

GUIDE SPECIFICATION FOR ARCHITECTURAL PRECAST CONCRETE

Prepared by PCI Committee on Architectural Precast
Concrete Guide Specifications

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The Guide Specification is intended to be used as a check-list in preparing a specification draft for this section. It must be edited or otherwise revised for proper correlation and coordination with plans for each specific project, and from this draft the final project specifications are developed. The Guide Specification should not be made a part of any contract by reference.

This Guide Specification is not meant to supersede similar guide specifications published by state or regional precast concrete associations. In such areas special conditions may dictate the use of local rather than national guidelines. The system and text presented herein require that each user makes the changes, additions or deletions necessary to adopt these specifications to his specific job condition and specification format.

The term Architect, the usual primary agent in specifications, might also include Engineer or other Owner agent.

The Guide Specification is in roman type. *Notes to specifiers are in italics.*

1. General

Reference to the Special and General Conditions may be added to this section. A special review of this specification against the general concrete specification and other related sections should be made to eliminate duplication and conflicting documents.

This Guide Specification covers any and all architectural precast concrete products fabricated in an established plant. The finished face refers to any surface permanently exposed to view in which either a natural stone surface or the concrete itself constitutes the final finish. Such concrete surfaces include bushhammered, sandblasted, form-board, honed or polished, or exposed aggregate treatments, and textured or smooth concrete finishes obtained by using special form liners.

- 1.1. Architectural precast concrete construction shall include all labor, materials, equipment and related services necessary for the manu-

facture of the precast work shown on the contract plans and specifications.

Local standard practice may indicate that responsibility for erection should also be included. Section 7 is included to cover this situation.

- 1.2. All architectural precast concrete shall be a product of a manufacturer who has demonstrated the capability to produce architectural precast concrete products of the quality specified. A manufacturer must be able to show that he has experienced personnel, physical facilities, and a management capability sufficient to execute the particular contract being considered. When requested by the Architect, the manufacturer shall submit written evidence of the above requirements.

The manufacturer of architectural precast concrete requires a greater degree of craftsmanship than most other concrete products, and therefore requires some pre-qualification of the manufacturer. Proprietary names may be used if permitted in the specification.

1.3. Shop Drawings

- 1.3.1. The precast manufacturer shall be furnished all applicable drawings including structural, mechanical and any other related trades if necessary. He shall submit for approval complete shop drawings showing product location, fabrication details, member identification marks, dimensions, reinforcement, connection details, and relationship to adjacent material in sufficient detail to cover manufacture, handling and erection. Identification marks coordinated to the shop drawings shall be on all units manufactured to facilitate hauling and erection. Identification marks shall include date of casting.
- 1.3.2. The General Contractor shall be responsible for project schedule, dimensions, and coordination with all construction phases. The precast manufacturer shall not proceed with fabrication of any products prior to receiving approval of shop drawings by both the Architect and General Contractor.

Approved or approved as noted shop drawings shall mean that the General Contractor and Architect/Engineer has completely checked and verified that dimensions are correct and final for overall building dimensions, column centerlines, floor elevations, floor thicknesses, column sizes, beam sizes, foundation elevations, location of mechanical openings and similar items to which the architectural precast concrete products fit. The precast manufacturer shall be responsible for the precast units fitting the building dimensions as given on the final approved drawings supplied to the manufacturer.

1.4 Samples

- 1.4.1. A minimum of three samples for each type of finished facing shall be submitted to the Architect for approval of

color and texture prior to commencement of manufacture. Samples shall be approximately 12 x 12 in. of appropriate thickness representative of the proposed finished product. One of the approved samples shall be returned to the General Contractor and one to the precaster prior to manufacture.

If the back face of a precast unit is also to be exposed, samples of the workmanship, color and texture of the backing shall be shown as well as the facing.

When large size samples are required in addition to the above samples, the size and number should be indicated by the Architect in the contract drawings. Fabrication will begin only after texture and color have been approved. These larger samples shall be made with the mix proportions and materials anticipated in actual production. The larger samples will contain typical cast-in inserts if requested. The concrete should be mixed, placed, consolidated and finished in the same manner as in actual production.

