Special Report

**Recommendations on
Responsibility for
Design and Construction of
Precast Concrete Structures**

prepared by

**The PCI Board Ad Hoc Committee for Responsibility
for Design of Precast Concrete Structures**

JOHN M. HANSON
Chairman

**E. FRED BRECHER
TED J. GUTT
PAUL D. MACK
MILO J. NIMMER**

**CHARLES H. RATHS
JAMES R. VOSS
HELMUTH WILDEN**

Presents recommendations on assignment of authority and responsibility for the design and construction of precast concrete structures. The role of the Owner, Engineer-Architect, General Contractor/Construction Manager and Manufacturer of precast concrete products is defined.

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Note: The Committee acknowledges the use of the October 20, 1985 report of the American Society of Civil Engineers entitled "Final Report and Recommendations on Assignment of Authority & Responsibility for Design of Steel Structures" in the preparation of this document.

1.0 INTRODUCTION

Design and construction of structures is a complex process. Defining the scope of work and the responsibilities of the parties involved in this process, by contract, is necessary to achieve a safe, high quality structure.

Besides the Owner, the parties involved in the design and construction of precast

concrete structures or other structures containing precast concrete members may include the Engineer, Architect, Construction Manager, General Contractor, Manufacturer, Precast Engineer, Erector and Inspector. These and other terms related to precast concrete construction are defined in Section 2.0.

2.0 TERMINOLOGY

Terms used in engineering practice and the construction industry may have meanings that differ somewhat from ordinary dictionary definitions. The following definitions are commonly understood in precast concrete construction.

Approval (Shop Drawings or Submittals)

Action with respect to shop drawings, samples and other data which the General Contractor is required to submit, but only for conformance with the design requirements and compliance with the information given in the contract documents. Such action does not extend to means, methods, techniques, sequences or procedures of construction, or to safety precautions and programs incident thereto, unless specifically required in the contract documents.

Authority

The power, conferred or implied by contract, to exercise effective direction and control over an activity for which a party has responsibility.

Connection

A structural assembly or component that transfers forces from one precast member to another, or from one precast member to another type of structural member.

Contract Documents

The design drawings and specifications, as well as general and supplementary conditions and addenda, that define the construction and the terms and conditions for performing the work. These documents are incorporated by reference into the contract.

Contractor

A person or firm that enters into an agreement to construct all or part of a project.

Construction Manager

A person or firm engaged by the Owner to manage and administer the construction.

Design

(As a transitive verb) The process of utilizing the principles of structural mechanics and materials science to determine the geometry, composition, and arrangement of members and their connections in order to establish the composition and configuration of a structure.

(As a noun) The product of the design process, as usually expressed by design drawings and specifications.

Design Drawings (Plans)

Graphic diagrams with dimensions and

accompanying notes that describe the structure.

Detail

(As a transitive verb) The process of utilizing the principles of geometry and the art of graphics to develop the dimensions of structural components.

(As a noun) The product of the detailing process, shown on either design or shop drawings, such as the graphic depiction of a connection.

Engineer/Architect

A person or firm engaged by the Owner or the Owner's representative to design the structure and/or to provide services during the construction process. In some cases the Engineer may be a Subcontractor to the Architect, or vice versa. The Engineer of Record is usually an individual employed by the Engineer or Architect.

Engineer of Record (EOR)

The registered professional engineer (or architect) who is responsible for developing the design drawings and specifications in such a manner as to meet all applicable requirements of governing state laws and of local building authorities. The EOR is commonly identified by the professional engineer's seal on the design drawings and specifications.

Erector

Usually the Subcontractor who erects the precast concrete components at the site. The General Contractor may also be the Erector.

General Contractor

A person or firm engaged by the Owner to construct all or part of the project. The General Contractor supervises the work

of its Subcontractors and coordinates the work with other Contractors.

Inspector

The person or firm retained by the Owner or the Owner's representative to observe and report on compliance of the construction with the contract documents.

Manufacturer (Producer, Precaster, Fabricator)

The firm that manufactures the precast concrete components.

Owner

The public body or authority, corporation, association, firm or person for whom the structure is designed and constructed.

Precast Concrete

Concrete cast elsewhere than in its final position. Includes prestressed and nonprestressed components used in structural or nonstructural applications.

Precast Engineer

The person or firm who designs precast members for specified loads and who may also direct the preparation of the shop drawings. The Precast Engineer may be employed by the Manufacturer or be an independent person or firm to whom the Manufacturer subcontracts the work.

Responsibility

Accountability for providing the services and/or for performing the work required by contract.

Shop Drawings

Graphic diagrams of precast members

and their connecting hardware, developed from information in the contract documents. They show information needed for both field assembly (erection) and manufacture (production) of the precast concrete. Shop drawings for precast concrete may be separated into erection and production drawings. Erection drawings typically describe the location and assembly details of each precast member at the construction site. Connection hardware is detailed on erection drawings and may be shown on production drawings. Production

drawings contain all information necessary for the manufacturer to cast the member.

