

## PCI と、米国のプレキャストコンクリート構造物産業

### 概 要

本論文では、プレキャスト/プレストレストコンクリート学会（PCI）と、学会が関係する産業の概要についてまとめている。PCI は、建物、駐車場、橋のような構造物とその部材を扱うプレキャストコンクリート構造物産業を代表している。一方、プレキャストコンクリートには、製品業界もあり、これら両方の産業の 2012 年における売上高は、104 億ドルであった。構造物産業だけの売上高は 33 億ドルで、これは、2011 年の売上に対して約 7% の増加となっている。International Green Construction Code のような新しい建設基準が、性能規定としての性格をより強め、より高いエネルギー性能を要求するようになったのに対して、プレキャストコンクリートはこれらの高性能を実現できる構造である。また、近年の暴風雨によって引き起こされた大きな被害から、高耐久性、高復元性および持続可能性に対する人々の関心は高くなっており、プレキャストコンクリートには好機が訪れていると言える。

PCI は 1954 年に設立され、以来、プレキャストコンクリート構造物産業の成長と発展を促進する主要な原動力となってきた。PCI の会員は、技術者、建築家、コンサルタント、建設業者、構造物所有者、政府関係者、教育者、学生、製品製造業者などである。PCI は、PCI Design Handbook や Bridge Design Manual などの技術マニュアル、報告書、PCI Journal などの定期刊行物、およびその他の情報文献を発行している。また、独自に研究を実施し、年次大会を開催し、継続教育を提供し、賞の授与も行っている。さらに、PCI は 48 年間続いている工場認定プログラムも提供している。北米では、280 以上の工場がこのプログラムに参加している。これらの工場の売上げは、アメリカのプレキャストコンクリート構造物全体の 90% を越えている。

PCI は、過去数十年間にわたって国際組織と連携してきた。北米では、カナダのプレキャストプレストレストコンクリート学会（CPCI）との協力関係がある。CPCI は、PCI の工場認定プログラムと技術マニュアルを採用してきた。また、メキシコ プレストレスプレキャストコンクリート建設業協会とも非公式ではあるが連携している。今後は、一貫性のある国際戦略に基づき、海外の機関と協力していく予定である。プレキャストコンクリート構造をさらに前進させるような技術団体の地球規模のネットワークの構築を進めていく。



# PCI and the US Precast Concrete Structures Industry

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## INTRODUCTION

Precast concrete has been in use for well over 100 years. The idea of prestressing concrete is generally thought to be a European innovation, but in fact, a patent for prestressed concrete pavement was awarded to P.H. Jackson of the United States in 1888, while Eugene Freyssinet only learned about it as a student in 1903. The first technical committee on prestressed concrete was organized in 1944 as a joint committee of the American Concrete Institute (ACI) and the American Society of Civil Engineers (ASCE).

This paper provides a brief summary of the Precast/Prestressed Concrete Institute (PCI) and the industry it serves, in an effort to promote better understanding and future relationships with our friends in Japan.

## NORTH AMERICAN PRECAST CONCRETE INDUSTRY

Precast concrete in North America is actually two industries, each represented by a major association. The *Precast Concrete Products* industry focuses on utility, underground, and other non-prestressed products, and is represented by the National Precast Concrete Association (NPCA). The *Precast Concrete Structures* industry, which is the subject of this paper, focuses on prestressed concrete elements, and on other precast concrete elements used in above-ground structures such as buildings, parking structures, and bridges. This industry is represented by the Precast/Prestressed Concrete Institute (PCI).

In 2012, combined sales for both industries in the United States (US) were \$10.4 billion, representing a decrease of about 5% relative to 2011 sales.

### Precast Concrete Structures Industry

The Precast Concrete Structures industry in the US (the "Industry") is considered to have begun in 1949 with the Walnut Lane Bridge, the first practical application of prestressed concrete technology to a US structure.

The Industry today is capable of a remarkable level of functional and aesthetic versatility. A wide array of precast concrete structure types can be found in virtually every major market segment, ranging from utilitarian bridges and industrial facilities to award-winning architectural masterpieces.

In 2012, sales for the Precast Concrete Structures Industry in the United States were \$3.3 billion, an increase of about 7% relative to 2011 sales. A slight increase in overall construction sales contributed partially to these gains, but there are also other favorable market factors creating opportunities specifically for precast concrete structures. For example, new building code requirements, such as the International Green Construction Code (IgCC), are more performance-based and require higher energy performance. This aligns well with the thermal mass properties and continuous insulation systems offered by precast concrete envelope systems. The Industry growth trend is shown in Table 1.