Note that larger samples require considerable time in their manufacture. They should not be specified unless considerable lead time is allowed for the entire project. Full size samples should be used as part of the contract where possible and it should be so specified by the Architect.

These production samples are not to be confused with the pre-bid samples on which the Architect based his initial selection of aggregate, color and texture. Slight variations are to be expected depending on the manufacturer and actual production materials, however, only deviations not affecting price should be permitted or required in the production samples.

1.4.2. All approved samples shall be initialed by the Architect.

- 1.5. It shall be the responsibility of the Architect and General Contractor to visit the precasting plant for inspection and review of the first production units. Precast products which do not meet the color and texture range or the dimensional tolerances of this specification should be cause for rejection at the option of the Architect/Engineer, if they cannot be satisfactorily corrected.

Whenever feasible, an existing structure, one or two production units, or a mock-up structure should be designated as a model for determining the range of acceptability with respect to color and texture variations, surface defects and over-all appearance.

- 1.6. The precast manufacturer shall guarantee the precast products against defects in materials and workmanship for a period of one year after acceptance by the Owner.

The Owner or his agent should be required to accept the precast products within 60 days after completion of erection to preclude inordinate delays that would extend the guarantee period unfairly.

2. Design

- 2.1. The following specifications, standards and codes shall govern

with modifications as specified herein.

The numbers listed for the various standards are the latest in effect at the time this Guide Specification was printed. The Architect should verify the number, date and contents of the standard in effect at the time the project specifications are being prepared. List only those applicable to the specific project, as different reference documents may contain conflicting statements.

2.1.1. American Concrete Institute

2.1.1.1. ACI 212—Admixtures for Concrete

2.1.1.2. ACI 213—Guide for Structural Lightweight Aggregate Concrete

2.1.1.3. ACI 214—Recommended Practice for Evaluation of Compression Test Results of Field Concrete

2.1.1.4. ACI 301—Specifications for Structural Concrete for Buildings

2.1.1.5. ACI 318—Building Code Requirements for Reinforced Concrete

2.1.2. American Society for Testing and Materials

ASTM C-31 ASTM C-192 ASTM A-36

ASTM C-33 ASTM C-231 ASTM A-185

ASTM C-39 ASTM C-260 ASTM A-416

ASTM C-94 ASTM C-291 ASTM A-421

ASTM C-143 ASTM C-330 ASTM A-497

ASTM C-150 ASTM C-567 ASTM A-615

ASTM C-173 ASTM A-616

ASTM A-617

2.1.3. American Welding Society

2.1.3.1. AWS D1.0 —Code for Welding in Building Construction

2.1.3.2. AWS D12.1—Recommended Practices for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction

2.2. Where any material or operation is specified by reference to the above published specifications, or standards of any other organization, the referenced specification or standard shall be as much a part of the section as if quoted in full herein.

2.3. The following documents, while not a part of these specifications except for sections specifically referred to herein, are recognized acceptable practices.

2.3.1. American Concrete Institute

2.3.1.1. ACI 315—Manual of Standard Practice for Detailing Reinforced Concrete Structures

2.3.1.2. ACI 347—Recommended Practice for Concrete Formwork

- 2.3.1.3. ACI 504—Guide to Joint Sealants for Concrete Structures
- 2.3.1.4. ACI 525—Minimum Requirements for Thin-Section Precast Concrete Construction
- 2.3.1.5. ACI 533—Quality Standards and Tests for Precast Concrete Wall Panels
- 2.3.1.6. ACI 533—Selection and Use of Materials for Precast Concrete Wall Panels
- 2.3.1.7. ACI 533—Fabrication, Handling and Erection of Precast Concrete Wall Panels
- 2.3.2. American Welding Society
 - 2.3.2.1. AWS D3.0—Standard Qualification Procedure
- 2.3.3. Prestressed Concrete Institute
 - 2.3.3.1. PCI MNL 117-68 Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products
 - 2.3.3.2. PCI MNL 116-70 Manual for Quality Control for Plants and Production of Precast Prestressed Concrete Products
- 2.3.4. Industrial Fasteners Institute
 - 2.3.4.1. Handbook on Fastener Standards
- 2.3.5. National Ready Mixed Concrete Association
 - 2.3.5.1. NRMCA Bulletin No. 44—Control of Quality of Ready-Mixed Concrete
- 2.4. Each precast concrete member shall be designed by a structural engineer, in accordance with applicable building codes. Local practice may be such as to have the manufacturer perform some of the design functions. However, the ultimate responsibility shall remain with the Architect/Engineer.