Specifications

Written requirements for materials and workmanship that complement the design drawings.

Subcontractor

A person or firm contracting to perform all or part of another's contract.

3.0 DESIGN PRACTICES

Practices vary throughout North America with respect to design of structures using precast concrete members. However, it is of fundamental importance that every aspect of the design be in accordance with the requirements of all state laws governing the practice of engineering and/or architecture, and also meet all requirements of local regulatory authorities. This generally requires that a registered professional engineer or architect accept responsibility as the Engineer of Record (EOR) for ensuring that these requirements are met. The EOR seals the contract documents. These documents constitute the structural design and are customarily submitted to regulatory authorities for a building permit. In addition, the EOR ordinarily approves shop drawings. The EOR may also have other ongoing responsibilities during construction to satisfy local authorities.

Structures are usually designed by an engineering firm that is retained by or on behalf of the Owner. A person within the firm is selected to prepare and/or to supervise the preparation of the contract documents. This person normally is registered to practice engineering in the state where the structure will be built and becomes the EOR when the design drawings and specifications are ap-

proved by the local regulatory authority. An individual in private practice may also be retained by an Owner to prepare the design and become the EOR. The design drawings and specifications become part of the contract documents used by contractors to construct the structure.

Procedures that allow consideration of alternative construction schemes are sometimes included in the contract documents. If a fully developed design is included in the contract documents, a contractor proposing an alternate for some part of the structure is expected to consider the effect of the alternate on all other parts of the structure, and to provide all necessary design changes. It is common to require that an alternate design be prepared under the direction of an engineer registered to practice in the state where the structure will be built. However, the EOR still has the responsibility to review and accept the alternate and to submit the alternate to the regulatory authorities.

Owners may also directly seek proposals from General Contractors who are willing to prepare the design. The General Contractor may use an employed registered professional engineer who is the EOR, or subcontract the design to a firm or individual who becomes the EOR. In

some instances, a Manufacturer may be the General Contractor. Since the Owner will already have a contract with the selected General Contractor, any additional contracts will be between the General Contractor and Subcontractors. Under this arrangement, the Owner often retains an engineering consultant to review the proposals and the design related work of the selected General Contractor.

Normally the Manufacturer is a Subcontractor to the General Contractor. Most Manufacturers are willing to accept responsibility for component design of the members that they produce, provided that sufficient information is contained in the contract documents. This design work is commonly done by a Precast Engineer. The Manufacturer may also accept responsibility for design of the connections when the forces acting on the connections are defined by the EOR. At the time of bidding, if there is insufficient information in the contract documents to fully cover all of the reinforcement requirements, the Manufacturer customarily assumes that industry minimum standards are acceptable. Manufacturers usually have standard

designs that fit common applications for their products and that are sufficient for design purposes. Manufacturers may design, produce and deliver a "structural frame" or a "structural shell" rather than a building ready for occupancy. In this case the Manufacturer may subcontract for parts of the work, such as the cast-in-place concrete or the precast erection.

Local regulatory authorities may approve design documents for starting construction without final design of the precast members. The design can be performed and submitted at a later time, often in conjunction with preparation of shop drawings. The EOR, if not employed by the Manufacturer, may require that a registered engineer seal the documents that depict the component design of the precast members. This does not relieve the EOR of responsibility to approve or accept the design as meeting the requirements of state laws and local authorities. However, some states accept designs made by these persons, relieving the EOR of some responsibility. For example, these persons have been called Specialty Engineers in the state of Florida.

4.0 RECOMMENDATIONS

The Prestressed Concrete Institute is keenly aware of the competitiveness in the marketplace for building systems. It believes precast concrete products provide a high quality structure. Along with quality, it is essential that a structure be both safe and serviceable, i.e., have structural integrity and perform as intended. Because the construction process involves many parties, it is essential that work assignments and responsibilities be clearly defined in the contractual arrangements. The Institute offers the following comments and recommendations towards achieving quality and integrity in precast concrete structures.

4.1 To the Owner

At the outset, the Owner must decide whether to enter into a contract with an Engineer or Architect to design and prepare contract documents for the structure which subsequently can be used to obtain bids by a General Contractor, or with a General Contractor (or Manufacturer willing to assume that responsibility) to both design and build the structure. These two arrangements may be summarized as follows:

1. Owner retains an Engineer or Architect who will be the EOR:
 - a. To design and prepare contract documents sufficient for con-

struction without further design by the General Contractor or Subcontractors.

- b. To prepare contract documents sufficient for construction with further design by the General Contractor or Subcontractor.

2. Owner contracts with a General Contractor for design and construction.

Under either arrangement, the Institute believes that the best control of structural integrity will be achieved when the EOR is given responsibility and authority for the entire structural design, including the connections, for review and approval of shop drawings, and for inspection during construction and acceptance of the finished construction. Under Arrangement 1b, the contract documents must establish the loadings and identify the criteria for design to be used by the contractor. Design work by any contractor should be submitted to and approved by the EOR. The EOR may require the design and shop drawings to be sealed by a registered professional engineer as a demonstration of qualifications. Under Arrangement 2, where the EOR will be engaged or employed by the Contractor, it may be desirable for the Owner to retain another Engineer or Architect for consultation on design criteria and verification that the design intent is achieved.

