaces by trowel, unless otherwise indicated. Consolidate concrete, bring to proper level with straightedge, float, and trowel to a smooth, uniform finish.
  - 1. Apply scratch finish to precast concrete units to receive a future concrete topping after installation. Following initial strike-off, transversely scarify surface to provide ridges approximately  $\frac{1}{4}$  inch deep.

## 2.10 HOLLOW-CORE SLAB UNITS

- A. Provide precast, prestressed concrete units with open, hollow cores running the full length of the slab units.
- B. Provide solid, monolithic, precast concrete slab units where shown on drawings. Design and fabricate solid units to dimensions and details indicated as required for hollow-core slab units.
- C. Furnish units free of voids or honeycombs.
- D. Reinforce units to resist transportation and erection stresses.
- E. Include cast-in weld plates where required.
- F. Coordinate with other trades for installation of cast-in items.
- G. Provide headers of cast-in-place concrete or structural steel shapes for openings larger than one slab width according to hollow-core slab unit fabricator's recommendations.

## 2.11 QUALITY CONTROL

- A. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL-116 requirements.
- B. Strength of precast concrete units will be considered potentially deficient when precast concrete units fail to comply with requirements, including the following:
  - 1. Fail to meet compressive-strength test requirements.
  - 2. Reinforcement, and pretensioning and detensioning tendons of prestressed concrete do not conform to fabrication requirements.
  - 3. Concrete curing and protection of precast units against extremes in temperature fail to meet requirements.
  - 4. Precast units are damaged during handling and erecting.
- C. Testing: When there is evidence that the strength of precast concrete units may be deficient or may not meet requirements, the Owner will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42.
  - 1. A minimum of 3 representative cores will be taken from precast concrete units of suspect strength, from locations directed by Architect.
  - 2. Cores will be tested in an air-dry condition per ACI 301 when precast concrete units will be dry under service conditions.



3. Strength of concrete for each series of 3 cores will be considered satisfactory if the average compressive strength is at least 85 percent of the 28-day design compressive strength and no core compressive strength is less than 75 percent of the 28-day design compressive strength.
  4. Test results will be made in writing on the same day that tests are made, with copies to Architect, Contractor, and precast fabricator. Test reports will include the Project identification name and number, date, name of precast concrete fabricator, name of concrete testing agency; identification letter, name, and type of precast concrete unit or units represented by core tests; design compressive strength, compressive strength at break and type of break, corrected for length-diameter ratio, and direction of applied load to core with respect to horizontal plane of concrete as placed.
- D. Patching: Where core test results are satisfactory and precast concrete units meet requirements, solidly fill core holes with patching mortar and finish to match adjacent concrete surfaces.
- E. Dimensional Tolerances: Units having dimensions smaller or greater than required and not meeting tolerance limits may be subject to additional testing.
1. Precast units having dimensions greater than required will be rejected if the appearance or function of the structure is adversely affected or if larger dimensions interfere with other construction. Repair or remove and replace rejected units, as required, to meet construction conditions.
- F. Defective Work: Precast concrete units that do not conform to requirements, including strength, manufacturing tolerances, and finishes, are unacceptable. Replace with precast concrete units that meet requirements.

## PART 3 – EXECUTION

### 3.1 EXAMINATION

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

### 3.2 INSTALLATION

- A. Members shall bear the minimum length called for on contract or shop drawings. If no bearing length is specified, 3 ½ inches shall be considered the minimum.
- B. Set vertical units dry, without grout, attaining joint dimension with lead or plastic spacers. Grout pack base of unit.
- C. Bearing Pads: Install bearing pads as precast concrete units are being erected. Set pads on true, level, and uniform bearing surfaces and maintain in correct position until precast units are placed.
- D. Welding: Perform welding in compliance with AWS D1.1 and AWS D1.4, with qualified welders.

1. Protect precast concrete units and bearing pads from damage by field welding or cutting operations and provide noncombustible shields as required.
  2. Repair damaged metal surfaces by cleaning and repriming damaged painted surfaces.
- E. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed units, unless otherwise acceptable to Architect.
- F. Erection Tolerances: Install precast units level, plumb, square, and true, without exceeding the recommended erection tolerances of PCI MNL-127 "Recommended Practice for Erection of Precast Concrete."
- G. Shore and brace precast concrete units to maintain location, stability, and alignment until permanent connections are installed.
- H. Remove lifting hooks if necessary.
- I. Grouting Connections and Joints: After precast concrete units have been placed and secured, grout open spaces at keyways, connections, and joints with cement grout.
1. Provide forms or other acceptable method to retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled. Place grout to finish smooth, plumb, and level with adjacent concrete surfaces. Keep grouted joints damp for not less than 24 hours after initial set. Promptly remove grout material from exposed surfaces before it hardens.
  2. Level differential elevation of adjoining horizontal members with grout to maximum slope of 1:12.
- J. Contractor shall coordinate all penetrations through and attachment to precast concrete elements with the precast manufacturer. Penetrations shall be located to not disturb or cut prestressing tendons. Attachment to the precast plank shall be located around tendon layout and shall incorporate fasteners designed for use in hollow concrete and that do not penetrate the concrete more than 3/4".

### 3.3 CLEANING

- A. Clean exposed surfaces of precast concrete units after erection to remove weld marks, other markings, dirt, and stains.
1. Wash and rinse according to precast concrete fabricator's recommendations. Protect other work from staining or damage due to cleaning operations.
  2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes.

END OF SECTION 034100