Table 2 provides a breakdown of US sales by type of structure and the change in sales for each in structure type from 2010 to 2011.

Table 3 provides a breakdown of US sales by type of product and the change in sales for each in product type from 2010 to 2011.

**Table 1: Sales Trend of US Precast Concrete Structures and Total Construction**

	<b>Total Construction</b>	<b>Precast Structures</b>	<b>Annual Precast Change</b>
<b>2009</b>	\$426 B	\$3.38 B	– 31.3%
<b>2010</b>	\$434 B	\$2.82 B	– 16.6%
<b>2011</b>	\$439 B	\$3.08 B	+8.9%
<b>2012*</b>	\$471 B	\$3.30 B	+7.1%
<b>2013*</b>	\$504 B	\$3.46 B	+5.0%

**Table 2: US Precast Concrete Structure Sales by Structure Type**

	<b>2011 Sales</b>	<b>Change</b>	<b>% Change</b>
<b>Parking Structures</b>	\$855 M	+ \$315 M	+ 58%
<b>Industrial (warehouses, manufacturing, storage)</b>	\$479 M	+ \$231 M	+ 93%
<b>Transportation (bridges, soundwalls, misc.)</b>	\$356 M	- \$362 M	– 50%
<b>Commercial (Office, retail)</b>	\$287 M	+ \$78M	+ 38%
<b>Residential (multi-family, hotel, etc.)</b>	\$169 M	+ \$48 M	+ 40%

Table 3: US Precast Concrete Structure Sales by Product Type

	2011 Sales	Change	% Change
<b>Structural</b>	\$1381 M	+ \$432 M	+ 45%
<b>Architectural</b>	\$981 M	+ \$187 M	+ 24%
<b>Transportation</b>	\$400 M	-\$329 M	- 45.0%
<b>Hollowcore</b>	\$222 M	+ \$2 M	+ 1 %
<b>GFRC</b>	\$21 M	- \$27 M	- 54%

The expected market performance of precast concrete or any other construction system in absolute terms has to be viewed in the general context of a very weak US economy, which is in turn tied, more closely than in the past, to the global economy. The world financial system still has major problems to address, and it is possible that there will be more "bumps in the road" in the future. With that in mind, our Industry is focusing on improving its market performance relative to competing construction systems.

The marketplace has a definite interest in "high-performance" structures, i.e., structures that offer long-term durability, resiliency, and sustainability beyond minimum building code requirements. While this interest appears to have been stimulated in part by recent severe storms in the US, we believe that this trend will continue and will drive greater market opportunities for precast concrete structures relative to competing systems.

### PCI

Precast concrete structures and their constituent elements are engineering-intensive, requiring relatively sophisticated engineering and design. They also involve life safety responsibilities, not only for occupants and users of structures, but also for production and erection personnel. As a result, very early in its history the Industry recognized the need for a technical institute, and founded PCI in 1954. Since then PCI has been a major force to foster the growth and development of the Precast Concrete Structures Industry.

PCI was founded as a technical institute with a core membership consisting of organizations, primarily fabricators, but the key individuals involved, mostly employees of these firms, were technical professionals. Today, PCI's membership has expanded to include individual members such as engineers, architects, consultants, contractors, owners, government officials, educators, and students, as well as organizations such as fabricators, product and service providers, and erectors.

As the Industry saw a need to interact more effectively in the marketplace, PCI adapted, devoting additional attention to marketing and promotion. As a result, PCI adapted to become a hybrid organization— part professional society with individual professional members, and part trade association that promotes the business interests of the Industry.

Over the past 15 years the focus of the Industry in the US broadened and evolved from a proprietary technology for producing high-strength structural concrete elements to a superior system for designing and building structures of all types— buildings, bridges, specialty structures, and more. In short, we have developed a better way to build. PCI adapted again to increase its body of technical knowledge in the areas of overall structure design and erection.

Today, PCI is viewed worldwide as the top technical authority for precast concrete structures. The PCI brand is widely recognized, and our publications can be found on the desks of engineers and designers in every developed country. It develops, maintains, and disseminates the body of technical knowledge for designing, fabricating, and constructing precast concrete structures and systems. It is ultimately from this body of knowledge that building codes, design guides, education, and certification programs are derived.

