

STRUCTURAL PRECAST CONCRETE – PLANT CAST

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. Precast concrete seating units

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.

B. Engineering responsibility: engage a fabricator who assumes undivided responsibility for engineering structural precast concrete units by employing a qualified professional engineer to prepare design calculations, fire-resistance calculations, shop drawings, and other structural data.

1.4 SUBMITTALS

A. General: Submit each item in this article according to the conditions of the concrete and division 1 specifications sections

B. Product data and instructions for manufactured materials and products

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

C. Shop drawings prepared by or under the supervision of a qualified professional engineer detailing fabrication and installation of precast concrete units. Indicate member dimensions and cross-sections, locations, sizes, and types of

reinforcement, including special reinforcement, and lifting devices necessary for handling and erection.

1. Indicate layout and dimensions, and identify 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 constructing at openings in precast units.
2. Indicate locations and details of anchorage devices that are to be embedded in other construction. Furnish templates, if required, for accurate placement.
3. For precast concrete units indicated to comply with design loadings or calculated fire-resistance requirements, include structural analysis data sealed and signed by the qualified professional engineer responsible for their preparation.

D. Welder certificates signed by contractor certifying that welders comply with requirements specified under the “Quality Assurance” article.

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

F. 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. Admixtures
4. Bearing pads

G. 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.

C. Professional Engineer Qualifications: A professional engineer legally authorized to practice in the jurisdiction where project is located and experienced in providing engineering services of the kind indicated that have resulted in the installation and successful in-service performance of precast concrete units similar to this Project in material, design, and extent.

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

E. PCI Design Standard: comply with recommendations of PCI MNL-120 "PCI Design handbook—Precast and Pre-stressed Concrete" applicable to types of structural precast concrete units indicated.

F. PCI Quality-control Standard: Comply with requirements of PCI MNL-116 "Manual for Quality control for Plants and Production of Precast and Pre-stressed 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."

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

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

I. Mockups: Prior to installing precast concrete units, construct mockups for each form of construction and finish required to verify selections made under sample submittals. Building mockups to comply with the following requirements, using materials indicated for final unit of work,

1. Locate mockups on site in the location and of the size indicated or, if not indicated, as directed by Architect.
2. Notify Architect one week in advance of the dates and times when mockups will be constructed.
3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Obtain Architects acceptance of mockups before start of final unit of work.
5. Retain and maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
 - a. When directed, demolish and remove mockups from project site.
 - b. Accepted mockups in an undisturbed condition at the time of Substantial Completion may become part of completed work.

J. Product Options: the drawings indicate size, profiles, and dimensional requirements of precast concrete units and are based on specific types of units indicated. Other fabricators precast concrete units with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery 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.

PART 2 – PRODUCTS

2.1 FORMWORK

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

2.2 REINFORCING MATERIALS

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

B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706, Grade 60.

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

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

E. Steel-Welded Wire Fabric; ASTM A 185, plain, cold drawn.

F. Epoxy-coated, steel Welded Wire Fabric: ASTM A 884, class A, deformed.

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

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

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

D. Water: Portable.

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

F. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

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

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

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

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

2.4 CONNECTION MATERIALS AND FINISHES

A. Steel shapes and plates: ASTM A 36.

B. Malleable Iron Castings: ASTM A 47.

C. Plate Stainless Steel: ASTM A 666, Type 304, of grade suitable for application.

D. Bolts and Studs: ASTM A 307, Grade A; carbon-steel, hex-head bolts and studs; carbon-steel nuts; and flat, unhardened steel washers.

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

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

G. Welding Electrodes: comply with AWS standards.

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

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

1. ASTM A 123 for galvanizing rolled, pressed, and forged shapes, plates, bars, and strips.

2. ASTM A 153 for galvanizing iron and steel hardware.

J. Galvanized Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20.

2.5 BEARING PADS

A. Provide bearing pads for precast concrete units as follows:

1. Random, Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. Surface hardness of 70 to 90 shore A durometer.

2.6 GROUT MATERIALS

A. Nonmetallic, Non-shrink Grout: Premixed, nonmetallic, non-corrosive, non-staining group containing selected silica sands, Portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and a 30-minute working time.

2.7 CURING MATERIALS

A. Clear, Waterbone, Membrane-forming Curing Compound: ASTM C 309, Type I, Class B.

1. Provide material that has a maximum volatile organic compound (VOC) rating of 350 g/L.

2.8 CONCRETE MIXES

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

1. Limit use of fly ash to not exceed, in aggregate, 25 percent of the Portland cement by weight.

B. Design mixes may be prepared by qualified independent testing agency or by qualified precast manufacturing plant personnel at precast fabricators option.

