Thomas J. D'Arcy

fib handbook, experience offer much to precasters outside Europe

Learning is a lifelong experience; we can never have enough of it. It can come from many sources. What I propose here is the value of extending our learning of precast/prestressed concrete beyond the borders of the United States of America. I intend to tell you a little about *fib* (International Federation for Structural Concrete) and then share a synopsis of one of its publications to pique your interest.

The beginnings of *fib* harken back to the father of prestressed concrete, Eugène Freyssinet, with the creation of FIP (International Federation for Prestressing).

The publications of *fib* include codes, reports, commission reports, symposium publications, and a technical journal. Much of their work and publications have direct and indirect implications for U.S. applications and the design of U.S. prestressed concrete and structural systems. I have been a member of *fib* for more than 20 years, and in the beginning, few sharing opportunities existed as PCI and *fib* went their own ways. However, in the past 5 to 10 years, *fib* and PCI have found ways to share and work together, producing joint standards and publications that combine the best of U.S. and global engineering. One example of this is that over 70 *fib* bulletins are available for free on the Members Only section of the PCI website under Technical Resources.

fib tends to have a different approach from PCI's straightforward, cut-to-the-chase style with sample problems. It is more philosophical, more introspective. For example, PCI designs in great detail, including the plate size, the anchorage, the weld size, the eccentricity of the loose plate, and the embed, in the *PCI Connections Manual for Precast and Prestressed Concrete Construction*. By contrast, the *fib* connections manual reviews the intent of the connection and the flow of forces, not only through the connection, but to the supporting members themselves. The results are typically similar, but the approach is different and *fib*'s is more total in scope. Having both in hand provides a more-thorough understanding and approach to connection design and its impact on the connection members.

fib recently published the *Planning and Design Handbook on Precast Building Structures*, *fib* Bulletin No. 74, which provides guides to good practice and design recommendations for precast concrete. The book's purpose is to help architects and engineers achieve a full understanding of precast concrete building structures, the advantages they offer, and their specific design philosophy. Here I describe the contents and highlights from each chapter in the handbook. *Planning and Design Handbook on Precast Building Structures* can be purchased from the Bulletin Store at http://www.fib-international.org.

Chapter 1: "Suitability of Precast Concrete Construction"

This chapter includes several examples of applications of precast concrete in a wide variety of structures and an excellent list of the advantages of precast/prestressed concrete. We in the United States seldom identify some of these advantages, such as what precast concrete can offer a structure in the incorporation of building services. The chapter is well illustrated, with excellent photographs of all types of applications.

Chapter 2: "Preliminary Design Considerations"

This chapter includes framing examples that emphasize uniformity of plan and the locating lateral resisting elements appropriately. Table 2.1 lists nine different building types and the advantages of four different framing systems—skeletal, wall frames, loading-bearing facades, and mixed construction—for each building type.

Chapter 3: "Precast Building Systems"

This chapter includes examples of typical U.S. products and applications as well as European products and systems. Fabric energy storage, also known as thermal mass, is covered. It is characterized by a slow response to dynamic temperature fluctuation with the ability of a panel to exchange heat with its environment.

Chapter 4: "Structural Stability"

Various framing systems are reviewed, with the key elements of design and detailing of each system discussed in a simplified manner. Cast-in-place topping on precast concrete members is presented as the floor diaphragm system, but pretopped systems are briefly discussed.

The need for tie systems within the structure to transfer lateral forces and to provide structural integrity is covered and includes peripheral, internal, horizontal or wall, and vertical ties. Each tie type includes minimum values given by simple formulas.

A section on reducing the risk of progressive collapse provides three different design approaches.

Chapter 5: "Structural Connections"

This chapter provides good basic information on the principal function of connections and many drawings of details. Sections on volume change and ductility are included. The philosophy of achieving ductile behavior is interesting, and the concept of balanced design is introduced and explained with drawings and details. As I noted in the introduction, the connection is considered a zone "designed and detailed so that the connection reaction is safely spread and transferred into the element." Connections are categorized by the type of force or action that is to be resisted: compression, tension, shear, flexure, and torsion. Each category is discussed at length, particularly the compression (or bearing) category. PCI engineers will find this extensive chapter most interesting.

