PCI Precast/Prestressed Concrete Institute

Design and Construction Responsibilities for Architectural Precast Concrete

PCI designer's notebook

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Design and construction with architectural precast concrete are simplified when all parties are working as cooperative partners. Clearly defining the scope of work and the responsibilities of the involved parties by means of the contract documents is critical to achieving a high-quality structure. This article provides a guide for all parties involved in a precast concrete project and defines the responsibilities of each party. These responsibilities and relationships between the parties should be defined in the contract documents for a particular project.

A successful precast concrete project requires teamwork—close cooperation and coordination among all of the participants, including the owner, architect, structural engineer of record (SER), precast concrete manufacturer, erector, general contractor (GC)/construction manager (CM), and all other parties involved. The scope of the precast concrete work and the responsibilities of each party should be established at an early stage in the development of a project to achieve the desired quality and keep the project on schedule (see Table 1). During construction, each party is responsible for communicating with all other parties through the GC/CM or architect. This helps prevent misunderstandings and confusion. When authority and responsibility roles are coordinated, consistent, and clearly defined by the contract documents, problems and conflicts are avoided. Local practices regarding the assignment and acceptance of responsibility in design and construction can vary.

One of the basic principles of the construction industry is that with the responsibility for any aspect of design or construction must go the authority for that aspect. Another principle is that every entity should be responsible for its own work. These principles are frequently not followed in practice. There have been cases where owners have sued architects or engineers for approving nonconforming work without giving them authority to monitor the work as it progressed. Safety enforcement agencies (OSHA) and plaintiffs' lawyers have charged engineers or architects with the responsibility for construction accidents contrary to language and responsibilities in the contract documents. These last two situations typically are cases of responsibility without authority, although there could be instances

where a design team's work or direction can affect jobsite safety. If the design team is involved with construction-management functions, they could be making decisions affecting worker safety as well as quality of construction. When agents of the owner give instructions directly to the construction workforce regarding how work is to be performed, they step over the line into the contractor's area of responsibility.

In order for architects to design economical structures for their clients, it is imperative that the designer become familiar with architectural precast concrete and obtain design input from a local precaster early in the schematic design process. The precaster will help inform the design and construction team regarding economical fabrication, delivery, and erection processes. In the event alternatives are approved, the design team retains responsibility for properly interfacing with other materials in contact with or adjacent to the precast concrete.

The SER always has to take overall responsibility for the structural design of the completed structure. However, certain aspects of the design are often delegated to specialty structural engineers (SSEs) working for the material suppliers or subcontractors. When any of this delegated structural design work for a portion of the structure involves engineering (as opposed to simply detailing), the design work should be reviewed and approved by the SER registered in the same state as the project or as required by the local jurisdiction. The SER then accepts responsibility for the overall structural design. Additionally, local regulatory authorities should be consulted for their specific requirements. Contract documents typically require the structural design be the responsibility of a professional engineer, regardless of conflicts with other governmental requirements.

Responsibilities of the Architect

The architect develops the project design concept, establishes overall structure geometry, selects the wall materials for appearance and function, provides details and tolerances for proper material interfacing and weatherproofing, and specifies performance and quality characteristics, as well as inspection and testing requirements in the contract documents.

Table 1 Design Responsibilities

Contract Information Supplied by Design Team	Responsibility of the Precaster
Option I	
Provide complete drawings and specifications detailing all aesthetic, functional, and structural requirements, including design criteria, plus dimensions.	The precaster should make shop drawings (erection and production drawings) as required, with details as shown by the designer. Modifications may be suggested that, in precaster's estimation, would improve the economics, structural soundness, or performance of the precast concrete installation. The precaster should obtain specific approval for such modifications. Full responsibility for the precast concrete design, including such modifications, remains with the designer. Alternative proposals from a precaster should match the required quality and remain within the parameters established for the project. It is particularly advisable to give favorable consideration to such proposals if the modifications are suggested so as to conform to the precaster's normal and proven procedures.
Option II	
Detail all aesthetic and functional requirements but specify only the required structural performance of the precast concrete units. Specified performance should include all limiting combinations of loads together with their points of application. This information should be supplied in such a way that all details of the unit can be designed without reference to the behavior of other parts of the structure. The division of responsibility for the design should be clearly stated in the contract documents.	The precaster has two alternatives: (a) Submit erection and shape drawings with all necessary details and design information for the approval and ultimate responsibility of the designer. (b) Submit erection and shape drawings and design information for approval and assume responsibility for the panel structural design; that is, the individual units, but not their effect on the building. Precasters accepting this practice may either stamp (seal) drawings themselves, or commission engineering firms to perform the design and stamp the drawings. The choice between alternatives (a) and (b) should be decided between the designer and the precaster prior to bidding, with either approach clearly stated in the specifications for proper allocation of design responsibility. Experience has shown that divided design responsibility can create contractual problems. It is essential that the allocation of design responsibility is understood and clearly expressed in the contract documents.
Option III	
Cover general aesthetic and performance requirements only and provide sufficient detail to define the scope of the precast concrete work.	The precaster should participate in the preliminary design stage and the development of the final details and specifications for the precast concrete units and should work with the design team to provide an efficient design. The precaster provides the engineering design of the precast concrete units and their connections to the structure and should work with the design team to coordinate the interfacing work. The precaster should submit design information for approval and shop drawings at various stages of completion for coordination with other work.

The architect and SER have a responsibility to coordinate the design aspects of the precast concrete panels, such as aesthetics, dimensions, and loads to structure. The architect or SER may specify in the contract documents that design services for portions of the work are to be provided by the precaster. Typically design services are performed for the precaster by a licensed engineer who can be an employee of the precaster or an independent structural engineer, who serves as the SSE. The contract documents should clearly define the scope of the precast concrete design requirements and review responsibilities, as well as the responsibilities of other parties providing design services.