The Institute publishes a broad array of technical manuals, reports, periodicals, and other informational documents. It also conducts research, organizes conferences, offers continuing education, and gives awards.

### **PCI Functional Model**

PCI conceptually follows a knowledge-based model. This model has three basic functional parts:

- Knowledge is collected, researched, and/or discovered;
- Knowledge is organized, vetted, and included in PCI's body of knowledge;
- Knowledge products to meet Industry and market needs are developed from the body of knowledge and disseminated through the appropriate delivery channels.

The advantage of this model is that the individual knowledge delivery channels (e.g., publications, seminars, web pages) are all tied to a single body of knowledge, rather than each cultivating its own sources of knowledge. This provides much greater efficiency and consistency, and identifies opportunities for knowledge delivery that would otherwise not be evident.

PCI connects its body of knowledge to those of other associations, particularly the American Concrete Institute (ACI), to access knowledge that is relevant to our Industry. This is done primarily through mutual reciprocal committee participation, and in some cases joint committees.

### **PCI Structure**

#### **Board**

PCI is governed by a 30-member board of directors that is structured to represent the membership constituencies and major program areas of the Institute. The Board defines the Institute's strategies, policies, and budgets, approves induction of organizational members, and bestows major awards. PCI's officers are the Chairman, Vice-Chairman, and Secretary-Treasurer, all of whom are elected from the membership, and the President, who is a full-time employee and serves as CEO. The officers, along with the Immediate Past Chairman, comprise an Executive Committee that broadly oversees the financial and operational activities of the Institute.

## Councils

Each program area of PCI is overseen by a Council, chaired by a member of the Board, that provides strategic guidance and coordination of committee activities within its area.

The **Technical Activities Council** is responsible for developing and maintaining PCI's technical Body of Knowledge and oversees the majority of PCI committees. The Council collects, organizes, and reviews technical information, establishes procedures for Institute technical activities, manages the work of all technical committees, develops and implements technical programs, approves all PCI technical documents, and makes recommendations to the Board on technical matters. This Council also manages PCI's relationships within the academic technical community, including support for academic professionals who participate in PCI technical activities.

The **Research and Development Council** facilitates research and development to solve practical Industry problems and generally advance Industry technology. The Council identifies research and development needs, defines project scopes, arranges funding from internal and external sources, administers projects to completion, and ensures appropriate dissemination of the resulting information. Projects are typically structured as contracted work or through a graduate student fellowship program.

The **Transportation Activities Council** promotes and advances precast concrete solutions for transportation-related infrastructure. This includes maintaining full cognizance of, and relationships within, the transportation market; developing manuals, documents, and design tools for the application of precast concrete to transportation structures; and responding to information inquiries. This Council works closely with the Technical Activities Council on all technical matters, and maintains active working relationships with the US Federal Highway Administration (FHWA) and the American Association of State Highway and Transportation Officials (AASHTO).

The **Quality Assurance Council** oversees PCI's Quality System, which includes certification programs for personnel, producers, and erectors. This system is operated in accordance with ISO Standards 17024 and 17065, and is in the process of being accredited by the International Accreditation Service (IAS).

The **Educational Activities Council** oversees all PCI education programs, including those associated with PCI Quality System. This Council also manages PCI's relationships within the academic education community, including student contests and support for academic professionals who participate in PCI educational activities.

The **Marketing Council** works to increase awareness, and promote the benefits, of precast concrete structures. Its strategy is to increase awareness of the benefits of precast concrete structures, to characterize precast concrete as a proven system sustainable design, to expand the specification of PCI Certification, to brand and position PCI as the key asset in the precast concrete structures industry, and to develop opportunities and tools to promulgate PCI-generated knowledge. In 2012 PCI's marketing programs resulted in nearly seven million "impressions" (number of times a message is viewed or displayed).

Currently PCI's marketing efforts are focused on a major new promotional campaign ("Discover High Performance Precast") and on three target markets (Institutional, Military, and Parking).

The **Business Performance Council** was organized in early 2012 to promote operational excellence and identify and promulgate best business practices within the PCI organizational membership. Its activities include development of business and production surveys, structured professional networks for plant personnel, and management education programs.