Chapter 6: "Portal Frame and Skeletal Structures"

This chapter focuses mainly on European framing systems, which typically employ long beams as roof rafters. High-rise structures are also included. Some load tables and typical beam sizes and shapes are provided. Various connections are shown using members similar to those that PCI recommends to achieve structural continuity.

Chapter 7: "Wall-Frame Structures"

The handbook lists the various wall framing solutions as integral wall system, cross-wall system, and spine wall system. Each solution is amply illustrated and its key design features presented more in a literal manner. Again, the philosophy of connection design and requirement for each system is presented. The concept of energy dissipation in seismic areas is also covered, and various connections between hollow-core floor and load-bearing wall are illustrated.

Chapter 8: "Floor and Roof Structures"

PCI members will be at home in this chapter because many typical PCI industry product shapes are included, though double tees are called ribbed floor units. The design of floors employing these members is presented and includes diaphragm actions and the distribution of concentrated loads. Tables showing the percentage of concentrated load distribution by span length and load location are particularly informative.

Chapter 9: "Architectural Concrete Facades"

As expected, the precast concrete application is identified by four cladding systems: load bearing, non–load bearing, and single skin or double skin (sandwich panels). The twin skin facade is interesting because it consists of two concrete leaves in which the inside and outside leaf are fabricated and erected separately. The interior leaf is load bearing and smooth, and the exterior leaf is erected with its insulation. Mold consideration and form drafts are suggested, as well as various surface finishings and connection to structural framing. Size and location of drip grooves is included, as well as joint-sealing suggestions.

Chapter 10: "Constructional Detailing and Dimensional Tolerances"

A table showing minimum nominal support length for various types of members seems a little too tight for U.S. tolerances. Indicative models for reinforcement for half-joint (dapped) members is provided. Corbel design consideration and reinforcing detailing is covered. A table for recommended openings through beam web for different locations and opening shapes is useful. Special reinforcing needs for anchorage zones, column ends, and walls with openings are provided. The section on tolerances only identifies requirements, not values.

Chapter 11: "Fire Resistance"

This chapter says that the design and calculation methods related to the analyses of the global structure during fire are still under development. Requirements are based on the ISO 834 standard fire curve, similar to ASTM 119. The basic criteria for a concrete structure to comply with basic fire-resistance requirements are stability, thermal insulation or heat transition, and flame tightness. These are similar to U.S. philosophy and requirements. Table 11.1 provides material performances for concrete, reinforcing steel, and prestressing strand for various temperatures. Some examples of a simplified calculation method are provided and employ reduced strength of reinforcement due to temperature similar to U.S. practice. Standard fire-resistance levels are described, as in the United States, by minutes exposed to a fire, ranging from 60 to 240 minutes. Various combinations of beam sizes and reinforcing cover are given in Table 11.3.

Reports from 2016 *fib* Commission 6 meetings in Killenard, Ireland

April 7 to 9, 2016, *fib* (International Federation for Structural Concrete) Commission 6: Prefabrication, or as we would call it, precast concrete, met in Killenard, Ireland. *fib* is similar to the American Concrete Institute (ACI) in that it writes codes for the design of concrete. Commission 6 is made up of subcommittees, each dealing with areas of precast concrete construction, such as different product types, quality control, and sustainability.

About 40 people representing most European countries as well as other parts of the world, such as Brazil and Australia, attended the *fib* Commission 6 meetings. The small group size and social networking make for productive meetings and allow everyone to get to know each other well. These events typically include a technical program, which at this meeting was a tour of a precast concrete plant that manufactures very high-quality precast concrete architectural panels for cladding high-rise structures. Paul Kourajian, Ned Cleland, and S. K. Ghosh share their experiences with *fib* and at the meetings in Ireland.

"I have had the opportunity to attend the Commission 6 meetings on three other occasions and have made a few other trips to Europe for work functions. This has allowed me to get to know the *fib* members well and to tour numerous precast concrete plants and construction sites. The precast concrete industry in Europe enjoys a much greater market share and manufactures a significantly larger amount of precast concrete than in the United States. That presents a great opportunity for PCI and its members to learn from the European experience and apply it to the U.S. market.