The Owner should consider the experience and qualifications of both the Engineer or Architect and the General Contractor with precast construction similar to that for the intended project.

If the Owner plans to have an active role in the project, it is essential this role and lines of communication with the other parties be clearly expressed in written documents pertaining to the project. The Owner must allow sufficient time in the various phases of the construction process to achieve quality.

Changes initiated after the start of construction invariably add cost to the structure. A thorough review by the Owner after the design is completed,

before construction is started, is essential.

The Institute maintains a Plant Certification Program. The Program is recognized by the Council of American Building Officials (CABO) as a Quality Assurance Inspection Agency. CABO includes the following major building codes:

- a. Building Officials & Code Administrators International (BOCA)
- b. International Conference of Building Officials (ICBO)
- c. Southern Building Code Congress International (SBCC)

PCI Plant Certification is also recognized in standard specifications by federal, state and local government agencies. The Owner or Engineer/Architect may choose to require that PCI Plant Certification be written into the project specifications.

No Manufacturer should be eliminated as a possible source for concrete products because they are not PCI certified. However, acknowledged confidence should be in order for the plant with PCI Certification credentials.

4.2 To the EOR (Engineer/Architect)

As discussed in Section 3, the role of the EOR (Engineer/Architect) varies significantly depending on whether this party is retained by the Owner or by other parties. If retained by the Owner, the EOR's lines of communication among the parties involved in the project should be established by written documents. Prebid and preconstruction conferences should be held, during which lines of communication and responsibilities are reviewed and the design requirements are discussed.

If retained or employed by the General Contractor or Manufacturer, the EOR must remain cognizant of the professional responsibility to satisfy state laws and local regulatory authorities. Procedures should be established to allow the

EOR to discharge these responsibilities without restriction by other parties involved in the construction.

Review and approval of shop drawings by the EOR is essential to ensure the design intent is achieved. Timeliness of review may be crucial to the Manufacturer. The EOR should establish the schedule and define the responsibilities of the various parties involved in preparing shop drawings. These parties should accept that the approval of the EOR does not relieve them of their responsibilities.

The EOR should make clear whether the contract documents, specifications or drawings prevail in the event of conflicts. It is recommended that they prevail in the order given above.

Where the design involves a nonself-supporting precast concrete frame, the contract documents should indicate which party is responsible for the design of the construction bracing and how long such bracing needs to remain in place.

Where erection procedures require special design and calculations, the contract documents should specify that a registered engineer perform these services. The EOR's review of this work should be limited to its effect on the integrity of the completed structure.

Interfaces between precast components and other construction materials require special attention. The EOR is responsible for considering these interface conditions during the design of the structure.

4.3 To the General Contractor

When the construction of a building that was independently designed for the Owner is undertaken, the General Contractor's responsibility is to build the structure in accordance with the contract documents. When design responsibility is accepted by the General Contractor, the professional nature of this

function must be recognized and allowed to be achieved in a manner that does not compromise integrity or impair quality.

The responsibilities of the Manufacturer must be clearly defined. It must be understood that all design is submitted through the EOR for approval or acceptance. The Manufacturer's responsibility is usually limited to product design and preparation of shop drawings. However, it may include the design of the entire structure if agreed to by the Manufacturer.

When the Manufacturer is responsible only for product design, all loads which are applied to the precast members, including forces developed by restraint, must be provided by the EOR. The Manufacturer should be given responsibility and authority for properly implementing the design drawings, properly furnishing materials and workmanship, maintaining the specified fabrication and erection tolerances, and for fit and erectibility of the structure.

The Manufacturer must be given all of the drawings and specifications that convey the full requirements for the precast members. Drawings are commonly divided into architectural, structural, electrical and mechanical groupings depending on the size and scope of the project. Other pertinent drawings may also be desirable, such as approved shop drawings from other trades, roofing requirements, alternates, etc.

Timely review and approval of shop drawings and other pertinent information submitted by the Manufacturer is essential.

4.4 For the Manufacturer

After award of the contract, the Manufacturer and Precast Engineer should meet with the EOR to review design requirements. The Manufacturer should prepare shop drawings in accordance with the design information supplied in

the contract documents and subsequent instructions from the EOR.

In those cases where the Manufacturer requests permission to revise certain connections to facilitate manufacture and/or erection, information supporting the revision should be submitted to the EOR for review and approval.

The Manufacturer and/or the Precast

Engineer should have a direct channel of communication with the EOR as the project goes forward and should keep the General Contractor informed.

The Manufacturer should request clarification in writing from the EOR on special connections or unusual structural conditions not clearly defined by the design drawings or specifications.

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NOTE: Discussion of this report is invited. Please submit your comments to PCI Headquarters by April 1, 1989.