### Staff

PCI is served by a full-time professional staff of 25 headquartered in Chicago, Illinois. The staff includes seven licensed professional engineers, two of whom are also certified under the Leadership in Energy and Environmental Design (LEED) program of the US Green Building Council.

PCI staff members are each highly knowledgeable in their respective functions, including design, fabrication, erection, marketing, publication management, event planning, and general association administration. They are supported by approximately ten specialty contractors, allowing the flexibility to adapt efficiently to changing workloads.

## PCI Publications

### Manuals and Technical Publications

PCI is the principal developer and publisher of design manuals and other technical documents for the Industry. Technical documents are developed through a rigorous process of knowledge collection, research, professional consensus, and expert technical review. PCI is presently in the process of becoming accredited by the American National Standards Institute (ANSI) as a developer of US National Standards. ANSI in turn is the US member body to ISO (International Organization for Standardization).

The *PCI Design Handbook*, now in its 7th edition, is the world's most widely-referenced standard for design, manufacture, and use of structural precast/prestressed concrete and architectural precast concrete.

PCI's *Bridge Design Manual* provides both preliminary and final design information for most precast concrete products and systems used for transportation structures, and is the principal publication of its kind in the US.

Other technical publications include:

- *Design for Fire Resistance of Precast/Prestressed Concrete*, 3rd ed. (MNL-124-11)
- *Precast Prestressed Concrete Bridge Design Manual*, 3rd ed. (MNL-133-11)
- *Seismic Design of Precast/Prestressed Concrete Structures*, 2nd ed. (MNL-140-12)
- *Blast-Resistance Design Manual*, 1st ed. (MNL-141-12)
- *Curved Precast Concrete Bridges State-of-the-Art Report* (CB-01-12)
- *State-of-the-Art Report on Full-Depth Precast Concrete Bridge Deck Panels* (SOA-01-1911)
- *State-of-the-Art Report on Precast Concrete Pavements*, 1st. ed. (PP-05-12)
- *State-of-the-Practice Report of Precast/Prestressed Adjacent Box Beam Bridges* (SOP-02-2011)

### Periodical Publications

The *PCI Journal* is an award-winning quarterly technical magazine, recognized worldwide for nearly 50 years as the Industry's key source of recommended practices and standards, in-depth descriptions of noteworthy new structures, design and construction innovations, data on new materials and production methods, reports on technical developments, and Industry news. Peer-reviewed technical articles form the backbone of its content.

As PCI's flagship periodical, the *PCI Journal* is distributed to approximately 8,000 subscribers, including all PCI members. Its readership includes precast concrete fabricators, engineers and architects in private practice, academics, and government officials.

Each *Journal* issue has a theme, with the majority of the peer-reviewed content being related to that theme. Past *Journal* themes include Seismic, Durability, Materials, Bridges, and Construction-Rehab-Repair. A cover story related to the theme traces the connection from laboratory research, to implementation in the field, to performance of the structure.

*Ascent* is a quarterly magazine targeted to architects in the buildings market, with a circulation of 31,000. It is also distributed to executives, managers, and sales personnel of PCI member firms. *Ascent* provides useful information that helps raise awareness of the benefits and applications of precast concrete, using a combination of project profiles, perspective pieces, case studies, "how-to" articles, and continuing education to deliver this information.

*Aspire* is a quarterly publication on concrete bridges with a circulation of 26,000. *Ascent* is produced by PCI in cooperation with the American Segmental Bridge Institute, the CRSI Epoxy Interest Group, the American Shotcrete Association, and several other members of the National Concrete Bridge Council.

Each issue includes several project articles, a profile of a major bridge consulting firm, and the highly-regarded "LRFD briefing." Regular features cover developments in concrete bridge engineering as well as news from the US Federal Highway Administration, state Departments of Transportation, and county and local government.

*PCI UPDATE* is a bi-weekly electronic newsletter sent to all PCI members. *Update* includes technical news, research developments, educational offerings, and upcoming events.

PCI's **e-Newsletter Series** is a set of monthly electronic newsletters, each focusing on one core area of the Institute. Currently these are the *Technical Newsletter*, the *Marketing Newsletter*, the *Quality Assurance Newsletter*, and the *Business & Operations Newsletter*. These newsletters provide content that is more focused and in-depth than that in *UPDATE*.

### PCI Quality System

One of PCI's hallmarks is its world-renown PCI Quality System, which includes certification for plant personnel, fabricators, and erectors. The preeminence of the PCI Quality System is rooted well beyond the system itself; it is based on the nature of PCI as the technical institute for the industry.