The contract drawings prepared by the design team should provide the overall geometry and dimensions of the structure, member or panel dimensions and cross sections, typical connection locations and details, and concepts so all precasters are estimating based on the same information. The architect's drawings may only show reveals or design articulation, allowing the precaster to determine panel sizes suitable to their handling and erection capabilities. In addition, the contract documents (specifications and design drawings) also should provide the general performance criteria, design loads (including concrete strength requirements), deflection requirements, temperature considerations, and any tolerance or clearance requirements for proper interfacing with other elements of the structure.

The order in which the project contract, specifications, or drawings prevail in the event of conflicts should be clearly defined. All aesthetic, functional, and structural requirements should be detailed.

The design team should provide complete, clear, and concise drawings and specifications. Contract documents should clearly define: (1) precast concrete components that are to be designed by the precaster (state who takes responsibility for design of elements at interfaces with other parts of the structure, such as the secondary steel bracing of the structure, to prevent rotation of beams or columns); (2) details or concepts of supports, connections, and clearances that are part of the structure designed by the design team and that will interface with the precast concrete components; and (3) permissible design load transfer points, indicating generic connection types to avoid having the precaster make assumptions on connection types and piece counts during bidding and design. It is preferable to leave specific panel and connection design to precasters so they can design details and connections suitable for their production and erection techniques.

The architect and SER should review designs, calculations, and shop drawings submitted by the precaster for conformance with design criteria, loading requirements, connection points, and design concepts as specified in the contract documents. This review, however, does not relieve the precaster and the precast concrete engineer of their design responsibilities.

Key Design Issues for the Design Team

The contract drawings prepared by the design team should provide a clear representation of the configurations and dimensions of individual precast concrete units and their relationship to the structure and to other materials. Contract documents that are unclear and lack detail may extend shop drawing preparation time, lead to confusion over work scope, and impact the project schedule.

The contract documents should supply the following information:

- Governing building codes, design loads, deflection limitations and temperature considerations;
- Elevations, wall sections, and dimensions necessary to define the sizes and shapes (profiles) of each different type of precast concrete element;
- Locations of joints and reveals, real (functional) or false (aesthetic), and drips;
- Required materials, color and finish treatment for all surfaces with a clear indication of the extent of all surfaces to be exposed to view when installed;
- Corner and return details;
- Details for jointing and interfacing with other materials (coordinated with the general contractor), including windows, roofing, and other wall systems;
- Insulated panel construction and insulation systems independent of the precast concrete;
- Openings for services and equipment, with their rough opening size and location;
- Details for special or unusual conditions including fire endurance requirements;
- Specified dimensional tolerances for the precast concrete and the supporting structure, location tolerances for the contractors' hardware, clearance requirements, and erection tolerances for the precast concrete. Exceptions to PCI MNL-117 or MNL-135 tolerances are not recommended;
- Support locations for gravity and lateral loads, as well as supplemental framing or bracing to support the precast concrete;
- Building location and site access; and
- Delineation of lateral bracing for structural beams.

The precaster uses the information from the contract drawings and documents to generate shape and erection drawings and design calculations. These drawings should detail elevations showing panel sizes, surface features, and panel relationships; detail sheets

should show panel cross sections, special edge conditions, and feature details and should specify connection details showing mechanisms and locations of load transfers to the supporting structure. Allowing the precaster to suggest configurations of the precast concrete units and to select which joints are false and which are real (panelization) will achieve greater economy and flexibility in production and erection.

The design team should review shop drawings in a timely manner to ensure their general conformance with the contract documents, to avoid delay in the project schedule, and to respond to aesthetic questions raised by the construction team. Architectural and structural review and clarification of dimensions and detailing should be anticipated. Following this review, the precaster will make the appropriate revisions to the shop drawings. Open discussion between the architect and precaster should be allowed and encouraged in order to achieve the best possible design for the project.

Producing small mockups is encouraged to help verify the appearance of the completed facade and clarify actual field-construction techniques and material interface issues. If the units have returns, the same size return should appear in the mockup panels.

The architect establishes the standards of acceptability for surface finish, color range, and remedial procedures for production and construction defects and damage. This can be best accomplished by the precaster producing at least three sample panels, 15 to 20 ft2 (1.4 to 1.9 m2) each, before the initial production to establish the range of acceptability with respect to color and texture variations, surface blemishes, and overall appearance. In addition the architect should visit the plant early in production to evaluate conformance with approved samples.

Panel-to-panel joint design and the proper sealing at windows and other penetrations in the exterior wall are necessary to prevent air and water infiltration. The architect is responsible for providing these designs and details. Precast concrete is inherently watertight and impermeable and therefore it is important to have watertight joints at the window-to-precast concrete interface to prevent water leaks. The architect should examine and modify these details as required. The contract documents should require that the same sealant contractor seal all joints in order to provide sealant continuity and avoid incompatibility, thereby providing single source responsibility.

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Ascent 2013 – DN-28: Design Factors Affecting Aesthetics of Architectural Precast Concrete

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Instructions

Review the learning objectives below.

Read the AIA Learning Units article. Note: The complete article is avaliable at www.pci.org/elearning

Complete the online test. You will need to answer at least 80% of the questions correctly to receive the 1.0 HSW Learning Units associated with this educational program.

Learning Objectives:

1. Discuss the three options for the design team to provide contract information to the precaster.
2. Describe the key information the contract documents should supply.
3. Discuss the sample and approval process for architectural precast.
4. Explain the design and construction responsibilities of each team member.

Questions: contact Education Dept. - Alex Morales, (312) 786-0300 Email amorales@pci.org