Precast architectural shop drawings approved or approved as noted by the Architect/Engineer means that the Architect/Engineer has reviewed the precast concrete connections and reinforcement as detailed by the precast manufacturer, and that the Architect/Engineer takes total responsibility for the strength and long term behavior of the precast concrete connections and reinforcement.

- 2.5. Design deviations requested by the manufacturer or erector will be permitted only after the Architect/Engineer's approval of the proposed design.

3. Materials

- 3.1. Unless otherwise stated within the specification, all materials shall comply with the specifications, standards and codes given within this Guide Specification. The Architect shall be furnished satisfactory certification that all materials incorporated in the architectural precast concrete products comply with the requirements

herein specified.

Because of the special requirements of gap-graded facing mixes and the advantages in having backup mixes as consistent as possible with facing mixes, the grading requirements of ASTM C-33 or C-330 are generally waived or modified.

- 3.1.1. Cement for each type of exposed concrete finish shall be of one type and from one source throughout the entire job.
- 3.1.2. Fine and coarse aggregates for each type of exposed finish shall be from a single source and pit for the entire job. They shall be clean, hard, strong, durable and inert, free of staining or deleterious material.

The Architect should normally select the size, color and quality of aggregate to be used based on visual inspection of the concrete samples prepared by the precast manufacturer. The precast manufacturer should request and receive assurance from the supplier of the aggregates that the aggregates required for the entire project are consistent in quality, gradation and color, and are stockpiled or otherwise made available for shipment as needed.

- 3.1.3. Air entrainment shall be required to increase resistance to freezing and thawing where conditions warrant.

Air-entraining admixtures are preferred to air-entraining cements because their use allows adjustment in order to obtain the correct proportion of air for the exposure condition. Other admixtures are not normally used unless a specific change is desired in the properties of the mix. All admixtures require proper control of dosage and frequent checks are necessary to insure the proper quantity is being used.

- 3.1.4. Mixing water shall be clean, clear and free of deleterious quantities of salts, acids, alkalies, oils, detergents, organic material or other matter that may interfere with the color, setting or strength of the concrete.
- 3.1.5. Reinforcing steel or mesh shall conform with the appropriate ASTM specifications and shall be free of grease and dirt. Reinforcing bars shall not be welded without specific approval of the Architect/Engineer. When galvanized reinforcement is used, the cages shall be fabricated from pre-galvanized rod stock with cut ends and splices painted with liquid galvanizing ZRC or equal.

In long and/or thin panels it may be desirable to use prestressing steel. If prestressing steel is used, follow the PCI recommendations in MNL 116-70.

- 3.1.6. Plates and angles cast into architectural precast concrete products shall be mild steel and shop painted. Inserts, bolts, and other accessories shall be electro-plated.

Hot dipped galvanizing of plates and angles should only be required when a corrosive environment is present.

Connection items such as plates, anchors, inserts or other accessories required for the erection of precast concrete units are normally called

"hardware" and are divided into three categories. These are plant hardware, erection hardware, and general contractor hardware. It should be clearly defined in the contract documents who should provide and place the hardware in each category.

- 3.1.7. Pigments or other coloring agents, when required, shall be resistant to lime and other alkalis. The amount and type of coloring agent used shall not reduce the quality of the concrete below that specified.

The color fading characteristics of the pigments or coloring agents and their effects upon concrete strengths should be considered by the Architect before making his final selection.

- 3.1.8. Insulation, when required, shall be selected and used in accordance with the recommendations of ACI Committee 533.

- 3.2. Water contents should be kept to a minimum consistent with the strength requirements and placement needs of the particular project. Concrete mixes shall be proportioned to produce a compressive strength of at least 5000 psi measured at 28 days on standard 6 x 12-in. cylinders or equivalent strength on cubes.

The strength requirements for facing mixes and backup mixes may differ; however, to reduce potential differential shrinkage, differences in water content in the two mixes should be held to a minimum. Also the strength at time of removal from the forms should be stated if critical to the engineering design of the units.