While at the recent meetings, I attended the Hollow-core and Precast Concrete in Tall Buildings Committee meetings, as well as the plenary meeting where they review the work of all committees. The Hollow-core Committee is working on a design manual and has a draft that is nearly complete and should be published in the near future. The meeting was spent reviewing comments and discussing the content of the manual. The Precast Concrete in Tall Buildings Committee is just getting started on a recommended practice document and is working on a table of contents. There was much interesting discussion, and the chapters were divided among the volunteers to develop content. There were also a couple of presentations on high-rise buildings constructed completely with precast concrete."

Paul Kourajian
Director of Drafting and Engineering,
Molin Concrete Products Co.
Lino Lakes, Minn.

"I attended the *fib* Commission 6 meeting to participate on a committee that is writing a document on tall-building development. At first, it may seem odd that a PCI member would be participating in a tall-buildings meeting because the impression is that we do not have much of a market for tall precast concrete buildings in the United States. We must ask, 'Why not?'

One of the problems with remaining insular in our North American practices is that we might miss opportunities to expand our markets based on the practice and success of precast concrete around the world. The participation with this committee affords an opportunity to contribute North American practices to a document that promotes a new market.

In the United States, a challenge in designing taller structures is that we have more significant seismic concerns than in most of Europe, but participants from Italy, Japan, and New Zealand bring experience and solutions that could help U.S. practice. Our practices with walls, hollow-core, insulated sandwich wall panels, tall columns, and stairs are efficient for manufacturing and erection and can point us toward the innovation that precast concrete CEOs are seeking.

I was most impressed with the European experience and practice with high-rise erection. The advancing erection shed can be done in the United States with the same schedule and efficiency gains that are realized in Europe. My first thought is, 'We can do that!'

Not every design or method is applicable to U.S. markets, but the first step toward thinking outside the box is to get out of the box. Tall-building practices have advanced on the West Coast through the efforts of a small number of firms practicing performance-based design for shear wall buildings that exceed the code limits of height for monolithic reinforced concrete. The benefits of the

PRESSS (Precast Seismic Structural Systems) hybrid walls continue to gain recognition.

Our plant tour of Techrete showed U.K. practice for large-scale precast concrete that was not constrained by the common carousel system. It was very impressive, and might give us ideas for doing it better."

Ned Cleland
President, Blue Ridge Design Inc.
Winchester, Va.

"My recent trip to Ireland for the *fib* Commission 6 meeting was similar to my trips for other such meetings. The top engineers, researchers, and professors and a few producers' representatives from various European countries congregate at these meetings. It is always a privilege to interact with and to learn from them. This group's members have long-standing relationships among themselves, yet they are welcoming and I never feel like an outsider. The respect they have for PCI is almost palpable. David Fernández-Ordóñez, the *fib* secretary general, is particularly well disposed toward us. Close cooperation between *fib* and PCI can only benefit both sides.

In Ireland, the meeting of the Precast Concrete in Tall Buildings Committee was notable. This group, led ably by our local host, George Jones, is likely to produce a worthwhile document. If we contribute our share and make the document as good as it can be, we stand to benefit from it in the United States because tall buildings have certainly not been our focus so far.

I hope PCI's cooperation with *fib* Commission 6 will not only continue but will grow stronger. It provides us with direct access to a lot of valuable precast concrete expertise that can only benefit us."

S. K. Ghosh
President, S. K. Ghosh Associates Inc.
Palatine, Ill.

About the author

Thomas J. D'Arcy, PE, SE, is a principal with The Consulting Engineers Group Inc. in San Antonio, Tex.

Abstract

PCI members get acquainted with *fib* (International Federation for Structural Concrete) publications and learn about the *fib* experience, including meeting other engineers and constructors who have experience in precast concrete and are both informative and enlightening. The informative *fib* symposiums are similar to PCI conventions and are held across the globe. This column discusses each chapter in the *fib Planning and Design Handbook on Precast Building Structures*, which is significantly different from the *PCI Design Handbook: Precast and Prestressed Concrete* and a valuable addition to your bookshelf.

Keywords

Fédération Internationale du Béton, *fib*, International Federation for Structural Concrete, prestressed concrete, tall buildings.

Reader comments

Please address reader comments to journal@pci.org or Precast/Prestressed Concrete Institute, c/o *PCI Journal*, 200 W. Adams St., Suite 2100, Chicago, IL 60606.