To convey this concept, PCI has identified twelve attributes that an industry organization must possess to maintain a comprehensive quality system for its industry, all of which must work together to provide superior quality programs. These are:

- Industry Standing
- Clearly Stated Purpose
- Broad Professional Involvement
- Governance and Consensus
- Research
- Validation
- Dissemination
- Certification of Personnel
- Certification of the Process
- Independent Audits
- Feedback and Recourse
- Continuing Commitment

The centerpiece of the PCI Quality System is the Plant Certification Program, which has served the Industry for 48 years. More than 280 individual plants currently participate in the program, all in North America. PCI-Certified plants represent well over 90% of US sales of precast concrete structures.

The PCI Plant Certification Program ensures that each plant has developed and documented an in-depth, in-house quality system based on time-tested national industry standards. Each plant undergoes two thorough, unannounced audits each year, conducted by trained third-party engineers, based upon requirements developed for the specific product types being fabricated. PCI membership is not a requirement for a plant to be PCI-Certified. However, a plant must be PCI-Certified in order for the firm to be a PCI producer member.

### PCI Regional Affiliates

PCI has eleven regional affiliates across the US. These are independent organizations with which PCI has a formal agreement for collaboration and financial support. Among these, seven are PCI Chapters, meaning that they share mutual reciprocal producer membership with PCI and are authorized to use the PCI brand. PCI's regional network is important to maintaining the Industry's relationships with academics, transportation officials, and other important constituencies, and is an essential component of the delivery system by which the Institute conducts promotion and education.

### PCI International Activities

PCI has had relationships with international organizations for decades. In North America, these range from a strong and active collaborative relationship with the Canadian Precast Prestressed Concrete Institute (CPCI), which has adapted its plant certification program and key technical manuals from those of PCI, and in informal relationship with the *Asociación Nacional de Industriales del Presfuerzo y la Prefabricación, A.C.* (ANIPPAC, the Mexican association of prestressed and precast concrete manufacturers).

PCI's relationships outside North America are similarly diverse. Our most active relationship is with the *fédération internationale du béton (fib)*, the international federation of structural concrete, where PCI heads the US Delegation and is extensively involved with Commission 6, Prefabrication. PCI has a Memorandum of Understanding with the British Precast Concrete Federation, regular interactions with *Associação Brasileira da Construção Industrializada de Concreto* (Brazilian Concrete Construction Industry Association), and occasional communications with several other organizations, including JPCI. As is evident from this discussion, PCI's approach to international relations has lacked a consistent framework or strategy.

This will now change, as PCI develops a cohesive international strategy based upon our knowledge model, formalizing the relationships we now have with national organizations relating to precast concrete, and developing additional collaborative relationships. Thus far PCI's international relationships have evolved gradually as opportunities have arisen, resulting in shared information, mutual conference participation, visits by national delegations, and in some cases formal cooperative agreements. The weak economy has made it difficult for PCI to develop these relationships as rapidly as we would like.

This year, however, our international strategy will take on a more directed approach with the planned formation of PCI's first National Chapter in the United Arab Emirates. The new Chapter will celebrate its formation with an international symposium in Dubai on December 2 this year.

PCI will also expanding its Quality System to accommodate international clients, and will establish PCI-UAE Plant Certification as its pilot program. Also, to expand the value of the PCI Design Handbook worldwide, PCI will release a metric version in 2014.

## CONCLUSION

Precast concrete structures, although historically recent, have developed into a high-performance option for virtually every market segment. Trends in the design of structures, including a growing preference for sustainable construction, favor further development and increased utilization of precast concrete construction systems.

As an engineering-intensive building system, precast concrete structures have benefitted from, and indeed been significantly advanced by, the existence of a technical institute such as PCI. The heart of any technical institute is its body of technical knowledge, and many technical associations worldwide have independently evolved their individual bodies of knowledge.

PCI believes that there is great potential benefit in connecting compatible bodies of knowledge among the world's technical associations. Such connections, which have proven highly valuable among US organizations, can yield even greater benefits at the international level.

PCI's new international strategy is intended to improve on existing friendly relationships and forge such connections. Beginning with the UAE, we intend to proceed deliberately as resources permit to build a global network of technical associations advancing precast concrete structures.