4. Quality Control

- 4.1. The architectural precast concrete manufacturer shall have an established quality control program in effect prior to letting of the contract. If requested by the Architect, an outline of this program shall be submitted along with the shop drawings.
- 4.2. Manufacturing and testing procedures shall be in general compliance with the recommendations in PCI MNL 117-68. All tests shall conform to methods described herein or in reference material. Tests for compliance with contract specifications shall be conducted by a qualified testing laboratory. Duplicate certified copies of test results shall be transmitted to the Architect, manufacturer, and the General Contractor.

Manufacturers who are certified by the PCI Plant Certification Program, by the Cement and Concrete Reference Laboratory, or by their own local governmental agencies should be allowed to perform their own testing. If an independent laboratory is used, it should be selected or approved by the Architect. The number and frequency of each type of test to be run should be clearly stated.

- 4.3. Dimensional tolerances shall be as outlined in Division I, Section 5, PCI MNL 117-68.

5. Manufacture

Successful production of architectural precast concrete relies on quality of workmanship as the top consideration. Plant facilities may vary widely as to size or type but all need skilled workmen, experienced direction, and emphasis on quality control. The manufacturers' normal methods of mixing, placing and consolidating concrete will be acceptable providing they are such as to produce uniform, durable concrete of the specified strength and appearance.

- 5.1. Forms for architectural precast concrete shall be rigid and constructed of materials that will result in finished products conforming to the shape, lines and dimensions shown on the approved shop drawings.
- 5.2. Concrete mix designs shall be established by tests on trial batches to achieve the required specified strengths. These tests may be done either at the precasting plant or in a commercial testing laboratory. Tests will be necessary on all mixes, including facing, backup and standard, which may be used in production of units. Water content shall remain as constant as possible during manufacture. Concrete shall be deposited and vibrated to insure proper consolidation, elimination of unintentional cold joints and to minimize entrapped air.

If color pigments are used, it becomes even more necessary to insure that a consistent quantity of both pigment and water is used.

- 5.3. All reinforcing steel shall have a minimum cover of $\frac{3}{4}$ in. and shall be accurately located as indicated on the approved shop drawings. Metal chairs, with or without coatings, shall not be used in the finished face. Embedded anchors, inserts, plates, angles and other cast-in items shall have sufficient anchorage and embedment for design requirements. All weldments, including tack welds, shall be made in accordance with the applicable provisions of the AWS.

Cover requirements over reinforcement should be increased when the precast units are exposed to a corrosive environment or severe exposure conditions. When welding reinforcement, special problems such as crystallization and embrittlement may occur.

- 5.4. The finished surfaces of architectural precast concrete products shall be uniform and shall match the approved samples within the limits as established by the Architect. Patches shall be similar to surrounding surfaces.

See Section 1.5 regarding establishing a range of acceptability.

- 5.5. Curing shall be in accordance with the recommendations made by ACI Committee 533.
- 5.6. Plant records on all production shall be kept available for the Architect upon request.

Plant records should include mix designs, test reports, inspection reports, member identification numbers along with date cast, shipping records and erection reports. Records should be kept for a minimum of two years after final acceptance.

6. Handling and Transportation

- 6.1. Architectural precast concrete units shall be lifted and supported during manufacturing, storage, transportation and erection operations only at the lifting or supporting points, or both, as shown on the contract and shop drawings. Blocking shall be clean and non-staining. Lateral support shall be sufficient to prevent excessive bowing and warping. Edges of the units shall be protected by padding or other means to prevent staining, chipping or spalling of the concrete.

7. Erection

Since erection sometimes comes under the responsibility of the precast manufacturer, this section has been included in the Guide Specification. This is not intended to indicate that erection should be part of the precaster's responsibility. The Architect should check local standard practice for panel erection.