C. Normal-weight concrete: Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.0 and ACI 301, using materials to be used on the Project, to 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.

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

1. Air Content: 6 percent for 1-inch maximum aggregate.
2. Air Content: 6 percent for 3/4-inch maximum aggregate.
3. Air Content: 7 percent for 1/2-inch maximum aggregate.

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

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

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, pre-stressed concrete units are stripped prior to detensioning, design forms so that stresses are not induced in precast units due to deformation of concrete under pre-stress 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 10 inches in diameter to 10 inches square according to final shop drawings. Other smaller holes may be field cut by trades requiring them, as applicable by the Architect.

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 coverage for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
4. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Pre-tensioning: Pretension tendons for precast, pre-stressed concrete either by single-strand tensioning method or multiple-strand tensioning method. Comply with PCI-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 304 R 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 309 R.
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 curing using low-pressure live steam or radiant heat and moisture.

J. Delay detensioning pre-stressed 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 tension 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, and 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 for joint marks, and minor chips and spalls will be tolerated. Major or unsightly imperfections, honeycombs, or structural defects are not permitted.

2. Commercial Finish: remove fins and large protrusions and fill large holes. Rub or grind ragged edges. Faces are to be true, well-defined surfaces.

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

4. Grade A Finish: Fill air pockets and holes greater than ¼ inch (6mm) in diameter with sand-cement paste matching color of precast concrete. Grind smooth form offsets or fins greater than 1/8 inch (3 mm). Float –apply a neat cement-paste coating to exposed surfaces. Rub dried paste coat with burlap to remove loose particles.

L. finish uniformed surfaces by trowel, unless otherwise indicated. Consolidate concrete; bring proper level with straightedge, float, and trowel to a smooth, uniform finish.

1. Apply scratch finish to precast concrete units that will receive concrete topping after installation. Following initial strike-off, transversely scarify surface to provide ridges approximately $\frac{1}{4}$ inch (6 min) deep.

2.10 STRUCTURAL FRAMING UNITS

A. Type: Precast concrete seating units.

B. Furnish units free of voids or honeycombs.

C. Provide smooth finish to precast units where seats will be mounted & hidden from view and on vertical surface. Provide light broom finish elsewhere.

D. Where ends of strands will not be enclosed or covered, cut flush and cover with a high-strength mortar bonded to unit with an epoxy-resin bonding agent.

E. Reinforce units to resist transportation and erection stresses.

F. Include cast-in weld plates where required.

G. Coordinate with other trades for installation of cast-in items.

2.11 SOURCE QUALITY CONTROL

A. The owner may employ an independent testing agency to evaluate precast fabricators quality control and testing methods.

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

B. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL-116 requirements.

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

1. Fail to meet compressive-strength test requirements.

2. Reinforcement, and pretensioning and detensioning tendons of pre-stressed 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 damaging during handling and erection.

D. Testing: When there is evidence that the strength of precast concrete units may be deficient or may not meet requirements, the Owner will employ an independent testing agency to obtain, prepare, and test cored drilled form 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, following immersion in water, in a wet condition per ACI 301 when precast concrete units will be wet under service conditions.
3. Cores will be tested in an air-dry condition per ACI 301 when precast concrete units will be dry under service conditions.
4. Strength of concrete for each series of 3 cores will be considered satisfactory if the average compressive strength is at least 85 percent of the 28-day design compressive strength and no core compressive strength is less than 75 percent of the 28-day design compressive strength.
5. Test results will be made in writing on the same day that tests are made, with copies to Architect, Contractor, and precast fabricator. Test reports will include the Project identification name and number, date, name of precast concrete testing agency, identification letter, name and type of precast concrete unit or units represented by core test; 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.

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

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

1. Precast units having dimensions greater than required will be rejected if the appearance 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.

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

Part 3-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. 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.

B. 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 damage metal surfaces by cleaning and applying a coat of galvanized repair paint to galvanized surfaces.

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

C. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, pre-stressed units, unless otherwise acceptable to Architect.

D. 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."

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

F. Grouting Connections and Joints: After precast concrete units have been placed and secured, grout open spaces at keyways, connections, and joints as follows:

1. Grout Type: Cement grout.
2. Grout Type: Metallic, non-shrink grout.
3. Grout Type: Nonmetallic, non-shrink grout.
4. Grout Type: Epoxy grout.
5. 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.

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.