- 7.1. It shall be the responsibility of the General Contractor to coordinate delivery and erection of precast concrete products with other job-site operations. Clear, well-drained unloading areas and road access around and in the building (where appropriate) shall be provided and maintained by the General Contractor to a degree that all trucks delivering precast concrete products are able to reach the unloading areas under their own power. The erector shall have uninterrupted access to the structure during erection. Arrangements shall be made with the General Contractor in advance to eliminate conflicts with other trades.
- 7.2. Prior to installation of precast units, the erector shall check at the job site all dimensions affecting the work under his contract. Any discrepancies between design dimensions and field dimensions which could adversely affect installation in accordance with the contract documents shall be brought to the General Contractor's attention, in writing. If such conditions exist, installation shall not proceed until they are corrected or until installation requirements are modified.
- 7.3. Only competent workmen who are properly trained to handle and erect architectural precast concrete units shall be employed. All precast concrete units shall be erected level, plumb, square and true within the allowable tolerances. They must be positioned so that cumulative dimensional error is not allowed to build up. Horizontal and vertical joints shall be correctly aligned, and uniform joint width shall be maintained, as erection progresses. Each panel shall be securely fastened in place as indicated on the ap-

proved drawings. Adjustments or changes in connections, which could involve additional stresses in the products or connections, shall not be permitted without approval by the Architect/Engineer.

- 7.4. Unless otherwise stated, dimensional tolerances of the erected units shall be as recommended in PCI MNL 117-68.
- 7.5 The erector shall be responsible for any chipping, spalling, cracking or other damage to the units after delivery to the job site. After installation is completed, any further damage is the responsibility of the General Contractor.
- 7.6. The erector shall protect units from damage by field welding or cutting operations and provide non-combustible shields as necessary during these operations.
 - 7.6.1. All structural welds shall be made by a certified welder in accordance with the erection drawings which shall clearly specify type, extent, sequence and location of welds.
 - 7.6.2. All work and materials of other trades shall be adequately protected by the erector at all times.
 - 7.6.3. A fire extinguisher, of an approved type and in operating condition, shall be located within reach of all burning and welding operations at all times.
 - 7.6.4. If galvanizing is specified, all weld areas and exposed or accessible steel anchorage devices shall be given a coat of liquid galvanizing ZRC or equal immediately after welding or cutting.
- 7.7. After all architectural precast concrete units have been set in place and before joint treatment, cleaning or waterproofing, the work shall be inspected by the Architect. Units found to be slightly damaged may be authorized for repair at this time. All repairs shall conform to the Architect's requirements and shall be structurally sound.

Precast concrete generally undergoes far less cracking than cast-in-place concrete. It should be recognized that a certain amount of cracking may occur without being detrimental. In determining the acceptability of cracks, the recommendations of ACI Committee 533 should be followed.

8. Joints and Joint Sealants

Joint treatment is normally the responsibility of the erector or the General Contractor.

- 8.1. In all instances, the edges of precast concrete units and of adjacent materials shall be sound, smooth, clean and free of all contaminants prior to joint treatment.

- 8.2. Sealant and primer shall be supplied by the same manufacturer and the primer (when required) shall be as recommended for the particular sealant used. All sealant compounds shall be delivered to the job in the manufacturer's original sealed containers with labels intact and shall be applied in accordance with the manufacturer's recommendation.

In design and selection of the joint size and joint sealant materials, the recommendations of ACI Committee 504 should be used. The report considers such items as movement, panel size, and temperature conditions to which the panel may be exposed. The type of sealant and primer should be clearly stated.

A guide for design of minimum joint width of architectural concrete wall panels would be $\frac{3}{8}$ in. joint width for panel dimensions up to 5 ft., $\frac{1}{2}$ in. for dimensions up to 18 ft., and $\frac{3}{4}$ in. for dimensions up to 30 ft.

9. Cleaning

Cleaning after erection is normally the responsibility of the erector or the General Contractor.

- 9.1. All exposed facings shall be cleaned as necessary to remove dirt and stains which may be on the panels after erection. The precast units shall be cleaned only after all installation procedures, including joint treatment, are completed. The exposed facings shall be washed and rinsed in accordance with the precast manufacturer's recommendation.
- 9.2. Care shall be taken that no part of the building or surrounding site work be damaged, or that the character of the architectural finishes be changed by the cleaning material or process.
- 9.3. Surface sealants when required shall be applied after the building has been caulked and all repairs and cleaning have been completed.

In some instances, architectural precast concrete products are sealed at the plant in hopes of limiting dirt and stains on the units during erection. However, this practice may make in-place repairs more difficult.